

704 - Electrical Installations to conform to This Code.

- a. All new electrical work shall conform to the requirements of this Code. When an old electrical installation or any part of such installation is found, upon inspection, to be unsafe to life or property, the Electrical Inspector shall require that such portion of the installation as is found to be hazardous be reconstructed to conform to any or all of the requirements of this Code.
- b. Installations which were made prior to the date on which this Code became effective are not to be considered as being in violation of the Code until such a time as the Electrical Inspector shall have notified the person responsible for such installations, of the existence of unsafe conditions.
- c. When any additions, alterations, or renewals of existing installations are made after the date on which the Code becomes effective, that portion of the installation which is extended, altered, or renewed, shall be made to conform to all of the applicable requirements contained herein.
- d. All installations shall be made in a neat workmanlike manner, and shall be so designed, constructed, installed and maintained as to reduce the personal hazard and the fire hazard as far as is reasonably possible.

705 - Explanation of Rules and Approval of Plans.

- a. The Electrical Inspector shall answer any relevant question concerning, or give any desired information in respect to, the meaning, intent, or application of the regulations and rules of this Code. The Electrical Inspector (in his official capacity) is not, however, empowered to, and cannot lay out work or act in the capacity of consulting engineer for inexperienced contractors, mechanics or owners.
- b. Plans which are submitted for approval as to compliance with the requirements of this Code cannot be accepted unless they are in sufficient detail.

706 - Requirements for Final Inspection.

- a. All necessary cutouts, cutout boxes or cabinets, fuses, switches, flush receptacles and other materials and devices shall be installed and all outlets properly connected before any certificate of final inspection will be issued. This work shall be done by the wiring contractor.

(Fine Print Note) The Electrical Division does not propose to act as arbitrator in disputes that may arise after the contract has been let or the work started. To insure a satisfactory installation, the plans and specifications should be drawn up so that electrical contractors may all bid on the same grade of work. The mere statement in the specifications that the electrical installation must conform to the National Electrical Code requirements and that a certificate from the City Inspection Department will be accepted as evidence that a contract has been fulfilled, does not mean that a modern and efficient electrical equipment will be installed. We desire this to be thoroughly understood as owners frequently complain to us that their electrical equipments are deficient in many particulars over which we have no control.

707 - Modifications.

A. The Electrical Board of Appeal (See Article 5) may, modify or waive the requirements of this Code in particular cases wherever any rules are shown to involve expense not justified by the protection secured or for any other reason to be impracticable; or whenever it is shown that equivalent or safer construction can be more readily accomplished in other ways.

B. The requirements of this Code may be modified or waived by special permission in particular cases in connection with which the term "Special Permission" is used. Such permission shall in all cases be obtained prior to the commencement of the work.

ARTICLE 8.**CLASSIFICATION AND USE OF ELECTRICAL SYSTEMS IN BUILDINGS.****801 - Constant Current Systems.**

a. Conductors of constant current systems (either primary or secondary) shall not be installed in or on buildings except central stations and substations unless special permission is obtained in advance.

802 - Railway Systems.

a. The use of current for power, heat or light from any electric railway system with ground return shall only be permitted in the places noted in section 2301(a) of this Code; provided, however, that in locations where an approved service supply can not be obtained, connection may be made with railway systems by special permission. Plans for such installations shall be submitted to, and approved by, the Electrical Division prior to the commencement of any work.

803 - Restrictions as to Voltage.

a. Conductors or equipment of systems operating at 600 volts and less, with the exception noted in section 802 of this Article, may be attached to, carried over, or installed in and about buildings.

b. Lighting shall be connected only to constant potential systems, and the voltage between the conductors of any branch circuit shall not exceed 300, and the voltage to ground from either conductors shall not exceed 150; provided, however, that in locations where the voltage to ground is not specifically limited to 150 volts by other sections of this Code, if the installation of an additional transformer would be required to keep the voltage to ground as low as 150 volts, a voltage to ground of 250 volts will be permitted.

c. Conductors or equipment of systems operating at more than 600 volts shall be installed and used as permitted and required by Article 29 of this Code.

804 - Signal Systems.

a. Signal systems, as covered in this Code, include three classes of installations, as follows:

1. Signal systems which are supplied or controlled from a central station, such as public service telephone and telegraph systems (and other similar systems which do not come in the public service class), district messenger and call-bell systems, and fire and burglar alarm systems; when such systems are so designed, installed, and operated as to be free from hazard other than that arising out of their liability to become crossed with light, heat or power circuits, either inside or outside of buildings.

2. Signal systems which do not extend beyond the building in which they are installed such as call-bell systems, automatic signal and calling systems, time recording or indicating systems, and similar systems which are free from hazard other than that arising out of the liability to become crossed with light, heat or power circuits in buildings.

3. Signal systems of any kind which have wiring or appliances either continuously or momentarily in connection with any light, heat, or power circuit, or which use equipment operating at more than 25 volts or generating, transforming or utilizing more than 50 watts of energy unless the transformers, motor generators or other devices used for supplying current to such systems are of a type expressly approved for such service (either individually or when assembled with other devices; as, for example, installations defined in paragraph 1 of this section.)

b. Signal systems of the class noted in item (1), paragraph (a) of this section, shall comply with the provisions of Sections 3001 to 3004, inclusive.

c. Signal systems of the class noted in item (2), paragraph (a) of this section, shall comply with the provisions of section 3002.

d. Signal systems of the class noted in item (3), paragraph (a) of this section, shall comply with all applicable requirements of this Code for light, heat and power installations.

(Fine print note) The requirements of this section do not apply to radio installations. For requirements applying to such installations see Article 26.

PART IIIARTICLE 9INSULATION, IDENTIFICATION AND USE
OF CONDUCTORS.901 - Insulation Requirements.

- a. Conductors shall have an approved rubber insulation for the voltage of the circuit in which it will be used unless otherwise required or permitted by this section. All rubber covered conductors shall be double braided for sizes No. 6 and larger.
- b. For open work in dry places, either rubber insulation, slow-burning weather proof, varnished cloth or slow-burning insulation shall be used.
- c. Conductors outside of buildings, when not in conduit, shall have either rubber or weather-proof insulation, except that rubber insulation shall be used for the conductors of festoon lighting systems.
- d. Conductors having varnished cloth insulation may be used in permanently dry locations for sizes No. 6 and larger. Varnished cloth insulated conductors, smaller than No. 6, may be used for leads on motors, generators, oil filled transformers, auto starters, oil switches, and other apparatus where oil may come in contact with the insulation and when such leads are furnished as part of the device.
- e. Conductors in the following locations shall have slow-burning insulation:
1. Permanently dry locations where exposed to temperatures in excess of 120 degrees F. (49 degrees C.)
 2. For the connection between resistance elements and the contact devices of a rheostat, except that rubber insulation is required where conductors are installed in conduit between resistor grids and control equipment.
 3. For wiring of fixtures which are intended to carry any lamp rated at more than 75 watts, when installed inside of buildings. (See Section 1902(d)).

(Fine Print Note) A temperature materially in excess of 120° F. will seriously injure rubber insulation if maintained for any considerable length of time.

f. Where exposed to fumes, injurious to rubber, weather-proof or varnished cloth insulation shall be used, except that where the environment is such that rapid deterioration of conductors or insulation may take place, the conductors shall be suitably enclosed, coated or otherwise protected to better withstand the particular conditions of service.

g. Paper insulated lead-sheathed conductors may be used if the insulation is thoroughly protected from moisture and mechanical injury where the conductor emerges from its metal sheath.

902 - The Use of Bare Conductors.

a. Bare conductors shall be used only for switchboards, panelboards, and similar connections; or for electrolytic, low-voltage furnace, or low-voltage welding circuits and similar connections; or for trolley wires, third rails, and other contact conductors. Such bare conductors shall be fixed at adequate separation by the use of suitable supports. Except at the point where a permanent ground connection is made, such conductors within buildings shall be kept insulated from the ground. Bare conductors shall not be used where inflammable gases or explosives are liable to exist in large quantities.

903 - Identification of Grounded Conductors.

a. On grounded systems where the voltage to ground does not exceed 150, all neutral conductors and the grounded conductor of all two-wire services, feeders, sub-feeders, and branch circuits, shall be permanently and conspicuously identified or marked at all points (such as light outlets, switch outlets, pull boxes, and cutout cabinets) where connections are to be made. This rule shall not apply to extensions made to existing unidentified circuits but it shall apply where new circuits are added to existing installations.

(Fine print note) It is recommended that, on polyphase circuits having one conductor grounded, the grounded conductor be suitably identified to facilitate proper connection of overload protective devices in the ungrounded conductors.

b. For sizes No. 14 to No. 8, inclusive, the exterior braid of the grounded conductor shall have either a white or natural gray color (with or without visible marker). The exterior braid of the ungrounded conductor or conductors shall have a solid dark color so that it may be readily distinguished from the grounded conductor. Neutral conductors larger than No. 8 need not be identified except in two wire services, feeders or branch circuits. White or gray rubber covered wire shall not be used for an ungrounded conductor in any circuit.

(Fine Print Note.) The above rule will not be construed as forbidding the use of two conductor assemblies, having one polarity identified wire, in single-pole switch loops or as 2 wire taps from the outside conductors of a 3 wire, 125-250 volt circuit having grounded neutral.

c. For fixtures, the fixture stem wire which is connected to the screw shells of sockets shall be identified (a) by having a white or natural gray insulating covering which will readily distinguish it from the ungrounded fixture wire; or (b) by painting a band of some color in contrast with the color of the insulating covering around the conductor at the socket and at the outlet end; or (c) by other equivalent means. (See also section 1902 (b)).

904 - General Requirements for Use of Conductors.

a. This section shall apply to wires, cables and cords generally, but the requirements of other sections of this Code shall be complied with as to the selection of conductors and the method of their installation and use in particular locations and classes of work.

b. All splices and joints in conductors shall be made both mechanically and electrically secure without solder. The joints shall then be soldered unless made with some form of approved splicing device. All joints shall be covered with an insulation equal to that on the conductors.

c. Stranded conductors (except in flexible cords) shall be soldered before being fastened under clamps or binding screws, and whether stranded or solid, when they have a conductivity greater than that of No. 8 B. & S. gage, they shall be soldered into lugs for all terminal connections, unless an approved solderless terminal connector is used.

d. Conductors shall not be laid in plaster, cement or similar finish, and shall never be fastened with staples. They shall not be fished for any great distance and only in places where the inspector can satisfy himself that the rules have been complied with.

e. Twin conductors shall be used only in conduits, or where flexible conductors are necessary.

f. In both alternating and direct current systems, when conduit, armored cable and metal raceways are used, the two or more conductors of a circuit shall be placed in the same conduit, armor or raceway. This shall not apply to extensions to existing outlets in fire-proof buildings installed as prescribed in Section 1010, paragraph (j).

g. In elevator shafts, conductors shall be installed in rigid metal conduit except that armored cable or flexible steel conduit may be used under conditions where the use of rigid conduit would be impracticable.

h. When entering cabinets, cutout boxes or junction boxes, except where they are run in conduit, armored cable or metal raceways, conductors shall be protected by non-combustible, non-absorptive insulation bushings which fit tightly the hole in the box or cabinet and are well secured in place. They should completely fill the holes in the bushings, so as to keep out dust, tape being used to build up the conductors if necessary. (See section 1004.)

i. When alterations (see section 1002) are permitted by this Code in installations where wooden cabinets are installed, approved flexible tubing may, in dry places, be used in lieu of the bushings required by paragraph (h) above provided it extends from the last porcelain support in the wooden cabinet.

j. The amount of open or exposed wire in any conduit, armored cable or metal raceway installation shall be the minimum practicable. Where the rules permit conduit to terminate at certain equipment without entering and being secured to a junction box or the casing of the equipment, the conduit shall terminate as close as practicable to the terminals of the equipment, and the exposed leads shall be suitably protected against injury. (See sections 2303).

905 - Special Requirements for Use of Flexible Cords.

a. Flexible cords shall be used only for pendants, wiring of fixtures, portable lamps or motors, portable heating apparatus or other portable devices.

b. No flexible cord of any description shall be placed on knobs or cleats, nor shall it be used for wiring that part of a circuit for which standard rubber covered wire is required.

c. When used where the voltage between any two conductors or from any conductor to ground is over 300 volts, the insulation on flexible cords shall be at least 3/64-inch in thickness for all conductor sizes No. 8 or less, except where type S cord is used.

- d. Where flexible cords supply current to portable devices, approved plug connectors shall be used, so arranged that the plug may be pulled out to open the circuit without leaving any live parts so exposed as to render likely accidental contact therewith.
- e. Flexible cords shall be approved and of a type suitable for the conditions under which they are to be used. (See section 906).
- f. Flexible cords shall not be used for the support of more than one medium screw base socket, complete with its reflector equipment, and shall not be used for the support of fixtures equipped with mogul sockets.
- g. All pendants which hang nearer to the floor than six feet shall be provided with cord adjusters. Other methods used for shortening cords, such as tying of knots and similar methods, shall not be used. No pendant shall hang nearer than twelve inches to the floor.
- h. When necessary to prevent portable lamps from coming into contact with inflammable materials, or to protect them from breakage, their flexible cord leads shall be equipped with handle socket and substantial guard, the guard being securely attached to socket or handle.
- i. Unless provided with approved metal armor flexible cord shall not be used in show windows or in show cases, except that approved portable cord may be used for the purpose of supplying current to portable lamps and other devices for exhibition purposes, and flexible cord may be used for chain fixtures. The armored cord need not be used unless the window is at least partially enclosed, having either a top or back. (See also paragraphs (g), (i), and (j), section 1902).
- j. Flexible cord shall, where entering sockets or where passing through covers of outlet boxes, be protected by approved bushings especially designed for this purpose, or the outlet box cover shall be provided with a smooth, well rounded surface on which the cord will bear. So-called hard rubber bushing shall not be used. Insulating bushings shall be used where moisture is prevalent.
- k. Flexible cord shall be so connected to all fittings that strain is taken from the joints and binding screws. No splices or taps shall be made in the flexible cord between fittings.
- l. Each conductor of flexible cords for general use shall have a carrying capacity not less than that of a No. 18 wire.

906 - Classification of Cords.

a. Cords of the several types shall comply with the general specifications of the following table with respect to their outer protective covering:

b. Cords of the several types shall conform to the descriptions given in items 1-11 inclusive below:

1. (Type C) May be used in the wiring of fixtures only.

2. (Type CB and CC.) These cords should hang freely in air.

3. (Type F.) For No. 18 conductors, rubber insulation on this type of cord may be 1/64 inch in thickness.

4. (Type PD and PO.) These cords are for use only in offices, dwellings and similar places where not liable to hard usage. When Type PO cord has 1/64 inch insulation its use shall be confined to portable lamp fixtures.

5. For Type PD the conductors are twisted together; for Type PO the conductors are laid parallel under the outer braid.

6. (Type PWP.) For No. 16 conductors, rubber insulation on this type or cord may be 1/64 inch in thickness.

7. (Type S.) For elevator lighting this cord consists of conductors not smaller than No. 14 and for elevator control of conductors not smaller than No. 16.

8. (Type SJ.) For general use, pendant or portable, in wet or dry locations.

9. (Type S.) For general use, pendant or portable, in wet or dry locations, and where extra hard service conditions exist, including theatre stages, elevator lighting and control cables and garages.

10. (Type SJ and S.) The rubber compounds for the insulation and jacket on these cords is of superior quality.

11. (Type H.) For Portable Heating Apparatus: This cord is for use with all smoothing and sad-irons and with other heating devices of the class mentioned in paragraph (b) Section 2201 of this Code. The covering may consist of a layer of rubber or other approved material, a covering of asbestos and an outer braid enclosing either all the conductors as a whole, or each conductor separately.

c. When polarity identification of flexible cords is required (see section 1905(h)), one conductor shall have a continuous identifying marker readily distinguishing it from the other conductors. This marker shall be a tracer in the braid of any color contrasting with that of the braid; or, in the case of cords having no braids, the insulation of one conductor shall be of a white or natural gray color and the insulation of the other conductor or conductors shall be of a color or colors which may be readily distinguished from white or natural gray.

907 - Special Requirements for Use of Conductors in Motor and Generator Rooms, Including Transformer and Storage Battery Rooms.

a. In generator or motor rooms, except as provided in paragraph (b) below for central and sub-stations, conductors shall be installed in approved metal conduit, tile or other fire-proof ducts; provided, however, that other wiring methods may be used by special permission obtained in advance. Conductors installed in conduit or ducts, where exposed to moisture, shall be lead sheathed and the sheathing shall be grounded. Except for

low potential systems, the insulation of the several conductors, where leaving the metal sheath of cables, shall be thoroughly protected from moisture and mechanical injury by means of a pethad or some equivalent method.

b. In central or sub-stations and in transformer and storage battery rooms, conductors shall, unless placed in approved metal conduit, tile or other fireproof ducts, be exposed to view and supported on approved non-combustible, non-absorptive insulators and kept so rigidly in place that they cannot come in contact. Where they pass through floors or firewalls, they shall be carried through individual openings in non-combustible, non-absorptive insulating tubes or their equivalent, and not through a common open space.

c. Conductors shall in all other respects comply with the provisions of this Code for conductors carrying a current of the same volume.

(Fine print note) For installation requirements where the voltage exceeds 600, see Article 29.

ARTICLE 10WIRING METHODS - LOW POTENTIAL
SYSTEMS.1001 - Methods of Installation Permitted.

a. All conductors (including the conductors of signal systems noted in section 804C, item 3 of this Code) installed in or on buildings shall be incased in rigid metal conduit, with the exceptions noted in Section 1002 hercof and in paragraphs (b) to (f) inclusive, below; provided, that outside the underground district, yard wires and service wires may be run open on the exterior of buildings if installed in compliance with Article 16 of this Code.

b. Metal raceway (metal molding) may be used in dry locations as a substitute for rigid metal conduit or other wiring methods subject to the following restrictions:

1. The maximum voltage between conductors in the raceway system shall not exceed 300 volts and the maximum wattage of any circuit shall not exceed 1800.

2. Metal raceways shall not be installed in any unfinished attic or roof space nor in any concealed location, except when passing directly through floors, walls or partitions as provided in paragraph (c) of Section 1009 of this Code.

3. Metal raceways shall not be installed in any elevator shaft; nor in any portion, except the offices and show rooms, of a garage having floor area to permit the storage of more than two machines; nor on the stage or in dressing rooms of theatres and motion picture shows; nor in any room or compartment where explosives, explosive dusts, or highly inflammable liquids, gases or vapors are present or are liable to be present, in dangerous quantities.

4. Metal raceway shall not be installed in any damp location nor in any location where exposed to corrosive fumes, or vapors or other substances injurious to the raceway or to the conductors or their insulation.

(Fine print note) Item 4 above will be construed to prohibit the installation of metal raceway on open porches or in open entrances to stores (except on ceilings), or similar locations where more or less exposed to the weather; or in the kitchens of restaurants, hotels, etc.

c. Metal wireways may be used in the wiring of foot, border, and proscenium lights as specified in Section 3613, for marquee wiring as specified in Section 2106, and as a substitute for rigid metal conduit at distribution centers, in motor board construction, or by special permission, in other locations where the use of rigid metal conduit is impracticable.

d. Flexible metal conduit may be used as a substitute for rigid metal conduit or other wiring methods in the following places:

1. Where flexibility of connection is necessary as for example in the connection of motors and similar appliances. Such runs of flexible metal conduit may extend to the starting device or switch controlling the motor or appliance if the required length of the run will not exceed 6 feet and it is suitably supported and protected from injury.

2. In the locations noted in items 2 to 5 inclusive of paragraph (e) of this section or in any location where the use of rigid metal conduit would be impracticable.

e. Metal armored cable may, where the size of conductors does not exceed No. 8 and where the maximum voltage between conductors does not exceed 300 volts, be used as a substitute for rigid metal conduit or other wiring methods in the following places:

1. In the places noted in item (1) paragraph (d) of this section.

2. In finished walls, floors, and ceilings, and in unfinished attics and unoccupied spaces under finished buildings.

3. For the purpose of extensions, alterations or repairs to existing concealed knob and tube or metal armored cable installations, metal armored cable may, except as modified by paragraph (b), Section 1002 hereof, be concealed in any wall, floor, ceiling or attic and may be installed in basements which contain knob and tube wiring; provided, that it shall not be fished into any floor, wall, or other concealed space in which knob and tube wiring is installed, unless it can first be definitely determined that the cable will not come in contact with or disturb the existing knob and tube wiring, or unless such existing wiring is to be permanently disconnected. (See Section 1002, paragraph (a)).

4. For extensions to existing branch circuit outlets in buildings of fireproof construction, if installed in compliance with paragraph (3) of section 1010.

5. For concealed work in single and two-family dwellings (as defined by the Housing Code of the City of Portland) and for concealed work in private garages having floor area to permit the storage of not more than two machines or in other out-buildings used in connection with single and two-family dwellings. For the purpose of this paragraph concealed work shall be considered as including wiring in unfinished attics and in unoccupied spaces under buildings.

(Plac print note) The above rule will be construed as requiring in new work, that all conductors in unceiled basements be installed in rigid metal conduit, which conduit shall terminate at the cabinet or cutout box and that all unceiled garages or other outbuildings be wired in rigid metal conduit. The rule will not be construed as permitting the installation of armored cable in buildings used or arranged to be used in part as dwellings and in part for business purposes, except, for example, in such minor cases as doctors' offices, laboratories, and similar occupancies in portions of single and two-family dwellings.

f. Open wiring may be substituted for rigid metal conduit or other wiring methods only under the conditions prescribed below:

1. For distinctly temporary purposes in the construction of buildings, in experimental or emergency work, or in the wiring of exhibitions, fairs, and similar celebrations of a temporary nature; but the installation of such temporary open wiring shall be conditional upon prompt discontinuance and removal thereof by the person making the installation upon the expiration of the period of time for which it is temporarily approved.

2. By special permission obtained in advance, open wiring with special insulation, enclosure or protection may be installed in locations where the use of rigid metal conduit would be impracticable on account of exposure to corrosive spray, fumes, or vapors, such as exist in portions of some chemical works, metal refineries and tanneries.

WIRING METHODS IN EXTENSIONS Repairs
 1002 - Additions, Alterations and Renewals.

a. Additions or extensions to, and alterations and renewals of, existing installations shall be made in compliance with the provisions of Section 1001 hereof, except as follows:

1. When making extensions to existing knob and tube installations, loomed conductors may, except as modified by paragraph (b) of this Section, be substituted for armored cable or other wiring methods when fished into any floor, wall, or other concealed space in which knob and tube wiring is installed; provided, however, that such loomed conductors shall not be used in the locations noted in paragraph (c), Section 1004.

2. When repairs to wiring are necessary on account of damage by fire, wiring methods similar to that of the existing installation may be used (except as restricted by paragraph (b) of this Section) provided that such existing installation was lawfully installed; but this shall not be construed as permitting the continuance of any unsafe or hazardous conditions. In renewing knob and tube wiring after fire damage or for other cause, such wiring shall be installed in compliance with the rules for knob and tube work as herein prescribed. Fixtures that have been damaged by water shall be overhauled and repaired before they are again placed in service.

3. By special permission, wiring methods similar to that of the existing installation may be used for circuit extensions not more than five feet in length provided that such existing installation was lawfully installed.

b. Where the lineal feet of extensions or alterations made to any circuit will amount to more than 50% of the lineal feet of the completed circuit, (including the extensions and alterations), the entire circuit shall be rewired in compliance with Section 1001 of this Code. Where the lineal feet of extensions or alterations made to any installation will amount to more than 50% of the lineal feet of the completed installation, (including the extensions and alterations), the entire installation shall be completely rewired in compliance with Section 1001 of this Code.

1003 - Open Work.

(Fine print note) For conditions under which open work may be used see Section 1001, paragraph (1) and Section 1002, item (2).

a. Supports shall be composed of approved non-combustible, non-absorptive insulating material, free from checks, rough projections or sharp edges which might injure the insulation on the conductor. If the supports are designed to grip the wires, either screws or nails may be used to fasten the supports in place, but nails shall be long enough to penetrate the woodwork not less than one-half the depth of the knob, and fully the thickness of the cleat. Cushion washers shall be used with nails.

b. Supports shall provide at least $\frac{1}{4}$ inch separation between the securing screw or nail and the wire, and shall be designed for two securing screws if of the split knob (or single-wire cleat) type intended for wires larger than No. 4.

c. Conductors shall be supported on split knobs or cleats, except that solid knobs may be used for the support of conductors smaller than No. 8 at angles and ends of runs. Tie wires shall not be used.

d. Multiple-wire cleats shall be so designed as to separate the wires at least $2\frac{1}{2}$ inches and maintain them at least $\frac{1}{4}$ inch from the surface wired over. Such cleats shall not be employed to support wires operating at a potential exceeding 300 volts.

e. Knobs shall be so designed as to maintain the wires at least 1-inch from the surface wired over, and shall conform to the following minimum dimensions:

f. Conductors in dry places shall be rigidly supported with a separation of $2\frac{1}{2}$ inches from each other, and $\frac{1}{2}$ inch from the surface wired over, for voltages not exceeding 300, and a separation of 4 inches and 1-inch, respectively, for voltages between 301 and 400. In damp places a separation of at least one inch from the surface wired over shall be maintained.

g. Rigid supporting requires under ordinary conditions, where wiring along flat surfaces, supports at least every four and one-half feet. If the conductors are liable to be disturbed, the distance between supports shall be shortened.

h. Conductors shall not be "dead-ended" at a resette, socket or receptacle, unless the last support is within twelve inches of the same.

i. Sub-bases of non-combustible, non-absorptive insulating material, which will separate the conductors at least one-half inch from the surface wired over, shall be installed under all snap switches used in exposed knob and cleat work.

j. Conductors exposed to mechanical injury shall be suitably protected by running boards not less than $\frac{1}{2}$ inch in thickness and three inches in width, or by guard strips not less than $7/8$ inch in thickness, and at least as high as the insulating supports, placed on each side of and close to the wiring.

k. Vertical conductors exposed to mechanical injury shall be installed in conduit.

l. Conductors shall be separated from contact with walls, floors, timbers or partitions through which they pass by tubes or bushings composed of approved non-combustible, non-absorptive in-

insulating material, except at outlets, where approved flexible tubing shall be used. If the bushing is shorter than the hole, a waterproof sleeve, such as an iron pipe, shall be inserted in the hole and an insulating bushing slipped into the sleeve at either end and in such a manner as to keep the wire absolutely out of contact with the sleeve.

m. Conductors shall be permanently separated from adjacent metallic piping or other conducting material, or from any exposed lighting, power or signal wire which approaches within two inches, by a firmly fixed and continuous non-conductor, additional to the insulation on the wire. Where an insulating tube is used, it shall be secured at the ends.

n. Conductors shall be so placed in wet places that an air space will be left between such conductors and pipes in crossing, and the former shall be run in such a way that they cannot come in contact with the pipe accidentally. The conductors shall, wherever possible, be run over - rather than under, pipes upon which moisture is likely to gather or which, by leaking, might cause trouble in a circuit.

1004 - Concealed Knob and Tube Work.

(Fine print note) For conditions under which concealed knob and tube work may be used see Section 1002 of this Code.

a. Supports shall conform to the requirements for knobs, tubes and bushings as prescribed in Section 1002 of this Code, except that, where passing through cross timbers in plastered partition, conductors shall be protected by an additional tube extending at least four inches above the timber. This additional tube need not be used when the vertical distances to the tube above is less than two feet.

b. Conductors shall be separated at least five inches and maintained at least one inch from the surface wired over. At distributing centers, meters, outlets, switches or other places where space is limited and the five-inch separation cannot be maintained, each wire shall be encased in a continuous length of approved flexible tubing.

c. Flexible tubing at outlets shall extend in continuous lengths from the last porcelain support into and be secured to the outlet box or plate by some approved device, except as noted in items (1) and (2) below:

1. Approved bushings may be used as noted in paragraph (h) of Section 904, in which case the flexible tubing shall terminate at the bushing and need not be secured to the box. This shall not apply in the case of fished work.

2. Where outlet boxes or plates are not required as noted in paragraph (1) of this section, the flexible tubing shall extend to at least one inch beyond straight electric outlets, and at least flush with the outlet ends of gas caps in the case of combination gas and electric outlets.

d. When in a concealed knob and tube system, it is impracticable to place the whole of a circuit on non-combustible supports of glass or porcelain, that portion of the circuit which cannot be so supported shall be installed with approved metal conduit or approved armored cable, except that if the difference of potential between the conductors is not over 300 volts and they are not exposed to moisture, the conductors may be fished if separately encased in approved flexible tubing, extending in continuous lengths from porcelain knob to porcelain knob, from porcelain knob to outlet, or from outlet to outlet.

e. Flexible tubing shall not be used at outlets on exposed outside walls or in other locations where it is exposed to moisture, nor shall it be used across water or steam pipes or down exposed brick walls unless an air space of at least four inches between the lath and plaster and the brick wall can be maintained. In locations where this separation cannot be maintained, conductors shall be installed in approved metal conduit or armored cable.

f. Four conductors may be brought down between 2 inch by 4 inch studding not less than fourteen inches apart. Six conductors may be brought down between 2-inch by 6 inch studding that are not less than fourteen inches apart, providing the conductors are properly staggered. Headers shall be placed not more than eighteen inches apart.

g. All tap wires shall be knobbed within six inches of the tap. At three way and gang switches, taps shall be made and secured outside of boxes.

h. If conductors are run diagonally through joists or timbers from outlet to outlet, the variation shall not exceed a maximum of one foot in ten from a line drawn at right angles to joists or timbers.

i. In attics and roof spaces, conductors shall be considered as exposed to mechanical injury, and shall not be run over floor joists or under roof joists, except that, in inaccessible roof spaces in finished buildings, where it is impracticable to bore and bush, the conductors may be supported on knobs on the upper edge of each joist. In attics which are reached only by scuttle hole, conductors shall be kept at least five feet from such opening, or be suitably protected.

j. Knobs shall not be placed on the same header which is used to support a light or switch outlet unless the header is more than one inch in thickness. All knobs or cleats when placed on supports of one inch or less in thickness shall be secured by screws.

k. Where a change is made from concealed knob and tube work to conduit or armored cable, an approved terminal fitting shall be used which provides a separate bushed hole for each conductor, which conductor shall then pass through the fitting without splice, joint or tap. In this case the terminal fitting need not be accessible.

l. Approved outlet boxes or plates shall be installed at all outlets except in the wiring of finished buildings where the conductors terminate at a rosette, switch, receptacle or other similar fitting without splice or tap, and except at combination gas and electric outlets. Boxes or plates shall be installed in all cases where metal lath or metal ceiling is used. (For the special requirements relating to boxes and plates at fixture outlets, see Sections 1102 and 1105).

1005 - Rigid Metal Conduit Work.

a. No conduit smaller than 1/2 inch, electrical trade size, shall be used; provided, however, that concealed extensions from existing branch circuit outlets in buildings of fireproof construction, may be made by means of approved flexible or rigid conduit, not smaller than 5/16 inch, or other forms of metal raceway approved for the purpose, and fittings containing one No. 14 rubber-covered wire. This conduit shall not be run in concealed spaces but may be laid on the face of the fireproofing and may be plastered over. Such extensions shall be confined to the room or suite in which they originate.

b. Conduit shall be electrically and mechanically continuous from outlet to outlet or to junction box, cutout box, or cabinet. All runs in conduit systems shall be installed as complete and continuous runs before the conductors are drawn in. Both ends of every length of conduit shall be carefully reamed to remove all burrs and sharp edges that might injure the insulation of the conductors. Threads shall be full, clean cut and true and shall be cleaned of enamel and other non-conducting material.

c. Whenever conduit enters boxes, cabinets, or other equipment, the conduit shall be provided with approved conduit bushings, or equivalent approved fittings, to prevent abrasion of the conductors.

d. Conduit shall be so secured in all cabinets, boxes and fittings that an effective electrical and mechanical bond will be established. Conduit shall enter boxes and cabinets squarely with

the walls of the boxes or cabinets, so that locknuts and bushings may be set up tightly and in thoroughly good contact with the metal surfaces. The surfaces of the metals where they come in contact with each other and the threads of conduit and fittings shall be carefully cleaned of enamel, paint, scale, and other non-conducting material, so that good electrical contact may be obtained.

e. Conduit shall be double lock-nutted in cabinets, boxes, etc., which are 4 inches or larger in size, except where screwed into threaded boxes or fittings. All couplings, locknuts, bushings, and other fittings shall be set up firmly and securely. (Section 1704(b) requires threaded fittings where conduit serves as a grounding conductor for service conduit).

f. A run of conduit, from end to end, shall include not more than the equivalent of four quarter bends, the bends which terminate within approximately 12 inches or less of the ends of run not being counted.

g. Elbows or bends shall be so made that the conduit will not be cracked, flattened, dented, or kinked. The radius of the curve of the inner edge of any bend shall be not less than $3\frac{1}{2}$ inches. Bends in conduit containing lead-sheathed conductors shall be of sufficient radius to permit the conductors to be drawn in without injury to the lead sheath. Standard conduit elbows should not be used.

(Fine print note) It is recommended that bends in conduits containing lead-sheathed conductors be of minimum radius as given in the following table:

Conduit size inches	Minimum radius inches	Conduit size inches	Minimum radius inches
1	10	$2\frac{1}{2}$	24
$1\frac{1}{2}$	10	3	36
$1\frac{3}{4}$	12	$3\frac{1}{2}$	36
2	14	4	36

h. The conduit system as a whole shall be mechanically secured in position in a firm and substantial manner. Where practicable, the conduit shall be fastened independently of the support afforded by the boxes or cabinets except that straight conduit runs between boxes or cabinets not more than about 6 feet apart may be installed without independent supports for the conduit if such boxes and cabinets are independently and securely fastened in place. As a general rule, at least one strap or fastening shall be placed as close as practicable to each coupling (or other fitting not independently supported) and the distance between supports or fastenings shall not exceed approximately 6 feet. Suitable pipe supports, such as straps, clamps, or hangers, shall be used for fastening conduit wherever the fastening must also serve as a support for the conduit.

1. When conduit is installed on concrete, brick, tile, or other similar surfaces, attachment to such surfaces shall be made by means of expansion bolts, expansion screws, toggle bolts, or other similar or equally effective method. Nails or screws driven or screwed into wooden plugs shall not be used for this purpose.

j. When making surface extensions from existing outlets in concealed work, an outlet box or extension ring, shall be provided as required by paragraph (c), Section 1102 of this Code.

k. The entire conduit system, including all cabinets, boxes, ~~boxes~~, etc., to which any conduit run is connected, shall be permanently and effectively grounded in compliance with Sections 1704 to 1707, inclusive, of this code. Isolated sections of conduit not over 25 feet long need not be grounded if they are clear of all pipes, metal, and other grounded objects and are located not less than 3 feet vertically from metal, concrete or any permanently damp floor or from other grounded objects upon which persons might stand, and at least 3 feet horizontally from all grounded objects and surfaces with which persons may come into contact while also in contact with the ungrounded section of conduit.

1006 - Conduit Work - Severe Conditions.

a. When conduit is installed in wet places or in the ground, it shall be made water-proof, and threaded fittings of types approved for the purpose shall be used. The threads of the conduit shall be painted with red lead, or other suitable compound (which will not destroy the electrical bond) to make the joints water-tight and to prevent oxidation at these points. Conduit which is installed on the exterior of buildings shall be considered as being in a wet place unless under cover (as in sheds or under porches). Conduit exposed to excessive or continued moisture or condensation as for example in portions of canneries, dairies, etc., shall be considered as being in a wet place.

(Fine print note) Where approved weather-proof boxes are not provided with threaded holes for conduit, suitable lead gaskets shall be provided for all conduit connections in top or sides of the box. Such gaskets shall be protected from injury by inserting a metal washer between the lock-nut and the gasket.

b. When conduit is installed in wet places, or in any location where condensation or other moisture is apt to enter the system, it shall be arranged to drain at low points so as to prevent the accumulation of such moisture in the conduit or fittings.

c. When different portions of the same conduit system are exposed to widely different temperatures (as, for example, in refrigerating or cold storage plants), provision shall be made to prevent circulation of air through the conduit from the warmer to the colder sections of the system.

d. When conduit is installed in locations where it is exposed to corrosive fumes or vapors, such as exist in some chemical works and metal refineries and in glue houses, fertilizer rooms, hide cellars, salt storages, casing rooms, etc., galvanized or sherardized conduit (or aluminum conduit) and threaded cast metal fittings shall be used and all joints shall be made as prescribed in paragraph (a) of this section for conduit in wet places. Under some unusually severe conditions permission may be obtained to install specially insulated and protected open wiring.

e. When conduit is installed in locations where explosive gases or vapors are present in dangerous quantities (as, for example, in cleaning and drying rooms of dry cleaning establishments or other similar locations where highly inflammable volatile liquids are used in considerable quantities), joints shall be made gas-tight and the conduit shall be sealed to prevent the entrance thereto of such gases or vapors.

1007 - Conductor Requirements in Conduit Work.

Note: See also section 904(j)

a. Conductors installed in conduit shall be of approved type and shall comply with the requirements of Article 9 of this Code, in so far as they do not conflict with the requirements of this section. All conductors No. 6 and larger shall be stranded when installed in conduit. Conductors within the conduit shall be without splices or taps. In both alternating and direct current systems, the two or more wires of a circuit shall be installed in the same conduit.

b. Conductor shall not be drawn in until all mechanical work on the building has been completed as far as possible. An exception to this rule may be allowed for installations in frame buildings provided conductor ends at outlet and junction boxes are properly connected and soldered at the time of drawing in.

c. Conductors of different systems shall not be installed in the same conduit, junction box, pull box, outlet box, cabinet, gutter or wireway except in connection with the meter and service wires installed and maintained by the serving agency and except as allowed in paragraph (f) of Section 1009. When a junction box, pull box, outlet box, cabinet, gutter or wireway is separated into two or more compartments by partitions of cold-rolled metal, conductors of one system may be installed in one compartment and conductors of another system in another compartment. (See section 1107(c).)

(Fine print note) For the purpose of the above rule the term "different system" shall be construed as applying to any system of wiring fed through a separate set of service conductors whether connected to the same supply system or not. An exception to the rule will be made

in the case of existing installations where separately metered circuits or feeders supplying different consumers are contained in the same conduit.

d. In new work, separately metered, circuits or feeders supplying different consumers shall not be installed in the same conduit. This rule shall not apply in the wiring of any dwelling (either single or multiple).

e. In alternating current systems, when two or more conductors are connected in multiple to increase the carrying capacity of the circuit (see sec. 1208) it is preferable that all the conductors be installed in one conduit. If this is not practicable, they shall be grouped in two or more conduits with one conductor of each phase or polarity in each conduit.

f. More than 9 wires shall not be installed in one conduit except (a) in the case of stage pocket and border circuits, (b) for circuits run from sign flashers to sign or (c) by special permission obtained in advance. For installations where more than nine wires of the same size are installed in one conduit the size of the conduit shall not be less than that given in Table III of this section.

g. When approved low-potential insulated conductors (not lead-sheathed) of the same size are installed in conduit, the size of the conduit shall not be less than that given in Table I of this section under the conditions specified in the table; provided, that where single conductor, single braid, solid wires only are used, four No. 14, or three No. 12 wires may be installed in $\frac{1}{2}$ inch conduit, and seven No. 14, six No. 12, four No. 10, or three No. 8 wires may be installed in a $\frac{3}{4}$ inch conduit.

(Fine print note) For conduit runs not longer than 30 feet and having not more than the equivalent of two quarter bends from end to end, two No. 10 wires may be installed in $\frac{1}{2}$ inch conduit and three No. 6 wires or six No. 8 wires in one inch conduit. For straight runs not exceeding 30 feet, the interior cross-sectional area of the conduit need not exceed twice the sum of the cross-sectional areas of the several conductors.

h. When approved low-potential insulated conductors (not lead-sheathed) of different sizes are installed in conduit, the size of the conduit shall not be less than that determined from Table II of this section.

i. For lead-sheathed conductors of various outside diameters, the size of conduit shall not be less than that shown in Table IV of this section.