F. From Racks

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

54.9 Low Voltage Racks, 0-750 Volts

A. General

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

B. Pole Arrangement and Clearance

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

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

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

C. Conductor Material

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

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

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

D. Conductor Spacing and Span Length

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

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

E. Vertical Clearance Between Conductor Levels

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

A. General

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

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

B. Pole Arrangement and Clearances

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

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

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

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

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

C. Conductor Material and Strength

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

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

D. Conductor Spacing

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

E. Vertical Clearance Between Conductor Levels

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

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

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

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

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

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

F. Climbing Space

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

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

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

G. Service Drops

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

H. Fastenings

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

I. Extended Messenger

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

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

55. CONDUCTOR INSULATORS

55.1 Material

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

55.2 Strength (see Rule 49.5)

55.3 Voltage Requirements

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

A. Pin Type

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

B. Suspension and Strain Types

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

C. Flashover Voltage

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

TABLE 12

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

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

D. Additional Insulation

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

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

56. OVERHEAD GUYS, ANCHOR GUYS AND SPAN WIRES

56.1 Definition (see Rule 21.3 and 22.9)

56.2 Use

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

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

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

56.3 Material and Strength (see Rule 49.6)

56.4 Clearance

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

A. Above Ground

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

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

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

(3) Above Swimming Pools:

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

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

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

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

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

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

B. Above Railways and Trolley Lines

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

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

C. From Conductors

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

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

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

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

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

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

D. From Guys or Span Wires

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

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

(3) Approximately Parallel and Attached to Same Poles:

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

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

E. From Poles

Where passing guys are less than 15 inches from surface of pole and less than 8 feet below supply conductors of less than 20,000 volts supported on the same pole, such guys shall be sectionalized, in addition to the normal

sectionalization required by Rule 56.6, by means of insulators in accordance with Rule 56.6-A as though attached to the pole or structure.

F. From Transformer Cases

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

G. Above Buildings

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

56.5 Fastenings

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

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

56.6 Requirements for Sectionalizing with Insulators

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

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

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

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

C. Ungrounded Overhead Guys

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

D. Guys Exposed to 20,000 Volts or More

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

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

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

E. Guys Attached to Grounded Poles or Structures

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

56.7 Location of Sectionalizing Insulators

A. Overhead Guys

Insulators installed in overhead guys to sectionalize such guys as required by any portion of Rule 56.6 shall be located at a distance of not less than 6 feet and not more than 9 feet, measured along the guys, from the

points of attachment of the guys to poles, crossarms or structures (see App. G, Fig. 46). In such overhead guys which are less than 17 feet in length with no section grounded, insulation at one location, approximately equidistant from each support will be sufficient.

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

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

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

B. Anchor Guys

An insulator shall be installed in each anchor guy which is required to be sectionalized by Rule 56.6-A or 56.6-B, so that such insulator is located not less than 8 feet above the ground and either 8 feet below the level of the lowest supply conductor or not less than 6 feet from surface of pole and not less than one foot below the level of the lowest supply conductor (see App. G, Fig. 49). These sectionalizing requirements for anchor guys can normally be met by insulation at one location; however, short guys or other conditions may require insulation at two locations, one location being not less than 8 feet above the ground and the other location either not less than 8 feet below the lowest supply conductor, or not less than 6 feet horizontally from pole and not less than one foot below the level of the lowest supply conductor. In order to prevent trees, buildings, messengers, metal-sheathed cables or other similar objects from grounding portions of guys above guy insulators, it is suggested that anchor guys be sectionalized, where practicable, near the highest level permitted by this Rule 56.7-B.

Ungrounded portions of anchor guys which pass through the level of communication conductors at positions other than between pole pin positions or outside of the outer pin position shall be sectionalized by insulators placed neither less than 6 inches nor more than 18 inches above the level of the communication conductors (see App. G, Fig. 49b).

Any anchor guy which enters the ground less than 8 feet below the lowest level of supply conductors on the pole or structure shall be treated as an overhead guy which is grounded by means of a grounded anchor guy or metal pole.

A grounded horizontal brace of a "sidewalk" guy shall in no case be less than 8 feet below the level of the lowest unprotected supply conductor on the same pole (see App. G, Fig. 51b).

C. Truss Guys

An insulator shall be installed in each truss guy which is required to be sectionalized by Rule 56.6-A, so that such insulator is located not less than 8 feet above the ground and not less than 8 feet below the level of the lowest supply conductor passing within 8 feet of the guy (see App. G, Fig. 51). These requirements can normally be met by insulation at one position; however, in certain unusual conditions the two 8-foot distances may overlap, in which case insulation will be necessary at two positions.

56.8 Guy Insulators

Insulators which sectionalize guys shall conform to the following specifications based on the highest voltage carried at the level on the pole, tower, structure or crossarm nearest which the guy is attached and also based on the voltage of higher voltage circuits through which the guy passes.

A. Material

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

B. Strength (see Rule 44, Table 4 and Rule 49.5-B)

C. Voltage Requirements

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

Insulators used in guys on supply lines shall have a dry flashover voltage not less than as specified in Table 13 when tested in accordance with the Standards (No. 41, March 1930) of the American Institute of Electrical Engineers under the maximum mechanical loadings specified by this Order for the guy construction involved.

TABLE 13

Guy Insulator Flashover Voltage

Nominal voltage of circuits nearest point of attachment	Dry flashover voltage of insulators
0-7500 volts	15,000 volts
7500-17,500 volts	Double the circuit voltage
Over 17,500 volts	35,000 volts

56.9 Protection

A substantial wood guard (preferably painted white), or metal guard, or a plastic guard of suitable materials, not less than 8 feet in length, shall be securely attached to each anchor guy which is exposed to traffic. Such a guard will not be required where the anchor rod is 1½ inches or greater in diameter, has an overall length above the ground of not less than 8 feet, and extends to a height of not less than 6 feet vertically above ground.

57. MESSENGERS AND INSULATED CABLES

57.1 Definition (see Rules 20.3 and 21.9)

57.2 Use of Messenger

Where a cable is of such weight that it would not meet the safety factors of Table 4 when self-supported, attachment to stranded messenger shall be made for supporting said weight.

57.3 Material and Strength (see Rule 49.7)

57.4 Clearances

Basic minimum clearances for messengers and insulated cables are specified in Rules 37 and 38, Tables 1 and 2 respectively and shall be measured to the nearest surfaces of the cable and messenger assembly, including cable rings and messenger supports. The basic clearances specified

for conductors as modified by provisions of Rule 54.4 are applicable to insulated cables. These clearances for messengers and cables are also subject to the following modifications. The clearances required for supply conductors of 0-750 volts shall be applied to suitably insulated cables of any voltage having a metallic sheath which is bonded and grounded as specified in Rule 57.8.

A. Above Ground (see Rule 54.4-A)

B. Above Railways and Trolley Lines

(1) Which Transport Freight Cars: The clearances specified in Table 1, Case 1, Columns A, B and D are based upon the maximum height of standard freight cars, 15 feet 1 inch from the top of rail to top of running board. These clearances shall in no case be reduced more than 5% because of temperature, wind or mechanical loading.

(2) Operated by Overhead Trolley: The clearances specified in Table 1, Case 2, Columns A and D are based upon a maximum trolley pole throw of 26 feet.

Messengers, and cables, which are bonded and grounded as specified in Rule 57.8, may have clearances above the rails or running surfaces used by trolley cars or coaches less than the distance specified in Table 1, Case 2, Columns A and D for trolley-throw clearance, provided the messengers and cables are not less than 4 feet above the trolley contact conductor and are encased in wood boxing or moulding 7/8-inch or more in thickness for distances of at least 2 feet horizontally from the vertical plane through each trolley contact conductor.

C. Between Conductors in Cables

No specified clearance is required between the individual conductors of suitably insulated cables, whether single or grouped, and therefore the clearances specified in Table 2, Cases 15, 16, and 17 do not apply between such conductors. Any such multiple-conductor group shall be treated as a single conductor in the application of other clearance requirements.

D. Between Cables and Messengers

Cables supported by messengers are not required to be any specified distance from their supporting messengers.

E. Between Messengers

The clearance specified in Table 2, Case 1, Column A does not apply and no clearance is required where messengers of the same electrical system branch or cross.

F. From Poles, Crossarms and Other Conductors

Messengers, and metal sheathed cables, which are bonded and grounded as specified in Rule 57.8 shall have clearances not less than the minimum clearances required for conductors of 0-750 volts with all of the following provisions being applicable:

Such grounded messengers and cables may be attached to the surfaces of poles or wood crossarms at less than the clearance specified in Table 1, Column D, Cases 8 and 9. When attached to pole or wood crossarm at less than 15 inches from center line of pole such grounded messenger or cable shall be not less than 4 feet vertically above or 6 feet vertically below any unprotected supply conductor except that where a guard arm (or arms) is placed above messenger and cable as specified in Rule 57.7, the clearance of 6 feet may be reduced to not less than 4 feet below unprotected conductors of 0-750 volts (see App. G, Fig. 53).

Such grounded messenger and cable when supported on the same crossarm with unprotected conductors in excess of 750 volts shall be placed on the side of pole opposite the unprotected conductors (see App. G, Fig. 54).

Such grounded messenger and cable when supported on the same arm with unprotected conductors of 0-750 volts, shall be placed at not less than pin spacing (Table 2, Case 15, Column D) beyond the outermost unprotected conductor on the same side of pole (see App. G, Fig. 54).

The clearances required in this Rule 57.4-E between a cable and unprotected conductors shall not be held to apply between a grounded cable (and its messenger) and unprotected conductors of the same circuit on poles where unprotected conductors enter (or leave) a cable. On such poles no grounded section of messenger or cable shall be less than 15 inches from surface of pole.

Where two or more cables are attached to the surface of the same wood pole in accordance with the provisions of this Rule 57.4-F, they shall be placed on the same side of pole when their vertical separation is less than 8 feet but in no case shall the vertical separation be less than 1 foot.

G. From Buildings and Other Structures

Messengers, and metal sheathed cables, which are bonded and grounded as specified in Rule 57.8 are not required to clear buildings and other structures any specified horizontal distance and the clearance specified in Table 1, Case 7, Column D does not apply in such instances. Such cables, and messengers, shall be installed so that they do not interfere with the free use of fire escapes, exits, etc., and shall be so arranged as to hamper and endanger workmen and firemen as little as possible in the performance of their duties.

57.5 Fastenings

Hardware used in connection with messengers shall meet the strength requirements of Rule 49.7-C. Dead-end attachments used on messengers or reinforced cables shall have a strength not less than that of the messenger or reinforced cable.

Cedar and other soft-wood poles around which any messenger having an ultimate strength of 5,000 pounds or more is wrapped shall be protected by suitable shims. Hooks, lag screws, or other equivalent means to prevent the messenger from slipping along the pole shall be provided where necessary.

57.6 Sectionalizing of Messengers with Insulators

The grounding of an extended messenger, as specified in Rule 57.8, is not required provided such extended messenger is sectionalized as a guy by means of insulators.

57.7 Use of Guard Arms and Coverings

Any guard arm which is required to be installed by the provisions of Rule 57.4-F shall be at least 4 feet in length (Rule 20.9-D) and parallel to and not more than 4 inches above the top of the cable or messenger. In lieu of the guard arm, suitable protective covering of wood at least 4 feet in length may be placed around the cable and messenger.

Double guard arms shall be used where such a messenger or cable is dead ended on or wrapped around a wood pole, at a vertical separation of less than 6 feet below unprotected supply conductors of other circuits of 750 volts or less. Portions of cables which take the form of a riser or a grounded lateral or vertical run shall be covered as specified in Rule 54.6-E for risers.

57.8 Bonding and Grounding

The provisions of Rules 57.4, 57.6 and 57.7 for grounded cables, and grounded messengers, are applicable only to cables having metallic sheaths, and to messengers which are effectively grounded at both ends of each run and at intermediate points not exceeding 800 feet apart. Where such a metal sheathed cable is supported on a messenger, each section of cable between splices shall be permanently bonded to the messenger at not less than two locations.

Cables not bonded and grounded as specified above shall conform to the requirements for unprotected supply conductors with the modifications provided in the several parts of Rule 57. The cables of circuits supported by a messenger and where covered in accordance with Rule 57.4-C are not required to have metallic sheaths.

57.9 Sags

The sags of messengers which support cables shall be such that under the maximum loading conditions the tensions in the messengers shall not exceed the safe working stresses specified in Rule 49.7-B.

58. MISCELLANEOUS EQUIPMENT

58.1 Traffic Signals

Traffic signals supported on overhead suspensions shall be treated as specified in the following rules:

A. Messenger and Span Wire Clearances

The suspension messenger or span wire of all traffic signals shall be installed to afford the clearances prescribed for span wires; Table 1, Column A, and Table 2, Column A.

B. Lead Wires

Lead wires of 0-750 volts to traffic signals supported on messengers may be less than the clearances above ground specified in Table 1, Column D, Cases 2 and 3 provided they are maintained at a clearance above ground as specified in Table 1, Column A, Cases 2 and 3 for the messenger on which they are supported.

C. Clearance Above Thoroughfares

Traffic signals supported by span wires and supplied from circuits of 0-750 volts shall have a clearance of not less than 14 feet vertically above thoroughfares over which they are suspended (see App. G, Fig. 55) except that where any thoroughfare is used by railroads, street railways, trolley coach lines and double deck motor coaches, clearance not less than the following shall be maintained:

Conveyance using thoroughfare	Minimum clearance of signal above thoroughfare
Street railways and coach lines operated by overhead trolley --	Height of trolley conductor plus 1 foot (a)
Railroads which transport freight cars ----------	25 feet (b)
Double deck motor coaches -------	18 feet

(a) May be reduced to 14 feet if signal is more than 8½ feet from nearest trolley contact conductor and if signal is maintained not less than 1 foot radially from trolley span wires.
(b) May be reduced to 14 feet if signal is more than 8½ feet from center line of track.

Traffic signals supplied directly (without protective transformers) from circuits classified in excess of 750 volts shall be installed with clearances as prescribed for street lighting equipment.

58.2 Street Lighting Equipment

A. Circuit Voltage

Constant current series lighting circuits supplied from transformers or devices having an open circuit output voltage of more than 750 volts, except those circuits supplied from transformers or devices having a normal full-load output voltage of 750 volts or less which transformers are equipped with effective protective devices to prevent the continued existence of open-circuit voltage on the circuit, shall be classified as circuits of more than 750 volts.

Constant current series lighting circuits which conform to the specifications for circuits of 0-750 volts may be installed and treated as circuits of more than 750 volts provided any circuit so treated in any respect is consistently so treated throughout its entirety.

B. Clearances

(1) Above Ground: No part of street lighting equipment shall be less than 20 feet above thoroughfares except for lamps supported on brackets or fixtures which do not extend more than 48 inches from the face of pole or street side of curb, in which case the clearance may be reduced to 15 feet, provided the voltage does not exceed 750 volts (see App. G, Fig. 56).

(2) Above Railways and Trolley Lines: No part of street lighting equipment which is less than 8½ feet horizontally from center line of tracks of railroads not operated by overhead trolley shall be less than 25 feet above such tracks.

No part of street lighting equipment which is less than 8½ feet horizontally from the center line of tracks or from the nearest trolley contact conductor shall be less than 4 feet above the level of the trolley contact conductor or less than 23 feet or 26 feet above running surfaces used by trolley cars or coaches depending upon the location of the contact conductors as required by Rule 74.4-B1.

Those parts of street lighting equipment which are 8½ feet or more horizontally from the center line of any railroad track or any trolley contact conductor shall be not less than 20 feet above the surface of the thoroughfare, except as provided in Rule 58.2-B1 (see App. G, Fig. 56).

(3) From Conductors

a) Messengers and Cables: All parts of street light drop wires, street lamps, and their supporting fixtures (including rods, braces and guys) shall be not less than 1 foot above or 2 feet below the level of messengers or conductors supported by messengers. These vertical clearance requirements shall not apply to those parts of such street lighting equipment which are 2 feet or more horizontally from the vertical plane of messengers, conductors supported by messengers, and metal boxes.

b) Conductors Not Supported by Messengers: All parts of street light drop wires, street lamps, and their supporting fixtures (including rods, braces and guys) shall be not less than 1 foot radially from all unprotected conductors not supported on messengers (including lead wires and taps) except the lead wires supplying the street lamps within 24 inches of their points of entrance to the street lighting equipment.

(4) From Poles: All exposed metal parts of lamps and all such parts of their supports, unless insulated from the parts carrying current, shall be maintained not less than 20 inches from the surface of wood poles, except at pole tops. This rule shall not apply if the voltage of the circuit from which the lamp is supplied does not exceed 750 volts.

C. Lead Wires

Unprotected conductors from one level on a pole or structure to another level or to street lighting equipment shall not pass within a climbing or working space, and shall not pass through any other circuit except between pole pin positions.

Such unprotected conductors shall clear the conductors of other circuits by distances as specified in Rule 54.6-A.

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

Unprotected leads to street lighting equipment shall be maintained at not less than the clearances above railroads, thoroughfares and ground specified for street lighting equipment in Rule 58.2-B.

D. Insulators In Supports

Where a street lighting fixture is supported by a span wire, strain insulators shall be inserted in the span wire on both sides of the fixture not more than 9 feet nor less than 6 feet from the structures supporting the span wire; except that, where such span wire is used as a trolley for the purpose of drawing the fixture to the pole, the strain insulator at the service end may be located a distance of not less than 15 inches from the center line of pole.

Where metallic ropes or chains are used for the suspension of street lamps, said ropes or chains shall be effectively insulated from current carrying parts of equipment and of such length that when the lamp is in its normal position the lower end of the chain or rope will be not less than 8 feet from the ground, or a strain insulator shall be inserted in the free end of the rope or chain at a point not less than 7½ feet from the ground when the lamp is in its normal position. Metallic ropes or chains shall be arranged so that they do not establish a metallic conducting path around a span-wire sectionalizing insulator. In case this construction will not permit the lamp to be lowered sufficiently for trimming purposes, a nonmetallic rope shall be used.

See App. G, Fig. 56.

E. Lighting Units on Transformer Poles

Where a lamp is installed above a transformer or switch, a minimum vertical separation of 4 feet from any portion of the transformer or switch and the lighting unit shall be maintained.

Where a lamp is installed below a transformer, any portion of the lighting equipment shall clear all supply equipment a minimum distance of 1 foot.

Where a lamp is installed to one side of a transformer, any portion of the lighting equipment, shall clear the transformer case a minimum distance of 6 inches.

F. Cutouts

Suitable devices shall be provided by which each street lamp on series circuits of more than 750 volts may be safely and entirely disconnected from the circuit, before the lamps are handled, unless the lamps are worked on from wood poles or from suitable insulating stools, platforms or tower wagons. Exempted from this provision are lamps such as incandescent lamps which in themselves present a noncurrent-carrying surface which may be utilized as a handle in removing them from their support.

G. Exceptions

Lighting units supported on ornamental posts and supplied from underground sources are not included herein.

58.3 Transformers

A. Position on Pole

Where more than one transformer is installed on a pole, all transformers shall be placed on the same side of pole.

Transformers shall not be supported on pole top extensions.

B. Case and Lead Wire Clearances

(1) Above Ground:

a) Lead and Bus Wires: The clearances above ground specified in Table 1 are applicable to unprotected lead and bus wires of transformer installations except as modified by the following provisions.

Clearances above ground of unprotected lead and bus wires of transformer installations may be less than 25 feet as specified in Table 1, Column E, Cases 3 and 4, but shall be not less than 22½ feet except where a clearance of not less than 18 feet above ground is permitted by the provisions of Rule 54.4-A2b in which case the clearance above ground of such lead and bus wires shall be not less than 18 feet.

Clearances above ground of unprotected lead and bus wires of transformer installations may be less than 30 feet as specified in Table 1, Column F, Cases 3 and 4, but shall be not less than 27 feet.

Clearances above ground of unprotected lead and bus wires of transformer installations on structures of two or more poles may be less than 22½ feet or 27 feet as specified above, or less than 25 feet as specified in Table 1, Column F, Case 5, but shall be not less than 20 feet above ground, provided such lead or bus wires are guarded by transformer platform flooring which extends not less than 1 foot horizontally outside the vertical planes of all such lead and bus wires on the structure.

b) Cases: Cases of transformers supported on poles or structures shall be not less than 17 feet above the ground except that in areas which are not in any way accessible to vehicles, the clearance of cases above ground may be less than 17 feet provided all cases which are less than 8 feet above ground shall be effectively grounded.

(2) From Buildings: Transformers on poles shall be so located that normally unenergized parts clear the surfaces of buildings by not less than 3 feet horizontally or by not less than 8 feet vertically. Lead and bus wires carried as unprotected conductors shall have the clearances from buildings as specified in Table 1, Cases 6 and 7.

In situations where the foregoing clearances of cases and lead and bus wires from walls of buildings (not windows, fire escapes, etc.) are impracticable to obtain, such as the location of transformers on poles in alleys, these clearances will not be held applicable provided wood barriers authorized by this Commission are used.

(3) Cases From Conductor Levels Above and Below: Transformers shall be so installed that normally unenergized metal parts clear unprotected conductors, except the transformer connecting leads, by distances specified in the following provisions:

a) From 0-750 Volt Conductors Below: The vertical clearance of transformer cases and hangers from the level of 0-750 volt conductors below (whether such conductors are supported on crossarms or racks) shall be not less than 6 inches except for certain conductors as provided in Rule 58.3-B4.

b) From 0-750 Volt Conductors Above: The vertical clearance of unenergized metal parts of transformers from 0-750 volt conductors supported on crossarms above shall be not less than 3 inches or, in lieu of such vertical clearance, the unenergized parts of transformers shall be not less than 6 inches horizontally from such conductors. The vertical clearance of unenergized metal parts of transformers from 0-750 volt conductors supported on racks above shall be not less than 4 feet.

c) From 750-7500 Volt Conductors Below: The vertical clearance of unenergized metal parts of transformers from the level of 750-7500 volt conductors below shall be not less than 12 inches.

d) From 750-7500 Volt Conductors Above: The clearance between unenergized metal parts of transformers and 750-7500 volt conductors above or alongside shall be not less than 12 inches vertically or 12 inches horizontally, except that conductors of the circuit to which the transformer is connected may be less than the 12-inch vertical clearance from such unenergized parts but shall be not less than 6 inches vertically from the transformer case and not less than 3 inches radially from the hanger provided no line conductor which is less than 12 inches horizontally from the case or hanger is less than 3 inches (Table 1, Case 9) above the level of the top surface of the crossarm.

(4) Transformer Cases From Certain Conductors Less Than 6 Inches Below the Cases:

a) Transformer Leads on Heel Arms: Heel arms shall not be used to support lead wires or taps except where necessary to clear the lower voltage transformer leads from the transformer case or other conductors.

b) Line Conductors Less Than 6 Inches Below Cases: Where a transformer case is unusually long, a crossarm supporting line conductors of 0-750 volts may be used as a heel arm or such conductors on an arm may be less than 6 inches below the transformer case (or the hangers) provided all of the following conditions are met:

No more than a single transformer with lower voltage of 0-750 volts is supported on the pole at the same level;

The vertical clearances between conductors on the hanger arm and such line arm below shall be not less than as specified in Table 2, Cases 9 to 13;

It is not practicable to obtain the clearance of at least 6 inches specified in Rule 58.3-B3;

Such 0-750 volt conductors clear the transformer case by not less than 15 inches horizontally;

Service drops are not run from the crossarm supporting 0-750 volt conductors at that location; and

The vertical clearance of 0-750 volt conductors below the lowest point of the transformer primary leads is not less than

18 inches for primary leads of 750-7500 volts,
24 inches for primary leads of 7500-20,000 volts, and
36 inches for primary leads of 20,000-35,000 volts.

(5) From Hardware: Transformer cases, hangers, and other metal parts in contact therewith shall clear through bolts, arm braces and other hardware by not less than 1½ inches; except that transformer cases and hangers shall clear crossarm braces and crossarm through bolts by not less than 1-inch air-gap distance and 1½-inch creepage distance.

The minimum clearance of 1½ inches from transformer cases hanger and other transformer metal parts to through bolts, arm braces, and other hardware, specified in Rule 58.3-B5, need not apply to through bolts in metallic contact with transformer cases or metal parts thereof nor to through bolts supporting heel arms, provided the portion of such through bolts extending into the climbing space is covered with a wood protective covering of well-seasoned douglas fir (Oregon pine) and are installed in a workmanlike manner or in the alternative, with impregnated fiber bolt covers 5/16 inches thick.

(6) From Guys: Transformer cases and hangers shall be not less than 4 inches from all portions of guys which are 6 inches or more from the surface of poles or crossarms at the guy attachment. Transformer cases and hangers shall be not less than 1½ inches from all portions of guys which are within 6 inches of the surface of poles or crossarms at the guy attachments.

(7) Treatment of Lead Wires: Vertical and lateral leads between line conductors and transformers shall comply with Rules 54.6 and 54.4-C6; and with the clearances specified in Table 1, Cases 8 and 9; and Table 2, Cases 15, 16 and 17. Where such leads enter cutouts or switches, Rule 58.5-C shall also apply. Such lead wires may be installed in the working space but shall not be installed in the climbing space.

All lead wires shall clear braces, bolts and other line hardware a distance of not less than 1½ inches.

C. Grounding

(1) Grounding of Windings: Transformer windings not exceeding 250 volts (except those used exclusively for energizing street lighting circuits and those used exclusively for energizing signal and track circuits) shall be effectively grounded as follows:

a) Single-Phase Systems: In two-wire (nominal 120-volt) systems one wire shall be grounded; in two-wire (nominal 240-volt) systems where the mid-point or some intermediate point of the winding is not available, one wire shall be grounded; in two-wire (nominal 240-volt) systems where the mid-point or some intermediate point of the winding is available, that point shall be grounded; in three-wire (nominal 120/240-volt) systems, the mid-point of the winding shall be grounded. (See App. G, Fig. 57.)

b) Two-Phase Systems: In three-wire (nominal 240-volt) systems, the point common to both windings shall be grounded; in four-wire (nominal 120/240-volt) systems, the mid-point of the winding on one phase shall be grounded; in four-wire (nominal 240-volt), and five-wire (nominal 120/240 volt) systems, the mid-points of both windings shall be connected and grounded. (See App. G, Fig. 58.)

c) Three-Phase Systems: In three-wire delta (nominal 120 or 240 volt) systems the mid-point of one transformer winding shall be grounded, or if the midpoint is not available on any of the transformer windings, a point common to two windings (one phase wire) shall be grounded; in three-wire star (nominal 120, 208, or 240 volt) systems, the point common to all windings shall be grounded or, if the common point is not available on a three-phase star-connected transformer of such a system, one of the phase wires shall be grounded; in four-wire star (nominal 120/208 volt) and three-wire T or Scott (nominal 240 volt) systems, the common point shall be grounded. (See App. G, Fig. 59.)

(2) Location of Transformer Winding Grounds: Transformer ground connections shall be provided at one of the following locations:

At the transformer pole,
At a pole adjacent to the transformer pole, or
At the load end of each service supplied from the transformer, separate from the usual house ground, except that where three or more services are supplied from one transformer or bank of transformers, ground connections at the two services nearest the transformer pole and one ground connection at services at approximately 500-foot intervals will suffice.

Transformer ground connections other than those occurring on common primary and secondary grounded neutral systems shall have a conductivity not less than that of No. 6 AWG copper wire.

Where a common primary and secondary grounded neutral system is used, ground connections shall conform to the requirements of Rule 59.4-A.

(3) Transformer Case Grounding or Bonding: Cases of transformers and metal parts in contact therewith shall not be grounded where supported on wood poles or wood structures.

Except in the case of partial underground distribution systems (see Rule 21.10), the hanging or placing of transformers on metal poles or structures is not recommended, particularly with respect to transformers connected to circuits of less than 14,000 volts. Transformers shall not be supported on metal poles or metal supports in contact with the ground unless the cases are securely bonded to the metal poles or parts of structures in contact with the ground and such poles or structures are effectively grounded. No transformer case shall be in contact with a metal crossarm or a metal beam attached to a wood pole or a wood structure, excepting a metal heel arm or rest which does not extend beyond the sides of any transformer case.

Transformers equipped with discharge gaps between windings and case shall be treated as above, and any discharge gap connected between case and ground shall be so arranged that the transformer case is grounded only during periods of arc-over of the gap.

The bonding of cases of transformers whose high voltage windings are connected to circuits of less than 20,000 volts is not recommended but where such cases are bonded the case bonding system shall not be electrically connected to any unassociated hardware or to other bonds.

Excepted from the provisions of this Rule 58.3-C3 applying to the grounding of transformer cases supported on wood poles or structures are the following:

Any transformer whose high-voltage winding is connected to a circuit of more than 14,000 volts, which may have its case grounded provided all such transformer installations on the system are so grounded, warning signs calling attention to the case grounding condition are posted on the structure so as to be readily legible from the climbing space or spaces, and no such grounded transformer case is less than 8 feet vertically or 4 feet horizontally from the unprotected conductors of any other supply-line circuit than those to which the transformer windings are connected;

Any transformer whose high-voltage winding is connected to a circuit of 750-14,000 volts, which may have its case grounded provided no unprotected conductors (including lead wires) of 750-14,000 volts shall be less than 8 feet vertically or 4 feet horizontally from the nearest part of such grounded case; and

Any transformer the case of which is less than 8 feet above the ground.

Transformer cases which are grounded in accordance with any provision of this rule shall be effectively grounded (see Rule 33.3).

D. Cutouts or Other Disconnecting Devices

Transformer cutouts, fuses, disconnects or switches shall be located so that they are readily accessible from climbing and working spaces. Such devices or their connecting leads shall not extend into the climbing space but may extend wholly or in part into the working space.

The vertical clearances of transformer cutouts, fuses, etc. above the levels of conductors of other circuits shall be not less than the clearances required between conductors as specified in Table 2, Cases 8 to 13.

The provisions of this rule shall not apply to partial underground distribution systems.

58.4 Capacitors and Voltage Regulators

A. Position on Pole

Where more than one capacitor or regulator is installed on a pole, all capacitors or regulators shall be placed on the same side of the pole. Excepted from this requirement are capacitors which may be installed on opposite sides of a pole between the two arms of a double arm provided no transformers, regulators, or oil switches are installed on the same pole.

Capacitors or regulators shall not be installed on pole top extensions.

B. Case and Lead Wire Clearances

(1) Above Ground: Any capacitor or regulator shall be so located that the bottom of the case and associated metal parts shall be not less than 17 feet above ground. The clearance above ground of leads to such apparatus shall conform to the requirements of Rule 58.3-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 1½ inches; except that such cases shall clear crossarm braces by not less than 1-inch air-gap distance and 1½-inch creepage distance.

(5) From Guys: Capacitor or regulator cases and their hangers shall be not less than 4 inches from all portions of guys which are 6 inches or more from the surface of poles or crossarms at the guy attachments. Such cases and hangers shall be not less than 1½ inches from all portions of guys which are within 6 inches of the surface of poles or crossarms at the guy attachment.

(6) Treatment of Lead Wires: Vertical and lateral leads between line conductors and capacitors or regulators shall comply with Rules 54.6 and 54.4-C6; and with the clearances specified in Table 1, Cases 8 and 9; and Table 2, Cases 15, 16 and 17. Where such leads enter cutouts or switches, Rule 58.5-C shall also apply. Such lead wires may be installed in the working space but shall not be installed in the climbing space.

All lead wires shall clear braces, bolts and other line hardware a distance of not less than 1½ inches.

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

C. Grounding and Bonding of Capacitors or Regulators

Cases of capacitors or regulators may be bonded together but shall not be bonded to cutouts, metal pins or dead-end hardware.

Cases of capacitors shall not be grounded where such cases or any parts thereof are within 8 feet vertically below, 4 feet vertically above or 4 feet horizontally from any unprotected conductors.

Any capacitor or regulator which may be grounded in accordance with any provision of this rule shall be effectively grounded (see Rule 33.3).

D. Cutouts or Other Disconnecting Devices

Cutouts, fuses, disconnects or switches used in connection with capacitors or regulators shall be located so that they are readily accessible from climbing and working spaces. Such devices or their connecting leads shall not extend into the climbing space, but may extend wholly or in part into the working space.

The vertical clearances of capacitor or regulator cutouts, fuses, etc., above the levels of conductors of other circuits shall be not less than the clearances required between conductors as specified in Table 2, Cases 8 to 13.

58.5 Line Switches and Disconnects

A. Clearance Between Energized Parts

Unenclosed switches supported on poles or pole structures shall be arranged with clearances not less than as specified in Table 2, Case 15 between the center lines of the separate phase units.

Unenclosed switches supported on poles or pole structures shall be arranged with clearances not less than as specified in Table 2, Case 17 between exposed parts which are energized from the same circuit from different phases or polarities.

B. Clearance Between Unenergized Parts and Unprotected Conductors

Metal switch cases and normally unenergized metal parts in contact therewith shall clear all unprotected conductors, except the connecting leads, by distances as specified in Rule 58.3-B3 for unenergized metal parts of transformers from unprotected conductors.

C. Lead Wires

Lead wires shall be suitably insulated from metal or wood cases of cutouts and switches at points of entrance thereto.

All unprotected lead wires including miscellaneous wiring shall clear braces, bolts and other line hardware a distance of not less than 1½ inches.

Where necessary at points of entrance to cutouts and switches, lead wires of 0-5000 volts may be less than 3 inches from the surface of crossarms (Table 1, Case 9, Column C, D, and E) but shall be not less than 1 inch from such surfaces.

D. Climbing and Working Space

Switches and cutouts shall be so located that when in either open or closed position they are not less than 15 or 18 inches from center line of pole as required by Table 1, Case 8, and no part of such equipment shall be in the climbing space. Such apparatus is permitted to be wholly or in part within working spaces.

E. Indicating Position

All enclosed switches shall indicate clearly whether they are in the open or closed position.

F. Grounding (see Rule 52.7-F)

G. Operating Mechanism

Grounded metal operating rods which pass through conductor levels shall be protected with a suitable insulating covering for a distance of 8 feet vertically or 6 feet horizontally from communication conductors (including cables) and from unprotected supply conductors. As an alternative to this provision, metal rods shall be ungrounded and shall have installed in them, at a point as near as possible to the switch, a suitable insulating link or section. All rods shall be securely held in position by staples or straps or other suitable means to afford clearances as specified in Table 2, Case 18 from conductors of circuits below the switch level.

All cables, ropes and other flexible means of operating switches shall have insulators installed in them at a point as close as possible to the switch and shall pass through guides to insure their separation from conductors through which they pass.

Where line switches are operated from the ground level by means of all-metal control mechanisms without suitable insulating links, an insulated platform shall be provided unless such operating mechanism is effectively grounded.

58.6 Time Switches, Meters, Metal Boxes and Other Apparatus

A. Location and Clearance From Transformer, Capacitor or Regulator Cases

Time switches, meters and other apparatus, including their enclosures, which extend more than 5 inches from the surface of a pole shall not be installed in the climbing space. Such apparatus, installed on the

surface of a pole supporting a transformer (or other equipment of similar dimensions), shall be not less than 4 feet above or below the nearest part of transformer case (or other equipment), unless the time switch, meter, etc., is installed on the side of the pole occupied by the transformer (or other equipment).

B. Clearance From Unprotected Conductors

On wood poles or structures, all grounded metal boxes and grounded metal cases for time switches, meters, or other apparatus shall be not less than 3 feet above or 6 feet below the level of unprotected supply conductors. Where it is impracticable to obtain a clearance of at least 6 feet below unprotected supply conductors of 750 volts or less, a clearance of not less than 4 feet below such conductors will be permitted if a protective covering or guard is provided above the grounded surface.

C. Within 8 Feet of the Ground

Boxes or enclosures containing switches, meters, or other apparatus having accessible live parts, which are located 8 feet or less above the ground shall be effectively locked or sealed.

Metal boxes which contain supply or control equipment or conductors and are located 8 feet or less above the ground shall be effectively grounded.

59. COMMON PRIMARY AND SECONDARY GROUNDED NEUTRAL SYSTEMS

59.1 Definition (see Rule 20.7)

59.2 Applicability

The following rules cover certain special details for common neutral systems where the neutral conductor is common to primary circuits of less than 15,000 volts and secondary circuits of 0-750 volts supplied therefrom. These rules are supplemental to the rules given for supply lines in general and to other detailed construction requirements for supply lines.

59.3 Conductors

A. Material

Conductors of common neutral systems shall be of copper, copper-covered steel, bronze, stranded composites of any of the foregoing, aluminum, aluminum cable steel reinforced, or of other corrosion-resisting metal, but shall not be of galvanized iron or steel.

B. Size

In common neutral systems the common neutral line conductor shall have a cross-sectional area approximately 50 per cent or more of the area of the largest related primary phase conductor, as set forth in Table No. 14, and in no case shall have less conductivity or mechanical strength than No. 6 AWG medium-hard-drawn copper wire.

TABLE 14

Relative Sizes of Common Neutral System Line Conductors

Size of primary phase conductor (cir mils or AWG)	Minimum size of neutral conductor (AWG)
500,000	4/0
350,000	3/0
250,000	2/0
4/0	1/0
3/0	1
2/0	2
1/0	3
1	4
2	6
4	6
6	6

This table is based on the requirement that the common neutral line conductor shall have a minimum area of approximately 50 per cent of the area of the largest related primary phase conductor and that the phase and neutral conductors are of the same material. Where these are not of the same material, the copper conductance equivalents of the table will be considered as meeting the requirements.

C. Connections

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

D. Neutral Conductors

The arrangement and continuity of common neutral conductors shall conform to the following requirements:

Wherever existing plant permits, cross ties of the neutral conductor shall be made to form a continuous interconnected grid network. From each grid section there shall be one or more separate and continuous metallic return conductors to the source of supply.

If one return conductor is used, it shall have a minimum area of approximately 50 per cent of the area of the primary phase conductor of the largest overhead feeder serving the area. (See Table No. 14 of Rule 59.3-B for minimum sizes.)

If more than one return conductor is used, the current-carrying capacity of the return system shall be such that a break in one path shall leave one return path which shall have a minimum area of approximately 50 per cent of the area of the primary phase conductor of the largest overhead feeder serving the area. (See Table No. 14 of Rule 59.3-B for minimum sizes.)

Primary neutral conductors or secondary neutral conductors, where continuous, may be used as a return loop from a common neutral provided they are of sufficient current-carrying capacity as specified in Rule 59.3-B and provided that they are grounded throughout in accordance with the requirements for common neutral line conductors as specified in Rule 59.4-B. Primary or secondary neutral line conductors so used shall be carried in their normal primary or secondary positions respectively.

E. Common Neutral Line Conductor Location

(1) With Primary Circuits: On poles where all circuits are in excess of 750 volts, the common neutral line conductor may be located in a conductor position in the primary space.

(2) With Secondary Circuits: On poles where all circuits of a common neutral system are of less than 750 volts, the common neutral line conductor shall be located in a secondary conductor position.

(3) With Primary and Secondary Circuits: On poles where circuits of a common neutral system are of more and less than 750 volts, the common neutral line conductor shall be located in a related secondary conductor position; or common neutral line conductors may be located in both primary and secondary positions provided a metallic connection of a size not smaller than the largest neutral line conductor involved is installed between the neutral conductors in accordance with the construction

requirements for ground wires on poles at each location where a ground is required, and provided proper designation (see Rule 59.3-F) is made of the common neutral conductor in the primary position.

(4) In Conduits: Common neutral conductors may be installed in the same conduits with related phase conductors, provided that the insulation of the neutral conductor is not less than that required of the phase wires and, further, that it is treated as a phase wire for the entire run between terminals. Where the conduit installation is an effectively grounded metal riser pipe, the reference to insulation of the common neutral need not apply, provided the neutral conductor is connected to both ends of the riser pipe and effectively grounded.

The reference to insulation of the common neutral need not apply where the conduit installation is a plastic pipe having a dielectric strength of not less than 1000 volts per mil and a mechanical strength of not less than rigid, high impact, Type II, polyvinyl chloride pipe of a wall thickness not less than 0.2 inch.

(5) Under Crossarms: Incidental pole wiring connected to the common neutral conductor may be stapled to the underside of crossarms, provided the installation is such as to offer the least possibility of contact to workmen and such wiring under crossarms in the primary position is covered by a suitable protective covering.

59.4 Grounding

A. Material and Size

(1) Grounding Conductors: The grounding conductor from each ground electrode to the base of pole shall be not less than 1 foot below the surface of the ground and shall have not less conductivity and mechanical strength than No. 4 AWG medium-hard-drawn stranded copper. The grounding conductor shall be continuous without splices and shall be not less than No. 4 AWG copper.

(2) Ground Electrodes: Ground electrodes on common neutral systems shall conform to the following specifications as a minimum:

a) Not Part of a Water System: Ground electrodes which are not part of a water system shall be one-piece corrosion-resisting metal rods or pipes (or equivalent in physical and electrical qualities) 5/8 inch in diameter by 8 feet in length and driven to a minimum depth of 8 feet below the surface of the ground.

When two or more metal rods are installed, they shall be located at not less than 6-foot centers.

b) Part of a Water System: Where ground conductors are attached directly to a water pipe system, they shall be connected on the main line side of any water metering equipment.

B. Neutral Conductors

(1) Location: The common neutral grid system shall be grounded at intervals not greater than 1500 feet. On branch circuits extending from a grid, where return loop paths are not available, the common neutral line conductor shall be grounded at intervals not greater than 800 feet. Each transformer installation on a branch circuit without a loop return shall be so located that there will be one or more metallic water pipe system grounds, each of a resistance not greater than 3½ ohms, on each side of the transformer installation.

(2) Resistance: Where a common neutral system is used the resistance of the continuous metallic neutral grid to ground at any point shall not exceed 3½ ohms at any time.

If, after definite effort has been made, it is found not practicable to meet the above requirement, the following alternate requirement will be accepted:

The resistance between any point of said grid and the ground connection at the substation shall not exceed 1 ohm, and, furthermore, the resistance of the ground connection at the substation either shall not exceed 1 ohm or, if in excess of 1 ohm, shall be lower than that of any individual ground connection on the grid and in no case in excess of 2 ohms.

Measurement of resistance by any approved method is recognized. In lieu of measurements of resistance of the neutral conductor under the second alternative prescribed above, approved joints and demonstrable calculations will be accepted.

C. Transformers

Ground conductors of transformers on common neutral systems shall conform to the requirements of Rule 59.4-A1.

On common neutral systems, each transformer installation on a branch circuit without a loop return shall be so located that there will be one or more metallic water pipe system grounds of a resistance not greater than 3½ ohms on each side of the transformer installation.

A transformer installation located on a grid section of a common neutral system requires no independent ground provided that there is a ground connection, having a resistance not in excess of 3½ ohms, to the common neutral line conductor either at the transformer pole or at an adjacent pole.