U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

SAFETY RULES FOR THE INSTALLATION AND MAINTENANCE OF ELECTRIC SUPPLY AND COMMUNICATION LINES

Comprising Part 2 and the Grounding Rules of the Fifth Edition of the National Electrical Safety Code

NATIONAL BUREAU OF STANDARDS HANDBOOK H32
[Supersedes H10]

U. S. DEPARTMENT OF COMMERCE
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NATIONAL BUREAU OF STANDARDS
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National Bureau of Standards Handbook H32

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PREFACE

This Handbook contains part 2 of the National Electrical Safety Code, dealing with the construction and maintenance of overhead and underground lines.

The present edition of these rules is the result of a revision which has been carried out according to the procedure of the American Standards Association, and the revised text has had the approval of a sectional committee organized in conformity with those rules of procedure.

A discussion of these rules will appear in a revised edition of the Handbook entitled Discussion of the National Electrical Safety Code.

Criticism of the rules and suggestions for their improvement are invited, especially from those who have experience in their practical application. In future editions every effort will be made to perfect the rules, both in the development of detail and in the modification of any of the requirements which it is found can be improved.

A widely representative Committee on Interpretations is being set up to prepare replies to requests for interpretation of these rules. Such requests addressed to the National Bureau of Standards will receive prompt attention.

Lyman J. Briggs, *Director*.

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SAFETY RULES FOR THE INSTALLATION AND MAINTENANCE OF ELECTRIC SUPPLY AND COMMUNICATION LINES

COMPRISING PART 2 AND THE GROUNDING RULES OF THE FIFTH EDITION OF THE NATIONAL ELECTRICAL SAFETY CODE

SEC. 1. DEFINITIONS OF SPECIAL TERMS

Alphabetical List of Defined Terms

1. **Alive** or **live** means electrically connected to a source of potential difference, or electrically charged so as to have a potential different from that of the earth. The term "live" is sometimes used in place of the term "current-carrying," where the intent is clear, to avoid repetitions of the longer term.

2. **Appliance** means current-consuming equipment, fixed or portable; for example, heating, cooking, and small motor-operated equipment.

3. **Automatic** means self-acting, operating by its own mechanism when actuated by some impersonal influence—as, for example, a change in current strength; not manual, without personal intervention. Remote control that requires personal intervention is not automatic, but manual.

4. **Cable vault.** (See definition of "Manhole.")

5. **Circuit** means a conductor or system of conductors through which an electric current is intended to flow.

6. **Circuit-breaker** means a device designed to open under abnormal conditions a current-carrying circuit without injury to itself. The term as used in this code applies only to the automatic type designed to trip on a predetermined overload of current.

7. **Climbing space** means the vertical space reserved along the side of a pole structure to permit ready access for linemen to equipment and conductors located on the pole structure.

8. **Common use** means simultaneous use by two or more utilities of the same kind.

9. **Conductor** means a metallic conducting material, usually in the form of a wire or cable, suitable for carrying an electric current. Does not include bus bars.

10. **Grounding conductor** means a conductor which is used to connect the equipment or the wiring system with a grounding electrode or electrodes.

11. **Lateral conductor** means, in pole wiring work, a wire or cable extending in a general horizontal direction approximately at right angles to the general direction of the line conductors.

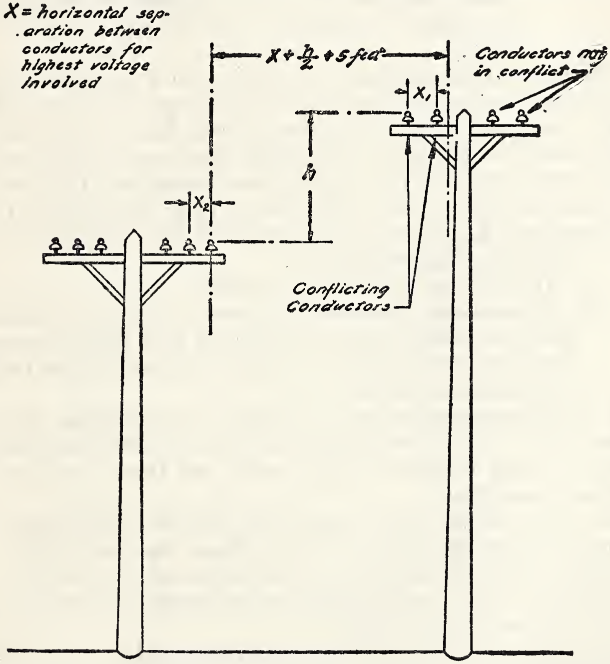
12. **Line conductor** means one of the wires or cables carrying electric current, supported by poles, towers, or

other structures, but not including vertical or lateral connecting wires.

13. Vertical conductor means, in pole wiring work, a wire or cable extending in an approximately vertical direction.

Conflict:

14. Antenna conflict means that an antenna or its guy wire is at a higher level than a supply or communication



Conductor Conflict

conductor and approximately parallel thereto, provided the breaking of the antenna or its support will be likely to result in contact between the antenna or guy wire and the supply or communication conductor.

15. Conductor conflict means that a conductor is so

situated with respect to a conductor of another line at a lower level that the horizontal distance between them is less than the sum of the following values:

(a) Five feet.

(b) One-half the difference of level between the conductors concerned.

(c) The value required in tables 6, 7, or 8 for horizontal separation between conductors on the same support for the highest voltage carried by either conductor concerned. (See illustration.)

16. **Structure conflict** (as applied to a pole line) means that the line is so situated with respect to a second line that the overturning (at the ground line) of the first line will result in contact between its poles or conductors and the conductors of the second line, assuming that no conductors are broken in either line. (See illustration.)

Exceptions: Lines are not considered as conflicting under the following conditions:

(1) Where one line crosses another.

(2) Where two lines are on opposite sides of a highway, street, or alley and are separated by a distance not less than 60 percent of the height of the taller pole line and not less than 20 feet.

17. **Current-carrying part** means a conducting part intended to be connected in an electric circuit to a source of voltage. Noncurrent-carrying parts are those not intended to be so connected.

18. **Dead** means free from any electric connection to a source of potential difference and from electric charge; not having a potential different from that of the earth. The term is used only with reference to current-carrying parts which are sometimes alive.

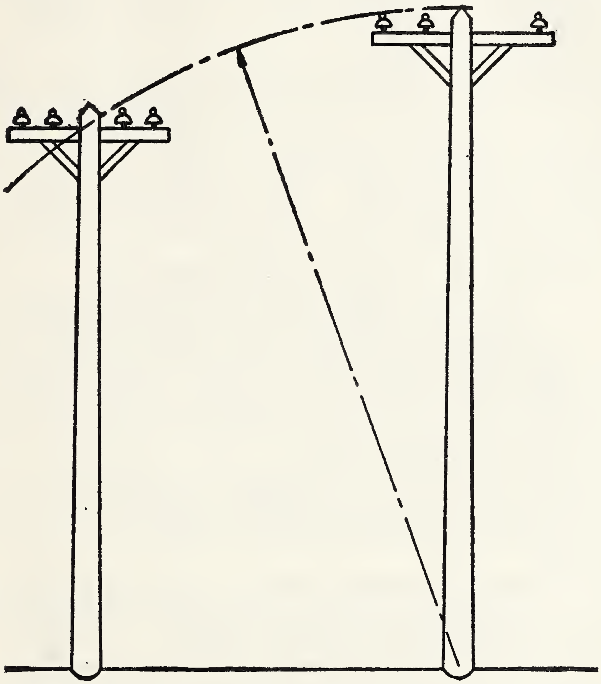
19. **Device** means a unit of an electric wiring system which is intended to carry but not consume electric energy.

20. **Disconnector** means a switch which is intended to open a circuit only after the load has been thrown off by some other means.

Note: Manual switches designed for opening loaded circuits are usually installed in circuit with disconnectors, to provide a safe means for opening the circuit under load.

21. **Duct** means (in underground work) a single tubular runway for underground cables.

22. **Electric fence** means a barrier to animals or fowls,



Structure Conflict

consisting of an electrified conductor energized through an electric-fence controller.

23. **Electric-fence wire** means any electrified conductor, such as a wire, ribbon, tape, rod, tube, plate, mesh, or any other form suitable for, and used as, a barrier to animals or fowls.

24. **Electrical supply station** means any building, room, or separate space within which electric-supply equipment is

located and the interior of which is accessible, as a rule, only to properly qualified persons.

Note: This includes generating stations and substations and generator, storage-battery, and transformer rooms, but excludes manholes and isolated-transformer vaults on private premises. (See definition of "transformer vault".)

25. **Equipment** means a general term including fittings, devices, appliances, fixtures, apparatus, and the like, used as a part of, or in connection with, an electric installation.

26. **Electric-supply equipment** means equipment which produces, modifies, regulates, controls, or safeguards a supply of electric energy. Similar equipment, however, is not included where used in connection with signaling systems under the following conditions:

(a) Where the voltage does not exceed 150.

(b) Where the voltage is between 150 and 400 and the power transmitted does not exceed 3 kilowatts.

27. **Utilization equipment** means equipment, devices, and connected wiring which utilize electric energy for mechanical, chemical, heating, lighting, testing, or similar purposes and are not a part of supply equipment, supply lines, or communication lines.

28. **Explosion-proof** means capable of withstanding without injury and without transmitting flame to the outside any explosion of gas which may occur within.

Exposed:

29. **Applied to circuits or lines** means in such a position that in case of failure of supports or insulation contact with another circuit or line may result.

30. **Applied to equipment** means that an object or device can be inadvertently touched or approached nearer than a safe distance by any person. It is applied to objects not suitably guarded or isolated.

31. **Externally operable** means capable of being operated without exposing the operator to contact with live parts.

Note: This term is applied to equipment, such as a switch, that is inclosed in a case or cabinet.

32. **Grounded** means connected to earth or to some extended conducting body which serves instead of the earth, whether the connection is intentional or accidental.

33. **Effectively grounded** means permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient current-carrying capacity to prevent the building up of voltages which may result in undue hazard to connected equipment or to persons.

34. **Grounded system** means a system of conductors in which at least one conductor or point (usually the middle wire, or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through a current-limiting device.

35. **Guarded** means covered, shielded, fenced, inclosed, or otherwise protected, by means of suitable covers or casings, barrier rails or screens, mats or platforms, to remove the liability of dangerous contact or approach by persons or objects to a point of danger.

36. **Handhole** means an opening in an underground system into which workmen reach, but do not enter.

37. **Inclosed** means surrounded by a case which will prevent accidental contact of a person with live parts. A solid inclosure means one which will neither admit accumulations of flyings or dust, nor transmit sparks or flying particles to the accumulations outside.

38. **Insulated** means separated from other conducting surfaces by a dielectric substance or air space permanently offering a high resistance to the passage of current and to disruptive discharge through the substance or space.

Note: When any object is said to be insulated, it is understood to be insulated in suitable manner for the conditions to which it is subjected. Otherwise, it is, within the purpose of these rules, uninsulated. Insulating covering of conductors is one means for making the conductors insulated.

39. **Insulating** (where applied to the covering of a conductor, or to clothing, guards, rods, and other safety devices) means that a device, when interposed between a person and current-carrying parts, protects the person making use of it against electric shock from the current-carrying parts with which the device is intended to be used; the opposite of conducting.

40. **Isolated** means that an object is not readily accessible to persons unless special means for access are used.

41. **Isolation by elevation** means elevated sufficiently so that persons may safely walk underneath.

42. **Joint use** means simultaneous use by two or more kinds of utilities.

43. **Lateral working space** means the space reserved for working between conductor levels outside the climbing space, and to its right and left.

44. **Lightning arrester** means a device which has the property of reducing the voltage of a surge applied to its terminals, is capable of interrupting follow current if present, and restores itself to its original operating conditions.

Lines:

45. **Communication lines** means the conductors and their supporting or containing structures which are located outside of buildings and are used for public or private signal or communication service, and which operate at not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. When operating at less than 150 volts no limit is placed on the capacity of the system.

Note: Telephone, telegraph, railroad-signal, messenger-call, clock, fire or police-alarm and other systems conforming with the above are included.

Lines used for signaling purposes, but not included under the above definition, are considered as supply lines of the same voltage and are to be so run.

Exception is made under certain conditions for communication circuits used in the operation of supply lines. (See rule 288, A).

46. **Minor communication lines** means communication lines carrying not more than two circuits used mainly for local telephone or telegraph service, or for police or fire-alarm service.

47. **Electric-supply lines** means those conductors and their necessary supporting or containing structures which are located entirely outside of buildings and are used for transmitting a supply of electric energy.

Does not include open wiring on buildings, in yards or similar locations where spans are less than 20 feet, and all the precautions required for stations or utilization equipment, as the case may be, are observed.

Railway signal lines of more than 400 volts to ground are always supply lines within the meaning of these rules, and those of less than 400 volts may be considered as supply lines, if so run and operated throughout.

48. **Low-voltage protection** means the effect of a device operative on the reduction or failure of voltage to cause and maintain the interruption of power supply to the equipment protected.

49. **Low-voltage release** means the effect of a device operative on the reduction or failure of voltage to cause the interruption of power supply to the equipment, but not preventing the reestablishment of the power supply on return of voltage.

50. **Manhole** (more accurately termed **splicing chamber** or **cable vault**) means an opening in an underground system which workmen or others may enter for the purpose of installing cables, transformers, junction boxes, and other devices, and for making connections and tests.

51. **Manual** means capable of being operated by personal intervention.

52. **Minor tracks** means railway tracks included in the following list:

(a) Spurs less than 2,000 feet long and not exceeding two tracks in the same span.

(b) Branches on which no regular service is maintained or which are not operated during the winter season.

(c) Narrow-gage tracks or other tracks on which standard rolling stock can not, for physical reasons, be operated.

(d) Tracks used only temporarily for a period not exceeding 1 year.

(e) Tracks not operated as a public utility, such as industrial railways used in logging, mining, etc.

53. **Open wire** means a conductor or pair of conductors separately supported above the surface of the ground.

54. **Panelboard** means a single panel, or a group of panel units designed for assembly in the form of a single panel, including buses and with or without switches and/or automatic overcurrent-protective devices for the control of light, heat, or power circuits of small individual as well as aggre-

gate capacity; designed to be placed in a cabinet or cut-out box placed in or against a wall or partition, and accessible only from the front. (See definition of "Switchboard.")

55. **Qualified** means familiar with the construction and operation of the apparatus and the hazards involved.

56. **Raceway** means any channel for loosely holding wires or cables in interior work, which is designed expressly and used solely for this purpose. Raceways may be of metal, wood, or insulating material, and the term includes wood and metal moldings consisting of a backing and capping, and also metal ducts into which wires are to be pulled.

57. **Reconstruction** means replacement of any portion of an existing installation by new equipment or construction. Does not include ordinary maintenance replacements.

58. **Rural districts** means all places not urban, usually in the country, but in some cases within city limits.

Sag:

59. **Apparent sag at any point** means the departure of the wire at the particular point in the span from the straight line between the two points of support of the span, at 60° F, with no wind loading.

60. **Apparent sag of a span** means the maximum departure of the wire in a given span from the straight line between the two points of support of the span, at 60° F, with no wind loading.

61. **Final unloaded sag** means the sag of a conductor after it has been subjected for an appreciable period to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed.

62. **Initial unloaded sag** means the sag of a conductor prior to the application of any external load.

63. **Maximum total sag** means the total sag at the midpoint of the straight line joining the two points of support of the conductor.

64. **Total sag** means the distance measured vertically from any point of a conductor to the straight line joining its two points of support, under conditions of ice loading equivalent to the total resultant loading for the district in which it is located.

65. **Unloaded sag of a conductor at any point in a span** means the distance measured vertically from the parti-

cular point in the conductor to a straight line between its two points of support, without any external load.

66. **Service** means the conductors and equipment for delivering electric energy from the secondary distribution or street main, or other distribution feeder, or from the transformer, to the wiring system of the premises served. For overhead circuits, it includes the conductors from the last line pole to the service switch or fuse. The portion of an overhead service between the pole and building is designated as "service drop."

67. **Span length** means the horizontal distance between two adjacent supporting points of a conductor.

68. **Splicing chamber.** (See definition of "Manhole.")

69. **Substantial** means so constructed and arranged as to be of adequate strength and durability for the service to be performed under the prevailing conditions.

70. **Switch** means a device for opening and closing or for changing the connection of a circuit. In these rules, a switch will always be understood to be manually operated, unless otherwise stated.

71. **Switchboard** means a large single panel, frame, or assembly of panels, on which are mounted (on the face, or back, or both) switches, fuses busses, and usually instruments.

72. **Tags** means "men at work" tags of distinctive appearance, indicating that the equipment or lines so marked are being worked on.

Tension:

73. **Final unloaded conductor tension** means the longitudinal tension in a conductor after the conductor has been stretched by the application for an appreciable period, and subsequent release, of the loadings of ice and wind, and temperature decrease, assumed for the loading district in which the conductor is strung (or equivalent loading).

74. **Initial conductor tension** means the longitudinal tension in a conductor prior to the application of any external load.

75. **Transformer vault** means an isolated inclosure either above or below ground with fire-resistant walls, ceiling, and floor, in which transformers and related equipment are

installed, and which is not continuously attended during operation.

76. **Urban districts** means thickly settled areas (whether in cities or suburbs) or where congested traffic often occurs. A highway, even though in the country, on which the traffic is often very heavy, is considered as urban.

Voltage:

77. **Voltage of a circuit** means the highest effective voltage between any two conductors of the circuit concerned.

Exception: Voltage of a grounded multiwire circuit, not exceeding 750 volts between any two conductors, means the highest effective voltage between any wire of the circuit and that point or conductor of the circuit which is grounded.

If one circuit is directly connected to another circuit of higher voltage (as in the case of an autotransformer), both are considered as of the higher voltage, unless the circuit of lower voltage is effectively grounded, in which case its voltage is not determined by the circuit of higher voltage. Direct connection implies electric connection as distinguished from connection merely through electromagnetic or electrostatic induction.

Voltage to ground of:

78. **A grounded circuit** means the highest effective voltage between any conductor of the circuit and that point or conductor of the circuit which is grounded.

79. **An ungrounded circuit** means the highest effective voltage between any two conductors of the circuit concerned.

Voltage to ground of a conductor of:

80. **A grounded circuit** means the highest effective voltage between such conductor and that point or conductor of the circuit which is grounded.

81. **An ungrounded circuit** means the highest effective voltage between such conductor and any other conductor of the circuit concerned.

82. **Wire gages:** The American Wire Gage (AWG), otherwise known as Brown & Sharpe (B&S), is the standard gage for copper, aluminum, and other conductors, excepting steel, for which the Steel Wire Gage (Stl. WG) is used throughout these rules.

SEC. 9. RULES COVERING METHODS OF PROTECTIVE GROUNDING OF OVERHEAD AND UNDERGROUND LINES AND RELATED EQUIPMENT

90. Scope of the Rules.

The following rules apply to the grounding of all lightning arresters except those on communication circuits, and of all circuits, equipment, or wire raceways when the grounding is intended to be a permanent and effective protective measure.

They do not apply to the grounded return of electric railways, nor to the grounding of lightning protection wires which are independent of electric circuits or equipment.

These rules do not require that grounding shall be done, but cover the methods for protective grounding. The rules requiring grounding, in accordance with the methods specified below, are included under the various parts of this code.

Other methods of construction and installation than those specified in the rules may be used as experiments to obtain information if done where supervision can be given by the proper administrative authority.

91. Application of the Rules.

A. **Waiving Rules.**

The rules are intended to apply to all installations except as modified or waived by the proper administrative authority or its authorized agents. They are intended to be so modified or waived in particular cases wherever any rules are shown for any reason to be impracticable, such as by involving expense not justified by the protection secured; provided equivalent or safer construction is secured in other ways.

B. **Application.**

The intent of the rules will be realized (1) by applying the rules in full to all new installations, reconstructions, and extensions, except where any rule is shown to be impracticable for special reasons or where the advantage of uniformity with existing

91. B. Application—Continued.

construction is greater than the advantage of construction in compliance with the rules, provided the existing construction is reasonably safe; (2) by placing grounds on existing installations or bringing present grounds into compliance with the rules, except where the expense involved is not justifiable. The time allowed for bringing existing installations into compliance with the rules will be determined by the proper administrative authority.

C. Temporary Installations.

It will sometimes be necessary to modify or waive certain of the rules for specified limited periods of time in case of temporary installations or installations which are shortly to be dismantled or reconstructed.

D. Emergency.

In cases of emergency or pending decision of the administrator the person responsible for the installation may decide as to modification or waiver of any rule, subject to review by proper authority.

92. Point of Attachment of Grounding Conductor.

A. Direct-Current Distribution Systems.

Direct-current systems which are to be grounded shall have the grounding connection made at one or more supply stations but not at individual services and not elsewhere on interior wiring. In three-wire direct-current systems the ground connections shall be made on the neutral.

B. Alternating-Current Distribution Systems.

In alternating-current systems the ground connection shall be made at the building service or near the transformer (or transformers) either by direct ground connection (through water-piping system or artificial ground, see rule 94) or by the use of a system ground wire to which are connected the grounded conductors of many secondary mains and which is itself effectually grounded at intervals that will fulfill, for any secondary utilizing the system

92. B. Alternating-Current Distribution Systems—Contd.

ground wire, the resistance and current-carrying requirements of these rules.

If the secondaries of transformers are supplying a common set of mains, fuses, if installed, shall be located only at such points as not to cause the loss of the ground connections after any fuses in the transformer circuits or mains have been blown.

Alternating-current secondary circuits supplied from a transformer outside the building shall not be grounded inside buildings except at the service entrance.

In single-phase, three-wire systems the ground shall be on the neutral conductor. In two-wire single-phase and in two-or three-phase systems the ground shall be made at that point of the system which brings about the lowest voltage from ground of unguarded current-carrying parts of connected devices. Where one phase of a two- or three-phase system is used for lighting, that phase should be grounded and at the neutral conductor, if one is used.

In the absence of direct grounds at all building services, ground connections shall be made to the grounded neutral or other grounded conductor of a secondary system supplying more than one utilization equipment, at intervals that will fulfill the resistance requirements of rule 96, A.

C. Current in Grounding Conductor.

Grounds shall be so arranged that under normal conditions of service there will be no objectionable flow of current over the grounding conductor.

The temporary currents set up under accidental conditions, while the grounding conductors are performing their intended protective functions, are not to be considered as objectionable.

If an objectionable flow of current occurs over a grounding conductor, due to the use of multiple grounds, (1) one or more of such grounds shall be abandoned, or (2) their location shall be changed, 92\. C. Current in Grounding Conductor—Continued

or (3) the continuity of the conductor between the grounding connections shall be suitably interrupted, or (4) other means satisfactory to the administrative authority shall be taken to limit the current.

D. Equipment and Wire Raceways.

Metal boxes, cabinets and fittings, or non-current-carrying metal parts of other fixed equipment, if metallically connected to grounded cable armor or metal raceway, are considered to be grounded by such connection. Where the metal enclosure of a wiring system is used as part of the protective grounding, the electrical continuity of the enclosure shall be assured.

For conduit, armored cable, or metal raceways the ground connection shall be as near as practicable to the point where the conductors in the raceway system concerned receive their supply.

E. Service Conduit.

When the service conduit is grounded, its grounding wire shall be run directly from it to the ground connection. The interior conduit, armored cable, or metal raceways, if well bonded to the service conduit, grounded as provided in this rule, needs no additional ground connection.

93\. Grounding Conductor.

A. Material and Continuity.

In all cases the grounding conductor shall be of copper or of other metal which will not corrode excessively under the existing conditions and, if practicable, shall be without joint or splice. If joints are unavoidable they shall be so made and maintained as to conform to the resistance requirements of rule 96.

In no case shall a fuse or automatic circuit-breaker be inserted in the grounding conductor or connection except in a ground connection from equipment where its operation will result in the automatic disconnection from all sources of energy of the circuit leads

93. A. Material and Continuity—Continued.

connected to equipment so grounded; no switch shall be so inserted except in plain sight, provided with distinctive marking and effectively isolated from unqualified persons. (See also rule 92, B, par. 2.)

For lightning arresters and ground detectors the grounding conductor shall be as short and straight as practicable and free from sharp bends.

B. Size and Capacity.

The grounding conductor shall conform to the following:

1. FOR DIRECT-CURRENT CIRCUITS.

A grounding conductor for a direct-current supply system shall have a current-carrying capacity not less than that of the largest conductor supplied by the system and in no case less than that of No. 8 copper.

2. FOR ALTERNATING-CURRENT CIRCUITS.

A grounding conductor for an alternating-current system shall have a current-carrying capacity not less than one-fifth that of the conductor to which it is attached and in no case less than that of No. 8 copper.

3. FOR INSTRUMENT TRANSFORMERS.

The grounding conductor for instrument cases and secondary circuits of instrument transformers shall not be smaller than No. 12 if of copper or, if of other metal, shall have equivalent current-carrying capacity.

4. FOR LIGHTNING ARRESTERS.

The grounding conductor or conductors shall have a current capacity sufficient to insure continuity and continued effectiveness of the ground connection under conditions of excess current caused by or following discharge of the arrester. No individual grounding conductor shall have less conductance than No. 6 (0.162-inch) copper wire.

93. B. Size and Capacity—Continued.

5. FOR RACEWAYS AND EQUIPMENT.

The current-carrying capacity of grounding conductors for equipment, raceways, cable armor, and other metal enclosures for wires, when provided with overcurrent protection, shall be sufficient to provide adequate draining of fault current during the time required for the protective device to operate. Where connected to artificial electrodes, the grounding conductor need not be larger than No. 6 copper wire or its equivalent. If no fuse or automatic circuit-breaker is provided, the capacity of the grounding conductor shall be determined by the design and operating conditions of the circuit, but shall not be smaller than No. 8.

6. FOR PORTABLE AND PENDENT EQUIPMENT.

For grounding portable or pendent equipment, the conductors to which are protected by fuses or circuit-breakers rated or set at not exceeding 15 amperes, No. 18 copper wire may be used. For grounding portable or pendent equipment protected at more than 15 amperes, see preceding paragraph.

C. Mechanical Protection and Guarding Against Contact.

Where exposed to mechanical injury, the grounding conductor shall be protected by substantial conduit or other guard. Guards for lightning-arrester grounding conductors shall be of nonmagnetic material unless the grounding conductor is electrically connected to both ends of the guard.

If the resistance of the ground connection is in excess of three ohms, the grounding conductor, except in rural districts, shall be protected and guarded by being inclosed in insulating conduit or

93. C. Mechanical Protection and Guarding Against Contact.—Continued.

molding to protect persons from injury by coming in contact with it.

Note: Such a high resistance may exist where artificial grounds are necessarily permitted in lieu of the preferable grounds to buried metallic water-piping systems.

Mechanical protection and insulating guards should extend for a distance of not less than 8 feet above any ground, platform, or floor from which grounding conductors are accessible to the public.

Note: Insulating mechanical protection is advisable for single arrester grounds, even when the connection is made to a water-piping system, and has therefore a low resistance, since a single connection is liable to be accidentally broken.

Even where ground connections have a resistance not exceeding that specified in rule 96 and no guard is therefore provided (or as an additional protection to persons even where guards are used), artificial grounds may be arranged to minimize the potential gradient along the surface of the earth by use of radial connecting wires underneath the earth surface or by other suitable means.

A grounding conductor for a circuit shall be guarded as required for current-carrying conductors of the circuit.

Exception 1: A grounding conductor for a circuit having at least two ground connections, where such conductor is entirely outside buildings and has strength and current capacity not less than No. 8 (0.1285-inch) copper wire.

Exception 2: In stations substantial bare ground busses may be used.

D. Underground.

Wires used for grounding conductors, if laid underground, shall, unless otherwise mechanically protected, be laid slack to prevent their being readily broken, and shall have joints carefully painted or otherwise protected against corrosion.

93. Grounding Conductor—Continued.

E. Common Grounding Conductor for Circuits, Metal Raceways, and Equipment.

The grounding conductor of an interior wiring system may be used also as the grounding conductor for equipment, conduit, and other metal raceways or enclosures for conductors, including service conduit or cable sheath and service equipment, provided such grounding conductor meets the current-carrying-capacity requirements for service raceways, as specified in paragraph B above; and provided further, that the secondary distribution circuit supplying the interior wiring system has at least one additional ground at the transformer or elsewhere.

94. Ground Connections.

The ground connection shall be permanent and effective, and be made as indicated below, but always to water-piping systems, if available.

A. Piping Systems.

For circuits, equipment, and arresters at supply stations, connections shall be made to all available active metallic underground water-piping systems between which no appreciable difference of potential normally exists, if the pipe is of sufficient capacity, and to one such system if appreciable differences of potential do exist between them. At other places connections shall be made to at least one such system, if available. Gas piping should be avoided for circuit grounding wherever practicable.

Note: The protective grounding of electric circuits and equipment to water-pipe systems in accordance with these rules should always be permitted, since such grounding offers the most effective protection to life and property and is not injurious to the piping systems.

Ground connections from circuits should not be made to jointed piping within buildings except water piping.

94. Ground Connections—Continued.

B. Alternate Methods.

Where underground metallic piping systems are not available, other methods which will secure the desired permanence and conductance may be permitted. In many cases metal well casings, and similar buried metal structures of considerable extent will be available and may be used in lieu of extended buried water-piping systems.

In some cases ground connection may be made to the steel frame of a building containing the grounded circuits or equipment, to which frames of machines and other noncurrent-carrying surfaces should also then be connected. In such cases the building frame should be itself well grounded by effective connection to the ground. This may require artificial grounding for steel-frame buildings supported on masonry or concrete footings.

C. Artificial Grounds.

If resort must be had to artificial grounds, their number should be determined by the following requirements:

1. Not more than one such ground is required for lightning arresters, except where for large current capacity.
2. At least two grounds are required for low-voltage alternating-current distribution circuits at transformers or elsewhere, except as specified in 3.
3. Where no part of the circuit or equipment protected can be reached by persons while they are standing on the ground or damp floors, or by persons while touching any metallic piping to which the grounding conductor is not effectively connected, a single artificial ground may be used even if its resistance exceeds that specified in rule 96. In such cases it is desirable to provide guards for the grounding conductor in accordance with rule 93, C, wherever it is otherwise accessible, or to provide insulating mats or platforms so located

94. C. Artificial Grounds—Continued.

that persons can not readily touch the grounding conductors without standing on such mats or platforms.

D. Grounds to Railway Returns.

Protective ground connections should not be made to railway negative-return circuits when other effective means of grounding are available, except ground connections from electric-railway lightning arresters.

When ground connections are of necessity made to the grounded track return of electric railways, they shall be made in such a manner as not to afford a metallic connection (as indirectly through a grounded neutral with multiple grounds) between the railway return and the other grounded conducting bodies (such as buried piping and cable sheaths).

Note: This rule does not prohibit the making of drainage connections (which are not protective grounds) between piping systems and railway negative-return circuits for the prevention of electrolysis.

Multiple protective ground connections from other circuits to railway returns should be avoided; and where multiple artificial grounds are made on such other circuits near such railway returns, they should be so arranged as to prevent the flow of any considerable current in and between such connections, which flow would reduce their effectiveness, or otherwise cause damage.

95. Method.

A. Piping.

The point of attachment of a grounding conductor to a water-piping system shall be on the street side of the water meter, or on a cold-water pipe of adequate current-carrying capacity, as near as practicable to the water-service entrance to the building or near the equipment to be grounded, and shall be accessible except by special permission. If the point of attachment is not on the street side of the water meter, the water-piping system shall be made electrically continuous by bonding together all parts between the attachment and the pipe entrance which

95. A. Piping—Continued.

are liable to become disconnected, as at meters and service unions. If water meters are located outside buildings or in concrete pits within buildings where piping connections are embedded in concrete flooring, the ground connections may be made on the building side of the meters.

Gas-piping systems within buildings shall not be used for purposes of this rule where water pipes are readily available. Gas piping may serve as the grounding electrode for fixtures located at a considerable distance from water piping. Where gas piping is so used it shall be bonded to the water-piping system at the point of entrance of water piping. (See rule 94, A.)

B. Ground Clamps.

The ground connection to metallic-piping systems shall be made by means of an approved clamp firmly bolted to the pipe after all rust and scale have been removed, or by means of a brass plug which has been tightly screwed into a pipe fitting or, where the pipe is of sufficient thickness, screwed into a hole in the pipe itself, or by other equivalent means.

The grounding conductor shall be attached to the clamp or to the plug by means of solder or by an approved solderless connector. The point of connection shall be as readily accessible as practicable.

Note: With bell-and-spigot-joint pipe it may be necessary to connect to several lengths where circuits or equipment of large current capacity are being grounded.

C. Contact Surfaces.

If conduit, couplings, or fittings having protective coating of nonconducting material, such as enamel, are used, such coating shall be thoroughly removed from threads of both couplings and conduit and such surfaces of fittings where the conduit or ground clamp is secured, in order to obtain the requisite good connection. Grounded pipes shall be free from rust, scale, etc., at the place of attachment of ground clamp.

95. C. Contact Surfaces—Continued.

Conduits, other metal raceways, and the armor of cables shall be securely fastened in outlet boxes, junction boxes, and cabinets, so as to secure good electrical connection.

In ice houses, packing plants, etc., where a great deal of moisture is present and where conduits are attached to metal cabinets, cut-out, pull, or junction boxes, compensators, etc., by means of lock nuts and bushings, these conduits should be bonded together.

D. **Electrodes for Artificial Grounds.**

Where artificial grounds are used, the electrodes shall, as far as practicable, be embedded below permanent moisture level.

Buried-plate electrodes shall present not less than 2 square feet of surface to exterior soil. Electrodes of plate copper shall be at least 0.06 inch in thickness. Electrodes of iron or steel plates shall be at least ¼ inch in thickness.

Electrodes of iron or steel pipe shall be galvanized and not less than ½ inch (nominal size). Electrodes of rods of steel or iron shall be at least ¾ inch minimum cross-sectional dimension. Approved rods of nonferrous materials or their approved equivalent used for electrodes shall be not less than ½ inch in diameter. Driven electrodes of pipes or rods, if of less than standard commercial length, shall preferably be of one piece, and, except where rock bottom is encountered, shall be driven to a depth of at least 8 feet regardless of size or number of electrodes used. Such pipes or rods shall have clean metal surfaces and shall not be covered with paint, enamel, or other poorly conducting materials.

Pole-grounding electrodes may be wire attached to the pole previous to the setting of the pole. The wire shall have a continuous length below ground level of not less than 12 feet, shall extend to the bottom of the pole, and shall be not smaller than No. 6 (0.162 inch).

96. Ground Resistance.

A. Limits.

The combined resistances of the grounding wire and the connection with the ground shall not exceed 3 ohms for water-pipe connections nor 25 ohms for artificial (buried or driven) grounds. Where it is impracticable to obtain, with one electrode, artificial-ground resistance as low as 25 ohms, this requirement shall be waived, and two or more electrodes, at least 6 feet apart, shall be provided.

B. Checking.

The resistance of station grounds should be checked when made.

Note: With artificial grounds this check may be made by measuring the voltage between the grounded point of the circuit, or the grounded frame of the equipment, or the grounded point of the lightning arrester, and an auxiliary metal reference rod or pipe driven into the ground, while a measured current is flowing through the ground connection and any exposed metal piping or other artificial ground not less than 20 feet distant.

If the station ground is to water piping, the check may be made with current flowing through the water piping and some independent piping system or artificial ground not less than 20 feet distant.

The auxiliary rod or pipe should be at least 10 feet from any artificial ground or piping systems through which the measured current is made to flow.

All ground connections shall be inspected periodically. Ground connections on distribution circuits should, when installed, be tested for resistance unless multiple grounding is used.

97. Separate Grounding Conductors and Grounds.

A. Grounding Conductors.

Grounding conductors from equipment and circuits of each of the following classes, if required by these rules, shall be run separately to the ground or to a sufficiently heavy grounding bus or system ground cable which is well connected to ground at more than one place, except as provided in paragraph C and in rule 285, C.

97. A. Grounding Conductors—Continued.

1. Lightning arresters.
2. Secondaries connected to low-voltage lighting or power circuits, except that if a secondary distribution system has multiple grounds, utilization equipment and wire enclosures may use the same grounding conductor.
3. Secondaries of current and potential instrument transformers having primary voltages of more than 750 volts, and cases of instruments on these secondaries.
4. Frames of direct-current railway equipment and of equipment operating in excess of 750 volts.
5. Frames of utilization equipment or wire raceways other than covered by item 4, except as provided in item 2.
6. Lightning rods.

B. Electrodes.

Where individual artificial grounds are used, separate grounding electrodes as well as separate grounding conductors shall be used. This does not prohibit the bonding together of these separate electrodes near the ground level.

C. Interconnection of Primary Arrester and Secondary Neutral.

1. SOLID INTERCONNECTION.

The grounding conductor of a lightning arrester protecting a transformer which supplies a secondary distribution system may be interconnected with the grounded conductor of such secondary distribution system, provided that in addition to the direct grounding connection at the arrester either:

(a) The secondary has elsewhere a grounding connection to a continuous metallic underground water piping system (except that in urban water-pipe areas where there are four water-pipe grounds

97. C. 1. Solid Interconnection—Continued.

in each mile of secondary and not less than four on any individual secondary, the direct grounding connection at the arrester may be omitted); or

(b) The secondary neutral (which may or may not be common with the primary neutral) has at least four ground connections in each mile of line in addition to a ground connection at each individual service, or

(c) Permission is obtained from the administrative authority for any other condition.

2. INTERCONNECTION THROUGH SPARK GAP.

Where the secondary is not grounded as in item 1, interconnection, if made, shall be through a spark gap having a 60-cycle breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 15 kilovolts, and there shall be at least one other ground on the grounded conductor of the secondary that is at least 20 feet distant from the lightning-arrester grounding electrode.

SEC. 20. SCOPE, NATURE, AND APPLICATION OF RULES

200. Scope of Rules.

A. Extent of Application.

The following rules apply to electric supply and communication lines in overhead and underground construction whether operated in connection with public utilities, privately or municipally owned, with industrial establishments, or otherwise.

B. Not Complete Specifications.

These rules are not complete specifications but are intended to embody the requirements which are most important from the standpoint of safety to employees and the public.

C. Conformity with Good Practice.

Construction should be made according to accepted good practice for the given local conditions in all particulars not specified in the rules.

201. Application of the Rules and Exemptions.

A. Intent, Modification.

The rules shall apply to all installations except as modified or waived by the proper administrative authority. They are intended to be so modified or waived whenever they involve expense not justified by the protection secured or for any other reasons are impracticable; or whenever equivalent or safer construction can be more readily provided in other ways.

B. Realization of Intent.

The intent of the rules will be realized:

1. By applying the rules in full to all new installations, reconstructions, and extensions, except where for special reasons any rule is shown to be impracticable or where the advantage of uniformity with existing construction is greater than the advantage of construction in conformity with the rules.

201. **Realization of Intent**—Continued.

2. By placing guards on existing installations or otherwise bringing them into compliance with the rules, except where the expense involved is not justifiable.

Note: The time allowed for bringing existing installations into compliance with the rules as specified in 2 will be determined by the proper administrative authority.

C. **Waiver for Temporary Installations.**

It will sometimes be necessary to modify or waive certain rules in cases of temporary installations or installations which are soon to be discarded or reconstructed.

D. **Waiver in Emergencies.**

In case of emergency or pending decision of the administrator, the person responsible for the installation may decide as to modification or waiver of any rule, subject to review by proper authority, but shall first notify all parties directly concerned in advance of construction.

202. Minimum Requirements.

The rules state the minimum requirements for spacings, clearances, and strength of construction. More ample spacings and clearances or greater strength of construction may be provided if other requirements are not neglected in so doing.

Note: Some of these minimum values are exceeded in much existing construction; service requirements frequently call for stronger supports and higher factors of safety than the minimum requirements of these rules.

SEC. 21. GENERAL REQUIREMENTS APPLYING TO OVERHEAD AND UNDERGROUND LINES

210. Design and Construction.

All electric supply and communication lines and equipment shall be of suitable design and construction for the service and conditions under which they are to be operated.

211. Installation and Maintenance.

All electric supply and communication lines and equipment shall be installed and maintained so as to reduce hazards to life as far as practicable.

212. Accessibility.

All parts which must be examined or adjusted during operation shall be arranged so as to be readily accessible to authorized persons by the provision of adequate climbing spaces, working spaces, working facilities, and clearances between conductors.

213. Inspection and Tests of Lines and Equipment.

A. When in Service.

1. INITIAL COMPLIANCE WITH RULES.

Lines and equipment shall comply with these safety rules upon being placed in service.

2. INSPECTION.

Lines and equipment shall be systematically inspected from time to time by the person responsible for the installation.

3. TESTS.

Lines and equipment shall be subjected, when necessary, to tests which will determine their fitness for service.

4. RECORD OF DEFECTS.

Any defects revealed by inspection, if not promptly corrected, shall be recorded.

5. REMEDYING DEFECTS.

Defective lines and equipment shall be put in good order or effectively disconnected.

B. When Out of Service.

1. LINES INFREQUENTLY USED.

Supply lines and equipment infrequently used shall be inspected to see that they are in safe condition for service.

213. B. When Out of Service—Continued.

2. LINES TEMPORARILY OUT OF SERVICE.

Lines temporarily out of service shall be maintained in such condition that a hazard will not be created.

3. LINES PERMANENTLY ABANDONED.

Lines permanently abandoned shall be removed or maintained in a safe condition.

Note: Overhead service drops to consumers are often disconnected without removal when the service is discontinued. This is considered good practice when it is undesirable to remove the service drop entirely.

214. ISOLATION AND GUARDING.

A. Current-carrying Parts.

To promote safety to the general public and to employees not authorized to approach conductors and other current-carrying parts of electric supply lines, such parts shall be arranged so as to provide adequate clearance from the ground or other space generally accessible, or shall be provided with guards so as to isolate them effectively from accidental contact by such persons.

B. Noncurrent-carrying Parts.

Ungrounded metal-sheathed service cables, service conduits, metal fixtures, and similar noncurrent-carrying parts, if located in urban districts and where liable to become charged to more than 300 volts to ground, shall be isolated or guarded so as not to be exposed to accidental contact by unauthorized persons.

As an alternative to isolation or guarding, grounding of certain noncurrent-carrying parts is permitted by rule 215, B, and rule 280, A, 4.

215. GROUNDING OF CIRCUITS AND EQUIPMENT.

A. Methods.

The methods to be used for effective grounding for lightning arresters of supply lines, for circuits,

215. A. Methods.—Continued.

for equipment and for wire raceways are given in section 9. The methods to be used for grounding of lightning arresters of communication lines are specified in rule 392, part 3 of this code.

B. Parts to be Grounded.

In urban districts metal conduits, cable sheaths, metal lamp posts, and frames, cases, and hangers of equipment shall be effectively grounded.

Exception 1: This rule does not apply when such parts are guarded from accidental contact by unauthorized persons.

Exception 2: This rule does not apply where such parts are 8 feet or more above the ground.

Exception 3: This rule does not apply to metal conduit and cable sheaths inclosing communication conductors, or supply conductors of not more than 300 volts to ground, provided such conduit and sheaths are not exposed to probable contact with circuits of more than 300 volts to ground.

Recommendation: It is recommended that supply cables have the sheath bonded to any conduit extending above the ground surface.

Note: Metal conduit above ground which contains extensions from metal-sheathed underground cable is considered to be sufficiently grounded by the cable sheath, provided such sheath is in good contact with the earth or is connected to a good ground. (For method of grounding see section 9.)

C. Use of Ground as Part of Circuit.

In urban districts supply circuits shall not be designed to use the ground normally as the sole conductor for any part of the circuit.

Recommendation: It is recommended that such use be avoided in rural districts.

216. Arrangement of Switches.

A. Accessibility.

All switches shall be readily accessible to authorized persons.

216. Arrangement of Switches—Continued.

B. Indicating Open or Closed Position.

All switches shall indicate clearly whether they are open or closed.

C. Locking.

Pole-top switches accessible to unauthorized persons shall have provision for locking in both open and closed positions.

D. Uniform Position.

The handles or control mechanism for all switches throughout any system shall have so far as practicable the same position when open and a uniformly different position when closed, in order to minimize operating errors. Where it is advisable to depart from this practice, the switches should be marked so as to minimize the liability to mistakes in operation.

SEC. 22. RELATIONS BETWEEN VARIOUS CLASSES OF LINES

220. Relative Levels.

A. Standardization of Levels.

The levels at which different classes of conductors are to be located should be standardized where practicable for any given community by agreement of the utilities concerned.

Note: This practice facilitates the extension of lines and promotes the safety of the public and workers by permitting the relative levels and required clearances to be readily obtained on jointly or commonly used poles as well as at crossings and conflicts.

B. Relative Levels—Supply and Communication Conductors.

1. PREFERRED LEVELS.

Where supply and communication conductors cross each other or are in conflict, or are located on the same poles or towers, the supply conduc-

220\. B. Relative Levels—Supply and Communication Conductors—Continued.

tors shall preferably be carried at the higher level.

Exception: This does not apply to trolley feeders which may be located for convenience approximately at the level of the trolley contact conductor.

Note: Supply lines generally use larger conductors than communication lines so there is less liability of contact between the two if the supply conductors are located in the upper position. This relative location also avoids the necessity of workmen on communication conductors passing through supply conductors and working above them and avoids the necessity of increasing the grade of construction required for communication conductors.

2\. MINOR EXTENSIONS.

In localities where the practice of placing conductors of communication circuits for public use above supply conductors has been generally established, minor extensions may be made in either system, keeping the conductors in the same relative position. These extensions should not continue beyond a location at which it becomes practicable to change to the arrangement standardized by these rules.

3\. SPECIAL CONSTRUCTION FOR SUPPLY CIRCUITS, THE VOLTAGE OF WHICH IS 550 VOLTS OR LESS AND CARRYING POWER NOT IN EXCESS OF 3,200 WATTS.

Where all circuits are owned or operated by one party or where cooperative consideration determines that the circumstances warrant and the necessary coordinating methods are employed, single-phase alternating-current or two-wire direct-current circuits carrying a voltage of 550 volts or less between conductors, with transmitted power not in excess of 3,200 watts, when involved in the joint use of poles with com-

220. B. Relative Levels—Supply and Communication Conductors—Continued.

munication circuits, may be installed in accordance with footnote 8 (3) of table 1 in rule 232, A and footnote (1) of table 11 in rule 238, A, 1, under the following conditions:

(a) That such supply circuits are of wire having a good grade of commercial double-braid weatherproof covering not smaller than No. 8 AWG medium hard-drawn copper or its equivalent in strength, and the construction otherwise conforms with the requirements for supply circuits of the same class.

(b) That the supply circuits be placed on the end and adjacent pins of the lowest through signal crossarm and that a 30-inch climbing space be maintained from the ground up to a point at least 24 inches above the supply circuits. The supply circuits shall be rendered conspicuous by the use of insulators of different form or color from others on the pole line or by stenciling the voltage on each side of the crossarm between the pins carrying each supply circuit, or by indicating the voltage by means of metal characters.

(c) That there shall be a vertical clearance of at least 2 feet between the crossarm carrying these supply circuits and the next crossarm above. The other pins on the crossarm carrying the supply circuits may be occupied by communication circuits used in the operation or control of a signal system or other supply system if owned, operated and maintained by the same company operating the supply circuits.

(d) That such supply circuits shall be equipped with arresters and fuses installed in the supply end of the circuit and where the

220. B. Relative Levels—Supply and Communication Conductors—Continued.

signal circuit is alternating current, the protection shall be installed on the secondary side of the supply transformer. The arresters shall be designed so as to break down at approximately twice the voltage between the wires of the circuit, but the break-down voltage of the arrester need not be less than 1,000 volts. The fuses shall have a rating not in excess of approximately twice the maximum operating current of the circuit, but their rating need not be less than 10 amperes. The fuses likewise shall in all cases have a rating of at least 600 volts, and where the supply transformer is a step-down transformer, shall be capable of opening the circuit successfully in the event the transformer primary voltage is impressed upon them.

(e) Such supply circuits when enclosed in effectively grounded metal-sheathed cable, or other cables carried on effectively grounded messenger, may be carried on a pole below communication attachments, with not less than 2 ft vertical separation between the supply cable and the lowest communication crossarm. Communication circuits other than those used in connection with the operation of the supply circuits shall not be carried in the same cable with such supply circuits.

(f) Where such supply conductors are carried below communication conductors, transformers and other apparatus associated therewith shall be attached only to the sides of the crossarm in the space between and at no higher level than, such supply wires.

(g) Lateral runs of such supply circuits carried in a position below the communication space

220. B. Relative Levels—Supply and Communication Conductors—Continued.

shall be protected through the climbing space by wood molding or equivalent covering, or shall be carried in multiple-conductor cable having a suitable substantial insulating covering, and such lateral runs shall be placed on the under side of the crossarm.

C. Relative Levels—Supply Lines of Different Voltage Classifications (as classified in table 11).

1. AT CROSSINGS OR CONFLICTS.

Where supply conductors of different voltage classifications cross each other or are in conflict, the higher-voltage lines shall preferably be carried at the higher level.

2. ON POLES USED ONLY BY SUPPLY CONDUCTORS.

Where supply conductors of different voltage classifications are on the same poles, relative levels should be as follows:

(a) Where all circuits are owned by one utility, the conductors of higher voltages should generally be placed above those of lower voltage.

Note: These relative levels will often avoid the necessity of increasing the grade of construction for crossarms, pins, and conductor fastenings of the lower-voltage conductors.

(b) Where different circuits are owned by separate utilities, the circuits of each utility may be grouped together and one group of circuits may be placed above the other group provided that the circuits in each group are located so that those of higher voltage are at the higher levels and that either of the following conditions is met:

(1) A vertical spacing of not less than 4 feet (or 6 feet where required by table 11,

220\. C. Relative Levels—Supply Lines of Different Voltage Classifications—Continued.

rule 238, A, 1) is maintained between the nearest line conductors of the respective utilities (this space to be identified if necessary as a division space).

(2) Conductors of a lower voltage classification are at a higher level than those of a higher classification only where on the opposite side of the pole.

221\. Avoidance of Conflict.

Two parallel pole lines, either of which carries supply conductors, shall where practicable be so separated from each other that neither conflicts with the other. If this is impracticable, then the conflicting line or lines shall be built of the grade of construction required by section 24 for a conflicting line or the two lines shall be combined in a single pole line.

222\. Joint Use of Poles by Supply and Communication Circuits.

A. Advantages.

Joint use of poles under suitable conditions and with certain types of circuits offers many advantages and promotes safety.

B. Cooperative Study.

Joint use involves contractual relations between utilities, consideration of service requirements, and economies as well as safety. It, therefore, requires cooperative study by the utilities concerned.

C. Conditions Under Which Joint Use is Desirable.

In the case of local or distribution circuits along the same highway or similar right-of-way, where, under the provisions of section 24 applying to joint use, grade C construction or less would be required, joint use is generally preferable to separate pole lines

222. C. Conditions Under Which Joint Use is Desirable—Continued.

(except sometimes in rural districts) unless the number of conductors is very large or the character of the circuits makes joint use undesirable.

Where circuits other than those mentioned above are involved, the choice between joint use of poles and separate pole lines shall be determined through cooperative consideration, by the utilities concerned, of all the factors involved, including the character of circuits, the total number and weight of conductors, tree conditions, number and location of branches and service drops, availability of right of way, etc. Where such joint use is mutually agreed upon, it shall be subject to the appropriate grade of construction as specified in section 24. Where such joint use is not employed, separate lines as specified in rule 223 shall be used.

In any event, joint use is preferable to separate lines where it would be impracticable to avoid an overbuilt conflict with separate lines.

223. Separate Pole Lines.

Where two separate pole lines are to be used, one of which carries supply conductors and the other communication conductors, they shall be separated, if practicable, so that neither conflicts with the other, but if within conflicting distance, they shall be separated as far as practicable and shall be built of the grade of construction required by section 24.

SEC. 23. CLEARANCES

230. General.

A. Application.

This section covers all clearances, including separations and climbing spaces, involving poles and wires. Clearances of lamps from pole surfaces, from spaces accessible to the general public, and height above ground are covered in rule 286, E.

230. General—Continued.

B. Constant-Current Circuits.

The clearances for constant-current circuits shall be determined on the basis of their nominal full-load voltage.

C. Metal-Sheathed Supply Cables.

As far as clearances are concerned, effectively grounded continuous metal-sheathed supply cables of all voltages and any supply cables supported on effectively grounded messengers, are classified the same as open supply wires of 0 to 750 volts between conductors.

D. Neutral Conductors.

Neutral conductors of supply circuits shall have the same clearances as the phase wires of the circuit with which they are associated, except that neutral conductors which are effectively grounded throughout their length and associated with circuits of 750 to 15,000 volts between conductors may have the same clearances as circuits of 0 to 750 volts between conductors.

E. Maintenance of Clearances.

The clearances required by this section shall be maintained at the specified values.

231. Horizontal Clearances of Supporting Structures from Other Objects.

Poles, towers, and other supporting structures and their guys and braces shall have the following horizontal clearances from other objects. The clearance shall be measured between the nearest parts of the objects concerned.

A. From Fire Hydrants.

Not less than 3 feet.

Recommendation: Where conditions permit, a clearance of not less than 4 feet is recommended.

231. Horizontal Clearances of Supporting Structures from Other Objects—Continued.

B. From Street Corners.

Where hydrants are located at street corners, poles and towers should not be set so far from the corners as to make necessary the use of flying taps inaccessible from the poles.

C. From Curbs.

Not less than 6 inches measured to the street side of the curb.

D. From Railroad Tracks.

Where railroad tracks are paralleled or crossed by overhead lines, the poles shall, if practicable, be located not less than 12 feet from the nearest track rail.

Exception 1: At sidings a clearance of not less than 7 feet may be allowed, provided sufficient space for a driveway be left where cars are loaded or unloaded.

Exception 2: Supports for overhead trolley contact conductors may be located as near their own track rail as conditions require. If very close, however, permanent screens on cars will be necessary to protect passengers.

Exception 3: Where necessary to provide safe operating conditions which require an uninterrupted view of signals, signs, etc., along tracks, the parties concerned shall cooperate in locating poles to provide the necessary clearance where practicable.

232. Vertical Clearance of Wires Above Ground or Rails.

The vertical clearance of all wires above ground in generally accessible places or above rails shall be not less than the following:

232. Vertical Clearance of Wires Above Ground or Rails—Continued.

A. Basic Clearances.

The clearances in table 1 apply under the following conditions:

1. Temperature of 60° F, no wind, with final unloaded sag in the wire, or with initial unloaded sag in cases where wires are maintained approximately at initial unloaded sags.
2. Span lengths not greater than the following:

Loading district	Span lengths
	Feet
Heavy	[a]175
Medium	[a]250
Light	350

[a] 150 feet in heavy-loading district and 225 feet in medium-loading district for 3-strand conductors, each wire of which is 0.09 inch or less in diameter.

3. Voltages 0 to 50,000 volts between conductors.
4. Fixed supports for the conductor or wire.

(For other conditions, see rule 232, B.)

232. A. Basic Clearances—Continued.

TABLE 1.—*Minimum vertical clearance of wires above ground or rails*

[All voltages are between wires unless otherwise stated. Supply wires include trolley feeders]

Nature of ground or rails underneath wires	Guys; messengers; communication, span, and lightning protection wires; effectively grounded continuous-metal-sheath cables of all voltages	Open supply line wires, arc wires and service drops			Trolley contact conductors and associated span or messenger wires [1]	
		0 to 750 volts	750 to 15,000 volts[14]	15,000 to 50,000 volts	0 to 750 volts to ground	Exceeding 750 volts to ground
WHERE WIRES CROSS OVER						
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
Track rails of railroads (except electrified railroads using overhead trolley conductors) handling freights cars on top of which men are permitted[2] [16]	[3] [15] 27	[3] 27	[3] 28	30	[4] 22	[4] 22
Track rails of railroads (except electrified railroads using overhead trolley conductors) not included above [2]	18	18	20	22	[5] 18	[5] 20
Public streets, alleys or roads in urban or rural districts	[6] [13] 18	18	20	22	[5] 18	[5] 20
Driveways to residence garages	10	10	20	22	[5] 18	[5] 20
Spaces or ways accessible to pedestrians only	[7] 15	[8] 15	15	17	[9] 16	[9] 18
WHERE WIRES RUN ALONG, AND WITHIN THE LIMITS OF PUBLIC HIGHWAYS OR OTHER PUBLIC RIGHTS-OF-WAY FOR TRAFFIC						
Streets or alleys in urban districts	[10] [11] [13] 18	[10] 18	20	22	[5] 18	[5] 20
Roads in rural districts	[10] [11] [12] 14	[10] 15	18	20	[5] 18	[5] 20

Footnotes on following page.

232. A. Basic Clearances—Continued.

[1] Where subways, tunnels, or bridges require it, less clearances above ground or rails than required by table 1 may be used locally. The trolley contact conductor should be graded very gradually from the regular construction down to the reduced elevation.

[2] For wire crossings over railways handling only cars considerably lower than ordinary freight cars, the clearance may be reduced by an amount equal to the difference in height between the highest car handled and the highest ordinary freight car, but the clearance shall not be reduced below that required for street crossings.

[3] This clearance may be reduced to 25 feet where paralleled by trolley contact conductor on the same street or highway.

[4] In communities where 21 feet has been established, this clearance may be continued if carefully maintained. The elevation of the contact conductor should be the same in the crossing and next adjacent spans. (See rule 289, D, 2, for conditions which must be met where uniform height above rail is impracticable.)

[5] In communities where 16 feet has been established for trolley contact conductors 0 to 750 volts to ground, or 18 feet for trolley contact conductors exceeding 750 volts, or where local conditions make it impracticable to obtain the clearance given in the table, these reduced clearances may be used if carefully maintained.

[6] If a communication service drop, or a guy which is effectively insulated against the highest voltage to which it is exposed, up to 8,700 volts, crosses a street, alley or road, the clearance may be reduced to 16 feet at the side of the traveled way.

[7] This clearance may be reduced to the following values:

	Feet
(1) For communication conductors of circuits limited to 160 volts to ground, and communication cables	8
(2) For conductors of other communication circuits	10
(3) For guys	8

[8] This clearance may be reduced to the following values:

	Feet
(1) Supply wires (except trolley contact wires) limited to 300 volts to ground	12
(2) Supply wires (except trolley contact wires) limited to 150 volts to ground and located at entrances to buildings	10
(3) Where supply circuits of 550 volts or less, with transmitted power of 3,200 watts or less, are run along fenced (or otherwise guarded) private rights-of-way in accordance with the provisions specified in rule 220, B, 3	10

[9] Trolley contact conductors for industrial railways when not along or crossing over roadways may be placed at a less height if suitably guarded.

[10] Where a pole line along a road is located relative to fences, ditches, embankments, etc., so that the ground under the line will never be traveled except by pedestrians, this clearance may be reduced to the following values:

	Feet
(1) Communication conductors limited to 160 volts to ground, and communication cables	8
(2) Conductors of other communication circuits	10
(3) Supply conductors	12

[11] No clearance from ground is required for anchor guys not crossing streets, driveways, roads, or pathways, nor for anchor guys provided with traffic guards and paralleling sidewalk curbs.

[12] This clearance may be reduced to 13 feet for communication conductors where no part of the line overhangs any part of the highway which is ordinarily traveled, and where it is unlikely that loaded vehicles will be crossing under the line into a field.

[13] Where communication wires or cables cross over or run along alleys, this clearance may be reduced to 15 feet.

[14] A conductor which is effectively grounded throughout its length and is associated with a circuit of 750 to 15,000 volts between conductors may have the clearances specified for open supply wires of 0 to 750 volts.

[15] This value may be reduced to 25 feet for guys and for cables carried on messengers.

[16] Adjacent to overhead bridges which restrict the practice of permitting men on top of cars, these clearances may be reduced, within the restricted area, by mutual agreement between the parties at interest, but in no case shall the wires or cables be at levels below the undersurface of the bridge.

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232. Vertical Clearance of Wires Above Ground or Rails—Continued.

B. Increased Clearances.

Greater clearances than specified in table 1 (rule 232, A) shall be provided where required by 1, 2, and 3 below. Increases are cumulative where more than one apply.

Exception: Increased clearances are not required for trolley contact conductors, for guys, or for cable supported by messenger.

1. SPANS LONGER THAN SPECIFIED IN RULE 232, A, 2. In applying the following rules, the "point of crossing" in the case of roads, streets, alleys and driveways is considered to be the edge of the traveled way farthest from the nearer support of the crossing span. In the case of a railroad crossing, it is the track rail which is farthest from the nearer support of the crossing span. In other situations it is the location under the conductors of any topographical feature which is the determinant of the clearance.

(a) WHERE POINT OF CROSSING OCCURS AT POINT OF MAXIMUM TOTAL SAG OF THE CONDUCTOR.

(1) GENERAL. For spans exceeding the limits specified in rule 232, A, 2, above, the clearance specified in table 1 shall be increased by 0.1 foot for each 10 feet of the excess of span length over such limits. See (3) below.

(2) RAILROAD CROSSINGS. For spans exceeding the limits specified in rule 232, A, 2, above, the clearance specified in table 1 shall be increased by the following amounts for each 10 feet by which the

232. B. Increased Clearances—Continued.

crossing span length exceeds such limits. See (3) below.

Loading district	Amount of increase per 10 feet	
	Large conductors	Small[1] conductors
	Feet	*Feet*
Heavy and medium	0. 15	0. 30
Light	. 10	. 15

[1] A small conductor is a conductor having an over-all diameter of metallic material equal to or less than the following values:

Material	Outside diameter of conductor	
	Solid	Stranded
	Inches	*Inches*
All copper	0. 160	0. 250
Other than all copper	. 250	. 275

(3) LIMITS. The maximum additional clearance need not exceed the following percentages of the "maximum sag increase" for the conductor concerned:

Loading district	Percentage
Heavy	75
Medium	85
Light	75

The "maximum sag increase" to which these percentages apply is the arithmetic difference between final unloaded sag at 60° F, no wind, and the maximum total sag under the entire conductor loading of rule 251 for the loading district con-

232. B. Increased Clearances—Continued.

cerned, or under 120° F, no wind, whichever sag is the greater, computed for the span length for which such difference is greatest.

(b) Where Point of Crossing is Not at Point of Maximum Total Sag of the Conductor.

Under these conditions the required clearance may be obtained by multiplying the clearance determined by rules 232, A and 232, B, 1 (a) by the following factors, but in no case shall the clearance be less than required by table 1:

Distance from nearer support of crossing span to point of crossing in percentage of crossing span length	Factors
5	0. 85
10	. 88
15	. 91
20	. 94
25	. 96
30	. 98
35	. 99
40 to 50	1. 00
Interpolate for intermediate values	

2. VOLTAGES EXCEEDING 50,000 VOLTS BETWEEN CONDUCTORS.

For these voltages the clearances given in table 1 (rule 232, A) shall be increased at the rate of 0.5 inch for each 1,000 volts of the excess.

3. CONDUCTORS SUPPORTED BY SUSPENSION-TYPE INSULATORS AT CROSSINGS OVER TRACK RAILS.

The clearance shall be increased by such an amount that the values specified in table 1

232. B. Increased Clearances—Continued.

(rule 232, A) will be maintained in case of a broken conductor in either adjoining span, if the conductor is supported as follows:

(a) At one support by suspension-type insulators in a suspended position, and at the other support by insulators which are not free to swing (including semistrain-type insulators).

(b) At one support by strain insulators, and at the other support by semistrain-type insulators.

4. METHODS OF AVOIDING THIS INCREASE OF CLEARANCE.

Any of the following construction methods will avoid the necessity for the increase in clearance required by rule 232, B, 3:

(a) *Suspension-type insulators* in a suspended position at both supports.

(b) *Semistrain-type insulators* at both supports.

(c) *Arrangement of insulators* so that they are restrained from displacement toward the crossing.

C. Supply Pole Wiring at Underground Risers.

Supply wires connecting to underground systems shall not be run open closer to the ground than is indicated by table 2:

TABLE 2.—*Clearance above ground for open supply wiring*

Location on pole	Voltage between conductors		
	0 to 750 volts	750 to 15,000 volts	More than 15,000 volts
	Feet	*Feet*	*Feet*
Side of pole adjacent to vehicular traffic	14	16	18
Side of pole not adjacent to vehicular traffic	8	11	13

233. WIRE-CROSSING CLEARANCES.

The clearance between any two wires crossing each other and carried on different supports shall be not less than the following:

A. **Basic Clearances.**

The clearances given in table 3 below apply under the following conditions:

1. Temperature of 60° F, no wind, with the upper conductor or wire at its final unloaded sag and the lower conductor or wire at its initial unloaded sag.
2. Span lengths not greater than the following for the upper conductor or wire:

Loading district	Span lengths
	Feet
Heavy	[1] 175
Medium	[1] 250
Light	350

[1] 150 feet in heavy loading district and 225 feet in medium loading district for 3-strand conductors, each wire of which is 0.09 inch or less in diameter.

3. Voltages 0 to 50,000 volts between conductors.
4. Fixed supports for the upper conductor or wire.

233. A. Basic Clearances—Continued.

TABLE 3.—*Wire-crossing clearances*

[All voltages are between wires except for trolley contact conductors where voltages are to ground]

[The insertion of a given clearance in italics indicates that in general the lines operating at the voltage named above this clearance should not cross over the lines at the voltage to the left of the clearance in italics]

Nature of wires crossed over	Communication wires, including cables and messengers	Open supply wires 0 to 750 volts; supply cables, all voltages, having effectively grounded continuous metal sheaths or messengers; messengers associated with such cables		Open supply wires and service drops [6]		Guys, span wires, lightning-protection wires
		Line wires	Service drops	750 to 8,700 volts	8,700 to 50,000 volts	
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
Communication, including cables and messengers	[2] 2	[9] [3] 4	[9] 2	[7] 4	[10] 6	[2] 2
Supply cables, all voltages, having effectively grounded continuous metal sheaths or messengers; messengers associated with such cables	*4*	2	2	2	4	2
Open supply wires:						
0 to 750 volts	*4*	2	2	2	4	2
750 to 8,700 volts	*4*	*2*	*4*	2	4	4
8,700 to 50,000 volts	*6*	*4*	*6*	*4*	4	4
Trolley contact conductors	[4] 4	[4] [5] 4	[4] 4	6	6	[4] 4
Guys, span wires, lightning-protection wires, service drops 0 to 750 volts	[2] [8] 2	2	2	4	4	[1] [2] 2

Footnotes on following page.

233. Wire-Crossing Clearances—Continued.

B. Increased Clearances.

Greater clearances than given in table 3 (rule 233, A) shall be provided under the following conditions. The increases in 1, 2, and 3 below are cumulative where more than one are applicable.

1. CROSSING SPANS LONGER THAN SPECIFIED IN RULE 233, A, 2.

Under these conditions the clearances specified in table 3 shall be increased as follows:

(a) Where the crossing occurs at the point of maximum total sag in the upper conductor, the clearances of table 3 shall be increased by the following amounts for each 10 feet by which the crossing span

---

[1] Completely insulated sections of guys attached to supporting structures having no conductor of more than 8,700 volts may have less than this clearance from each other.

[2] The clearance of communication conductors and their guy, span, and messenger wires from each other in locations where no other classes of conductors are involved may be reduced by mutual consent of the parties concerned, subject to the approval of the regulatory body having jurisdiction, except for fire-alarm wires and wires used in the operation of railroads, or where one set of conductors is for public use and the other used in the operation of supply systems.

[3] Except where neutral conductors of primary supply circuits are concerned, a clearance of 2 feet may be permitted where the supply conductor is above the communication conductor, provided the crossing is not within 6 feet of any pole concerned in the crossing and the voltage to ground does not exceed 300 volts. (See note 9.)

[4] Trolley-contact conductors of more than 750 volts should have at least 6 feet clearance. This clearance should also be provided over lower-voltage trolley-contact conductors unless the crossover conductors are beyond reach of a trolley pole leaving the trolley-contact conductor or are suitably protected against damage from trolley poles leaving the trolley-contact conductor.

[5] Trolley feeders are exempt from this clearance requirement for trolley-contact conductors if they are of the same nominal voltage and of the same system.

[6] A conductor which is effectively grounded throughout its length and is associated with a circuit of 750 to 15,000 volts between conductors may have the clearances specified for open supply wires of 0 to 750 volts.

[7] This clearance shall be increased to 6 feet where the supply wires cross over a communication line within 6 feet horizontally of a communication pole.

[8] This clearance shall be increased to 4 feet where communication cables cross over open supply service wires.

[9] Where a 2-foot clearance is required at 60° F, and where conditions are such that the sag in the upper conductor would increase more than 1.5 feet at the crossing point under the applicable loading of rule 251, the 2-foot clearance shall be increased by the amount of sag increase less 1.5 feet.

[10] Multigrounded wye circuits not exceeding 8,700 volts to ground may have a 4-foot clearance if the lowest supply wire at the crossing under conditions of 60° F, no wind, and final unloaded sag is not lower than a straight line joining the points of support of the highest communication conductor, provided it is not within 6 feet horizontally of a communication pole.

233. B. Increased Clearances—Continued.

length exceeds the limits specified in rule 233, A, 2:

Loading district	Amount of increase per 10 feet	
	Large conductors	Small conductors [1]
	Feet	*Feet*
Heavy and medium	0. 15	0. 30
Light	. 10	. 15

[1] A small conductor is a conductor having an over-all diameter of metallic material equal to or less than the following values:

Material	Outside diameter of conductor	
	Solid	Stranded
	Inches	*Inches*
All copper	0. 160	0. 250
Other than all copper	. 250	. 275

The maximum additional clearance need not exceed the following percentages of the "maximum sag increase" for the conductor concerned:

Loading district	Percentage
Heavy	75
Medium	85
Light	75

The "maximum sag increase" to which these percentages apply is the arithmetic difference between final unloaded sag at 60° F, no wind, and the maximum total sag under the entire conductor loading of

233. B. Increased Clearances—Continued.

rule 251 for the loading district concerned, or under 120° F, no wind, whichever sag is the greater, computed for the span length for which such difference is greatest.

(b) If the crossing point is located elsewhere than at the point of maximum total sag in the upper span, the required clearance may be obtained by multiplying the clearance determined in rule 233, A and B, 1 (a) by the following factors, but in no case shall the clearance be less than required by table 3:

Distance from nearer support of crossing span to point of crossing, in percentage of crossing span length	Factors for basic clearance of—	
	4 feet	6 feet
5	0.35	0.47
10	.47	.58
15	.60	.68
20	.71	.78
25	.82	.85
30	.90	.92
35	.96	.98
40 to 50	1.00	1.00
Interpolate for intermediate values.		

2. VOLTAGES EXCEEDING 50,000 VOLTS BETWEEN CONDUCTORS.

For these voltages the clearances given in table 3 (rule 233, A) shall be increased at the rate of 0.5 inch for each 1,000 volts of the excess.

3. CONDUCTORS SUPPORTED BY SUSPENSION-TYPE INSULATORS AT CROSSINGS OVER COMMUNICATION WIRES.

For such conductors the clearance shall be increased by such an amount that the values

233. B. Increased Clearances—Continued.

specified in table 3 (rule 233, A) will be maintained in case of a broken conductor in either adjacent span, provided such conductor is supported as follows:

(a) At one support by suspension-type insulators in a suspended position, and at the other support by insulators not free to swing (including semistrain-type insulators).

(b) At one support by a strain insulator, and at the other support by a semistrain-type insulator.

4. METHODS OF AVOIDING THIS INCREASE OF CLEARANCE.

Any of the following construction methods will avoid the necessity for the increase in clearance required by rule 233, B, 3:

(a) *Suspension-type insulators* in a suspended position at both supports.

(b) *Semistrain-type insulators* at both supports.

(c) *Arrangement of insulators* so that they are restrained from displacement toward the crossing.

234. Clearances of Conductors of One Line from Other Conductors and Structures.

A. Clearances from Conductors of Another Line.

The clearance in any direction between any conductor of one line and any conductor of a second and conflicting line shall be not less than the largest value required by 1, 2, or 3 below at 60° F, no wind:

1. Four feet.
2. The values required by rule 235, A, 2, (a) (1), or (2) for separation between conductors on the same support.
3. The apparent sag of the conductor having the greater sag, plus 0.2 inch per kilovolt of the highest voltage concerned.

234. A. Clearances from Conductors of Another Line—Continued.

Exception: In situations where supply-line conductors only are involved, the clearance required by 3 above need not be greater than the value required by rule 233, A and B, for a center-span crossing, assuming the conductor having the larger sag swinging through an arc of 45° from the vertical.

B. Clearances from Supporting Structures of Another Line.

Conductors of any line passing near a pole or similar supporting structure of a second line, without being attached thereto, shall have clearances from any part of such structure not less than the larger value required by either 1 or 2 below at 60° F, no wind:

1. Three feet if practicable.
2. The values required by rule 235, A, 2, (a) (1) and (2) for separation between similar conductors on the same support, increased by 1 inch for each 2 feet of the distance from the supporting structure of the second line to the nearest supporting structure of the first line.

The climbing space on the structure of the second line shall in no case be reduced by a conductor of the first line.

C. Clearances from Buildings.

1. GENERAL.

Conductors shall be arranged and maintained so as to hamper and endanger firemen as little as possible in the performance of their duties.

2. LADDER SPACE.

Where buildings exceed three stories (or 50 feet) in height, overhead lines should be arranged where practicable so that a clear space or zone at least 6 feet wide will be left, either adjacent to the building or beginning not over 8 feet from

234. C. Clearances from Buildings—Continued.

the building, to facilitate the raising of ladders where necessary for fire fighting.

Exception: This requirement does not apply where it is the unvarying rule of the local fire departments to exclude the use of ladders in alleys or other restricted places which are generally occupied by supply lines.

3. OPEN SUPPLY CONDUCTORS ATTACHED TO BUILDINGS.

Where the permanent attachment of open supply conductors of any class to buildings is necessary for an entrance, such conductors shall meet the following requirements:

(a) Conductors of more than 300 volts to ground shall not be carried along or near the surface of the building unless they are guarded or made inaccessible.

(b) Clearance of wires from building surface shall be not less than those required in table 9 (rule 235, A, 3, (a)) for clearance of conductors from pole surfaces.

4. CONDUCTORS PASSING BY OR OVER BUILDINGS.

(a) MINIMUM CLEARANCES. Unguarded or accessible supply conductors carrying voltages in excess of 300 volts between conductors shall not come closer to any building or its attachments (balconies, platforms, etc.) than listed below, except that this rule should not be interpreted as restricting the installation of a trolley contact conductor over the approximate center line of the track it serves.

(1) SPANS 0 TO 150 FEET. For spans of 0 to 150 feet, the clearances shall be as given in table 4.

234. C. Clearances from Buildings—Continued.

TABLE 4.—*Clearances of supply conductors from buildings*

[All voltages are between conductors]

Voltage of supply conductors	Horizontal clearance	Vertical clearance
	Feet	*Feet*
300 to 8,700	3	8
8,700 to 15,000	8	8
15,000 to 50,000	10	10
Exceeding 50,000	10 plus 0.5 inch per kv in excess.	10 plus 0.5 inch per kv in excess.

(2) SPANS EXCEEDING 150 FEET. Where span lengths exceed 150 feet, the increased clearances required by rule 232, B, 1 shall be provided.
Exception: These increased clearances are not required where the voltage of the supply conductors is from 300 to 8,700 volts between conductors.

(b) GUARDING OF SUPPLY CONDUCTORS. Supply conductors of 300 volts or more between conductors shall be properly guarded by grounded conduit, barriers, or otherwise, under the following conditions:

(1) Where the clearances set forth in table 4 (rule 234, C, 4, (a), (1)) cannot be obtained.

(2) Where such supply conductors are placed near enough to windows, verandas, fire escapes, or other ordinarily accessible places, to be exposed to contact by persons.

Note: Supply conductors in grounded metal-sheathed cable are considered to be guarded within the meaning of this rule.

234. Clearances of Conductors of One Line from Other Conductors and Structures—Continued.

D. Clearances from Bridges.

1. CLEARANCES OF CONDUCTORS FROM BRIDGES.

Supply conductors, not installed in grounded conduit or metal-sheath cable, which pass under, over, or near a bridge shall have clearances therefrom not less than given in table 5.

2. GUARDING TROLLEY-CONTACT CONDUCTORS LOCATED UNDER BRIDGES.

(a) WHERE GUARDING IS REQUIRED. Guarding is required where the trolley-contact conductor is located so that a trolley pole leaving the conductor can make simultaneous contact between it and the bridge structure.

TABLE 5.—*Clearances from bridges*

Voltages between conductors	Readily accessible portions (other than traveled ways [1]) of any bridge, including wing walls or bridge attachments		From ordinarily inaccessible portions [2] of bridges (other than brick, concrete, or masonry) and from abutments	
	For conductors attached to bridge [3]	For conductors not attached to bridge	For conductors attached to bridge [3 5]	For conductors not attached to bridge [4 5]
	Feet	*Feet*	*Feet*	*Feet*
0 to 2,500	3. 0	3. 0	0. 5	3. 0
Over 2,500 to 5,000	3. 0	3. 0	1. 0	3. 0
Over 5,000 to 8,700	3. 0	3. 0	3. 0	3. 0
Over 8,700 to 15,000	5. 0	5. 0	5. 0	5. 0
Over 15,000 to 25,000	7. 5	7. 5	7. 5	7. 5
Over 25,000 to 35,000	7. 5	9. 0	7. 5	9. 0
Over 35,000 to 50,000	7. 5	12. 0	7. 5	12. 0

[1] Where over traveled ways on or near bridges, the clearances of rule 232 apply.

[2] Bridge seats of steel bridges carried on masonry, brick, or concrete abutments which require frequent access for inspection shall be considered as readily accessible portions.

[3] Conductors should have clearance not less than given in this column, where practicable.

[4] Conductors should have the clearances given in this column increased as much as practicable.

[5] Where conductors passing under bridges are adequately guarded against contact by unauthorized persons and can be deenergized for maintenance of the bridge, clearances of the conductors from the bridge, at any point, may have the clearances specified in table 9 for clearance from surfaces of crossarms plus one-half the final unloaded sag of the conductor at that point.

234. D. Clearances from Bridges—Continued.

(b) Nature of Guarding. Guarding shall consist of a substantial inverted trough of non-conducting material located above the contact conductor, or of other suitable means of preventing contact between the trolley pole and the bridge structure.

235. Minimum Line-Conductor Clearances and Separations at Supports.

A. Separation Between Conductors on Pole Lines.

1. application of rule.

(a) Multiconductor Wires or Cables. Cables, and duplex, triple or paired conductors supported on insulators or messengers, whether single or grouped, are for the purposes of this rule considered single conductors even though they may contain individual conductors not of the same phase or polarity.

(b) Conductors Supported by Messengers or Span Wires. Clearances between individual wires or cables supported by the same messenger, or between any group and its supporting messenger, or between a trolley feeder, supply conductor, or communication conductor, and their respective supporting span wires, are not subject to the provisions of this rule.

(c) Measurement of Clearances. The clearances and separations stated may be measured from the center of the supporting insulator instead of from the conductor itself.

2. horizontal separations between line conductors.

(a) Fixed Supports. Line conductors attached to fixed supports shall have horizontal separations from each other not less than the

235\. A. Separation Between Conductors on Pole Lines—Continued.

larger value required by either (1) or (2) below for the situation concerned.

Exception 1: The pin spacing at buckarm construction may be reduced as specified in rule 236, F, to provide climbing space.

Exception 2: The pin spacing at bridge fixtures may be reduced as specified in rule 235, C.

Exception 3: Grades D and N need meet only the requirements of (1) below.

Exception 4: These clearances do not apply where conductors have insulating covering adequate for the voltage concerned.

(1) MINIMUM HORIZONTAL SEPARATION BETWEEN LINE CONDUCTORS OF THE SAME OR DIFFERENT CIRCUITS. Separations shall be not less than given in table 6.

TABLE 6.—*Minimum horizontal separation at supports between line conductors of the same or different circuits*

[All voltages are between conductors except for railway feeders, which are to ground]

Class of circuit	Separation	Notes
	Inches	
Communication conductors	6	Preferable minimum. Does not apply at conductor transposition points.
	3	Permitted where pin spacings less than 6 inches have been in regular use. Does not apply at conductor transposition points.
Railway feeders:		
0 to 750 volts, No. 4/0 or larger	6	
0 to 750 volts, smaller than No. 4/0	12	Where 10- to 12-inch separation has already been established by practice, it may be continued, subject to the provisions of rule 235, A, 2, (*a*), (2), for conductors having apparent sags not over 3 feet and for voltages not exceeding 8,700.
750 volts to 8,700 volts	12	
Other supply conductors:		
0 to 8,700 volts	12	
For all conductors of more than 8,700 volts add for each 1,000 volts in excess of 8,700 volts	0.4	

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235. A. Separation Between Conductors on Pole Lines—Continued.

(2) SEPARATIONS ACCORDING TO SAGS. The separation at the supports of conductors of the same or different circuits of grades B, or C shall in no case be less than the values given by the following formulas, at 60° F, no wind. The requirements of rule 235, A, 2, (a), (1) apply if they give a greater separation than this rule.

For line conductors smaller than No. 2 AWG:

Separation$=$0.3 inch per kilovolt$+7\sqrt{(S/3)-8}$.

For line conductors of No. 2 AWG or larger:

Separation$=$0.3 inch per kilovolt$+8\sqrt{S/12}$.

S is the apparent sag in inches of the conductor having the greater sag, and the separation is in inches.

TABLE 7.—*Separation in inches required for line conductors smaller than No. 2 AWG*

Voltages between conductors	Sag (in inches)						
	36	48	72	96	120	180	240
2,400	14.5	20.5	28.5	35.0	40.5	51.5	60.0
7,200	16.0	22.0	30.0	36.5	42.0	52.5	61.5
13,200	18.0	24.0	32.0	38.5	43.5	54.5	63.5
23,000	21.0	27.0	35.0	41.5	46.5	57.5	66.5
34,500	24.5	30.5	38.5	44.5	50.5	61.0	70.0
46,000	28.0	34.0	42.0	48.0	53.5	64.5	73.0
69,000	-------	40.5	48.5	55.0	60.5	71.0	80.0

235. A. Separation Between Conductors on Pole Lines—Continued.

TABLE 8.—*Separation in inches required for line conductors No. 2 AWG or larger*

Voltages between conductors	Sag (in inches)						
	36	48	72	96	120	180	240
2,400	14.5	16.5	20.5	23.5	26.0	31.5	36.5
7,200	16.0	18.0	22.0	25.0	27.5	33.0	38.0
13,200	18.0	20.0	23.5	26.5	29.5	35.0	39.5
23,000	21.0	23.0	26.5	29.5	32.0	38.0	42.5
34,500	24.0	26.5	30.0	33.0	35.5	41.5	46.0
46,000	27.5	30.0	33.5	36.5	39.0	45.0	49.5
69,000	--------	36.5	40.5	43.5	46.0	51.5	56.5

(b) SUSPENSION INSULATORS NOT RESTRAINED FROM MOVEMENT. Where suspension insulators are used and are not restrained from movement, the conductor separation shall be increased so that one string of line insulators may swing transversely through an angle of 45° from a vertical position without reducing the values given in (a) above.

3. CLEARANCES IN ANY DIRECTION FROM LINE CONDUCTORS TO SUPPORTS, AND TO VERTICAL OR LATERAL CONDUCTORS, SPAN OR GUY WIRES, ATTACHED TO THE SAME SUPPORT.

(a) FIXED SUPPORTS. Clearances shall be not less than given in table 9.

235. A. Separation Between Conductors on Pole Lines—Continued.

TABLE 9.—*Minimum clearance in any direction from line conductors to supports, and to vertical or lateral conductors, span or guy wires attached to the same support*

[All voltages are between conductors]

Clearance of line conductors from—	Communication lines—		Supply lines		
	In general	On jointly used poles	0 to 8,700 volts: In general	0 to 8,700 volts: On jointly used poles	Exceeding 8,700 volts, add for each 1,000 volts of excess
Vertical and lateral conductors:	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Of same circuit	3	3	3	3	0.25
Of other circuits	3	3	[6] 6	[6] 6	.4
Span and guy wires attached to same pole:					
General	[3] 3	[1 8] 6	6	6	.4
When parallel to line	[8] 3	[1 8] 6	[1] 12	[1] 12	.4
Lightning-protection wires parallel to line	([2 5])	([2 5])	([2 5])	([2 5])	.4
Surfaces of crossarms	[3] 3	[3] 3	3	3	.25
Surfaces of poles	[3] 3	[3] 5	[7] 3	[4 7] 5	.25

[1] For guy wires, if practicable. For clearances between span wires and communication conductors, see rule 238, E, 3.

[2] Clearance shall not be less than the separation required by table 6 or rule 235, A, 2, (a), (2) between two line conductors of the voltage concerned.

[3] Communication conductors may be attached to supports on the sides or bottoms of crossarms or surfaces of poles with less clearances, if at least 40 inches from any supply line conductor of less than 8,700 volts and at least 60 inches from any supply line conductor of more than 8,700 volts carried on the same pole.

[4] This clearance applies only to supply conductors carried on crossarms below communication conductors, on joint poles. Where supply conductors are above communication conductors the clearance shall be at least 3 inches.

[5] For the purpose of applying the above table, the voltage of lightning-protection wires shall be considered as being the voltage to ground of the associated supply conductors.

[6] For supply circuits of 0 to 750 volts, this clearance may be reduced to 3 inches.

[7] A neutral conductor which is effectively grounded throughout its length and is associated with a circuit of 0 to 15,000 volts between conductors may be attached directly to the pole surface.

[8] Guys and messengers may be attached to the same strain plates or to the same throughbolts.

235. A. Separation Between Conductors on Pole Lines—Continued.

(b) Suspension Insulators not Restrained From Movement. Where suspension insulators are used and are not restrained from movement, the conductor clearances from surfaces of supports, from span or guy wires, or from vertical or lateral conductors shall be such that the values of clearances required by (a) above will be maintained with an insulator swing of 45° from the vertical position on steel or concrete supports, or 30° if on wood poles.

4. CONDUCTOR SEPARATION—VERTICAL RACKS.

Conductors or cables may be carried on vertical racks or separate brackets other than wood placed vertically at one side of the pole and securely attached thereto, if all the following conditions are met:

(a) The voltage between conductors shall be not more than 750 volts, except that cables having effectively grounded continuous metal sheath may carry any voltage.

(b) Conductors shall be of the same material or materials.

(c) Vertical spacing between conductors shall be not less than the following:

Span length	Vertical clearance between conductors
Feet	*Inches*
0 to 150	4
150 to 200	6
200 to 250	8
250 to 300	12

(See table 9, rule 235, A, 3, for necessary clearances from pole surfaces and rule 236, G, for method of providing climbing space.)

235. A. Separation Between Conductors on Pole Lines—Continued.

5. SEPARATION BETWEEN SUPPLY CIRCUITS OF DIFFERENT VOLTAGE CLASSIFICATIONS ON THE SAME CROSSARM.

Supply circuits of any one voltage classification as given in table 11 (rule 238, A, 1) may be maintained on the same crossarm with supply circuits of the next consecutive voltage classification only under the following conditions:

(*a*) If they occupy pin positions on opposite sides of the pole.

(*b*) If in bridge-arm or side-arm construction they are separated by a distance of not less than the climbing space required for the higher voltage concerned and provided for in rule 236.

(*c*) If the higher-voltage conductors occupy the outer pin positions and the lower-voltage conductors the inner pin positions.

(*d*) If series lighting or similar supply circuits are ordinarily dead during periods of work on or above the crossarm concerned.

(*e*) If the two circuits concerned are communication circuits used in the operation of supply lines, and supply circuits of less than 8,700 volts, and are owned by the same utility, provided they are installed as in (a) or (b) above.

B. Separation Between Conductors Attached to Buildings.

Separation of wires from each other shall be not less than those required in table 6 (rule 235, A, 2, (a) (1)) for separation of conductors from each other at supports.

Exception: Conductors on vertical racks or separate brackets other than wood placed vertically meeting the requirements of rule 235, A, 4 may have the separations specified in that rule.

235. Minimum Line-Conductor Clearances and Separations at Supports—Continued.

C. Separation Between Conductors Attached to Bridges.

Supply conductors attached to bridges and supported at frequent intervals may have less separation at supports than required by rule 235, A, 2, (*a*), (1) and (2). The separation shall be not less than the clearance between supply conductors and the surfaces of poles or crossarms required by rule 235, A, 3, (a), or less than the following:

	Separation
Span length:	*Inches*
0 to 20 feet	6
20 to 50 feet	9

236. Climbing Space.

A. Location and Dimensions.

1. A climbing space having the horizontal dimensions specified in rule 236, E, shall be provided past any conductors, crossarms, or other parts.
2. The climbing space need be provided on one side or corner of the pole only.
3. The climbing space shall extend vertically past any conductor or other part between levels above and below the conductor as specified in rule 236, E, F, G, and I, but may otherwise be shifted from any side or corner of the pole to any other side or corner.

B. Portions of Supporting Structures in Climbing Space.

Portions of the pole or structure when included in one side or corner of the climbing space are not considered to obstruct the climbing space.

C. Crossarm Location Relative to Climbing Space.

Recommendation: Crossarms should be located on the same side of the pole.

Exception: This recommendation does not apply where double crossarms are used on any pole or where crossarms on any pole are not all parallel.

236. Climbing Space—Continued.

D. Location of Supply Apparatus Relative to Climbing Space.

Transformers, regulators, lightning arresters, and switches when located below conductors or other attachments shall be mounted outside of the climbing space.

E. Climbing Space Through Conductors on Crossarms.

1. CONDUCTORS OF SAME VOLTAGE CLASSIFICATION ON SAME CROSSARM.

Climbing space between conductors shall be of the horizontal dimensions specified in table 10 (rule 236, E, 3), and shall be provided both along and across the line, and shall be projected vertically not less than 40 inches above and below the limiting conductors. Where communication conductors are above supply conductors of more than 8,700 volts, the climbing space shall be projected vertically at least 60 inches above the highest supply conductor.

Exception 1: This rule does not apply if it is the unvarying practice of the employers concerned to prohibit employees from ascending beyond the conductors of the given line, unless the line is killed.

Exception 2: For supply conductors carried on a pole in a position below communication facilities in the manner permitted in rule 220, B, 3, the climbing space need not extend more than 2 feet above such supply space.

2. CONDUCTORS OF DIFFERENT VOLTAGE CLASSIFICATIONS ON SAME CROSSARM.

The climbing space shall be that required by table 10 (rule 236, E, 3) for the highest voltage of any conductor bounding the climbing space. The climbing space shall extend vertically to the limits specified in rule 236, E, 1, and the exceptions thereto.

236. E. Climbing Space Through Conductors on Crossarms—Continued.

3. HORIZONTAL CLIMBING-SPACE DIMENSIONS.

TABLE 10.—*Minimum horizontal dimensions of climbing space*

Character of conductors adjacent to climbing space	Voltage of conductors		Horizontal dimensions of climbing space (inches)			
			On poles used solely by—		On jointly used poles	
	To ground	Between wires	Communication conductors	Supply conductors	Supply conductors above communication conductors	Communication conductors above supply conductors [1]
Communication conductors.	0 to 150		No requirement.		(2)	No requirement.
	Exceeding 150.		24 recommended.		(2)	24 recommended.
Supply conductors.	Less than 300.			24	24	30.
	300 to	8,700		30	30	30.
		8,700 to 15,000.		36	36	36.
		Exceeding 15,000.		More than 36.[3]	More than 36.[3]	More than 36.[3]

[1] This relation of levels is not, in general, desirable and should be avoided where practicable.
[2] Climbing space shall be the same as required for the supply conductors immediately above, with a maximum of 30 inches, except that a climbing space of 16 inches across the line may be employed for communication cables or conductors where the only supply conductors at a higher level are secondaries (0 to 750 volts between conductors) supplying airport or airway marker lights or crossing over the communication line and attached to the pole top or to a pole-top extension fixture.
[3] Where practicable. (Attention is called to the operating requirements of rule 422, part 4 of this code.)

F. Climbing Space on Buckarm Construction.

The full width of climbing space shall be maintained on buckarm construction and shall extend vertically in the same position at least 40 inches (or 60 inches where required by rule 236, E, 1) above and below any limiting conductor.

Method of Providing Climbing Space on Buckarm Construction. With circuits of less than 8,700 volts and span lengths not exceeding 150 feet and sags not exceeding 15 inches for wires of No. 2 and larger sizes, or 30 inches for wires smaller than No. 2, a six-pin cross-

236. F. Climbing Space on Buckarm Construction—Con.

arm having pin spacing of 14½ inches may be used to provide a 30-inch climbing space on one corner of a junction pole by omitting the pole pins on all arms, and inserting pins midway between the remaining pins so as to give a spacing of 7¼ inches, provided that each conductor on the end of every arm is tied to the same side of its insulator, and that the spacing on the next pole is not less than 14½ inches.

G. Climbing Space for Longitudinal Runs.

The full width of climbing space shall be provided past longitudinal runs and shall extend vertically in the same position from 40 inches below the run to a point 40 inches above (or 60 inches where required by rule 236, E, 1). The width of climbing space shall be measured from the longitudinal run concerned. Longitudinal runs on racks, or supply cables on messengers, are not considered as obstructing the climbing space if all wires concerned are covered by rubber protective equipment or otherwise guarded as an unvarying practice before workmen climb past them. This does not apply where communication conductors are above the longitudinal runs concerned.

Exception 1: If a supply longitudinal run is placed on the side or corner of the pole where climbing space is provided, the width of climbing space shall be measured horizontally from the center of the pole to the nearest supply conductors on crossarms, under the following conditions:

Where the longitudinal run consists of open supply conductors carrying not more than 750 volts between conductors or of effectively grounded continuous metal-sheathed supply cable carrying any voltage, and is supported close to the pole as by brackets, racks, or pins close to the pole, and

Where the nearest supply conductors on crossarms are parallel to and on the same side of

236. G. Climbing Space for Longitudinal Runs—Continued.

the pole as the longitudinal run and within 4 feet above or below the run.

Exception 2: For supply conductors carried on a pole in a position below communication facilities in the manner permitted in rule 220, B, 3, the climbing space need not extend more than 2 feet above such supply space.

H. Climbing Space Past Vertical Conductors.

Vertical runs incased in suitable conduit or other protective covering and securely attached to the surface of the pole or structure are not considered to obstruct the climbing space.

I. Climbing Space Near Ridge-Pin Conductors.

The climbing space specified in rule 236, E, 3 shall be provided above the top crossarm to the ridge-pin conductor but need not be carried past it.

237. Working Space.

A. Location of Working Spaces.

Working spaces shall be provided on the climbing face of the pole at each side of the climbing space.

B. Dimensions of Working Spaces.

1. ALONG THE CROSSARM.

The working space shall extend from the climbing space to the outmost pin position on the crossarm.

2. PERPENDICULAR TO THE CROSSARM.

The working space shall have the same dimension as the climbing space (see rule 236, E). This dimension shall be measured from the face of the crossarm.

3. VERTICALLY.

The working space shall have a height not less than that required by rule 238 for the vertical separation of line conductors carried at different levels on the same support.

237. Working Space—Continued.

C. Location of Vertical and Lateral Conductors Relative to Working Spaces.

The working spaces shall not be obstructed by vertical or lateral conductors. Such conductors shall be located on the opposite side of the pole from the climbing side or on the climbing side of the pole at a distance from the crossarms at least as great as the width of climbing space required for the highest-voltage conductors concerned. Vertical conductors inclosed in suitable conduit may be attached on the climbing side of the pole.

D. Location of Buckarms Relative to Working Spaces.

Buckarms may be used under any of the following conditions, provided the climbing space is maintained. Climbing space may be obtained as in rule 236, F.

1. STANDARD HEIGHT OF WORKING SPACE.

Lateral working space of the height required by table 11 (rule 238, A, 1) may be provided between the buckarms and adjacent line arms to which conductors on the buckarms are not attached.

Method of meeting requirements. This may be accomplished by increasing the spacing between the line crossarm gains.

2. REDUCED HEIGHT OF WORKING SPACE.

Where no circuits exceeding 8,700 volts between conductors are involved, and the clearances of rule 235, A, 2, (a), (1) and (2) are maintained, buckarms may be placed between line arms having normal spacing, even though such buckarms obstruct the normal working space; provided that a working space of not less than 18 inches in height is maintained either above or below each line arm and each buckarm.

237. D. Location of Buckarms Relative to Working Spaces—Continued.

Exception: The above working space may be reduced to 12 inches if both of the following conditions exist:

Not more than two sets of line arms and buckarms are involved.

Working conditions are rendered safe by providing rubber protective equipment or other suitable devices to insulate and cover line conductors and equipment which are not being worked upon.

238. Vertical Separation Between Line Conductors, Cables, and Equipment Located at Different Levels on the Same Pole or Structure.

All line conductors, cables, or equipment located at different levels on the same pole or structure shall have the vertical separations set forth below.

A. Vertical Separation Between Horizontal Crossarms.

Crossarms supporting line conductors shall be spaced in accordance with table 11. Vertical separations between crossarms shall be measured from center to center.

Exception: Where it is established practice to gain poles with lesser crossarm spacings than specified in table 11 such reduced crossarm separations may be employed if all other applicable separations are complied with.

1. BASIC SEPARATIONS.

The separations given in the following table are for crossarms carrying conductors of 0 to 50,000 volts between conductors attached to fixed supports.

238. A. Vertical Separation Between Horizontal Crossarms—Continued.

Table 11.—*Vertical separation of crossarms carrying conductors*

[All voltages are between conductors]

Conductors usually at lower levels	Supply conductors; preferably at higher levels: Open wires, 0 to 750 volts; cables, all voltages, having effectively grounded continuous metal sheath or messenger	750 to 8,700 volts	8,700 to 15,000 volts	15,000 to 50,000 volts: Same utility	15,000 to 50,000 volts: Different utilities
	Feet	*Feet*	*Feet*	*Feet*	*Feet*
Communication conductors:					
General	[1 2] 4	4	6	------	6
Used in operation of supply lines	2	[3] 2	4	4	6
Supply conductors:					
0 to 750 volts	2	[4] 2	4	4	6
750 volts to 8,700 volts	--------	[4] 2	4	4	6
8,700 volts to 15,000 volts:					
If worked on alive with long-handled tools, and adjacent circuits are neither killed nor covered with shields or protectors	--------	------	4	4	6
If not worked on alive except when adjacent circuits (either above or below) are killed or covered by shields or protectors, or by the use of long-handled tools not requiring linemen to go between live wires	--------	------	2	[5] 4	[5] 4
Exceeding 15,000 volts, but not exceeding 50,000 volts	--------	------	------	[5] 4	[5] 4

Footnotes on following page.

238. A. Vertical Separation Between Horizontal Crossarms—Continued.

2. INCREASED SEPARATIONS FOR VOLTAGES EXCEEDING 50,000 VOLTS BETWEEN CONDUCTORS.

For voltages greater than 50,000 volts between conductors the clearances of table 11 shall be increased at the rate of 0.4 inch per 1,000 volts of the excess.

B. Vertical Separation Between Line Conductors on Horizontal Crossarms.

Where line conductors are supported on horizontal crossarms spaced as required in rule 238, A, the vertical separation between such conductors shall be not less than the following:

1. WHERE CONDUCTORS ON THE CROSSARM ARE OF THE SAME VOLTAGE CLASSIFICATION.

Under these conditions, the vertical separation required by table 11 may be reduced as follows:

Where crossarm separation required by table 11 is—	Separation between conductors may be reduced to—
2 feet	16 inches.
4 feet	40 inches.
6 feet	60 inches.

---

[1] Where supply circuits of 550 volts or less, with transmitted power of 3,200 watts or less, are run below communication circuits in accordance with rule 220, B, 3 the clearance may be reduced to 2 feet.

[2] In localities where the practice has been established of placing on jointly used poles, crossarms carrying supply circuits of less than 300 volts to ground and crossarms carrying communcation circuits at a vertical separation less than specified in the table, such existing construction may be continued until the said poles are replaced provided that—

The minimum separation between existing crossarms is not less than 2 feet, and that—

Extensions to the existing construction shall conform to the clearance requirements specified in table 11.

When communication conductors are all in cable, a supply crossarm carrying only wires of not more than 300 volts to ground may be placed at not less than 2 feet above the point of attachment of the cable to the pole provided that—

The nearest supply wire on such crossarm shall be at least 30 inches horizontally from the center of the pole, and that—

The cable be placed so as not otherwise to obstruct the climbing space.

[3] This shall be increased to 4 feet when the communication conductors are carried above supply conductors unless the communication-line-conductor size is that required for grade C supply lines.

[4] Where conductors are operated by different utilities, a minimum vertical spacing of 4 feet is recommended.

[5] These values do not apply to adjacent crossarms carrying phases of the same circuit or circuits.

238. B. Vertical Separation Between Line Conductors on Horizontal Crossarms—Continued.

2. WHERE CONDUCTORS OF DIFFERENT VOLTAGE CLASSIFICATIONS ARE ON SAME CROSSARM.

Under these conditions, the vertical separation between conductors on adjacent crossarms shall be that required by table 11 (rule 238 A, 1) above for the highest voltage classification concerned.

3. CONDUCTORS OF DIFFERENT SAGS ON SAME SUPPORT.

(a) VARIATION IN CLEARANCE. Line conductors supported at different levels on the same structure and strung to different sags shall have vertical spacings at the supporting structures so adjusted that the minimum spacing at any point in the span, at 60° F, no wind, shall not be reduced more than 25 percent from that required at the supports by rule 235, A, 2, (a), (1) and (2) and this rule.

(b) READJUSTMENT OF SAGS. Sags should be readjusted when necessary to accomplish the foregoing, but not reduced sufficiently to conflict with the requirements of rule 261, F, 4. In cases where conductors of different sizes are strung to the same sag for the sake of appearance or to maintain unreduced clearance throughout storms, the chosen sag should be such as will keep the smallest conductor involved in compliance with the sag requirements of rule 261, F, 4.

C. Separation in Any Direction.

The separation in any direction between conductors of the same or different voltage classification when carried on the same structure, but on crossarms which are not horizontal, shall be not less than the values given in table 11 (rule 238, A, 1 and 2) for vertical separation.

238. C. Separation in Any Direction—Continued.

The separation in any direction shall not in any case be less than the horizontal separation specified in rule 235, A, 2, (a), (1) and (2).

D. Vertical Separation for Line Conductors Not Carried on Crossarms.

The vertical separation between conductors not carried on crossarms shall be the same as required in rule 238, B, 1 for conductors on crossarms.

Exception: Conductors on vertical racks or separate brackets other than wood placed vertically meeting the requirements of rule 235, A, 4 may have separations as specified in that rule.

E. Vertical Separation Between Conductors and Non-Current-Carrying Metal Parts of Equipment.

1. EQUIPMENT.

For the purpose of measuring separations under this rule, "equipment" shall be taken to mean noncurrent-carrying metal parts of equipment, including metal supports for cables or conductors, and metal supply-crossarm braces which are attached to metal crossarms or are less than 1 inch from transformer cases or hangers which are not effectively grounded.

2. SEPARATIONS IN GENERAL.

Vertical separations between supply conductors and communication equipment, between communication conductors and supply equipment, and between supply and communication equipment shall be as follows, except as provided in 3, below:

Supply voltage between conductors	Vertical separation
	Inches
0 to 8,700	40
Exceeding 8,700	[a] 60

[a] Transformer cases and associated hangers and supply cables which are effectively grounded may have a separation of 40 inches.

238. E. Vertical Separation Between Conductors and Non-Current-Carrying Metal Parts of Equipment—Continued.

3. SEPARATIONS FOR SPAN WIRES AND BRACKETS.

Span wires or brackets for lamps or trolley contact conductors shall have at least the vertical separations from communication equipment set forth below:

From open communication conductors on cross-arms:

Span wire or bracket above cross-arm	20 inches.[1]
Span wire or bracket below cross-arm	2 feet.
From messenger wires carrying communication cables	1 foot.
From terminal box of communication cables, if practicable	1 foot.[2]
From communication brackets, bridle wire rings, or drive hooks	2 inches

[1] This may be reduced to 12 inches for either span wires or metal parts of lamp brackets at points 40 inches or more from the pole surface.

[2] Where it is not practicable to obtain a clearance of 1 foot from terminal boxes of communication cables, all metal parts of terminals shall have the greatest practicable separation from fixtures or span wires, including all supporting screws and bolts of both attachments.

Exception: If lamp brackets are effectively grounded, these separations do not apply.

239. Clearances of Vertical and Lateral Conductors From Other Wires and Surfaces on the Same Support.

Vertical and lateral conductors shall have the clearances and separations required by this rule from other conductors, wires, or surfaces on the same support.

Exception 1: This rule does not prohibit the placing of supply circuits of the same or next voltage classification in the same iron pipe, if each circuit or set of wires be inclosed in a metal sheath.

Exception 2: This rule does not prohibit the placing of paired communication conductors in rings attached directly to the pole or to messenger.

239. Clearances of Vertical and Lateral Conductors From Other Wires and Surfaces on the Same Support—Continued.

Exception 3: This rule does not prohibit placing grounding conductors, neutral conductors which are effectively grounded throughout their length and associated with supply circuits of 0 to 15,000 volts, metal sheathed supply cables or conductors enclosed in conduit, directly on the pole.

Exception 4: This rule does not prohibit placing supply circuits of 550 volts or less and not exceeding 3,200 watts and properly insulated, in the same cable with control circuits with which they are associated.

A. Location of Vertical or Lateral Conductors Relative to Climbing Spaces, Working Spaces, and Pole Steps.

Vertical or lateral conductors shall be located so that they do not obstruct climbing spaces, or lateral working spaces between line conductors at different levels, or interfere with the safe use of existing pole steps.

Exception 1: This rule does not apply to portions of the pole which workmen do not ascend while the conductors in question are alive.

Exception 2: This rule does not apply to vertical runs incased in suitable conduit or other protective covering. (See rule 236, H.)

B. Conductors not in Conduit.

Conductors not incased in conduit shall have the same clearances from conduits as from other surfaces of structures.

C. Mechanical Protection near Ground.

Where within 8 feet of the ground, all vertical conductors, cables, and grounding wires shall be protected by a covering which gives suitable mechanical protection. For grounding wires from light-

239. C. Mechanical Protection near Ground—Continued.
ning arresters, the protective covering specified above shall be of wood molding, or other insulating material giving equivalent protection.

Exception 1: This covering may be omitted from armored cables or cables installed in a grounded metal conduit.

Exception 2: This covering may be omitted from lead-sheathed cables in rural districts.

Exception 3: This covering may be omitted from vertical runs of communication cables or conductors.

Exception 4: This covering may be omitted from grounding wires in rural districts having triple-braid weather-proof covering, or where such grounding wire is one of a number of grounding wires used to provide multiple grounds.

Exception 5: This covering may be omitted from wires which are used solely to protect poles from lightning.

D. Requirements for Vertical and Lateral Supply Conductors on Supply Line Poles or Within Supply Space on Jointly Used Poles.

1. GENERAL CLEARANCES.

In general, clearances shall be not less than the values specified in table 12.

239. D. Requirements for Vertical and Lateral Supply Conductors on Supply Line Poles, etc.—Continued.

TABLE 12.—*General clearances*

[All voltages are between conductors]

Clearance of vertical and lateral conductors	Clearances for highest voltage concerned in the clearance	
	0 to 8,700 volts	Exceeding 8,700 volts, add the following for each 1,000 in excess
	Inches	*Inches*
From surfaces of supports	3	0.25
From span, guy, or messenger wires	6	.4
From line conductors rigidly supported on fixed supports, such conductors being of—		
Same circuit	3	.25
Different circuits	6	.4
From line conductors not rigidly supported on fixed supports	(1)	(1)

[1] The clearances shall be increased beyond the values given above from line conductors on fixed supports (See rule 235, A, 2, (b), and 3, (b)).

2. SPECIAL CASES.

The following requirements apply only to portions of a pole which workmen ascend while the conductors in question are alive:

(a) SIDE-ARM CONSTRUCTION. Vertical conductors in metal-sheathed cables and grounding wires may be run without insulating protection from supply line conductors on poles used only for supply lines and employing side-arm construction on the side of the pole opposite to the line conductors if climbing space is provided on the line-conductor side of the pole.

(b) ON INSULATORS. Vertical and lateral conductors of less than 8,700 volts between con-

239. D. Requirements for Vertical and Lateral Supply Conductors on Supply Line Poles, etc.—Continued.

ductors if on poles used only for supply lines may be run in multiple-conductor cables having suitable substantial insulating covering, if such cable is held taut on standard insulators supported on pins or brackets and is arranged so that the cable is held at a distance of approximately 5 inches from the surface of the pole, and from any pole step.

(c) Conductors to Street Lamps. On poles used only for supply lines, open wires may be run from the supply line arm directly to the head of a street lamp, provided the clearances of table 12 are obtained and the open wires are substantially supported at both ends.

(d) Conductors of Less Than 300 Volts. Vertical or lateral secondary supply conductors of not more than 300 volts to ground may be run in multiple-conductor cable attached directly to the pole surface or to crossarms in such a manner as to avoid abrasion at the point of attachment. Each conductor of such cable which is not effectively grounded, or the entire cable assembly, shall have an insulating covering required for a conductor of at least 1,000 volts.

(e) Other Conditions. If open wire conductors are within 4 feet of the pole, vertical conductors where within a zone of 4 feet above and below such line conductors of not more than 8,700 volts between conductors, or where within a zone 6 feet above and below such line conductors of more than 8,700 volts between conductors, shall be run in one of the following ways:

(1) So as to clear the pole center by not less than 15 inches if the vertical conduc-

239. D. Requirements for Vertical and Lateral Supply Conductors on Supply Line Poles, etc.—Continued.

tors are of 8,700 volts or less between conductors, or 20 inches if more than 8,700 volts;

(2) Enclosed in insulating conduit, or in metal conduit or cable protected by an insulating covering;

(3) Conductors with triple-braid weatherproof or equivalent covering and covered by wood molding.

Methods (2) and (3) apply also to lateral runs and to grounding conductors, except that conductors for grounding lightning-protection wires are not required to be covered within 6 feet above or below circuits of 15,000 volts or more.

E. Requirements for Vertical and Lateral Communication Conductors on Communication Line Poles or Within the Communication Space on Jointly Used Poles.

1. CLEARANCES FROM WIRES.

The clearances and separations of vertical and lateral conductors from other conductors (except those in the same ring run) and from guy, span, or messenger wires shall be 3 inches.

2. CLEARANCES FROM POLE AND CROSSARM SURFACES.

Vertical and lateral insulated communication conductors may be attached directly to a pole or crossarm. They shall have a vertical clearance of at least 40 inches from any supply conductors (other than vertical runs or lamp leads) of 8,700 volts or less between conductors, or 60 inches if more than 8,700 volts between conductors.

Exception: These clearances do not apply where the supply circuits involved are those carried in the manner specified in rule 220, B, 3.

239. Clearances of Vertical and Lateral Conductors From Other Wires and Surfaces on the Same Support—Continued.

F. Requirements for Vertical Supply Conductors Passing Through Communication Space on Jointly Used Poles.

Vertical supply conductors, including grounding wires, which pass through communication line space on jointly used poles shall be installed as follows:

1. METAL-SHEATHED SUPPLY CABLES.

Metal-sheathed supply cables shall be covered as follows:

(a) EXTENT OF COVERING. Covering shall extend from the lowest points of such cables up to 40 inches above the highest communication conductors.

(b) NATURE OF COVERING. The covering shall consist of wood molding or other suitable insulating material at points higher than 8 feet above the ground.

Exception 1: Metal pipe may be used throughout, under the following conditions:

On poles where there are no trolley attachments and the metal pipe is effectively grounded, no insulating covering is required.

On poles where there are trolley attachments or where the metal pipe is not effectively grounded, the pipe shall be covered with wood molding or other suitable insulating material from a point six feet below the lowest communication wire or trolley attachment to a point 40 inches above the highest communication wire or trolley attachment.

Exception 2: No insulating covering is required over supply secondary multi-

239. F. Requirements for Vertical Supply Conductors Passing Through Communication Space on Jointly Used Poles—Continued.

conductor cables attached directly to the pole surface in accordance with the requirements of rule 239, F, 2 (c).

Exception 3: Where there are no trolley attachments on the pole, no insulating covering is required over supply cables having effectively grounded lead sheath, or supply cables having effectively grounded metal sheath of other types where mutually agreed to by the parties concerned.

2. SUPPLY CONDUCTORS.

Supply conductors shall be installed in one of the following ways:

(a) IN CONDUIT. Conductors of all voltages may be inclosed in the same way and to the same extent as required in 1 above for metal-sheathed cables.

(b) ON PINS AND INSULATORS. Vertical and lateral conductors of street-lighting circuits and service leads of less than 750 volts to ground may be run on the street side of the pole in multiple-conductor cable having suitable substantial insulating covering if such cable is held taut on standard insulators supported on pins or brackets and arranged so that the cable shall be held at a distance of approximately 5 inches away from the surface of the pole or from any pole steps.

(c) INSTALLED ON THE POLE SURFACE. Secondary supply conductors of not more than 300 volts to ground may be run in multiple-conductor cables attached directly to the pole surface in such a manner as to avoid abrasion at the points of attachment. In

239. F. Requirements for Vertical Supply Conductors Passing Through Communication Space on Jointly Used Poles—Continued.

the case of aerial services, the point where such cables leave the pole shall be at least 40 inches above the highest, or 40 inches below the lowest, communication attachment. Each conductor of such cable which is not effectively grounded shall be insulated for a potential of at least 1,000 volts.

(d) Suspended From Supply Crossarm. Lamp leads of street lighting circuits may be run from supply crossarms directly to a street lamp bracket or luminaire under the following conditions:

(1) The vertical run shall consist of paired wires or multiple-conductor cable securely attached at both ends to suitable brackets and insulators.

(2) The vertical run shall be held taut at least 40 inches from the surface of the pole (through the communication space), at least 12 inches beyond the end of any communication crossarm by which it passes, and at least 6 inches from communication drop wires.

(3) Insulators attached to lamp brackets for supporting the vertical run shall be capable of meeting, in the position in which they are installed, the same flashover requirements as the luminaire insulators.

(4) Each conductor of the vertical run shall be No. 10 AWG or larger.

3. SUPPLY GROUNDING WIRES.

Supply grounding wires shall be covered with wood molding or other suitable insulating cover-

239. F. Requirements for Vertical Supply Conductors Passing Through Communication Space on Jointly Used Poles—Continued.

ing to the extent required for metal-sheathed cables in 1 above.

Exception: If there are no trolley attachments on the pole, insulating covering is not required for a grounding conductor which is metallically connected to a conductor which forms part of an effective grounding system.

4. SEPARATION FROM THROUGH BOLTS.

Vertical runs of supply conductors shall be separated from the ends of through bolts associated with communication line equipment by one-eighth of the circumference of the pole where practicable, but in no case less than 2 inches.

G. **Requirements for Vertical Communication Conductors Passing Through Supply Space on Jointly Used Poles.**

All vertical runs of communication conductors passing through supply space shall be installed as follows:

1. METAL-SHEATHED COMMUNICATION CABLES.

Vertical runs of metal-sheath communication cables shall be covered with wood molding, or other suitable insulating material, where they pass trolley feeders or other supply-line conductors. This insulating covering shall extend from a point 40 inches above the highest trolley feeders, or other supply conductors, to a point 6 feet below the lowest trolley feeders or other supply conductors, but need not extend below the top of any mechanical protection which may be provided near the ground.

Exception: Communication cables may be run vertically on the pole through space occupied by railroad-signal supply circuits in the lower position, as permitted in rule 220, B, 3, without insulating covering within the supply space.

239. G. Requirements for Vertical Communication Conductors Passing Through Supply Space on Jointly Used Poles—Continued.

2. COMMUNICATION CONDUCTORS.

Vertical runs of insulated communication conductors shall be covered with wood molding, or other suitable insulating material, to the extent required for metal-sheathed communication cables in 1 above, where such conductors pass trolley feeders or other supply conductors.

Exception: Communication conductors may be run vertically on the pole through space occupied by railroad-signal supply circuits in the lower position, as permitted in rule 220, B, 3, without insulating covering within the supply space.

3. COMMUNICATION GROUNDING CONDUCTORS.

Vertical communication grounding conductors shall be covered with wood molding or other insulating material between points at least 6 feet below and 40 inches above any trolley feeders or other supply line conductors by which they pass.

Exception: Communication grounding conductors may be run vertically on the pole through space occupied by railroad-signal supply circuits in the lower position, as permitted in rule 220, B, 3, without insulating covering within the supply space.

4. SEPARATION FROM THROUGH BOLTS.

Vertical runs of communication conductors shall be separated from the ends of through bolts associated with supply-line equipment by one-eighth of the circumference of the pole where practicable, but in no case less than 2 inches.

240. General.

For the purposes of section 26, "Strength requirements", and section 27, "Line insulators", conductors and their supporting structures are classified under the grades specified in this section on the basis of the relative hazard existing.

241. Application of Grades of Construction to Different Situations.

A. Supply Cables.

For the purposes of these rules, supply cables are divided into two classes as follows:

1. SPECIALLY INSTALLED CABLES.

In this class are included metal-sheathed supply cables installed in accordance with rule 261, G, 1.

Note: Such cables are sometimes permitted to have a lower grade of construction than open-wire supply conductors of the same voltage.

2. OTHER CABLES.

In this class are included all other supply cables.

Note: Such cables are required to have the same grade of construction as open-wire supply conductors of the same voltage.

B. Two or More Conditions.

In any case where two or more conditions affecting the grade of construction exist, the grade of construction used shall be the highest one required by any of the conditions.

C. Order of Grades.

For supply and communication conductors and supporting structures, the relative order of grades is B, C, and N, grade B being the highest. Where grades D and N are specified for communication lines, grade D is the higher.

Note: Grade D cannot be directly compared with grades B and C, but rule 241, D, 3, (c) provides for cases where these two conditions are present.

241. Application of Grades of Construction, etc.—Con.

D. At Crossings.

1. GRADE OF UPPER LINE.

Conductors and supporting structures of a line crossing over another line shall have the grade of construction specified in rules 241, D, 3; 242, and 243.

2. GRADE OF LOWER LINE.

Conductors and supporting structures of a line crossing under another line need only have the grades of construction which would be required if the line at the higher level were not there.

3. MULTIPLE CROSSINGS.

(*a*) WHERE A LINE CROSSES IN ONE SPAN OVER TWO OTHER LINES. The grade of construction of the uppermost line shall be not less than the highest grade which would be required of either one of the lower lines if it crossed the other lower line.

Example: If a 2,300-volt line crosses in the same span over a communication line and a direct-current trolley contact conductor of more than 750 volts, the 2,300-volt line is required to comply with grade B construction at the crossing.

This is a double crossing and introduces a greater hazard than where the upper supply line crosses the communication line only.

(*b*) WHERE ONE LINE CROSSES OVER A SPAN IN ANOTHER LINE, WHICH SPAN IS IN TURN INVOLVED IN A SECOND CROSSING. The grade of construction for the highest line shall be not less than that required for the next lower line.

Exception: This requirement does not apply when the two upper lines are of

241. D. At Crossings—Continued.

such a nature and have such circuit protection that the danger of causing a break in the lower of these two lines by mechanical or electrical contact is eliminated.

(c) WHERE COMMUNICATION CONDUCTORS CROSS OVER SUPPLY CONDUCTORS AND RAILROAD TRACKS IN THE SAME SPAN. The grades of construction shall be in accordance with table 13.

Recommendation: It is recommended that the placing of communication conductors above supply conductors at crossings, conflicts, or on jointly used poles, be avoided unless the supply conductors are trolley contact conductors and their associated feeders.

TABLE 13.—*Grades of construction for communication conductors crossing over railroad tracks and supply lines*

When crossing over—	Communication conductor grades
Railroad tracks and supply lines of 0 to 750 volts to ground, or specially installed supply cables of all voltages	D
Railroad tracks and supply lines exceeding 750 volts to ground	B

E. Conflicts.

1. HOW DETERMINED.

Where two lines are adjacent (except at crossing spans) the distance between them and the relative heights above ground of poles and of conductors on each line determine whether conflict exists, and, if so, whether the conflict is a structure conflict (see definition) or a conductor conflict (see definition), or both.

241. E. Conflicts—Continued.

2. CONDUCTOR CONFLICT.

At conductor conflicts, the grade of construction of the conflicting conductor shall be as required by rules 241, D, 3, and 242.

3. STRUCTURE CONFLICT.

At structure conflicts, the grade of construction of the conflicting structure shall be as required by rule 243.

242. GRADES OF CONSTRUCTION FOR CONDUCTORS.

The grades of construction required for conductors of all classes in different stituations are given in tables 14 and 15. For the purpose of these tables certain classes of circuits are treated as follows:

A. Status of Constant-Current Circuits.

The grade of construction for a constant-current supply circuit involved with a communication circuit and not in specially installed cable shall be based on either its current rating or on the open-circuit voltage rating of the transformer supplying such circuit, as set forth in tables 14 and 15. In all other cases the grade of construction for a constant-current circuit shall be based on its nominal full-load voltage.

B. Status of Railway Feeders and Trolley Contact Conductors.

In determining grades of construction where railway feeders and trolley-contact conductors are involved, they shall be considered as other supply conductors of the same voltage.

Exception: Direct-current trolley circuits exceeding 750 volts to ground where crossing over, conflicting with, or on jointly used poles with and above communication circuits, shall have the grades of construction specified in table 14 for direct-current railway feeders.

TABLE 14.—*Grades of construction for supply conductors alone, at crossings, at conflicts, or on same poles with other conductors*

[All voltages are to ground, which for ungrounded circuits means the highest voltage between any two conductors]

Conductors, tracks and rights of way at lower levels / Supply Conductors at Higher Levels [a]	Constant-potential supply conductors, other than direct current railway feeders									Constant current supply conductors				Direct current railway feeders				Communication conductors used exclusively in the operation of, and run as, supply lines	
	0 to 750 volts		750 to 2,900 volts			Exceeding 2,900 volts				0 to 7.5 amperes		Exceeding 7.5 amperes		0 to 750 volts		Exceeding 750 volts			
	Urban	Rural	Urban		Rural	Urban		Rural											
	Open or Cable	Open or Cable	Open	Cable	Open or Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable	Open	Cable
Fenced rights of way	N	N	[b]N	N	N	[b]N	[b]N	N	N	B, C or N See Rule 242-A				B, C or N See Rule 242-B				C or N See Rule 242-C	
Elsewhere than on fenced rights of way	N	N	C	N	N	[c]B	C	N	N										
Railroad tracks – Main or Minor	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Street-railway tracks having no overhead contact conductor	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Constant-potential supply conductors — 0 to 750 volts — Open or Cable	N	N	C	N	N	[c]B	C	[d]C	N	B, C or N See Rule 242-A				B, C or N See Rule 242-B				B, C or N See Rule 242-C	
Constant-potential supply conductors — 750 to 2,900 volts — Open	[e]C	N	C	C	N	[c]B	C	N	N										
Constant-potential supply conductors — 750 to 2,900 volts — Cable	N	N	C	N	N	[c]B	C	N	N										
Constant-potential supply conductors — Exceeding 2,900 volts — Open	[e]B	[e]C	B	B	N	[c]B	C	N	N										
Constant-potential supply conductors — Exceeding 2,900 volts — Cable	[e]C	N	C	N	N	[c]B	C	N	N										
Constant current supply conductors – open or cable	B, C or N See Rule 242-A									B, C or N See Rule 242-A				B, C or N See Rules 242-A & B				B, C or N See Rules 242-A & C	
Direct current railway feeders – open or cable	B, C or N See Rule 242-B									B, C or N See Rules 242-A & B				B, C or N See Rule 242-B				B, C or N See Rules 242-B & C	
Trolley contact conductors – alternating or direct current	B, C or N See Rule 242-B									B, C or N See Rules 242-A & B				B, C or N See Rule 242-B				B, C or N See Rules 242-B & C	
Communication conductors, open or cable, used exclusively in the operation of supply lines	B, C or N See Rule 242-C									B, C or N See Rules 242-A & C				B, C or N See Rules 242-B & C				B, C or N See Rule 242-C	
Communication conductors – urban or rural, open or cable — Major [f]	N	N	C	C	C	[gh]B	[i]C	[gh]B	[i]C	C	C or N see Rule 242-A	[gj]B	C or N see Rule 242-A	N	N	[g]B	[i]C	B, C or N See Rule 242-C	
Communication conductors – urban or rural, open or cable — Minor [f]	N	N	C	C	C	C	C	C	C	C		C		N	N	C	C		

a. The words "open" and "cable" appearing in the headings have the following meanings as applied to supply conductors: "Cable" means the specially installed cables described in rule 241, A, 1. "Open" means open wire and also supply cables not "specially installed."

b. Where lines are located so that they can fall outside the fenced right-of-way into urban districts, the construction shall comply with the grades specified for lines not on fenced rights-of-way for corresponding voltages.

c. If circumstances within a given area warrant it, supply conductors need only meet the requirements of grade C construction if the supply circuits are so constructed, operated, and maintained that such circuits will be promptly deenergized, both initially and following subsequent breaker operations, in the event of a contact with lower supply conductors or other grounded objects.

d. Grade N construction may be used, if crossing over or conflicting with, supply services only.

e. If the wires are service drops, they may have grade N sizes and sags as set forth in tables 28 and 29 (rule 263, E).

f. Grade N construction may be used where the communication conductors consist only of not more than 1 insulated twisted-pair or parallel-lay conductor, or where 2 or more such insulated conductors are involved and these consist of service drops not grouped together in a single run.

g. The supply conductors need only meet the requirements of grade C construction if both of the following conditions are fulfilled:

(1) The supply and communication circuits are so constructed, operated and maintained that the supply circuits will be promptly deenergized, both initially and following subsequent breaker operations, in the event of a contact with the communication plant.

(2) The voltage and current impressed on the communication plant in the event of a contact with the supply conductors are not in excess of the safe operating limit of the communication protective devices.

h. Grade C construction may be used for ungrounded supply circuits not exceeding 5,000 volts between conductors.

i. Grade C construction applies to any supply cable on jointly used poles if carried above communication attachments and supported on an effectively grounded messenger.

j. Grade C construction may be used if the open-circuit voltage of the transformer supplying the circuit does not exceed 2,900 volts.

242. Grades of Construction for Conductors—Continued.

C. Status of Communication Circuits Used Exclusively in the Operation of Supply Lines.

In determining grades of construction where communication circuits used exclusively in the operation of supply lines are concerned, they shall be considered as ordinary communication circuits when run as such (see rule 288, A, 3) and as supply circuits when run as such (see rule 288, A, 4).

Exception: Communication circuits located below supply circuits with which they are used shall not require such supply circuits to meet any rules for grade of construction other than that the sizes of such supply conductors shall be not less than required for grade C (see rule 261, F, 2).

D. Status of Fire-Alarm Conductors.

In determining grades of construction where fire-alarm conductors are concerned, they shall be considered as other communication circuits.

Exception: Fire-alarm conductors shall always meet grade D where the span length is from 0 to 150 feet, and grade C where the span length exceeds 150 feet.

E. Status of Neutral Conductors of Supply Circuits.

Supply-circuit neutral conductors, which are effectively grounded throughout their length and are not located above supply conductors of more than 750 volts to ground, shall have the same grade of construction as supply conductors of not more than 750 volts to ground, except that they need not meet any insulation requirements. Other neutral conductors shall have the same grade of construction as the phase conductors of the supply circuits with which they are associated.

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242. E. Status of Neutral Conductors of Supply Circuits—Continued.

TABLE 15.—*Grades of construction for communication conductors alone, or in upper position at crossings, at conflicts, or on joint poles*

[All voltages are to ground, which, for ungrounded circuits, means the highest voltage between any two conductors.]

Conductors, tracks, and rights-of-way at lower levels ↓ / Communication conductors at higher levels [1] →			Communication conductors, rural or urban, open or cable, including communication conductors run as such, but used exclusively in the operation of supply lines: Major	Minor
Fenced rights-of-way			N	N
Elsewhere than on fenced rights-of-way			N	N
Railroad tracks—main or minor			D	D
Street-railway tracks having no overhead-contact wire			N	N
Constant-potential supply conductors [2]	0 to 750 volts	Open or cable	N	N
	750 to 2,900 volts	do	C	C
	Exceeding 2,900 volts	Open	B	C
		Cable	C	C
Constant-current supply conductors.[2]	0 to 7.5 amperes	Open [3]	C	C
	Exceeding 7.5 amperes	do.[3]	[4] B	C
Direct-current railway feeders.[2]	0 to 750 volts	Open or cable	N	N
	Exceeding 750 volts	do	B	C
Trolley-contact conductors.	0 to 750 volts	ac or dc	C	C
	Exceeding 750 volts	ac	[5] B or C	[5] B or C
		dc	B	C
Communication conductors, open or cable, used exclusively in the operation of supply lines			B, C, or N [6]	
Communication conductors, open or cable, urban or rural, major or minor			N	

[1] It is recommended that the placing of communication conductors above supply conductors at crossings, conflicts, or on jointly used poles be avoided, unless the supply conductors are trolley-contact conductors and their associated feeders.

[2] The words "open" and "cable" appearing in the headings have the following meaning as applied to supply conductors: "Cable" means the specially installed cables described in rule 241, A, 1. "Open" means open wire and also supply cables not specially installed.

[3] Where constant-current circuits are in specially installed cable, they are considered on the basis of the nominal full-load voltage.

[4] Grade C construction may be used if the open-circuit voltage of the transformer supplying the circuit does not exceed 2,900 volts.

[5] See rule 242, B.

[6] See rule 242, C.

243. GRADES OF SUPPORTING STRUCTURES.

A. Poles or Towers.

The grade of construction shall be that required for the highest grade of conductors supported.

Exception 1: The grade of construction of jointly used poles, or poles used only by communication lines, need not be increased merely because of the fact that communication wires carried on such poles cross over trolley contact conductors of 0 to 750 volts to ground.

Exception 2: Poles carrying grade C or D fire-alarm conductors, where alone, or where concerned only with other communication conductors, need meet only the requirements of grade N.

Exception 3: Poles carrying supply service loops of 0 to 750 volts to ground shall have at least the grade of construction required for supply line conductors of the same voltage.

Exception 4: Where communication lines cross over supply conductors and a railroad in the same span and grade B is required by rule 241, D, 3, (c) for the communication conductors, due to the presence of railroad tracks, the grade of the poles or towers shall be D.

Exception 5: At structure conflicts, even though no conductor conflict exists, the grade of construction which would be required by rule 242, if the conductors were in conflict, shall be applied to the pole or tower.

Note: This requirement may result in a higher grade of construction for the pole or tower than for the conductors carried thereon.

Exception 6: In the case where a structure conflict does not exist, but any conductor is in conductor conflict, the grade of construction of the pole or tower is not required to meet the conductor grade due to the conductor conflict.

243. Grades of Supporting Structures—Continued.

B. Crossarms.

The grade of construction shall be that required for the highest grade of conductors carried by the crossarm concerned.

Exception 1: The grade of construction of crossarms carrying only communication conductors need not be increased merely because of the fact that such conductors cross over trolley-contact conductors of 0 to 750 volts to ground.

Exception 2: Crossarms carrying grade C or D fire-alarm conductors, where alone or where concerned with other communication conductors, need meet only the requirements for grade N.

Exception 3: Crossarms carrying supply service loops of 0 to 750 volts to ground shall have at least the grade of construction required for supply line conductors of the same voltage.

Exception 4: Where communication lines cross over supply conductors and a railroad in the same span and grade B is required by rule 241, D, 3, (c) for the communication conductors due to the presence of railroad tracks, the grade of the crossarm shall be D.

C. Pins, Insulators, and Conductor Fastenings.

The grade of construction shall be that required for the conductor concerned.

Exception 1: The grade of construction of pins, insulators, and conductor fastenings carrying only communication conductors need not be increased merely because of the fact that such conductors cross over trolley-contact conductors of 0 to 750 volts to ground.

Exception 2: In the case of grade C or D fire-alarm conductors where alone, or where concerned only with other communication conductors, pins,

243. C. Pins, Insulators, and Conductor Fastenings—Con.

insulators, and conductor fastenings need meet only the requirements for grade N.

Exception 3: In the case of supply service loops of 0 to 750 volts to ground, pins, insulators, and conductor fastenings shall have at least the same grade of construction as required for supply-line conductors of the same voltage.

Exception 4: Where communication lines cross over supply conductors and a railroad in the same span, and grade B is required by rule 241, D, 3, (c) for the communication conductors due to the presence of railroad tracks, the grade of pins, insulators, and conductor fastenings shall be D.

Exception 5: In case communication conductors are required to meet grade B or C, the insulators need meet only the requirements for mechanical strength for these grades.

SEC. 25. LOADING FOR GRADES B, C, AND D

250. General Loading Map.

Three general degrees of loading due to weather conditions are recognized and are designated as heavy, medium, and light loading. The map in figure 1 shows the districts in the United States in which these loadings are normally applicable. It is recognized that loadings in certain areas in each of the loading districts are greater, and in some cases may be less, than those specified for the districts. It is expected that detailed districting will be carried out by state administrative authorities, which will delineate, as far as practicable, such areas. In the absence of such detailed districting, however, no reduction in the loadings specified in this code shall be made without approval of the administrative authority.

Note: The localities in the different groups are classed according to the relative prevalence of high wind velocity and thickness of ice which accumulates on wires, light loading being,

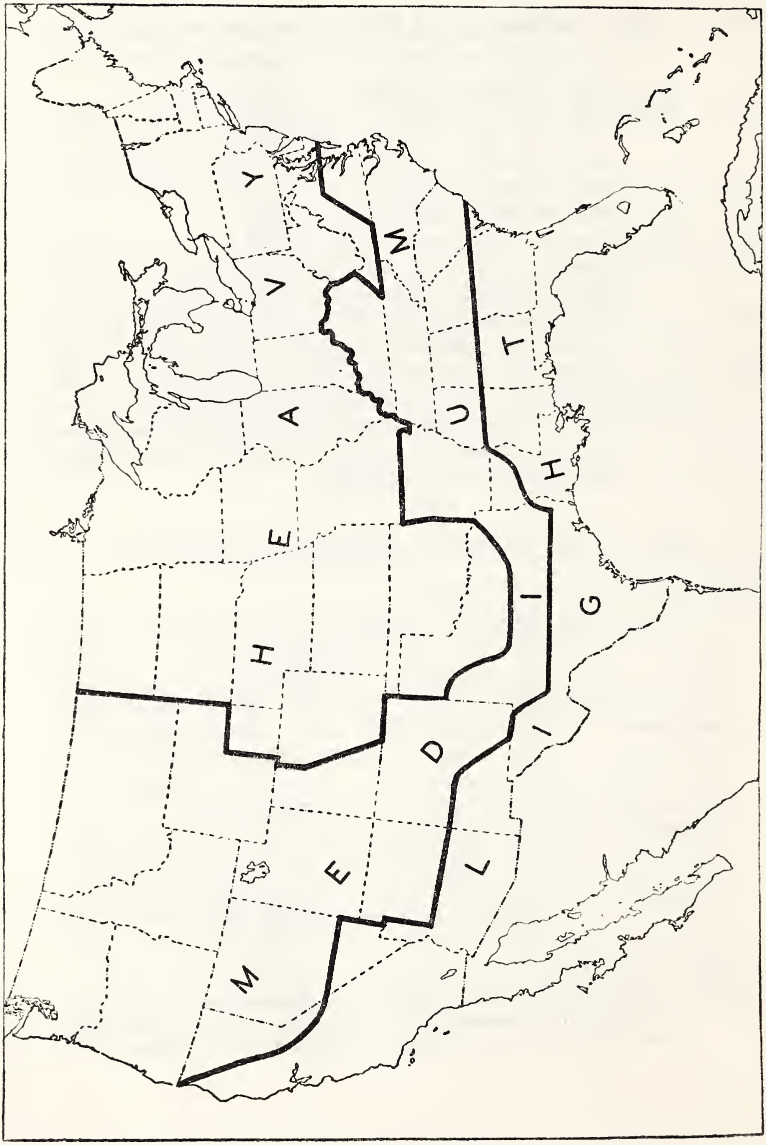

FIGURE 1.—*General loading map showing territorial division of the United States with respect to loading of overhead lines.*

250. General Loading Map—Continued.

in general, for places where little, if any, ice ever accumulates on wires.

Where high wind velocities are frequent in a given place the loading for that place may be classed as heavy, even though ice does not accumulate to any greater extent than at some other place having less severe winds which has been classed as a medium loading district.

251. Conductor Loading.

The loading on conductors shall be assumed to be the resultant loading per foot equivalent to the vertical load per foot of the conductor, ice-covered where specified, combined with the transverse loading per foot due to a transverse, horizontal wind pressure upon the projected area of the conductor, ice-covered where specified, to which equivalent resultant shall be added a constant. In the tabulation below are the values for ice, wind, temperature, and constants which shall be used to determine the conductor loading.

	Loading district		
	Heavy	Medium	Light
Radial thickness of ice (in.)	0. 50	0. 25	0
Horizontal wind pressure in pounds per square foot	4	4	9
Temperature (° F)	0	+15	+30
Constant to be added to the resultant in pounds per foot:			
For bare conductors of copper, steel, copper alloy, copper-covered steel, and combinations thereof	0. 29	0. 19	0. 05
For bare conductors of aluminum (with or without steel reinforcement)	. 31	. 22	. 05
For weather-proof and similar covered conductors (all materials)	. 31	. 22	. 05

251. Conductor Loading—Continued.

Note: Since heavy ice does not often form on conductors in a heavy wind, the transverse loading assumed is deemed sufficient for the purpose, but is not sufficient to represent the vertical (or combined) load which is imposed on conductors by the heavy deposits of ice which frequently form in comparatively still air. In order to apply a total loading to conductors representing more nearly the conditions encountered in practice, constants have been added to the conductor loading which make no substantial change in the conductor loading specified in the fourth edition of this code.

Where cables are concerned, the specified loadings shall be applied to both cable and messenger.

In applying loadings to bare stranded conductors, the coating of ice shall be considered as a hollow cylinder touching the outer strands.

252. Loads Upon Line Supports.

A. Assumed Vertical Loading.

The vertical loads upon poles, towers, foundations, crossarms, pins, insulators, and conductor fastenings shall be their own weight plus the superimposed weight which they support, including all wires and cables, ice-coated in heavy and medium loading districts, together with the effect of any difference in elevation of supports. The radial thickness of ice shall be computed only upon wires, cables, and messengers, and shall be taken as the following:

Heavy loading district (H), 0.50 inch of ice.
Medium loading district (M), 0.25 inch of ice.
Light loading district (L), no ice.

Ice is assumed to weigh 57 pounds per cubic foot.

Note: The weight of ice upon supports is ignored for the sake of simplicity.

B. Assumed Transverse Loading.

In computing the stresses in poles, towers, and side guys the loading shall be taken as one of the following according to climatic conditions of the locality concerned.

252. B. Assumed Transverse Loading—Continued.

1. HEAVY LOADING (H).

A horizontal wind pressure, at right angles to the direction of the line, of 4 pounds per square foot upon the projected area of cylindrical surfaces of all supported conductors and messengers, when covered with a layer of ice 0.5 inch in radial thickness and on surfaces of the poles and towers without ice covering, shall be called heavy loading. (See 4 and 5 following.)

For supporting structures carrying more than 10 wires, not including cables supported by messengers, where the pin spacing does not exceed 15 inches, the transverse load shall be calculated on two-thirds of the total number of such wires with a minimum of 10 wires.

2. MEDIUM LOADING (M).

A horizontal wind pressure at right angles to the direction of the line, of 4 pounds per square foot upon the projected area of cylindrical surfaces of all supported conductors and messengers when covered with a layer of ice 0.25 inch in radial thickness and on the surfaces of the poles and towers without ice covering, shall be called medium loading. (See 4 and 5 following.)

For supporting structures carrying more than 10 wires, not including cables supported by messengers, where the pin spacing does not exceed 15 inches, the transverse load shall be calculated on two-thirds of the total number of such wires with a minimum of 10 wires.

3. LIGHT LOADING (L).

A horizontal wind pressure at right angles to the direction of the line of 9 pounds per square foot upon the projected area of cylindrical surfaces of all supported conductors and messengers, poles and towers without ice covering, shall be called light loading. (See 4 and 5 following.)

252. B. Assumed Transverse Loading—Continued.

4. TROLLEY-CONTACT CONDUCTORS.

When a trolley-contact conductor is supported on a pole it shall be included in the computation of the transverse load on the structure.

5. FLAT SURFACES.

For flat surfaces the assumed unit wind pressure shall be increased by 60 percent. Where latticed structures are concerned, the actual exposed area of one lateral face shall be increased by 50 percent to allow for the pressure on the opposite face; this total, however, need not exceed the pressure which would occur on a solid structure of the same outside dimensions. The results obtained by more exact calculations may be substituted for the values obtained by this simple rule.

6. AT ANGLES (COMBINED LONGITUDINAL AND TRANSVERSE LOADING).

Where a change in direction of wires occurs, the loading upon the structure, including guys, shall be assumed to be a resultant load equal to the vector sum of the transverse wind load given in 1, 2, or 3 above and the resultant load imposed by the wires due to their change in direction. In obtaining these loadings, a wind direction shall be assumed which will give the maximum resultant load, proper reduction being made in loading to account for the reduced wind pressure on the wires resulting from the angularity of the application of the wind to the wires.

C. Assumed Longitudinal Loading.

1. CHANGE IN GRADE OF CONSTRUCTION.

The longitudinal loading upon supporting structures, including poles, towers, and guys at ends of sections required to be of grade B construction, when located in lines of lower than grade B construction, shall be taken as an unbalanced pull in

252. Assumed Longitudinal Loading—Continued.

the direction of the higher grade section equal to the pull of two-thirds of the conductors supported thereon which are smaller than No. 2 AWG, the conductor loading to be that given in rule 251, and such two-thirds of the conductors being selected so as to produce the maximum stress in the supports.

If the application of the above results in a fractional part of a conductor, the nearest whole number shall be used. In no case shall the assumed unbalanced pull on the supporting structure be less than the maximum loaded tension in any two of the conductors carried (including overhead ground wires), such two conductors being selected so as to produce the maximum stress in the supports.

2. JOINTLY USED POLES AT CROSSINGS OVER RAILROADS OR COMMUNICATION LINES.

Where a joint line crosses over a railroad or a communication line and grade B is required for the crossing span, the tension in the communication conductors of the joint line may be considered as limited to one-half their breaking strength, provided they are smaller than No. 8 Stl. WG, if of steel, or No. 6 AWG, if of copper, regardless of how small the initial sags of the communication conductors at 60° F.

3. DEAD-ENDS.

The longitudinal loading upon supporting structures shall be taken as an unbalanced pull equal to the tensions of all conductors and messengers (including overhead ground wires), under the conditions of conductor loading specified in rule 251.

4. COMMUNICATION CONDUCTORS ON UNGUYED SUPPORTS AT RAILROAD CROSSINGS

The longitudinal loading shall be assumed equal to an unbalanced pull in the direction of the

252. C. Assumed Longitudinal Loading—Continued.

crossing of all open-wire conductors supported, the pull of each conductor being taken as 50 percent of its ultimate strength in the heavy loading district, 33⅓ percent in the medium loading district, and 22¼ percent in the light loading district.

D. Average Span Lengths.

1. GENERAL.

The calculated transverse loads upon poles, towers, and crossarms, except as provided in 2 below, shall be based upon the average span length of a section of line that is reasonably uniform as to height, number of wires, grade, and span length. In no case shall the average value taken be less than 75 percent or more than 125 percent of the actual average of the two spans adjacent to the structure concerned.

2. CROSSINGS.

In the case of crossings over railroads or communication lines (other than minor communication lines) the actual lengths of the two spans adjacent to the two structures concerned shall be used.

E. Simultaneous Application of Loads.

1. When calculating transverse strength, the assumed transverse and vertical loads shall be taken as acting simultaneously.
2. In calculating longitudinal strength, the assumed longitudinal loads shall be taken without consideration of the vertical or transverse loads.

SEC. 26. STRENGTH REQUIREMENTS

260. PRELIMINARY ASSUMPTIONS.

It is recognized that deformation, deflection, or displacement of parts of the structure will, in some cases, change the effects of the loads assumed. In the calculation of stresses, however, no allowance shall be made for such

260. Preliminary Assumptions—Continued.

deformation, deflection, or displacement of supporting structures (including poles, towers, guys, crossarms, pins, conductor fastenings, and suspension insulators) unless the methods used to evaluate them have been approved by the administrative authority.

261. Grades B and C Construction.

A. Poles and Towers.

The strength requirements for poles and towers may be met by the structures alone or with the aid of guys or braces.

1. AVERAGE STRENGTH OF THREE POLES.

A pole (single-base structure) not individually meeting the transverse strength requirements will be permitted when reinforced by a stronger pole on each side, if the average strength of the three poles meets the transverse strength requirements, and the weak pole has not less than 75 percent of the required strength.

An extra pole inserted in a normal span for the purpose of supporting a service loop may be ignored, if desired, in the calculation of the strength of the line.

Exception: In the case of crossings over railroads or communication lines (other than minor communication lines), the actual strengths of the crossing poles shall be used.

2. REINFORCED-CONCRETE POLES.

Reinforced-concrete poles shall be of such material and dimensions as to withstand, for vertical and transverse strength, the loads assumed in rules 252, A and B, and for longitudinal strength the loads in rule 252, C, without exceeding the following percentages of their ultimate strength at the ground line for unguyed poles, or at the point of guy attachment for guyed poles. (Where guys are used, see rule 261, C.)

261. A. Poles and Towers—Continued.

	Percentages of ultimate strength for reinforced-concrete poles	
	Grade B	Grade C
For transverse strength (when installed)	25	37.5
For longitudinal strength (at all times):		
In general	100	No requirement.
At dead-ends	50	75.0

3. STEEL SUPPORTING STRUCTURES.

In the design of steel structures, the term "overload capacity factor" referred to in table 16 is to be interpreted in such a manner that the completed structure, if tested, shall support without permanent deflection the maximum loading to which it will be subjected as specified in section 25, multiplied by the factors given in table 16. The absence of permanent set on the structure indicates that no part has been stressed beyond the yield point. Allowance should be made for bolt slip.

Steel supports, steel towers, and metal poles shall be designed and constructed so as to meet the following requirements:

(a) VERTICAL AND TRANSVERSE STRENGTH. The completed structure shall be so designed and of sufficient strength as to provide overload capacity factors specified in table 16 under the vertical and transverse loading specified in rule 252, A and B, 1 to 5, inclusive.

(b) LONGITUDINAL STRENGTH.

Grade B. The completed structure shall be so designed and of sufficient strength as to provide overload capacity factors

261. A. Poles and Towers—Continued.

specified in table 16 under the longitudinal loading specified in rule 252, C.

Grade C. No longitudinal strength requirements except at dead-ends.

(c) Minimum Strength. Steel structures shall have strength sufficient to withstand, with an overload capacity factor of 1.1, a transverse load on the structures without conductors, equal to six times the specified wind pressure.

(d) Strength at Angles in a Line. At an angle in a line having supports of steel poles or towers, the strength of the support shall be sufficient to withstand a combination of the transverse and longitudinal loadings specified in rule 252, B, 6. For grade B the transverse load shall be multiplied by 1.54, and for grade C by 2.00, before combining with the load arising from change in direction of conductors. The allowable overload capacity factor at dead-ends given in table 16 shall be provided for the total load thus computed.

Table 16.—*Minimum overload capacity factors of completed structures*

[Based on yield point of steel]

	Overload capacity factors	
	Grade B	Grade C
Vertical strength	1.27	1.10
Transverse strength	2.54	2.20
Longitudinal strength:		
At crossings—		
In general	1.10	No requirement.
At dead-ends	1.65	1.10
Elsewhere—		
In general	1.00	No requirement.
At dead-ends	1.65	1.10

261. A. Poles and Towers—Continued.

(e) THICKNESS OF STEEL. The thickness of metal in members of steel poles or towers shall be not less than the following:

TABLE 17.—*Thickness of steel*

	Thickness of main members of crossarms and legs	Thickness of other members
	Inches	*Inches*
For localities where experience has shown deterioration of protective covering is rapid	1/4	3/16
For other localities	3/16	1/8

(f) UNSUPPORTED LENGTH OF COMPRESSION MEMBERS. The ratio of L, the unsupported length of a compression member, to R, the least radius of gyration of the member, shall not exceed the following (these figures do not apply to the complete structure):

TABLE 18.—*L/R for compression members*

Kind of compression member	L/R
Leg members	150
Other members having figured stresses	200
Secondary members without figured stresses	250

(g) GENERAL CONSTRUCTION FEATURES. Steel poles or towers, including parts of footings above ground, shall be constructed so that all parts are accessible for inspection, cleaning, and painting, and so that pockets are not formed in which water can collect.

Recommendation: Unless sample structures, or similar ones, have been tested to assure the compliance of structures in any line with these

261. A. Poles and Towers—Continued.

requirements, it is recommended that structures be designed to have a computed strength at least 10 percent greater than that required by these rules.

(h) Protective Covering or Treatment. All iron or steel poles, towers, or supporting structures shall be protected by galvanizing, painting, or other treatment which will effectively retard corrosion. Such protective covering shall be adequately maintained.

4. WOOD POLES.

Wood poles shall be of such material and dimensions as to meet the following requirements (where guys are used, see rule 261, C):

(a) Transverse Strength. Wood poles shall withstand the transverse and vertical loads assumed in rule 252, A and B, 1 to 4, inclusive, without exceeding at the ground line for unguyed poles, or at the point of guy attachment for guyed poles, the appropriate allowable percentages of their ultimate stress given in table 20.

(b) Longitudinal and Dead-End Strength. The longitudinal and dead-end strength of wood poles shall be such that they will withstand the appropriate longitudinal loading specified in rule 252, C, without exceeding, at the ground line for unguyed poles or at the point of guy attachment for guyed poles, the following percentages of the applicable ultimate fiber stress given in table 19.

261. A. Poles and Towers—Continued.

	Percentages of ultimate fiber stress for wood poles	
	Grade B	Grade C
Longitudinal:		
When installed	[1] 75	No requirement.
At replacement	100	Do.
Dead-ends:		
When installed	[1] 50	[1] 75
At replacement	75	100

[1] Where supply lines alone are involved and built for a fixed period of temporary service not exceeding 5 years the prescribed percentage of fiber stress at installation may be increased, provided the percentage of ultimate fiber stress required at replacement is not exceeded during the life of the line.

Exception 1: At a Grade B crossing, in a straight section of line, wood poles of approximately round cross section, complying with the transverse strength requirements of rule 261, A, 4 (a), without the use of transverse guys, shall be considered as having the required longitudinal strength. This exception does not modify the requirements of this rule for dead-ends.

Exception 2: At a grade B crossing of a supply line over a highway and a communication line in the same span, where there is an angle in the supply line, wood poles of approximately round cross section shall be considered as having the required longitudinal strength if all of the following conditions obtain:

1. The angle is not over 20 degrees.
2. The corner pole is guyed in the plane of the resultant of the conductor tensions on both sides of the corner pole; the tension in this guy not to exceed 50 percent of its ultimate strength under the loading of rule 252, B, 6.

261. A. Poles and Towers—Continued.

3. The corner pole has sufficient strength to withstand, without guys, the transverse loading of rule 252, B, 1, 2 or 3, which would exist if there were no angle at that pole, without exceeding 25 percent of its ultimate stress when installed, or 37½ percent at replacement.

(c) Ultimate Fiber Stress. Different kinds of wood poles are considered as having the ultimate fiber stresses given in table 19.

Table 19.—*Ultimate fiber stresses of wood poles*

Kind of wood	Ultimate fiber stress
	lb/sq in.
Creosoted southern pine	7, 400
Douglas fir	7, 400
Lodgepole pine	6, 600
Chestnut	6, 000
Western red cedar	5, 600
Cypress	5, 000
Northern white cedar	3, 600
Redwood	3, 600

When values for ultimate stresses of cypress and redwood have been approved as standard by the American Standards Association, such values shall be used in place of those given above.

(d) Allowable Percentages of Ultimate Stress. The allowable percentages of ultimate stress of treated and untreated poles to withstand vertical and transverse loads are given in table 20, except as modified in the following paragraph.

At crossings where grade B construction is required, if the supply line is not maintained throughout (or between and including the nearest guyed points on each side of the crossing) so that the poles will not be stressed at any time in excess of 50 percent

261. A. Poles and Towers—Continued.

of their ultimate stress under the transverse loading assumed in rule 252, B, the crossing poles, if unguyed, shall be of such strength that they will withstand the transverse loading assumptions of rule 252 B, 1, 2, or 3, without exceeding 16⅔ percent of their ultimate stress at installation or 25 percent at replacement. If the crossing poles are side guyed, such guys shall meet the requirements of rule 261, C, 5.

TABLE 20.—*Allowable percentages of ultimate stress for treated or untreated wood poles under vertical and transverse loading*

	When installed	At replacement
Grade B	25.0	37.5
Grade C:		
At crossings	37.5	75.0
Elsewhere	50.0	75.0

(e) FREEDOM FROM DEFECTS. Wood poles shall be of suitable and selected timber free from observable defects that would decrease their strength or durability.

(f) MINIMUM POLE SIZES. Wood poles shall have a nominal top circumference of not less than 15 inches.

(g) SPLICED AND STUB-REINFORCED POLES. Spliced poles shall not be used at crossings, conflicts, or joint-use sections requiring grades B or C construction.

Except at crossings over major railroad tracks, the use of stub reinforcements that develop the required strength of the pole is permitted, provided the pole above the ground is in good condition and is of sufficient size to develop its required strength.

261. A. Poles and Towers—Continued.

5. TRANSVERSE-STRENGTH REQUIREMENTS FOR STRUCTURES WHERE SIDE GUYING IS REQUIRED, BUT CAN ONLY BE INSTALLED AT A DISTANCE.

Grade B. In the case of structures where, because of very heavy or numerous conductors or relatively long spans, the transverse-strength requirements of this section can not be met except by the use of side guys or special structures, and it is physically impracticable to employ side guys, the transverse-strength requirements may be met by side-guying the line at each side of, and as near as practicable to, the crossing or other transversely weak structure, and with a distance between such side-guyed structures of not over 800 feet, provided that:

(a) The side-guyed structures for each such section of 800 feet or less shall be constructed to withstand the calculated transverse load due to wind on the supports and ice-covered conductors, on the entire section between the side-guyed structures.

(b) The line between such side-guyed structures shall be substantially in a straight line and the average length of span between the side-guyed structures shall be not in excess of 150 feet.

(c) The entire section between the transversely strong structures shall comply with the highest grade of construction concerned in the given section, except as to the transverse strength of the intermediate poles or towers.

Grade C. The above provision is not applicable to grade C.

261. A. Poles and Towers—Continued.

6. LONGITUDINAL-STRENGTH REQUIREMENTS FOR SECTIONS OF HIGHER GRADE IN LINES OF A LOWER GRADE OF CONSTRUCTION.

(a) METHODS OF PROVIDING LONGITUDINAL STRENGTH.

Grade B. The longitudinal-strength requirements for sections of line of higher grade in lines of a lower grade (for assumed longitudinal loading, see rule 252, C, 1) are usually met by placing supporting structures of the required longitudinal strength at either end of the higher-grade section of the line.

Where this is impracticable, the supporting structures of the required longitudinal strength may be located one or more span lengths away from the section of higher grade, within 500 feet on either side and with not more than 800 feet between the longitudinally strong structures, provided such structures and the line between them meet the requirements as to transverse strength and stringing of conductors, of the highest grade occurring in the section, and provided that the line between the longitudinally strong structures is approximately straight or suitably guyed.

The requirements may also be met by distributing the head guys over two or more structures on either side of the crossing, such structures and the line between them complying with the requirements for the crossing as to transverse strength and as to conductors and their fastenings.

Where it is impracticable to provide the longitudinal strength, the longitudinal loads shall be reduced by increasing the conductor sags. This may require greater conductor separations. (See rule 235, A, 2, (a).)

Grade C. The above provision is not applicable to grade C.

261. A. Poles and Towers—Continued.

(b) Flexible Supports.

Grade B. When supports of the section of higher grade are capable of considerable deflection in the direction of the line, as with wood or concrete poles, or some types of metal poles and towers, it may be necessary to increase the normal clearances specified in section 23, or to provide head guys or special reinforcement to prevent such deflection.

So-called flexible steel towers or frames, if used at such locations, shall be adequately reinforced to meet the requirements of rule 261, A, 3 (b).

When the situation is one involving an isolated crossing of higher grade in a line of lower-grade construction, then the structure shall, when practicable, be head-guyed or otherwise reinforced to prevent reduction in the clearances required in section 23.

Grade C. The above provision is not applicable to grade C.

7. STRENGTH AT ANGLES IN A LINE.

At an angle in the line, the strength of a pole at the ground line, if not guyed, or at the point of guy attachment if guyed, shall be sufficient to withstand a combination of the transverse and longitudinal loadings specified in rule 252, B, 6. For grade B the transverse load shall be multiplied by 2.0 and for grade C by 1.5, before combining with the load arising from change in direction of conductors. The allowable percentage of ultimate stress at dead-ends given in rule 261, A, 4 (b) shall not be exceeded for the total load thus computed.

261. Grades B and C Construction—Continued.

B. Foundations.

1. USE OF FOUNDATIONS.

(a) WOOD AND REINFORCED-CONCRETE POLES. No special foundation construction is generally required.

(b) STEEL POLES OR TOWERS. Steel poles or towers set in earth shall be suitably protected against injurious corrosion at and below the ground line.

2. STRENGTH OF FOUNDATIONS.

(a) STEEL SUPPORTS. The foundations and footings shall be so designed and constructed as to withstand the stresses due to the loads assumed in rule 252. Steel parts shall withstand these loads with the overload capacity factors specified in table 16.

Since in many localities the soil and climatic conditions are such as to alter the strength of foundations considerably from time to time, there should usually be provided a considerable margin of strength in foundations above that which (by calculation) will just withstand the loads under the assumption of average conditions of climate and soil.

(b) WOOD AND CONCRETE POLES. Foundations and settings for unguyed poles shall be such as to withstand the loads assumed in rule 252 A, B, and C.

C. Guys.

1. GENERAL.

The general requirements for guys are covered under "Miscellaneous Requirements (sec. 28).

2. FOR POLES IN INSECURE EARTH.

Where crossing poles are set in insecure earth the transverse strength requirements should, where practicable, be met by the use of side guys or braces.

261. C. Guys—Continued.

3. ON STEEL STRUCTURES.

The use of guys to obtain compliance with these requirements is regarded as generally undesirable. When guys are necessarily used, the steel supports or towers, unless capable of considerable deflection, shall be regarded as taking all of the load up to their allowable working load, and the guys shall have sufficient strength to take the remainder of the assumed maximum load. (See rule 261, A, 6, (b) for flexible supports.)

4. ON WOOD OR CONCRETE POLES.

When guys are used to meet the strength requirements for wood or concrete poles, they shall be considered as taking the entire load in the direction in which they act, the poles acting as struts only. Frequently the use of shorter spans or larger poles will permit the omission of guys at crossings.

5. STRENGTH OF GUYS.

(a) Guys, when required, shall be of such material and dimensions as will withstand the transverse loads assumed in rule 252, B, 1 to 5, inclusive, and the longitudinal load assumed in rule 252, C, without exceeding the following percentages of their ultimate strength:

	Percentages of ultimate strength	
	Grade B	Grade C
For transverse strength (when installed)	37. 50	50. 00
For longitudinal strength (at all times):		
In general	100. 00	No requirement.
At dead-ends	[1] 66. 70	[1] 87. 50

[1] If deflection of supporting structures is taken into account in the computations, 66⅔ percent shall be reduced to 60 percent and 87½ percent shall be reduced to 75 percent.

261. C. Guys—Continued.

(b) At an angle in the line, the strength of a transverse guy or guys shall be sufficient to withstand the combination of transverse and longitudinal loadings specified in rule 252, B, 6. The transverse load shall be multiplied by 1.78 for both grades B and C before combining with the load arising from the change in direction of conductors. The allowable percentage of ultimate strength at dead-ends given in (a) above shall not be exceeded for the total load thus computed.

D. Crossarms.

1. VERTICAL STRENGTH.

Crossarms shall, when installed, withstand the vertical loads specified in rule 252, A without the stress under these loads exceeding 50 percent of the assumed ultimate stress of the material.

Exception: For built up steel crossarms on steel structures, see table 16 for minimum overload capacity factors.

2. BRACING.

Crossarms shall be securely supported by bracing, if necessary, so as to support safely all other loads to which they may be subjected in use, including linemen working on them. Any crossarm or buckarm except the top one shall be capable of supporting a vertical load of 225 pounds at either extremity in addition to the weight of the conductors.

3. LONGITUDINAL STRENGTH.

(a) GENERAL. Crossarms shall withstand any unbalanced longitudinal loads to which they are exposed, with a limit of unbalanced tension where conductor pulls are normally balanced, of 700 pounds at the outer pin.

261. D. Crossarms—Continued.

(b) At Dead-ends and at Ends of Higher-Grade Construction in Line of Lower Grade.

Grade B. Wood crossarms shall be of sufficient strength to withstand at all times, without exceeding their ultimate stresses, an unbalanced pull equal to the tension in all supported conductors under the assumed conductor loading given in rule 251. Steel arms shall withstand this load with the overload capacity factor for longitudinal loads given in table 16.

Grade C. The above provisions do not apply to grade C.

(c) At Ends of Transversely Weak Sections.

Grade B. The crossarms connected to the structure at each end of the transversely weak section, such as described in rule 261, A, 5, shall be such as to withstand at all times without exceeding their ultimate stresses, under the conductor loading prescribed in rule 251, an unbalanced load equivalent to the combined pull in the direction of the transversely weak section of all the conductors supported.

Grade C. The above provision does not apply to grade C.

(d) Methods of Meeting Rules 261, D, 3, (b) and (c).

Grade B. Where conductor tensions are limited to a maximum of 2,000 pounds per conductor, double wood crossarms fitted with spacing bolts equipped with spacing nuts and washers, pipe spacers, or similar construction, or with spacing blocks or plates, will be considered as meeting the

261\. D. Crossarms—Continued.

strength requirements in (b) and (c) preceding.

Grade C. The above provisions do not apply to grade C.

4\. DIMENSIONS OF CROSSARMS OF SELECTED YELLOW PINE OR FIR.

The cross-sectional dimensions of selected yellow pine or fir crossarms shall be not less than the values of table 21.

TABLE 21.—*Crossarm cross sections*

Number of pins	Grade B	Grade C	
		Supply	Communication
	Inches	*Inches*	*Inches*
2 or 4	3 by 4	2¾ by 3¾	
6 or 8	3¼ by 4¼	3 by 4	
6			2¾ by 3¾
10			3 by 4

5\. DOUBLE CROSSARMS OR BRACKETS.

Grade B. Where pin-type construction is used, two points of support shall be provided for each conductor by means of double crossarms or double brackets at each crossing structure, at ends of joint use or conflict sections, at dead-ends, and at corners where the angle of departure from a straight line exceeds 20 degrees.

Exception: Where communication cables or conductors cross below supply conductors and are attached to the same pole, the above does not apply unless another condition which requires double pins and fastenings for the supply conductors is involved.

Grade C. The above provision applies to grade *C* where supply conductors of more than 5,000

261. D. Crossarms—Continued.

volts between wires (or of more than 2,900 volts to ground in the case of grounded neutral circuits) cross over minor communication lines at locations such that the supply pole is more than 6 feet from the nearest communication conductor, unless other means of providing equivalent safety and strength are agreed to by the parties involved.

6. LOCATION.

In general, crossarms should be maintained at right angles to the axis of the pole and to the direction of the attached conductors. At crossings, crossarms should be attached to that face of the structure away from the crossing, unless special bracing or double crossarms are used.

E. Pins and Conductor Fastenings.

1. LONGITUDINAL STRENGTH

(a) GENERAL. Pins and ties or other conductor fastenings shall have sufficient strength to withstand an unbalanced tension in the conductor, up to a limit of 700 pounds per pin or fastening.

(b) AT DEAD-ENDS AND AT ENDS OF HIGHER-GRADE CONSTRUCTION IN LINE OF LOWER GRADE.

Grade B. Pins and ties or other conductor fastenings connected to the structure at each end of the higher-grade section shall be of sufficient strength to withstand at all times without exceeding their ultimate strength, an unbalanced pull due to the conductor loading specified in rule 251.

Grade C. The above provisions do not apply to grade C.

(c) AT ENDS OF TRANSVERSELY WEAK SECTIONS.

Grade B. Pins and ties or other conductor fastenings connected to the structure at

261\. E. Pins and Conductor Fastenings—Continued.

each end of the transversely weak section as described in rule 261, A, 5 shall be such as to withstand at all times without exceeding their ultimate strength under the conductor loading prescribed in rule 251, the unbalanced pull in the direction of the transversely weak section of the conductor supported.

Grade C. The above provisions do not apply to grade C.

(d) METHOD OF MEETING RULES 261, E, 1, (b), AND (c).

Grade B. Where conductor tensions are limited to 2,000 pounds and such conductors are supported on pin insulators, double pins, and ties or equivalent fastenings will be considered to meet the requirements of (b) and (c) preceding.

Grade C. The above provision does not apply to grade C.

2\. SHARP EDGES ON FASTENINGS.

Tie wires, fastenings, or supports shall have no sharp edges or burrs at contacts with the conductors.

3\. HEIGHT OF PIN.

The height of the pin and the conductor fastenings and the material and cross section of the pin should be chosen so as to afford the required strength.

Note: The method of attaching conductors by suitable ties to single pin-type insulators mounted on 1½ by 9 inch wood pins of locust or equivalent wood will usually provide strength up to 1,000 pounds conductor tension with the conductor 3.5 inches above the crossarm. Steel pins may afford greater strength, both for the pins and for the crossarms.

261. E. Pins and Conductor Fastenings—Continued.

4. DOUBLE PINS AND CONDUCTOR FASTENINGS.

Grade B. Where pin-type construction is used, two points of support shall be provided for each conductor by means of double pins and conductor fastenings at each crossing structure, at ends of joint use or conflict sections, at dead-ends, and at angles where the angle of departure from a straight line exceeds 20 degrees.

Exception: Where communication cables or conductors cross below supply conductors and are attached to the same pole, the above does not apply unless another condition which requires double pins and fastenings for the supply conductors is involved.

Grade C. The above provision applies to grade C where supply conductors of more than 5,000 volts between wires (or of more than 2,900 volts to ground in the case of grounded neutral circuits) cross over minor communication lines at locations such that the supply pole is more than 6 feet from the nearest communication conductor, unless other means of providing equivalent safety and strength are agreed to by the parties involved.

F. Open Supply Conductors.

1. MATERIAL.

Conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

Recommendation: It is recommended that hard-drawn or medium-hard-drawn copper wire (conforming to the specifications of the American Society for Testing Materials) be used instead of soft in new construction where bare wire or cable is used, especially for sizes smaller than No. 2.

261. F. Open Supply Conductors—Continued.

2. MINIMUM SIZES OF SUPPLY CONDUCTORS.

Supply conductors, both bare and covered, shall have an ultimate strength and an over-all diameter of metallic conductor not less than that of medium-hard-drawn copper of the gage size AWG shown in table 22, except that conductors made entirely of bare or galvanized iron or steel shall have an over-all diameter not less than Stl. WG of the gage sizes shown.

Exception 1: At railroad crossings, for stranded conductors, other than those in which a central core wire is entirely covered by the outside wires, any individual wire of such a stranded conductor containing steel shall be not less than 0.100 inch in diameter if copper-covered and not less than 0.115 inch in diameter if otherwise protected or if bare.

Exception 2: Supply service leads of 0 to 750 volts to ground may have the sizes set forth in rule 263, E.

Exception 3: Where the short-span method of construction is employed in accordance with rule 261, K, the conductor sizes and sags herein specified are not required.

TABLE 22.—*Minimum over-all conductor sizes*

Grade of construction	Gage size [1]
B	6
C	8

[1] For No. 6 and No. 8 medium-hard-drawn copper wire the nominal diameters are 0.1620 and 0.1285 inch, and the minimum values of breaking load are 1,010 and 643.9 pounds, respectively. For steel wire gage the nominal diameters are 0.192 inch for No. 6 and 0.162 inch for No 8.

3. LIGHTNING PROTECTION WIRES.

Lightning-protection wires paralleling the line conductors shall be regarded in respect to size, material, and stringing requirements as supply conductors with which they are associated.

261. F. Open Supply Conductors—Continued.

4. SAGS AND TENSIONS.

Conductor sags shall be such that, under the assumed loading of rule 251 for the district concerned, the tension of the conductor shall be not more than 60 percent of its ultimate strength. Also the tension at 60° F, without external load, shall not exceed the following percentages of the conductor ultimate strength:

Initial unloaded tension------35 percent.
Final unloaded tension-------25 percent.

Exception: In the case of conductors having a cross section of a generally triangular shape, such as cables composed of three wires, the final unloaded tension at 60° F shall not exceed 30 percent of the ultimate strength of the conductor.

Note: The above limitations are based on the use of recognized methods for avoiding fatigue failures by minimizing chafing and stress concentration. If such practices are not followed, lower tensions should be employed.

5. SPLICES AND TAPS.

Grade B. Splices shall as far as practicable be avoided in the crossing and adjacent spans. If it is impracticable to avoid such splices, they shall be of such a type and so made as to have a strength substantially equal to that of the conductor in which they are placed.

Taps shall be avoided in the crossing span where practicable, but if required shall be of a type which will not impair the strength of the conductors to which they are attached.

Grade C. The above does not apply to grade C.

6. TROLLEY CONTACT CONDUCTORS.

In order to provide for wear, no trolley contact conductor shall be installed of less size than No. 0, if of copper, or No. 4, if of silicon bronze.

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261. Grades B and C Construction—Continued.

G. Supply Cables.

1. SPECIALLY INSTALLED SUPPLY CABLES.

Cables having effectively grounded continuous metal sheath or armor, where located on jointly used poles, or where located on other poles and having a grade of construction less than that required for open wire supply lines of the same voltage, shall meet the requirements of (a), (b), (c), and (d) below.

(a) MESSENGERS. Messengers shall be stranded and of corrosion-resistant material, and shall not be stressed beyond 60 percent of their ultimate strength under the loadings specified in rule 251.

(b) GROUNDING OF CABLE SHEATH AND MESSENGER. Each section of cable between splices shall be suitably and permanently bonded to the messenger wire at not less than two places. The messenger wire shall be grounded at the ends of the line and at intermediate points not exceeding 800 feet apart. (See section 9 for method.)

(c) CABLE SPLICES. Splices in the cable shall be made so that their insulation is not materially weaker than the remainder of the cable. The sheath or armor at the splice shall be made electrically continuous.

(d) CABLE INSULATION. The conductors of the cable shall be insulated so as to withstand a factory potential test of at least twice the operating voltage at operating frequency applied continuously for 5 minutes between conductors and between any conductor and the sheath or armor.

261. G. Supply Cables—Continued.

2. OTHER SUPPLY CABLES.

The following requirements apply to all supply cables not included in 1 above.

(a) MESSENGER. The messenger shall be of corrosion-resistant material, and shall not be stressed beyond 60 percent of its ultimate strength under the loadings specified in rule 251.

(b) CABLE. There are no strength requirements for cables supported by messengers.

H. Open-wire Communication Conductors.

Open-wire communication conductors in grade B or C construction shall have the sizes and sags given in rule 261, F, 2 and 4 for supply conductors of the same grade.

Exception: Where open-wire communication conductors in spans of 150 feet or less are above supply circuits of 5,000 volts or less between conductors, grade C sizes and sags may be replaced by grade D sizes and sags, except that where the supply conductors are trolley-contact conductors of 0 to 750 volts to ground, No. 12 wire may be used for spans of 0 to 100 feet, and No. 9 steel wire may be used for spans of 125 to 150 feet.

I. Communication Cables.

1. METAL-SHEATHED COMMUNICATION CABLES.

There are no strength requirements for such cables supported by messengers.

2. MESSENGER.

The messenger shall be of corrosion-resistant material, and shall not be stressed beyond 60 percent of its ultimate strength under the loadings specified in rule 251.

261. Grades B and C Construction—Continued.

J. Paired Communication Conductors.

1. PAIRED CONDUCTORS SUPPORTED ON MESSENGER.

(a) USE OF MESSENGER. A messenger of corrosion-resistant material may be used for supporting paired conductors in any location, but is only required for paired conductors crossing over trolley-contact conductors of more than 7,500 volts to ground.

(b) SAG OF MESSENGER. Messenger used for supporting paired conductors required to meet grade B construction because of crossing over trolley-contact conductors shall meet the sag requirements for grade D messengers.

(c) SIZE AND SAG OF CONDUCTORS. There are no requirements for paired conductors when supported on messenger.

2. PAIRED CONDUCTORS NOT SUPPORTED ON MESSENGER.

(a) ABOVE SUPPLY LINES.

Grade B. Sizes and sags shall be not less than those required by rule 261, F, 2 and 4 for supply conductors of similar grade.

Grade C. Sizes and sags shall be not less than the following:

Spans 0 to 100 feet. No sag requirements. Each conductor shall be of corrosion-resistant material, and shall have an ultimate strength of not less than 170 pounds.

Spans 100 to 150 feet. Sizes and sags shall be not less than required for grade D communication conductors.

Spans exceeding 150 feet. Sizes and sags shall be not less than required for grade C supply conductors. (See rule 261, F, 4.)

261. J. Paired Communication Conductors—Continued.

(b) ABOVE TROLLEY-CONTACT CONDUCTORS.

Grade B. Sizes and sags shall be not less than the following:

Spans 0 to 100 feet. No size requirements. Sags shall be not less than for No. 8 AWG hard-drawn copper. (See rule 261, F, 4.)

Spans exceeding 100 feet. Each conductor shall be of corrosion-resistant material, and shall have an ultimate strength of not less than 170 pounds. Sags shall be not less than for No. 8 AWG hard-drawn copper. (See rule 261, F, 4.)

Grade C. Sizes and sags shall be as follows:

Spans 0 to 100 feet. No requirements.

Spans exceeding 100 feet. No sag requirements. Each conductor shall be of corrosion-resistant material, and shall have an ultimate strength of not less than 170 pounds.

K. Short-Span Crossing Construction.

Where supply lines cross over railways or communication lines by the short-span method, the requirements for grade B or C conductor sags and sizes are waived, in so far as such grades are required by the crossing, provided that an effectively grounded guard arm is installed at each cross-over support in such a manner as to prevent conductors which break in either adjoining span from swinging back into the conductors crossed over, or in the case of a railroad crossing into the space between the crossing supports.

Note: The short-span method of crossing requires the cross-over span to be of such a height that a conductor breaking in that span cannot come within 15 feet of the ground or rails at a railroad crossing or make contact with any wires crossed over at a wire crossing.

This character of construction is facilitated where the cross-over supports can be placed quite near together and in the case of wire crossings where the span crossed over is at a minimum elevation above ground.

261. Grades B and C Construction—Continued.

L. Cradles at Supply-Line Crossings.

Cradles should not be used.

Note: It is less expensive and better to build the supply line strong enough to withstand extreme conditions than to build a cradle of sufficient strength to catch and hold the supply line if it falls.

M. Protective Covering or Treatment for Metal Work.

All hardware, including bolts, washers, guys, anchor rods, and similar parts of material, subject to injurious corrosion under the prevailing conditions, shall be protected by galvanizing, painting, or other treatment which will effectively retard corrosion.

262. GRADE D CONSTRUCTION.

A. Poles.

1. STRENGTH OF UNGUYED POLES.

Unguyed poles, except as provided in rule 262, A, 8, shall withstand the vertical and transverse loads specified in rule 252, A and B, and the longitudinal loads specified in rule 252, C, 4, without exceeding the following percentages of their ultimate stress:

	Percentages of ultimate stress
For transverse loads:	
When installed	25. 0
At replacement	37. 5
For longitudinal loads:	
When installed	75. 0
At replacement	100. 0

2. STRENGTH OF GUYED POLES.

Where poles are guyed, the poles shall be considered as acting as struts, resisting the vertical component of the tension in the guy, calculated as in rule 262, C, combined with the vertical load.

262. A. Poles—Continued.

3. STRENGTH REQUIREMENTS FOR POLES WHERE GUYING IS REQUIRED, BUT CAN ONLY BE INSTALLED AT A DISTANCE.

Where on account of physical conditions it is impracticable to guy or brace the crossing poles as specified in rule 262, C the requirements there given may be met by head-guying and side-guying the line as near as practicable to the crossing, but at a distance not exceeding 500 feet from the nearest crossing pole, provided that the line is approximately straight and that a stranded steel wire or other standard strand of strength equivalent to that of the head guy is run between the two guyed poles, being attached to the guyed poles at the point at which the head guys are attached, this wire being securely attached to every pole between the guyed poles.

4. POLE LOCATIONS AT CROSSINGS.

Where communication lines cross over railroads, the poles shall be located as follows:

(*a*) The poles supporting the crossing span and the adjacent spans should be located in a straight line, if practicable. Where the poles supporting the crossing span and the adjacent spans are not in line, guying shall be placed to take care of the unbalanced load.

(*b*) The crossing span shall, where practicable, not exceed 100 feet in the heavy loading district, 125 feet in the medium loading district, and 150 feet in the light loading district.

5. FREEDOM FROM DEFECTS.

Wood poles shall be of suitable and selected timber free from observable defects that would decrease their strength or durability.

262. A. Poles—Continued.

6. MINIMUM POLE SIZE.

Wood poles shall have a nominal top circumference of not less than 15 inches.

7. SPLICED AND STUB-REINFORCED POLES.

Spliced poles shall not be used at grade D crossings. At crossings over minor railroad tracks, the use of stub-reinforcements that develop the required strength of the pole is permitted, provided the pole above the ground line is in good condition and is of sufficient size to develop its required strength.

8. POLES LOCATED AT CROSSINGS OVER SPUR TRACKS.

Where a communication line paralleling a railroad track on the right-of-way of the railroad crosses a spur or stub track without any change in the general direction of line, the transverse strength requirements for grade D construction may be met without the use of side guys, provided the pole is not stressed beyond one-third of its ultimate stress. No requirements for longitudinal strength are made if the conductor tensions are balanced. Where conductor tensions are not balanced, due to a small angle in the line at one or both poles, or to dead-ending any of the wires, either guys or braces capable of withstanding such unbalanced tensions shall be installed.

B. Pole Settings.

Foundations and settings for unguyed poles shall be such as to withstand the loads assumed in rule 252, A, B, and C.

C. Guys.

1. GENERAL.

The general requirements for guys are covered under "Miscellaneous Requirements" (sec. 28).

262. C. Guys—Continued.

2. WHERE USED.

Side guys or braces shall be used on poles supporting the crossing span to withstand the loads put upon them in accordance with the conditions specified in rule 252, B.

Head guys shall be installed in accordance with table 23.

Exception 1: Side guys are not required where the crossing poles have the transverse strength specified in rule 262, A, 1 without the reduction for conductor shielding specified in rule 252, B, 1 and 2.

Exception 2: Head guys are not required where the crossing poles have the longitudinal strength specified in rule 262, A, 1, or where they carry a cable supported on 6,000-pound or stronger messenger.

Exception 3: Where a line crossing a railroad changes direction more than 10 degrees at either crossing support, the side guy within the angle may be omitted and the head guy, if required, shall be placed in the direction of the adjacent span unless the angle of turn is greater than 60 degrees.

Exception 4: Guying may be omitted where communication lines cross over spur or stub tracks as provided in rule 262, A, 8.

Exception 5: This rule does not apply to crossing poles under the special conditions set forth in rule 262, A, 3.

262. C. Guys—Continued.

Table 23.—*Strength (in pounds) of head guys required for loading districts indicated* [1]

[Combinations of standard-size guys may be used]

Number of wires	Ratio of guy lead to height not less than—				
	1¼	1	¾	⅔	½
HEAVY LOADING					
2	4,000	4,000	4,000	4,000	4,000
6	4,000	4,000	4,000	4,000	6,000
10	6,000	6,000	6,000	10,000	10,000
20	10,000	10,000	12,000	16,000	16,000
30	16,000	16,000	20,000	20,000	26,000
40	20,000	20,000	26,000	26,000	32,000
50	20,000	20,000	30,000	32,000	42,000
60	26,000	30,000	36,000	36,000	48,000
70	30,000	30,000	40,000	48,000	60,000
80	36,000	40,000	48,000	60,000	70,000
MEDIUM LOADING					
2	4,000	4,000	4,000	4,000	4,000
6	4,000	4,000	4,000	4,000	4,000
10	4,000	4,000	6,000	6,000	6,000
20	6,000	10,000	10,000	10,000	12,000
30	10,000	10,000	12,000	16,000	16,000
40	12,000	16,000	16,000	16,000	20,000
50	16,000	16,000	20,000	20,000	26,000
60	20,000	20,000	26,000	26,000	30,000
70	20,000	20,000	26,000	30,000	36,000
80	26,000	26,000	30,000	32,000	40,000
LIGHT LOADING					
2	4,000	4,000	4,000	4,000	4,000
6	4,000	4,000	4,000	4,000	4,000
10	4,000	4,000	4,000	4,000	4,000
20	4,000	6,000	6,000	6,000	10,000
30	6,000	10,000	10,000	10,000	12,000
40	10,000	10,000	10,000	12,000	16,000
50	10,000	10,000	16,000	16,000	20,000
60	12,000	16,000	16,000	16,000	20,000
70	16,000	16,000	20,000	20,000	26,000
80	16,000	20,000	20,000	26,000	30,000

[1] This table is based on ultimate or breaking strength of guys equal to seven-sixths of the nominal strengths shown in the table and a wire load of 50 percent No. 8 BWG iron and 50 percent No. 9AWG copper with an average pull of 408.75 pounds per wire.

No guy will be required for cable, since the messenger serves as a head guy.

262. C. Guys—Continued.

3. GUYS USED FOR TRANSVERSE STRENGTH.

Side guys used in straight sections of line shall be considered as taking the entire load in the direction in which they act, without exceeding 37.5 percent of their ultimate strength.

4. GUYS USED FOR LONGITUDINAL STRENGTH.

(a) DIRECTION OF HEAD GUYS. Where head guys are required, they shall be installed in the direction away from the crossing.

(b) SIZE AND NUMBER OF HEAD GUYS. Guys, if required for various open-wire loads, shall be in accordance with table 23.

5. MAINTENANCE.

Guys and anchors shall be maintained so that the guys carry the load.

D. Crossarms.

1. MATERIAL.

Wood crossarms supporting the crossing span shall be of yellow pine, fir, or other suitable timber.

2. MINIMUM SIZE.

(a) WOOD CROSSARMS. Wood crossarms shall have a cross section not less than the following:

Maximum number of wires to be carried	Nominal length		Nominal cross section (Inches)
	Feet	Inches	
2	1	4½	2 5/16 by 3 5/16
4	3	4½	2 5/16 by 3 5/16
6	6	0	2¾ by 3¾
10	8	6	2¾ by 3¾
10	10	0	3 by 4
12 [1]	10	0	3¼ by 4¼
16 [2]	10	0	3¼ by 4¼

[1] Where crossarms are bored for ½-inch steel pins, 3-inch by 4¼-inch crossarms may be used.

[2] Permitted in medium and light loading districts only.

262. D. Crossarms—Continued.

(b) Steel or Iron Crossarms. Galvanized or painted iron or steel crossarms of strength equal to wood crossarms may be used.

3. DOUBLE CROSSARMS.

Crossarms and insulators shall be double on the crossing poles. The crossarms shall be held together with properly fitted spacing blocks or bolts placed immediately adjoining the outside pins. Spacing blocks or spacing bolts are not required for two-pin crossarms.

E. Brackets and Racks.

Wood brackets may be used only if used in duplicate or otherwise designed so as to afford two points of support for each conductor. Single metal brackets, racks, drive hooks or other fixtures may be used if designed and attached in such manner as to withstand the full dead-end pull of the wires supported.

F. Pins.

1. MATERIAL.

Insulator pins shall be of steel, wrought iron, malleable cast iron, or locust or equivalent wood.

2. STRENGTH.

Insulator pins shall have sufficient strength to withstand the loads to which they may be subjected.

3. SIZE.

(a) Wood Pins. Wood pins shall be sound and straight-grained with a diameter of shank not less than 1¼ inches.

(b) Metal Pins. Steel or iron pins shall have diameter of shank not less than ½ inch.

G. Insulators.

Each insulator shall be of such pattern, design, and material that when mounted it will withstand without injury and without being pulled off the pin, the ultimate strength of the conductor attached to the insulator.

262. Grade D. Construction—Continued.

H. Attachment of Conductor to Insulator.

The conductors shall be securely tied to each supporting insulator.

I. Conductors.

1. MATERIAL.

Conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

2. SIZE.

Conductors of the crossing span, if of hard-drawn copper or galvanized steel, shall have sizes not less than specified in (a) and (b) below. Conductors of material other than the above shall be of such size and so strung as to have a mechanical strength not less than that of the sizes of copper conductors given in (a) and (b) below.

(a) SPANS NOT EXCEEDING 150 FEET. The sizes in table 24 apply for all loading districts.

TABLE 24.—*Minimum wire sizes*

[AWG for copper; Stl. WG for steel]

Conductor	Spans of 125 feet or less	Spans 125 to 150 feet
Copper, hard-drawn	10	9
Steel, galvanized:		
In general	10	8
In rural districts of arid regions	12	10

(b) SPANS EXCEEDING 150 FEET. If spans in excess of 150 feet are necessary, the size of conductors specified above or the sags of the conductors shall be correspondingly increased.

262. I. Conductors—Continued.

3. PAIRED CONDUCTORS WITHOUT MESSENGERS.

Paired wires without a supporting messenger shall be eliminated as far as practicable and where used shall meet the following requirements:

(a) MATERIAL AND STRENGTH. Each conductor shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions and shall have an ultimate strength of not less than 170 pounds.

(b) LIMITING SPAN LENGTHS. Paired wires shall in no case be used without a supporting messenger in spans longer than 100 feet in the heavy loading district, 125 feet in the medium loading district, and 150 feet in the light loading district.

4. SAGS.

Table 25 specifies the recommended sags for wires shown in table 24.

TABLE 25.—*Stringing sags*

HEAVY AND MEDIUM LOADING DISTRICTS

Length of span	100°F	80°F	60°F	40°F	20°F	0°F
Feet	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
70	5.7	4.4	3.4	2.7	2.2	1.8
75	6.4	5.1	4.0	3.1	2.5	2.1
80	7.4	5.8	4.5	3.5	2.9	2.4
85	8.4	6.6	5.1	4.0	3.2	2.7
90	9.4	7.3	5.7	4.5	3.6	3.0
95	10.0	8.2	6.3	5.0	4.0	3.4
100	11.6	9.0	7.0	5.5	4.5	3.7
110	14.0	11.0	8.5	6.7	5.4	4.5
120	16.6	13.0	10.1	7.9	6.4	5.4
130	19.5	15.3	11.8	9.3	7.6	6.3
140	22.6	17.7	13.7	10.8	8.8	7.3
150	26.0	20.3	15.8	12.4	10.1	8.4

262. I. Conductors—Continued.

TABLE 25.—*Stringing sags*—Continued

LIGHT LOADING DISTRICT

Length of span	110°F	100°F	80°F	60°F	40°F	20°F	10°F
Feet	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
80	5.5	5.0	4.2	3.4	2.8	2.4	2.2
85	6.2	5.7	4.7	3.9	3.2	2.7	2.5
90	7.0	6.4	5.3	4.3	3.6	3.0	2.8
95	7.8	7.1	5.8	4.8	4.0	3.4	3.1
100	8.6	7.9	6.5	5.3	4.4	3.7	3.5
110	10.4	9.5	7.8	6.5	5.4	4.5	4.2
120	12.4	11.3	9.3	7.7	6.4	5.4	5.0
130	14.6	13.3	11.0	9.0	7.5	6.3	5.9
140	16.9	15.4	12.7	10.5	8.7	7.3	6.8
150	19.4	17.7	14.6	12.0	10.0	8.4	7.8

5. SPLICES AND TAPS.

Splices shall as far as practicable be avoided in the crossing and adjacent spans. If it is impracticable to avoid such splices, they shall be of such a type and so made as to have a strength substantially equal to that of the conductor in which they are placed.

Taps shall be avoided in the crossing span where practicable, but if required shall be of a type which will not impair the strength of the conductors to which they are attached.

J. Messengers.

1. MINIMUM SIZE.

(*a*) SPANS NOT EXCEEDING 150 FEET. Table 26 gives the minimum sizes of galvanized steel-strand messenger to be used for supporting different sizes of cables:

TABLE 26.—*Minimum sizes of messenger*

Size of cable in weight per foot	Messenger (nominal breaking load)
	Pounds
Less than 2.25 pounds	6,000
2.25 to 5 pounds	10,000
Exceeding 5 and less than 8.5 pounds	16,000

262. J. Messengers—Continued.

(*b*) SPANS EXCEEDING 150 FEET. For spans exceeding 150 feet or for heavier cables a proportionately larger messenger or other proportionately stronger means of support shall be used.

2. SAGS AND TENSIONS.

Multiple-conductor cables and their messengers shall be so suspended that when they are subjected to the loading prescribed in rule 251, the tension in the messenger will not exceed 60 percent of its ultimate strength.

K. **Inspection.**

See rule 213.

263. GRADE N CONSTRUCTION.

A. **Poles and Towers.**

Poles used for lines for which neither grade B, C, or D is required shall be of such initial size and so guyed or braced, where necessary, as to withstand safely the loads to which they may be subjected, including linemen working on them. Such poles and stubs on State and Federal highways shall be located as far as practicable from the traveled portion of such highways. The number of crossings over such highways should be kept to a minimum. Such poles and stubs located within falling distance of the traveled portion of such highways, or so located that their failure would permit wires, cables, guys, or other equipment to fall into the traveled portion of the highway, or would reduce the clearances specified in table 1 over the traveled portion of such highways, shall be periodically inspected and maintained in safe condition.

B. **Guys.**

The general requirements for guys are covered under "Miscellaneous Requirements" (sec. 28).

263. Grade N Construction—Continued.

C. Crossarm Strength.

Crossarms shall be securely supported, by bracing if necessary, so as to support safely loads to which they may be subjected in use, including linemen working on them. Any crossarm, or buckarm, except the top one, shall be capable of supporting a vertical load of 225 pounds at either extremity, in addition to the weight of the conductors.

Note: Double crossarms are generally used at crossings, unbalanced corners, and dead-ends, in order to permit conductor fastenings at two insulators, and so prevent slipping, although single crossarms might provide sufficient strength. To secure extra strength, double crossarms are frequently used, and crossarm guys are sometimes used.

D. Supply-line Conductors.

1. MATERIAL.

All supply-line conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

2. SIZE.

Supply-line conductors shall be not smaller than the following:

TABLE 27.—*Grade N minimum sizes for supply-line conductors*

[AWG for copper and aluminum; Stl. WG for steel]

	Urban	Rural
Soft copper	6	8
Medium or hard-drawn copper	8	8
Steel	9	9
	Urban and rural	
	Spans 150 feet or less	Spans exceeding 150 feet
Stranded aluminum:		
Not reinforced	1	0
Steel-reinforced	6	4

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263. D. Supply-line Conductors—Continued.

Recommendation: It is recommended that, except as modified in rule 261, F, 2, these minimum sizes for copper and steel not be used in spans longer than 150 feet for the heavy-loading district, and 175 feet for the medium- and light-loading districts.

E. Supply Services.

1. MATERIAL.

All supply service conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

2. SIZE OF OPEN-WIRE SERVICES.

(a) NOT OVER 750 VOLTS BETWEEN CONDUCTORS. Supply-service leads of not over 750 volts between conductors shall be not smaller than required by (1) or (2) below:

(1) SPANS NOT EXCEEDING 150 FEET. Sizes shall be not smaller than specified in table 28.

TABLE 28.—*Minimum sizes of service leads carrying 750 volts or less*

[All voltages are between conductors except trolley-contact conductors where voltages are to ground]

[AWG for copper; Stl. WG for steel]

Situation	Copper wire		Steel wire
	Soft-drawn	Medium or hard-drawn	
Alone	10	12	12
Concerned with communication conductors	10	12	12
Over supply conductors of—			
0 to 750 volts	10	12	12
750 to 8,700 volts [1]	8	10	12
Exceeding 8,700 volts [1]	6	8	9
Over trolley-contact conductors—			
0 to 750 volts ac or dc	8	10	12
Exceeding 750 volts ac or dc	6	8	9

[1] Installation of service leads of not more than 750 volts above supply lines of more than 750 volts should be avoided where practicable.

263. E. Supply Services—Continued.

(2) SPANS EXCEEDING 150 FEET. Sizes shall be not smaller than required for Grade C. (Rule 261, F, 2.)

(b) EXCEEDING 750 VOLTS BETWEEN CONDUCTORS. Sizes of supply-service leads of more than 750 volts between conductors shall be not less than required for supply-line conductors of the same voltage.

3. SAG, OPEN-WIRE SERVICES.

(a) NOT OVER 750 VOLTS BETWEEN CONDUCTORS. Supply service leads of not over 750 volts between conductors shall have sags not less than shown in table 29.

TABLE 29.—*Sags for open-wire services*

Span lengths	Sag
Feet	*Inches*
100 or less	12.
100 to 125	18.
125 to 150	27.
Exceeding 150	Grade C sags.

(*b*) EXCEEDING 750 VOLTS BETWEEN CONDUCTORS. Supply service leads of more than 750 volts between conductors shall comply as to sags with the requirements for supply line conductors of the same voltage.

4. CABLED SERVICES.

Supply service leads may be grouped together in a cable, provided the following requirements are met:

(*a*) SIZE. The size of each conductor shall be not less than required for leads of separate conductors (rule 263, E, 2).

(*b*) SAG. The sag of the cable should be not less than required for leads of separate conductors (rule 263, E, 3).

263. E. Supply Services—Continued.

(*c*) Insulation. The insulation should be sufficient to withstand twice the normal operating voltage.

F. Lightning-Protection Wires.

Lightning-protection wires paralleling the line conductors shall be regarded, in respect to size and material requirements, as supply conductors.

G. Trolley-Contact Conductors.

In order to provide for wear, no trolley-contact conductors shall be installed of less size than No. 0, if of copper, or No. 4, if of silicon bronze.

H. Cradles at Supply-Line Crossings.

Cradles should not be used.

Note: It is less expensive and better to build the supply line strong enough to withstand extreme conditions than to build a cradle of sufficient strength to catch and hold the supply line if it falls.

I. Communication Conductors.

There are no specific requirements for grade N communication line conductors or service drops.

SEC. 27. LINE INSULATORS

270. Application of Rule.

These requirements apply only to supply lines in situations where grade B construction is required. (See rule 242, E, for insulation requirements for neutral conductors.)

271. Material and Marking.

Insulators for operation on supply circuits at voltages of 2,300 and above shall be of porcelain, made by the wet process or one equally suitable as regards electrical and mechanical properties, or other material which will give equally good results in respect to mechanical and electrical performance and durability. They should be marked by the maker with his name, trade-mark, or identification number so applied as not to reduce the electrical or mechanical strength of the insulator.

272. ELECTRICAL STRENGTH OF INSULATORS IN STRAIN POSITION.

Where insulators are used in a strain position they shall have not less electrical strength than the insulators generally used on the line when under the normal mechanical stresses imposed by the loadings specified in section 25.

273. RATIO OF FLASH-OVER TO PUNCTURE VOLTAGE.

Insulators shall be designed so that their dry flash-over voltage is not more than 75 percent of their puncture voltage at a frequency of 60 cycles per second.

274. TEST VOLTAGES.

Insulators when tested under the current specifications of the American Standards Association shall not flash over at values less than given in table 30.

TABLE 30.—*Test-voltage requirements*

[For application see rules 276 and 278]

Nominal voltage between conductors	Minimum test dry flash-over voltage of insulators	Nominal voltage between conductors	Minimum test dry flash-over voltage of insulators
750	5, 000	46, 000	125, 000
2, 400	20, 000	69, 000	175, 000
7, 200	40, 000	115, 000	315, 000
13, 200	55, 000	138, 000	390, 000
23, 000	75, 000	161, 000	445, 000
34, 500	100, 000	230, 000	640, 000
(Interpolate for intermediate values.)			

275. FACTORY TESTS.

Each insulator or insulating part thereof for use on circuits operating at voltages in excess of 15,000 volts shall be subjected to a routine dry flash-over test at the factory for a period of 3 minutes at a frequency of 60 cycles per second or to any other test sanctioned by good modern practice, such as high-frequency tests.

276. Selection of Insulators.

A. Insulators for Constant-Current Circuits.

Insulators for use on constant-current circuits shall be determined on the basis of the nominal full-load voltage of the circuit.

B. Insulators for Single-phase Circuits Directly Connected to Three-phase Circuits.

Insulators used on single-phase circuits directly connected to three-phase circuits (without intervening isolating transformers) shall have a flash-over voltage not less than that required for the insulators on the three-phase circuits.

C. Insulators for Nominal Voltages Between Conductors.

In selecting insulators of the test voltage to be used for any nominal voltage between conductors, consideration shall be given to the conditions under which the line will operate as follows:

1. Where the system is of moderate extent, in open country, subject to intermittent rains and moderate lightning, insulators having flash-over values not less than given in table 30 shall be used.
2. Where operating conditions are more severe than set forth in 1 above, due to extent of system, prevalence of exceptionally severe lightning, bad atmospheric conditions (caused by chemical fumes, smoke, cement dust, salt fog, or other foreign matter), or to a long, dry season with heavy dust accumulation followed by moisture, insulators having a higher flash-over than given in table 30 or other equally effective means of increasing insulation shall be used. The increase is to be determined by local conditions and experience.

277. Protection Against Arcing.

In installing the insulators and conductors, such precautions as are sanctioned by good modern practice shall be taken to prevent, as far as possible, any arc from forming or to prevent any arc which might be formed from injuring or burning any parts of the supporting structures, insulators or conductors which might render the conductors liable to fall.

278. Compliance With Rule 277 at Crossings.

Construction in accordance with any one of the methods (A to G) given below will be considered as a means of meeting the requirements of rule 277 above, provided that insulators having a flash-over not less than required by rule 276, C, 1 or C, 2 are used, and in no case having a lower flash-over than insulators generally used in adjacent sections of the line.

Exception: If the insulator hardware on the structure is grounded at crossings and is not grounded on the adjacent parts of the line, construction in accordance with A or B below should be followed, or other equally effective means employed.

The use of grounded construction at crossings only should in general be avoided.

A. The use of a protective device such as a gap, protector tube, lightning arrester, or the like, on or adjacent to the insulator, which is effective in suppressing the power arc or in holding it clear of the insulator, conductor, supporting structure, and hardware.

B. The use of protective gaps or other voltage-limiting devices on structures adjacent to crossing structures, if such devices limit the voltage to not more than 80 percent of the flash-over value of the insulators on the crossing structures.

C. The use of circuit protection by fast-clearing fuses or circuit-breakers. Fuses, or breakers in combination with their relays, shall be considered "fast-clearing" if they interrupt fault currents within one-fifth second (12 cycles at 60 cycles per second).

278. Compliance With Rule 277 at Crossings—Continued.

D. The use of one or more overhead ground wires installed at a higher level than the phase wires on not less than five consecutive spans, including two adjacent spans on each side of the crossing span, provided the ground wire is effectively grounded at structures adjacent to crossing structures.
   Such overhead ground wires shall not be grounded at crossing structures unless such structures are inherently grounded or unless the ground wires are grounded at each of the two supporting structures on both sides of and adjacent to the crossing structures. In this latter case the down leads from the overhead ground wires shall be suitably offset from the crossing structures or otherwise arranged so as not to appreciably increase the probability of lightning flash-over from the overhead ground wire and its connections to the phase wires and other current-carrying parts.

E. The use of insulators with ungrounded pins or supporting insulator attachments carried on wood arms.

F. The use of insulators having a flash-over 25 percent greater than those employed on adjacent sections of the line, but not less than 25 percent greater than the values in table 30.

G. If the insulator supports on the crossing structure and on adjacent sections of the line are grounded, the use of insulator strings with higher flash-over voltage at crossing supports than on the adjacent sections, as follows:

   (1) If the adjacent parts of the line have five or less units—one extra unit at the crossing.
   (2) If the adjacent parts of the line have six or more units—two extra units at the crossing.
   (3) Insulation equivalent to that provided by (1) or (2).

280. SUPPORTING STRUCTURES FOR OVERHEAD LINES.

A. Poles and Towers.

1. RUBBISH.

Poles and towers shall be placed, guarded, and maintained so as to be exposed as little as practicable to brush, grass, rubbish, or building fires.

2. GUARDING POLES.

(*a*) PROTECTION AGAINST MECHANICAL INJURY. Where poles and towers are exposed to abrasion by traffic or to other damage which would materially affect their strength, they shall be protected by guards.

(b) PROTECTION AGAINST CLIMBING. On closely latticed poles or towers carrying supply conductors exceeding 300 volts to ground, either guards or warning signs shall be used, except as follows:

Exception 1: Where the right-of-way is completely fenced.

Exception 2: Where the right-of-way is not completely fenced, provided the poles or towers are not adjacent to roads, regularly traveled thoroughfares, or places where people frequently gather, such as schools or public playgrounds.

3. WARNING SIGNS.

(a) ON POLES OR TOWERS. For warning signs on poles or towers, see rule 280, A, 2, (b).

(b) ON BRIDGE FIXTURES. Structures attached to bridges for the purpose of supporting conductors shall be plainly marked with the name, initials, or trade-mark of the utility responsible for the attachment and, in addition, where the voltage exceeds 750 volts to ground, by the following sign or its equivalent:

"Danger—Do Not Touch."

280. A. Poles and Towers—Continued.

4. GROUNDING METAL POLES.

Metal poles not guarded or isolated shall always be specially grounded where in contact with metal-sheathed cable or the metal cases of equipment operating at voltages exceeding 750 volts to ground.

Metal poles not guarded, isolated, or specially grounded should always be considered as imperfectly grounded and the insulators supporting line conductors as well as the strain insulators in attached span wires should, therefore, have a suitable margin of safety and be maintained with special care to prevent leakage to the pole as far as practicable.

5. POLE STEPS.

(a) METAL STEPS. Steps closer than 6½ feet from the ground or other readily accessible place shall not be placed on poles.

(b) WOOD BLOCKS. One wood block (or on private right-of-way more than one) may be placed on poles carrying communication cables or conductors below supply conductors, but the lowest block is not to be less than 3½ feet from the ground or other readily accessible place. On poles carrying only communication conductors, additional wood blocks may be used.

6. IDENTIFICATION OF POLES.

Poles, towers and other supporting structures on which are maintained electric conductors shall be so constructed, located, marked, or numbered as to facilitate identification by employees authorized to work thereon. Date of installation of such structures shall be recorded where practicable by the owner.

280. A. Poles and Towers—Continued.

7. OBSTRUCTIONS.

All poles should be kept free from posters, bills, tacks, nails, growing vines, and other unnecessary obstructions, such as through bolts not properly trimmed.

B. Crossarms.

1. LOCATION.

In general, crossarms should be maintained at right angles to the axis of the pole and to the direction of the attached conductors, and at crossings should be attached to that face of the structure away from the crossing, unless special bracing or double crossarms are used.

Note: Double crossarms are generally used at crossings, unbalanced corners, and dead-ends in order to permit conductor fastenings at two insulators and so prevent slipping, although single crossarms might provide sufficient strength. To secure extra strength, double crossarms are frequently used and crossarm guys are sometimes used.

2. BRACING.

Crossarms shall be securely supported, by bracing if necessary, so as to support safely loads to which they may be subjected, including linemen working on them. Any crossarm or buckarm, except the top one, shall be capable of supporting a vertical load of 225 pounds at either extremity in addition to the weight of the conductors.

C. Unusual Conductor Supports.

Where conductors are attached to structures other than those used solely or principally for supporting the lines, all rules shall be complied with as far as they apply and such additional precautions as may be deemed necessary by the administrative authority shall be taken to avoid injury to such structures or to the person using them. The supporting of conductors on trees and roofs should be avoided where practicable.

281. Tree Trimming.

A. General.

Where trees exist near supply-line conductors, they shall be trimmed, if practicable, so that neither the movement of the trees nor the swinging or increased sagging of conductors in wind or ice storms or at high temperatures will bring about contact between the conductors and the trees.

Exception: For the lower-voltage conductors, where trimming is difficult, the conductor may be protected against abrasion and against grounding through the tree by interposing between it and the tree a sufficiently nonabsorptive and substantial insulating material or device.

B. At Wire Crossings and Railroad Crossings.

The crossing span and the next adjoining spans shall be kept free, as far as practicable, from overhanging or decayed trees which might fall into the line.

282. Guying.

A. Where Used.

When the loads to be imposed on poles, towers, or other supporting structures are greater than can be safely supported by the poles or towers alone, additional strength shall be provided by the use of guys, braces or other suitable construction.

Guys shall be used also, where necessary, whereever conductor tensions are not balanced, as at corners, angles, dead-ends, and changes of grade of construction.

Note: This is to prevent undue increase of sags in adjacent spans as well as to provide sufficient strength for those supports on which the loads are considerably unbalanced.

B. Strength.

The strength of the guy shall meet the requirements of section 26 for the grade of construction that applies.

When guys are used with wood or other poles or

282. B. Strength—Continued.

towers capable of considerable deflection before failure, the guys shall be able to support the entire load in the direction in which they act, the pole acting simply as a strut.

C. Point of Attachment.

The guy should be attached to the structure as near as practicable to the center of the conductor load to be sustained, but for voltages exceeding 8,700 volts between conductors, the insulation afforded by wood crossarms and poles should not be reduced any more than is necessary.

D. Guy Fastenings.

Guys should be stranded and where attached to anchor rods should be protected by suitable guy thimbles or their equivalent. Cedar and other softwood poles around which any guy having a strength of 10,000 pounds or more is wrapped should be protected by the use of suitable guy shims and, where there is a tendency for the guy to slip off the shim, guy hooks or other suitable means of preventing this action should be used. Shims are not necessary in the case of supplementary guys, such as storm guys.

E. Guy Guards.

The ground end of all guys attached to ground anchors exposed to traffic shall be provided with a substantial and conspicuous wood or metal guard not less than 8 feet long.

Recommendation: It is recommended that in exposed or poorly lighted locations such guards be painted white or some other conspicuous color.

F. Insulating Guys from Metal Poles.

Where anchors would otherwise be subject to electrolysis, guys attached to metal poles or structures and not containing guy insulators should be insulated from the metal pole or structure by suitable blocking.

282. Guying—Continued.

G. Anchor Rods.

Anchor rods shall be installed so as to be in line with the pull of the attached guy when under load, except in rock or concrete. The anchor rod shall have an ultimate strength in the eye and shank equal to that required of the guy.

H. Grounding.

The anchored end of guys attached to wood poles carrying circuits of more than 15,000 volts shall be effectively grounded (see section 9 for method) wherever this part of the guy has a clearance of less than 8 feet to ground.

Exception 1: This does not apply to guys in rural districts.

Exception 2: This does not apply if the guy contains an insulator which will meet the requirements of rule 283, A, 2 for the highest voltage liable to be impressed on it.

283. INSULATORS IN GUYS ATTACHED TO POLES AND TOWERS.

A. Properties of Guy Insulators.

1. MATERIAL.

(a) GRADE B. Guy insulators shall be made by the wet-porcelain process or a process equally suitable as regards electrical and mechanical properties.

(b) GRADES C, D, AND N. No requirements are made for material.

2. ELECTRICAL STRENGTH.

Guy insulators shall have a dry flash-over voltage at least double the normal line voltage and a wet flash-over voltage at least as high as the normal line voltage between conductors.

3. MECHANICAL STRENGTH.

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

283. Insulators in Guys Attached to Poles and Towers—Continued.

B. Use of Guy Insulators.

1. ONE INSULATOR.

An insulator shall be located in each guy which is attached to a pole or structure carrying any supply conductors of more than 300 volts to ground and not more than 15,000 volts between conductors, or in any guy which is exposed to such voltages. This guy insulator shall be located at least 8 feet above the ground.

Exception 1: A guy insulator is not required where the guy is grounded under the conditions set forth in 4 following.

Exception 2: A guy insulator is not required if the guy is attached to a pole on private right-of-way carrying no supply circuits whose voltage exceeds 550 volts or whose transmitted power exceeds 3,200 watts.

Exception 3: A guy insulator is not required if all supply conductors are in a cable having a grounded metal sheath or supported by a grounded messenger.

2. TWO INSULATORS.

Where a guy attached to any pole carrying communication or supply conductors or both, is carried over or under any overhead supply conductor of more than 300 volts to ground and where hazard would otherwise exist, two or more guy insulators shall be placed so as to include the exposed section of the guy between them as far as possible. Neither insulator shall be within 8 feet of the ground.

Exception: These insulators are not required where the guy is grounded under the conditions set forth in 4 following.

283. B. Use of Guy Insulators—Continued.

3. RELATIVE LOCATION OF INSULATORS IN GUYS LOCATED ONE ABOVE THE OTHER.

Where guys in which it is necessary to install insulators are so arranged that one crosses or is above another, insulators shall be so placed that in case any guy sags down upon another the insulators will not become ineffective.

4. GROUNDING OF GUYS.

Insulators are not required in guys under the following conditions:

(a) Where the guy is electrically connected to grounded steel structures or to a ground connection on wood poles.

(b) Where the guys are uniformly effectively grounded throughout any system of overhead lines.

(c) Where the guys are connected to a line conductor which has at least four ground connections in each mile of line in addition to the ground connections at individual services.

284. SPAN-WIRE INSULATORS.

A. Mechanical Strength.

Span-wire insulators shall have a mechanical strength at least equal to that required of the span wire in which they are installed.

B. Use of Span-Wire Insulators.

All span wires, including bracket span wires, shall have a suitable strain insulator (in addition to an insulated hanger if used) inserted between each point of support of the span wire and the lamp or trolley-contact conductor supported, except that single insulation, as provided by an insulated hanger, may be permitted when the span wire or bracket is supported on wood poles supporting only trolley, railway feeder, or communication conductors used in the operation of the railway con-

284. B. Use of Span-Wire Insulators—Continued.

cerned. In case insulated hangers are not used, the strain insulator shall be located so that in the event of a broken span wire the energized part of the span wire cannot be reached from the ground.

Exception: This rule does not apply to insulated feeder taps used as span wires.

285. OVERHEAD CONDUCTORS.

A. Identification.

All conductors of electric-supply and communication lines should be arranged to occupy definite positions throughout, as far as practicable, or shall be constructed, located, marked, numbered, or attached to distinctive insulators or crossarms, so as to facilitate identification by employees authorized to work thereon. This does not prohibit systematic transposition of conductors.

B. Branch Connections.

1. ACCESSIBILITY.

Connections of branches to supply circuits, service loops, and equipment in overhead construction shall be readily accessible to authorized employees. When possible, connections shall be made at poles or other structures.

2. CLEARANCE.

Branch connections shall be supported and placed so that swinging or sagging cannot bring them in contact with other conductors or interfere with the safe use of pole steps, or reduce the climbing or lateral working space.

C. Common Neutral.

Primary and secondary circuits may utilize a single conductor as a common neutral if such conductor has at least four ground connections in each mile of line. Ground connections at individual services are to be counted only if made to underground water piping systems.

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286. Equipment on Poles.

A. Identification.

All equipment of electric-supply and communication lines should be arranged to occupy definite positions throughout, as far as practicable, or shall be constructed, located, marked, or numbered so as to facilitate identification by employees authorized to work thereon.

B. Location.

Transformers, regulators, lightning arresters, and switches, when located below conductors or other attachments, shall be mounted outside of the climbing space.

C. Guarding.

Current-carrying parts of switches, automatic circuit-breakers, and lightning arresters shall be suitably inclosed or guarded if all the following conditions apply:

1. If of more than 300 volts to ground, and,
2. If located on the climbing side of the pole less than 20 inches from the pole center, and,
3. If located below the top crossarm.

D. Hand Clearance.

All current-carrying parts of switches, fuses, lightning arresters, also transformer connections and other connections which may require operation or adjustment while alive and are exposed at such times, shall be arranged so that in their adjustment while alive the hand need not be brought nearer to any other current-carrying part at a different voltage than the clearances from pole surfaces required in table 9, rule 235, A, 3, (a), for conductors of corresponding voltages. (See also rule 422, A, B, and C, part 4 of this code, for clearances from live parts.)

286. Equipment on Poles—Continued.

E. Street-Lighting Equipment.

1. CLEARANCES FROM POLE SURFACE.

All exposed metal parts of lamps and their supports (unless effectively insulated from the current-carrying parts) shall be maintained at the following distances from the surface of wood poles:

	Inches
In general	20
If located on the side of the pole opposite the designated climbing side	5

Exception: This does not apply where lamps are located at pole tops.

2. CLEARANCES ABOVE GROUND.

Street lamps shall be mounted at not less than the following heights above ground:

	Feet
Over walkways	10
Over roadways:	
Connected to circuits of 150 volts or less	14
Connected to circuits of more than 150 volts	15

3. HORIZONTAL CLEARANCE.

Arc and incandescent lamps in series circuits should have at least 3 feet horizontal clearance from windows, porches, and other spaces accessible to the general public.

4. MATERIAL OF SUSPENSION.

The lowering rope or chain for lighting units arranged to be lowered for examination or maintenance shall be of a material and strength designed to withstand climatic conditions and to sustain the lighting unit safely. The lowering rope or chain, its supports, and fastenings shall be examined periodically.

286. E. Street-Lighting Equipment—Continued.

5. INSULATORS IN SUSPENSION ROPES.

Effective insulators, as specified in rule 283, A, should be inserted at least 8 feet from the ground in metallic suspension ropes or chains supporting lighting units of series circuits.

6. ARC-LAMP DISCONNECTORS.

A suitable device shall be provided by which each arc-lighting unit on series circuits of more than 300 volts to ground may be safely and entirely disconnected from the circuit before the lamp is handled, unless the lamps are always worked on from suitable insulating stools, platforms, or tower wagons, or handled with suitable insulating tools, and treated as under full voltage of the circuit concerned.

7. GROUNDING LAMP POSTS.

Metal lamp posts shall be effectively grounded.

F. Transformers.

Transformers mounted on arms or poles on public thoroughfares shall be at a height above ground not less than 10 feet where over walkways and not less than 15 feet where over roadways.

Exception: Where it is the established practice to mount transformers at lesser distances above ground, such practice may be continued if the reduced mounting heights are carefully maintained.

287. PROTECTION FOR EXPOSED OVERHEAD COMMUNICATION LINES.

A. Open Wire.

Communication lines for public use and fire-alarm lines shall be treated as follows, if at any point they are exposed to supply (including trolley) lines of more than 400 volts to ground:

1. At stations for public use they shall be protected by one of the methods specified in part 3, section 39 of this code.

287. A. Open Wire—Continued.

2. Elsewhere they shall be isolated by elevation or otherwise guarded so as to be inaccessible to the public.

B. **Metal-Sheathed Cable.**

Metal-sheathed cables and messengers shall be isolated or grounded in conformity with the general requirements of section 21.

288. Circuits of One Class Used Exclusively in the Operation of Circuits of Another Class.

A. **Overhead Communication Circuits Used Exclusively in the Operation of Supply Circuits.**

1. CHOICE OF METHOD.

Communication circuits used exclusively in the operation of supply lines may be run either as ordinary communication circuits or as supply circuits under the conditions specified in 3 and 4 of this rule, respectively. After selection of the type of communication-circuit construction and protection for any section which is isolated, or is separated by transformers, such construction and protection shall be consistently adhered to throughout the extent of such isolated section of the communication system.

2. GUARDING.

Communication circuits used in the operation of supply lines shall be isolated by elevation or otherwise guarded at all points so as to be inaccessible to the public.

3. WHERE ORDINARY COMMUNICATION-LINE CONSTRUCTION MAY BE USED.

Communication circuits used in the operation of supply lines may be run as ordinary communication conductors under the following conditions:

(a) Where such circuits are below supply conductors in the operation of which they are used (including high-voltage trolley feeders)

288. A. Overhead Communication Circuits Used Exclusively in the Operation of Supply Circuits—Continued.

at crossings, conflicts, or on commonly used poles, provided:

(1) Such communication circuits occupy a position below all other conductors or equipment at crossings, conflicts, or on commonly used poles.

(2) Such communication circuits and their connected equipment are adequately guarded and are accessible only to authorized persons.

(3) The precautions in part 3, section 39, and part 4, section 44 of this code, have been taken.

(b) Where such circuits are below supply conductors in the operation of which they are used and are above other supply or communication conductors at wire crossings, conflicts, or on the same poles, provided the communication circuits are protected by fuseless lightning arresters, drainage coils, or other suitable devices to prevent the communication circuit voltage from normally exceeding 400 volts to ground.

Note: The grades of construction for communication conductors with inverted levels apply.

4. WHERE SUPPLY-LINE CONSTRUCTION MUST BE USED.

Communication circuits used in the operation of supply lines shall comply with all requirements for the supply lines with which they are used, where they do not comply with the provisos of 3 (a) or (b) above.

Exception 1: If the voltage of the supply conductors concerned exceeds 8,700 volts between conductors, the communication conductors, need only meet the requirements for supply

288. A. Overhead Communication Circuits Used Exclusively in the Operation of Supply Circuits—Continued.

conductors of 5,000 to 8,700 volts between conductors.

Exception 2: Where the supply conductors are required to meet grade C, the size of the communication conductors may be the same as for grade D (see rule 262, I, 2) for spans up to 150 feet.

B. Supply Circuits Used Exclusively in the Operation of Communication Circuits. (See also sec. 29.)

Circuits used for supplying power solely to apparatus forming part of a communication system may be run either in open wire or in aerial or underground cable as follows:

1. Where run in open wire, such circuits shall have the grades of construction, clearances, insulation, etc., prescribed elsewhere in part 2 for supply or communication circuits of the voltage concerned.

2. Where run in aerial or underground cable and the following requirements are met, the grades of construction, clearances, separations, locations, etc., prescribed elsewhere in part 2 for communication cables shall apply:

(a) Such cables are covered with effectively grounded continuous metal sheaths or are carried in metal cable rings on effectively grounded messengers.

(b) All circuits in such cables are owned or operated by one party and are maintained only by qualified employees.

(c) Supply circuits included in such cables are terminated at points accessible only to qualified employees.

(d) Communication circuits brought out of such a cable, if they do not terminate in a repeater station or terminal office, shall be so protected or arranged that in the event of a

288. B. Supply Circuits Used Exclusively in the Operation of Communication Circuits—Continued.

failure within the cable, the voltage on these communication circuits will not exceed 400 volts to ground.

(e) Terminal apparatus for the power supply shall be arranged so that live parts are inaccessible when such supply circuits are energized.

Exception: The provisions of B, 1 and 2 above, do not apply to supply circuits of 550 volts or less and which carry power not in excess of 3,200 watts, covered in rule 220, B, 3.

289. Overhead Electric Railway Construction.

A. Trolley-Contact Conductor Supports.

All overhead trolley-contact conductors shall be supported and arranged so that the breaking of a single contact conductor fastening will not allow the trolley conductor, live span wire, or current-carrying connection to come within 10 feet (measured vertically) from the ground, or from any platform accessible to the general public.

Span-wire insulation for trolley-contact conductors shall comply with rule 284.

B. High-Voltage Contact Conductors.

Every trolley-contact conductor of more than 750 volts in urban districts where not on fenced right-of-way shall be suspended so as to minimize the liability of a break and, as far as practicable, so that if broken at a single point, it can not fall within 12 feet (measured vertically) from the ground or any platform accessible to the general public.

C. Third Rails.

Third rails shall be protected where not on fenced rights-of-way by adequate guards composed of wood or other suitable material.

289. Overhead Electric Railway Construction—Continued.

D. Prevention of Loss of Contact at Railroad Crossings.

Trolley-contact conductors shall be arranged as set forth in either 1 or 2 following, at grade crossings with interurban or other heavy-duty or high-speed railroad systems:

1. The trolley-contact conductor shall be provided with live trolley guards of suitable construction, or,
2. The trolley-contact conductor shall be as far as practicable at the same height above its own track throughout the crossing span and the next adjoining spans. Where a uniform height above rail is not adhered to, the change shall be made in a very gradual manner. Where the crossing span exceeds 100 feet, catenary construction shall be used.

Exception: This rule does not apply where the system is protected by interlocking derails or by gates.

E. Guards Under Bridges.

1. WHERE GUARDING IS REQUIRED.

Guarding is required where the trolley-contact conductor is so located that a trolley pole leaving the conductor can make simultaneous contact between it and the bridge structure.

2. NATURE OF GUARDING.

Guarding shall consist of a substantial inverted trough of nonconducting material located above the contact conductor, or other suitable means of preventing contact between the trolley pole and the bridge structure.

SEC. 29. RULES FOR UNDERGROUND LINES

(See also rule 288, B, 2.)

290. LOCATION.

A. General Location.

Underground systems of electric conductors should be located so as to be subject to the least practicable disturbance. Railway tracks and underground structures, including catch basins, gas pipes, etc., should be avoided where practicable.

B. Ducts.

The ducts between adjacent manholes or other outlets should be laid as straight and direct as practicable.

C. Manholes.

Manhole openings, where practicable, shall be located so as to provide safe and convenient access. At crossings under railroads, the manholes, pull boxes, and terminals should, where practicable, be located away from the roadbed.

291. CONSTRUCTION OF DUCT AND CABLE SYSTEMS.

A. Material, Size, and Finish of Ducts.

Ducts shall be of such material, size, mechanical strength, and finish as to facilitate the installation and maintenance of conductors or cables. Ducts shall be freed from burrs before laying and shall have clear bores.

B. Grading of Ducts.

Where it is necessary to drain ducts the grade of the ducts shall be such as to permit proper and adequate drainage.

C. Settling.

Ducts should be suitably reinforced or be laid on suitable foundations of sufficient mechanical strength where necessary to protect them from settling.

291. Construction of Duct and Cable Systems—Continued.

D. Clearances.

1. GENERAL.

The clearance between duct or cable systems and other underground structures paralleling them, shall be as great as practicable. The distance between the top covering of the system and the pavement surface, or other surface under which the system is constructed, shall be sufficient to protect the system from injury by traffic.

2. BELOW BASE OF RAIL.

The top of all duct and cable system structures, except as hereafter specified, shall generally be located at a depth of not less than 30 inches, in the case of street railways, and not less than 42 inches, in the case of steam and electric railroads, below the base of rail. Where unusual conditions exist or where proposed construction would interfere with existing construction, a greater depth than specified above may be required.

Exception 1: Where this is impracticable, or for other reasons, this clearance may be reduced by agreement between the parties concerned. In no case, however, shall the top of the conduit protection extend higher than the bottom of the ballast section which is subject to working or cleaning.

Exception 2: Where physical and chemical conditions will permit, a conduit consisting of not more than two iron pipes, not exceeding 4 inches in diameter, or two creosoted wood ducts not exceeding 6 inches square, or one or more cables of a type designed for burying directly in the earth used for communication lines, or for service supply circuits not exceeding 750 volts, may be laid in the ground beneath railroad tracks without any form of

291. D. Clearances—Continued.

protection at a minimum depth of 18 inches below the base of the rail unless the worked ballast section of the roadbed exceeds 18 inches, in which case the conduit shall be laid below the ballast section.

3. IRON PIPE CONDUIT.

Where iron pipe is used as a conduit for underground cables or conductors, it shall not be laid in contact with water, gas, or steam metallic-pipe systems. Where the clearance is less than two inches, the metal conduit shall be adequately separated from other metallic-pipe systems by a barrier of suitable materials, or they shall be electrically bonded together at the point of least separation.

E. Separations Between Supply and Communication Duct Systems.

1. GENERAL.

Duct systems, including laterals, to be occupied by communication conductors for public use should be separated, where practicable, from duct systems, including laterals, for supply conductors by not less than 3 inches of concrete, 4 inches of brick masonry, or 12 inches of well-tamped earth.

Exception 1: Extensions may, however, be made to existing interconnected or jointly owned and jointly occupied duct systems used in common by municipalities, communication companies, or supply companies with less effective separations than above specified.

Exception 2: Cables containing circuits of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts, used exclusively in connection with the operation of a railway signal or supply system, may be carried in the same

291. E. Separations Between Supply and Communication Duct Systems—Continued.

duct system with communication cables, if such construction is agreed to by all parties concerned, and where the communication cables are exclusively used for the operation of the railway signal or supply system, they may be carried in the same duct.

2. ENTERING MANHOLES.

Where communication and supply conductors or cables occupy ducts terminating in the same manhole, the two classes of ducts should be separated as widely as practicable and where practicable should enter the manhole from opposite sides.

Note: This requirement is made so that cables can be racked along side walls with a minimum of crosses between the two classes of conductors.

F. Duct Entrances Into Manholes.

Iron-pipe conduit terminating in manholes, handholes, or other permanent openings of underground systems, shall be provided with an effective shield, bushing or other smooth outlet.

Exception: This does not apply to communication conductors, to supply conductors of less than 300 volts between conductors, or to armored cables of any voltage.

G. Sealing Laterals.

Lateral ducts for service connections to buildings, through which gas or water may enter buildings or other duct systems, should be effectively plugged or cemented by the use of asphaltum, pitch, or other suitable means.

H. Duct Arrangement for Dissipation of Heat.

Duct systems intended to carry supply cables of large current capacity should be arranged, where practicable, so that ducts carrying such cables will not dissipate their heat solely through other ducts.

292. Construction of Manholes.

A. Minimum Strength.

The design and construction of manholes and handholes shall provide sufficient strength to sustain, with a suitable margin of safety, the loads which may reasonably be imposed on them.

B. Dimensions.

Manholes should meet the following requirements where practicable:

1. WIDTH.

The least horizontal inside dimension should be not less than 3 feet 6 inches.

2. WORKING SPACE.

A clear working space should be provided. The horizontal dimension should be not less than 3 feet. The vertical dimension should be not less than 6 feet except in manholes where the opening is within 1 foot on each side of the full size of the manhole.

Exception: The dimensions specified in 1 and 2 above are not necessary in service boxes, handholes, or in manholes serving a small number of ducts, or in manholes used exclusively for communication-system equipment and cables.

C. Drainage.

Where drainage is into sewers, suitable traps shall be provided to prevent entrance of sewer gas into manholes.

D. Ventilation.

Adequate ventilation to open air shall be provided for manholes from which any openings exist into subways entered by the public. Where such manholes house transformers, sectionalizing switches, or regulators, etc., the ventilator ducts shall be cleaned at necessary intervals.

Exception: Subways under water or in other locations where it is impracticable to comply.

292. Construction of Manholes—Continued.

E. Manhole Openings.

Round openings to any manhole should be not less than 24 inches in diameter. Rectangular openings should have dimensions not less than 24 by 20 inches.

Exception: The dimensions specified above are not necessary in service boxes and handholes or in manholes serving a small number of ducts.

F. Manhole Covers.

Manholes and handholes, while not being worked in, shall be securely closed by covers of sufficient strength to sustain such loads as may reasonably be imposed upon them.

G. Supports for Cables.

Cables should be adequately supported at each manhole.

H. Manhole Location.

Manhole openings shall, where practicable, be located so that barriers or other suitable guards can be placed to protect the opening effectively when uncovered.

293. Location of Cables.

A. Accessibility.

Cables in manholes shall be reasonably accessible to workmen and clear working space shall be maintained at all times.

B. Cables Carrying Large Currents.

Cables intended to carry large currents should be located, where practicable, in outside ducts so that they will not necessarily dissipate heat solely through adjacent ducts.

C. Separation Between Conductors.

1. CABLES OF DIFFERENT VOLTAGES.

Cables shall be arranged and supported in ducts and manholes so that those operating at higher

293. C. Separation Between Conductors—Continued.

voltages will be separated as far as practicable from those operating at lower voltages.

2. CABLES OF DIFFERENT SYSTEMS.

Cables belonging to different systems, particularly supply-distribution and communication systems, shall not be installed in the same duct.

Exception: This does not apply to the installation of railway-signal supply and communication cables in the same duct, as permitted by exception 2 in rule 291, E, 1.

3. CABLES OF SUPPLY AND COMMUNICATION SYSTEMS.

(a) GENERAL. Supply cables and communication cables for public use should, in general, be maintained in separate duct systems, and particularly in separate manholes.

Exception 1: Cable extensions may be made to existing interconnected or jointly owned and jointly occupied duct systems used in common by municipalities, communication companies, or supply companies.

Exception 2: This does not apply where railway-signal supply and communication cables are carried in the same duct system as permitted in exception 2, rule 291, E, 1.

(b) IN THE SAME MANHOLE. Supply cables and communication cables for public use occupying the same manhole should, where practicable, be maintained at opposite sides of the manhole.

Where supply and communication cables must cross, a separation of at least 1 foot shall, where practicable, be maintained.

294. Protection and Separation of Conductors Buried in Earth.

A. Separation.

The separation between buried communication and buried supply conductors or cables shall consist of not less than 12 inches of well tamped earth, 4 inches of brick, or 3 inches of concrete.

Exception: This separation and protection is not required where supply circuits having a potential of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts are laid adjacent to communication cables, if all cables are used exclusively for the operation of a railway-signal or supply system, and are maintained by the same company.

B. Protection at Crossings of Cables.

At all crossings where buried supply conductors or cables are above communication conductors or cables, the supply conductors or cables shall be protected from digging operations by concrete or creosoted wood plank or equivalent mechanical protective covering extending at least 2 feet in each direction from the point of crossing.

Exception: This separation and protection is not required where supply circuits having a potential of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts are laid adjacent to communication cables, if all cables are used exclusively for the operation of a railway-signal or supply system, and are maintained by the same company.

C. Protection of Cables Installed Parallel.

Where buried communication and buried supply conductors or cables are installed in the same trench generally parallel to each other, the buried supply conductors or cables shall be covered with

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294. C. Protection of Cables Installed Parallel—Continued.

concrete or creosoted wood plank or equivalent mechanical protection, except that this covering may be omitted in the following cases:

1. Where the voltage of the supply conductors does not exceed 300 volts to ground.
2. Where the supply conductors or cables are encased in a continuous metallic sheath effectively grounded.
3. Where the supply conductors or cables are installed more than 2 feet horizontally from communication conductors.

Exception: This separation and protection is not required where supply circuits having a potential of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts are laid adjacent to communication cables, if all cables are used exclusively for the operation of a railway-signal or supply system, and are maintained by the same company.

295. Protection of Conductors in Duct Systems and Manholes.

A. Protection Against Arcing.

A suitable fire-resistant covering should be placed on the following cables to prevent injury from arcing:

1. Closely grouped lead-sheathed supply cables containing circuits of more than 8,700 volts, or of large current capacity operating at more than 750 volts ac or 300 volts dc.
2. Communication cables and supply cables of large current capacity, if occupying the same side of the manhole, or if they cross each other.

B. Bonding.

Exposed metallic cable sheaths shall be bonded at suitable intervals with a conductor of suitable size, electrolysis conditions permitting. Supply cable sheaths need not be bonded to communication cable sheaths.

296. Guarding of Live Parts in Manholes.

A. **Conductor Joints or Terminals.**

Joints or terminals of conductors or cables of supply systems shall be arranged so that there are no bare ungrounded current-carrying metal parts exposed to accidental contact within manholes or handholes.

B. **Apparatus.**

Live parts of protective, control or other apparatus installed and maintained in manholes should be enclosed in suitable grounded cases or in cases having no exposed metallic parts.

297. Construction at Risers from Underground.

A. **Separation Between Risers of Communication and Supply Systems.**

The placing of risers for communication systems and risers for supply systems on the same pole should be avoided where practicable. If it is necessary to use the same pole for the risers of both systems, they shall be placed on opposite semicircumferences of the pole where practicable. Where located on streets or highways, risers should, where practicable, be placed on poles so as to be in the safest available location from the point of view of traffic damage.

B. **Mechanical Protection of Conductors.**

All supply conductors or cables from underground systems which connect to overhead systems shall be protected by a covering which gives suitable mechanical protection up to a point 8 feet above the ground.

Exception: Armored cables or cables installed in a grounded metal conduit.

C. **Grounding of Riser Pipes.**

Exposed metal riser pipes containing supply conductors shall be grounded unless such conductors are covered with a grounded metal sheath or are themselves grounded.

297. Construction at Risers from Underground—Continued.

D. Conductor Terminal Construction.

The terminals of underground cables operating at more than 750 volts to ground and connecting to overhead open-wire systems shall meet the following requirements:

1. PROTECTION AGAINST MOISTURE.

Protection shall be provided so that moisture will not enter the cable.

2. INSULATION OF CONDUCTORS.

Conductors shall be properly insulated from the grounded metal sheath. In addition, the conductors of multiple-conductor cable shall be properly separated and insulated from each other.

Note: These requirements may be fulfilled by the use of potheads or other equivalent devices, such as oil switches, if incidentally they accomplish the same purpose.

E. Clearance Above Ground for Open Supply Wiring.

For supply wires connecting to underground systems see rule 232, C.

298. IDENTIFICATION OF CONDUCTORS.

Cables shall be permanently identified by tags or otherwise at each manhole or other permanent opening of the underground system. Where the duct formation on opposite sides of the manhole is the same, the cables where practicable should be installed in corresponding ducts.

Exception: This requirement does not apply where the position of a cable, in conjunction with diagrams supplied to workmen, gives sufficient identification, or where the manhole is occupied solely by the communication cables of one utility, or of two utility companies agreeing thereto.

299. Identification of Apparatus Connected in Multiple.

Where transformers, regulators, or other similar apparatus not located in the same manhole operate in multiple, special tags, diagrams, or other suitable means shall be used to indicate that fact.

Exception: This requirement does not apply where disconnecting devices are provided to permit cutting such equipment completely off the system.

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