

# RULES AND REQUIREMENTS

OF THE

## NATIONAL BOARD OF FIRE UNDERWRITERS

For the Installation of Wiring and Apparatus for Electric Light,  
Heat and Power as Recommended by the Underwriters'  
National Electric Association.

*Edition of January 1, 1896.*

### GENERAL SUGGESTIONS.

In all electric work conductors, however well insulated, should always be treated as bare, to the end that under no conditions, existing or likely to exist, can a grounding or short circuit occur, and so that all leakage from conductor to conductor, or between conductor and ground, may be reduced to the minimum.

In all wiring special attention must be paid to the mechanical execution of the work. Careful and neat running, connecting, soldering, taping of conductors and securing and attaching of fittings, are specially conducive to security and efficiency, and will be strongly insisted on.

In laying out an installation the work should, if possible, be started from a center of distribution, and the switches and cut-outs, controlling and connected with the several branches, be grouped together in a safe and easily accessible place, where they can be readily got at for attention or repairs. The load should be divided as evenly as possible among the branches and all complicated and unnecessary wiring avoided.

The use of wire-ways for rendering concealed wiring permanently accessible is most heartily endorsed and recommended.

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and this method of accessible concealed construction is advised for general use.

Architects are urged, when drawing plans and specifications, to make provision for the channeling and pocketing of buildings for electric light or power wires, and in specifications for electric gas lighting to require a two-wire circuit, whether the building is to be wired for electric lighting or not, so that no part of the gas fixtures or gas piping be allowed to be used for the gas-lighting circuit.

### CLASS A, CENTRAL STATIONS.

#### FOR LIGHT OR POWER

(These rules also apply to dynamo rooms in isolated plants connected with or detached from buildings used for other purposes; also to all varieties of apparatus therein of both high and low potential).

#### 1. GENERATORS:—

*a.* Must be located in a dry place.

*b.* Must be insulated on floors or base frames, which must be kept filled to prevent absorption of moisture, and also kept clean and dry. Where frame insulation is impossible, the Inspector may, in writing, permit its omission, in which case the frame must be permanently and effectively grounded.

*c.* Must never be placed in a room where any hazardous process is carried on, nor in places where they would be exposed to inflammable gases or flyings of combustible material.

*d.* Must each be provided with a waterproof covering.

#### 2. CARE AND ATTENDANCE:—

A competent man must be kept on duty in the room where generators are operating.

Oily waste must be kept in *approved* metal cans and removed daily.

*Approved* waste cans shall be made of metal, with legs raising can three inches from the floor, and with self-closing covers.

#### 3. CONDUCTORS:—

From generators, switchboards, rheostats or other instruments, and thence to outside lines, conductors

*a.* Must be in plain sight or readily accessible.

*b.* Must be wholly on non-combustible insulators, such as glass or porcelain.

*c.* Must be separated from contact with floors, partitions or walls, through which they may pass, by non-combustible insulating tubes, such as glass or porcelain.

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*d.* Must be kept rigidly so far apart that they cannot come in contact.

*e.* Must be covered with non-inflammable insulating material sufficient to prevent accidental contact, except that "bus bars" may be made of bare metal.

*f.* Must have ample carrying capacity to prevent heating. (See Table of Capacity of Wires.)

### 4. SWITCHBOARDS:—

*a.* Must be so placed as to reduce to a minimum the danger of communicating fire to adjacent combustible material.

Special attention is called to the fact that switchboards should not be built down to the floor, nor up to the ceiling, but a space of at least eighteen inches, or two feet, should be left between the floor and the board, and between the ceiling and the board, in order to prevent fire from communicating from the switchboard to the floor or ceiling, and also to prevent the forming of a partially concealed space very liable to be used for storage or rubbish and oily waste.

*b.* Must be accessible from all sides when the connections are on the back; or may be placed against a brick or stone wall when the wiring is entirely on the face.

*c.* Must be kept free from moisture.

*d.* Must be made of non-combustible material, or of hardwood in skeleton form, filled to prevent absorption of moisture.

*e.* Bus bars must be equipped in accordance with Rule 3 for placing conductors.

### 5. RESISTANCE BOXES AND EQUALIZERS:—

*a.* Must be equipped with metal, or other non-combustible frames.

The word "frame" in this section relates to the entire case and surroundings of the rheostat, and not alone to the upholding supports.

*b.* Must be placed on the switchboard, or, if not thereon, at a distance of a foot from combustible material, or separated therefrom by a non-inflammable, non-absorptive, insulating material.

### 6. LIGHTNING ARRESTERS:—

*a.* Must be attached to each side of every overhead circuit connected with the station.

*b.* Must be mounted on non-combustible bases in plain sight on the switchboard, or in any equally accessible place, away from combustible material.

*c.* Must be connected with at least two "earths" by separate metallic strips or wires having a conductivity not less than that of a No. 6 B. & S. wire. These strips or wires must be run as nearly as possible in a straight line from the arresters to the earth connection.

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*d.* Must be so constructed as not to maintain an arc after the discharge has passed, and must have no moving parts.

It is recommended to all electric light and power companies that arresters be connected at intervals over systems in such numbers and so located as to prevent ordinary discharges entering, over the wires, buildings connected to the lines.

### 7. TESTING:—

*a.* All series and alternating circuits must be tested every two hours while in operation to discover any leakage to earth, abnormal in view of the potential and method of operation.

*b.* All multiple arc low-potential systems (300 volts or less) must be provided with an indicating or detecting device, readily attachable, to afford easy means of testing.

*c.* Data obtained from all tests must be preserved for examination by insurance inspectors.

These rules on testing to be applied at such places as may be designated by the association having jurisdiction.

### 8. MOTORS:—

*a.* Must be wired under the same precautions as with a current of the same volume and potential for lighting. The motor and resistance box must be protected by a double-pole cut-out and controlled by a double-pole switch, said switch plainly indicating whether "on" or "off," except in cases where one-quarter horse-power or less is used on low-tension circuits a single-pole switch will be accepted.

*b.* Must be thoroughly insulated, mounted on filled, dry wood, be raised at least eight inches above the surrounding floor, be provided with pans to prevent oil from soaking into the floor, and must be kept clean.

*c.* Must be covered with a waterproof cover when not in use, and, if deemed necessary by the inspector, be inclosed in an *approved* case.

From the nature of the question, the decision as to what is an *approved* case must be left to the inspector to determine in each instance.

*d.* Must be, when combined with ceiling fans, hung from insulated hooks, or else there shall be an insulator interposed between the motor and its support.

### 9. RESISTANCE BOXES:—

*a.* Must be equipped with metal or other non-combustible frames.

The word "frame" in this section relates to the entire case and surroundings of the rheostat, and not alone to the upholding supports.

*b.* Must be placed on the switchboard, or at a distance of a foot from combustible material, or separated therefrom by a non-inflammable, non-absorptive insulating material.

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### CLASS B. HIGH POTENTIAL SYSTEMS

(OVER 300 VOLTS )

(Any circuit attached to any machine, or combination of machines, which develops over 300 volts difference of potential between any two wires, shall be considered as a high potential circuit and coming under that class, unless an approved transforming device is used which cuts the difference of potential down to less than 300 volts.)

#### 10. OUTSIDE CONDUCTORS:—

All outside, overhead conductors (including services)

*a.* Must have an *approved* insulating covering, and be firmly secured to properly insulated and substantially built supports, all tie wires having an insulation equal to that of the conductors they confine.

Insulation that will be *approved for service wires* must be solid, at least  $\frac{3}{4}$  of an inch in thickness and covered with a substantial braid. It must not readily carry fire, must show an insulating resistance of one megohm per mile after two weeks' submersion in water at 70 degrees Fahrenheit, and three days' submersion in lime water, with a current of 550 volts, and after three minutes' electrification.

A wire with an insulating covering that will not support combustion, will resist abrasion, is at least  $\frac{1}{8}$  of an inch in thickness, and thoroughly impregnated with a moisture repellent, will be *approved* for outside overhead conductors, except service wires.

*b.* Must be so placed that moisture cannot form a cross connection between them, not less than a foot apart, and not in contact with any substance other than their insulating supports.

*c.* Must be at least seven feet above the highest point of flat roofs, and at least one foot above the ridge of pitched roofs over which they pass or to which they are attached.

*d.* Must be protected by *dead insulated guard irons or wires* from possibility of contact with other conducting wires or substances to which current may leak. Special precautions of this kind must be taken where sharp angles occur, or where any wires might possibly come in contact with electric light or power wires.

*e.* Must be provided with petticoat insulators of glass or porcelain. Porcelain knobs or cleats and rubber hooks will not be approved.

*f.* Must be so spliced or jointed as to be both mechanically and electrically secure without solder. The joints must then be soldered, to insure preservation, and covered with an insulation equal to that on the conductors.

All joints must be soldered, even if made with the McIntyre or any other patent splicing device. This ruling applies to joints and splices in all classes of wiring covered by these rules.

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10. Telegraph, telephone and similar wires must not be placed on the same cross-arm with electric light or power wires.

### 11. SERVICE BLOCKS:—

Must be covered over their entire surface with at least two coats of waterproof paint.

### 12. ALL INTERIOR CONDUCTORS:—

a. Must be covered where they enter buildings from outside terminal insulators to and through the walls with extra waterproof insulation and must have drip loops outside. The hole through which the conductor passes must be bushed with waterproof and non-combustible insulating tube, slanting upwards toward the inside. The tube must be sealed with tape, thoroughly painted, and securing the tube to the wire.

b. Must be arranged to enter and leave the building through a double-contact service switch, which will effectually close the main circuit and disconnect the interior wires when it is turned "off." The switch must be so constructed that it shall be automatic in its action, not stopping between points when started, and prevent an arc between the points under all circumstances; it must indicate on inspection whether the current be "on" or "off," and be mounted in a non-combustible case, and kept free from moisture, and easy of access to police or firemen. So-called "snap switches" shall not be used on a high potential system.

c. Must be always in plain sight, and never encased, except when *required* by the Inspector.

d. Must have an *approved* insulating covering.

Insulation that will be *approved* for interior conductors must be solid, at least  $\frac{3}{4}$  of an inch in thickness and covered with a substantial braid. It must not readily carry fire, must show an insulating resistance of one megohm per mile after two weeks' submersion in water at 70 degrees Fahrenheit, and three days' submersion in lime water, with a current of 550 volts, and after three minutes' electrification.

e. Must be supported on glass or porcelain insulators, and kept rigidly at least eight inches from each other, except within the structure of lamps or on hanger-boards, cut-out boxes, or the like, where less distance is necessary.

f. Must be separated from contact with walls, floors, timbers or partitions through which they may pass by non-combustible, non-absorptive, insulating tubes, such as glass or porcelain.

g. Must be so spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered, to insure preservation, and covered with an insulation equal to that on the conductors.

All joints must be soldered, even if made with the McIntyre or any other *patent splicing device*. This ruling applies to joints and splices in all classes of *wiring covered by these rules*.

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*h.* Must be protected from mechanical injury, when necessary on side walls, by a substantial boxing, retaining an air space of one inch around the conductors, closed at the top, and extending not less than five feet from the floor. Where crossing exposed floor timbers in cellars or rooms, the conductors must be attached by their insulating supports to the under side of a wooden strip not less than one-half an inch in thickness.

### LAMPS AND OTHER DEVICES.

#### 13. ARC LAMPS—In every case:—

*a.* Must be carefully isolated from inflammable material.

*b.* Must be provided at all times with a glass globe surrounding the arc, securely fastened upon a closed base. No broken or cracked globes to be used.

*c.* Must be provided with an *approved* hand-switch, also an automatic switch that will shunt the current around the carbons should they fail to feed properly.

The hand-switch to be *approved*, if placed anywhere except on the lamp itself, must comply with requirements for switches on hanger-boards as laid down in Section *g* of Rule 13.

*d.* Must be provided with reliable stops to prevent carbons from falling out in case the clamps become loose.

*e.* Must be carefully insulated from the circuit in all their exposed parts.

*f.* Must be provided with a wire netting (having a mesh not exceeding one and one-quarter inches) around the globe, and an *approved* spark arrester above, to prevent escape of sparks, melted copper or carbon, where readily inflammable material is in the vicinity of the lamps. It is recommended that plain carbons, not copper-plated, be used for lamps in such places.

An *approved* spark arrester is one which will so close the upper orifice of the globe that it will be impossible for any sparks thrown off by the carbons to escape.

Arc lamps, when used in places where they are exposed to flyings of easily inflammable material, should have the carbons enclosed completely in a globe in such manner as to avoid the necessity for spark arresters. For the present, spark arresters will not be required on so-called "inverted arc" lamps.

*g.* Hanger-boards must be so constructed that all wires and current-carrying devices thereon shall be exposed to view and thoroughly insulated by being mounted on a non-combustible, non-absorptive, insulating substance. All switches attached to the same must be so constructed that they shall be automatic in their action, cutting off both poles to the lamp, not stopping between points when started, and preventing an arc between points under all circumstances.

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*a.* Where hanger-boards are not used, lamps to be hung from insulated supports other than their conductors.

### 14. INCANDESCENT LAMPS IN SERIES CIRCUITS HAVING A MAXIMUM POTENTIAL OF 300 VOLTS OR OVER:—

*a.* Must have the conductors installed as provided in Rule 12, and each series lamp must be provided with an automatic cut-out.

*b.* Must have each lamp suspended from a hanger-board by means of rigid tubes.

*c.* No electro-magnetic device for switches and no system of multiple-series or series-multiple lighting will be approved.

*d.* Under no circumstances can series lamps be attached to gas fixtures.

## CLASS C, LOW POTENTIAL SYSTEMS.

(300 VOLTS OR LESS.)

### OUTSIDE CONDUCTORS.

### 15. OUTSIDE OVERHEAD CONDUCTORS:—

*a.* Must be erected in accordance with the rules for high potential conductors.

*b.* Must be separated not less than twelve inches, and be provided with an *approved* fusible cut-out, that will cut off the entire current as near as possible to the entrance to the building and inside the walls.

An *approved* fusible cut-out must comply with the sections of Rules 23 and 24, describing fuses and cut-outs. The cut-out required by this section must be placed so as to protect the switch required by Rule 17.

### 16. UNDERGROUND CONDUCTORS:—

*a.* Must be protected, when brought into a building, against moisture and mechanical injury, and all combustible material must be kept removed from the immediate vicinity.

*b.* Must have a switch and a cut-out for each wire between the underground conductors and the interior wiring when the two parts of the wiring are connected.

These switches and fuses must be placed as near as possible to the end of the underground conduit, and connected therewith by specially insulated conductors, kept apart by not less than two and one-half inches.

The cut-out required by this section must be placed so as to protect the switch.

*c.* Must not be so arranged as to shunt the current through a *building* around any catch-box.

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### INSIDE WIRING. GENERAL RULES.

17. At the entrance of every building there shall be an *approved* switch placed in the service conductors by which the current may be entirely cut off.

The switch required by this rule, to be *approved*, must be of such construction that each wire entering the building will be disconnected when the switch is open, must plainly indicate whether the current is "on" or "off," and must comply with sections *a*, *c*, *d* and *e* of Rule 26, relating to switches.

### 18. CONDUCTORS:—

*a*. Must have an *approved* insulating covering, and must not be of sizes smaller than No. 14 B. & S., No. 16 B. W. G. or No. 4 E. S. G., except as allowed under Rule 27 (*d*) and 31 (*a*).

In so-called "concealed" wiring, moulding and conduit work, and in places liable to be exposed to dampness, the insulating covering of the wire, to be *approved*, must be solid, at least  $\frac{3}{8}$  of an inch in thickness, and covered with a substantial braid. It must not readily carry fire; must show an insulating resistance of one megohm per mile after two weeks' submersion in water at 70 degrees Fahrenheit, and three days' submersion in lime water, with a current of 550 volts, and after three minutes' electrification.

For work which is *entirely* exposed to view throughout the whole interior circuits, and not liable to be exposed to dampness, a wire with an insulation covering that will not support combustion, will resist abrasion, is at least  $\frac{1}{8}$  of an inch in thickness and thoroughly impregnated with a moisture repellent, will be *approved*.

*b*. Must be protected when passing through floors, walls, partitions, timbers, etc., by non-combustible, non-absorptive, insulating tubes, such as glass or porcelain.

*c*. Must be kept free from contact with gas, water or other metallic piping, or any other conductors or conducting material which they may cross, by some continuous and firmly fixed non-conductor, creating a separation of at least one inch. Deviations from this rule may sometimes be allowed by special permission.

*d*. Must be so placed in wet places that an air space will be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run *over* all pipes upon which moisture is liable to gather, or which by leaking might cause trouble on a circuit.

*e*. Must be so spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered, to insure preservation, and covered with an insulation equal to that on the conductors.

All joints must be soldered, even if made with the McIntyre or any other patent splicing device. This ruling applies to joints and splices in all classes of wiring covered by these rules.

*f*. Must be protected from mechanical injury, when necessary in side walls, by a substantial boxing, retaining an air sp

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one inch around the conductors, closed at the top, and extending not less than five feet from the floor, or by an iron-armored or metal-sheathed insulating conduit sufficiently strong to withstand the strain it will be subjected to, the inner insulating tubing to extend one-half inch beyond the ends of the metal tube, which must extend not less than five feet from the floor. Where crossing exposed floor timbers in cellars or rooms, the conductors must be attached by their insulating supports to the under side of a wooden strip not less than one-half inch in thickness and not less than three inches in width.

### SPECIAL RULES.

#### 19. WIRING NOT INCASED IN MOULDING OR APPROVED CONDUIT:—

*a.* Must be supported wholly on non-combustible insulators, constructed so as to prevent the insulating coverings of the wire from coming in contact with other substances than the insulating supports.

*b.* Must be so arranged that wires of opposite polarity, with a difference of potential of 150 volts or less, will be kept apart at least two and one-half inches.

*c.* Must have the above distance increased proportionately where a higher voltage is used.

*d.* Must not be laid in plaster, cement or similar finish.

*e.* Must never be fastened with staples.

#### IN UNFINISHED LOFTS, BETWEEN FLOOR AND CEILINGS, IN PARTITIONS AND OTHER CONCEALED PLACES.

*f.* Must have at least one inch clear air space surrounding them.

*g.* Must be at least ten inches apart when possible, and should be run singly on separate timbers or studding.

*h.* Wires run as above immediately under roofs, in proximity to water tanks or pipes, will be considered as exposed to moisture.

*i.* When from the nature of the case it is impossible to place concealed wire on non-combustible insulating supports of glass or porcelain, the wires may be fished on the loop system, if encased throughout in *approved* continuous flexible tubing or conduit.

American Circular Loom Tubing is approved for use under this rule.

*j.* Wires must not be fished for any great distance, and only in places where the Inspector can satisfy himself that the above *rules have been* complied with.

*k.* Twin wires must never be employed in this class of *concealed work*.

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### 20. MOULDINGS:—

- a. Must never be used in concealed work or in damp places.
- b. Must have, both outside and inside, at least two coats of waterproof paint, or be impregnated with a moisture repellent.
- c. Must be made of two pieces, a backing and capping, so constructed as to thoroughly encase the wire and provide a one-half inch tongue between conductors and a solid backing, which, under grooves, shall not be less than three-eighths of an inch in thickness, and must afford suitable protection from abrasion.

It is recommended that only hardwood moulding be used.

### 21. SPECIAL WIRING:—

In breweries, packing-houses, stables, dye-houses, paper and pulp mills, or other buildings specially liable to moisture or acid, or other fumes liable to injure the wires or insulation, except where used for pendants, conductors—

- a. Must be separated at least six inches, and should have no joints or splices.
- b. Must be provided with an *approved* insulating covering.

The insulating covering of the wire to be *approved* under this section must be solid, at least  $\frac{3}{8}$  of an inch in thickness and covered with a substantial braid. It must not readily carry fire, must show an insulating resistance of one megohm per mile after two weeks' submersion in water at 70 degrees Fahrenheit, and three days' submersion in lime water, with a current of 550 volts, after three minutes' electrification, and must *also* withstand a satisfactory test against such chemical compounds or mixtures as it will be liable to be subjected to in the risk under consideration.

- c. Must be carefully put up.

d. Must be supported by glass or porcelain insulators. No switches, key-sockets or fusible cut-outs will be allowed where exposed to inflammable gases or dust, or to flyings of combustible material. In damp places switches and cut-out blocks must be mounted on porcelain knobs.

e. Must be protected when passing through floors, walls, partitions, timbers, etc., by non-combustible, non-absorptive, insulating tubes, such as glass or porcelain.

### 22. INTERIOR CONDUITS\*:—

The American Circular Loom Company Tube, the *brass-sheathed* and the *iron-armored* tubes made by the Interior Conduit and Insulation Company, the *iron-armored* tube made by the Builders' Insulating Tube Company, of Lynn, Mass., the *iron-armored* tube made by the Clifton Mfg. Co., of Boston, and the Vulca Tube, are approved for the class of work called for in this rule.

a. Must be continuous from one junction box to another, or to fixtures, and must be of material that will resist the fusion of the wire or wires they contain without igniting the conduit.

\*The object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury, and, as far as possible, from moisture. Tubes or conduits are to be considered merely as raceways, and are not to be relied on for insulation between wire and wire, or between the wire and the ground.

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*b.* Must not be of such material or construction that the insulation of the conductor will ultimately be injured or destroyed by the elements of the composition.

*c.* Must be first installed as a complete conduit system, without the conductors, which must not be drawn in until all mechanical work on the building has been, as far as possible, completed.

*d.* Must not be so placed as to be subject to mechanical injury by saws, chisels or nails.

*e.* Must not be supplied with a twin conductor or two separate conductors in a single tube, except in an *approved* iron or steel-armored conduit.

The use of approved wires of opposite polarity, either separate or twin conductor, in a straight conduit installation, is allowed in *approved* iron-armored or steel-armored conduits, but not in any of the other approved conduits.

Iron or steel-armored conduit to be approved must fulfill the following specifications:

1. Must not be seriously affected externally by burning out a wire inside the tube when the iron pipe is connected to one side of the circuit.

2. When bent with a sag of one foot in the middle of a ten-foot length, and filled with water, must have an insulation resistance between the water and the iron pipe of one megohm after three days, temperature being 21 degrees Centigrade (70 degrees Fahrenheit).

3. The insulating material removed from the tube must not absorb more than ten per cent., by weight, of water after one week's immersion.

4. The insulating material must not soften at a temperature below 70 degrees Centigrade (158 degrees Fahrenheit), and must leave the water in which it is boiled practically neutral.

5. The insulating material must not become mechanically weak after three days' immersion in water.

*f.* Must have all ends closed with good adhesive material, either at junction boxes or elsewhere, whether such ends are concealed or exposed. Joints must be made air-tight and moisture-proof.

*g.* Conduits must extend at least one inch beyond the finished surface of walls or ceilings until the mortar or other similar material be entirely dry, when the projection may be reduced to half an inch.

### 23. DOUBLE-POLE SAFETY CUT-OUTS:—

*a.* Must be in plain sight or inclosed in an *approved* box, and readily accessible. They must not be placed in the canopies or shells of fixtures.

To be *approved* boxes must be constructed, and cut-outs arranged, whether in a box or not, so as to obviate any danger of the melted fuse metal coming in contact with any substance which might be ignited thereby.

*b.* Must be placed at every point where a change is made in the size of the wire (unless the cut-out in the larger wire will protect the smaller).

*c.* Must be supported on bases of non-combustible, insulating, moisture-proof material.

*d.* Must be supplied with a plug (or other device for inclosing *the fusible strip* or wire) made of non-combustible and moisture-

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proof material, and so constructed that an arc cannot be maintained across its terminals by the fusing of the metal.

*c.* Must be so placed that no set of lamps, whether grouped on one fixture or on several fixtures or pendants, requiring a current of more than six amperes, shall be ultimately dependent upon one cut-out. Special permission may be given in writing by the Inspector for departure from this rule in case of large chandeliers.

### 24. SAFETY FUSES:—

*a.* Must all be stamped or otherwise marked with the maximum number of amperes they will carry indefinitely without melting.

*b.* Must have fusible wires or strips (where the plug or equivalent device is not used), with contact surfaces or tips of harder metal, soldered or otherwise, having perfect electrical connection with the fusible part of the strip.

*c.* Must all be so proportioned to the conductors they are intended to protect that they will melt before the maximum safe-carrying capacity of the wire is exceeded.

### 25. TABLE OF CAPACITY OF WIRES:—

It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects and not upon the amount of current to be used on the circuit. Below is a table showing the safe carrying capacity of conductors of different sizes in Brown & Sharpe gauge, which must be followed in the placing of interior conductors:—

<i>B. &amp; S. G.</i>	<i>Amperes.</i>	<i>Amperes.</i>
TABLE A, CONCEALED WORK.	TABLE B, OPEN WORK.	
0000.....	218.....	312
000.....	181.....	262
00.....	150.....	220
0.....	125.....	185
1.....	105.....	156
2.....	88.....	131
3.....	75.....	110
4.....	63.....	92
5.....	53.....	77
6.....	45.....	65
8.....	33.....	46
10.....	25.....	32
12.....	17.....	23
14.....	12.....	16
16.....	6.....	8
18.....	3.....	5

**NOTE.**—By "open work" is meant construction which admits of all parts of the surface of the insulating covering of the wire being surrounded by free air. The carrying capacity of 16 and 18 wire is given, but no wire smaller than 14 is to be used, except allowed under Rules 27 (*d*) and 31 (*a*).

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### 26. SWITCHES:—

*a.* Must be mounted on moisture-proof and non-combustible bases, such as slate or porcelain.

*b.* Must be double pole when the circuits which they control supply more than six 16 candle-power lamps, or their equivalent.

*c.* Must have a firm and secure contact; must make and break readily, and not stop when motion has once been imparted by the handle.

*d.* Must have carrying capacity sufficient to prevent heating.

*e.* Must be placed in dry, accessible places, and be grouped as far as possible, being mounted—when practicable—upon slate or equally non-combustible back boards. Jackknife switches, whether provided with friction or spring stops, must be so placed that gravity will tend to open rather than close the switch.

### 27. FIXTURE WORK:—

*a.* In all cases where conductors are concealed within or attached to gas fixtures, the latter must be insulated from the gas-pipe system of the building by means of *approved* insulating joints placed as close as possible to the ceiling.

Insulating joints with soft rubber in their construction will not be approved. It is recommended that the gas-outlet pipe be protected above the insulating joint by a non-combustible, non-absorptive insulating tube having a flange at the lower end, where it comes in contact with the insulating joint, and that, where outlet tubes are used, they be of sufficient length to extend below the joint, and that they be so secured that they will not be pushed back when the canopy is put in place. Where iron ceilings are used care must be taken to see that the canopy is thoroughly and permanently insulated from the ceiling.

Insulating joints to be *approved* must be entirely made of material that will resist the action of illuminating gases, and will not give way or soften under the heat of an ordinary gas flame. They shall be so arranged that a deposit of moisture will not destroy the insulating effect, and shall have an insulating resistance of 250,000 ohms between the gas-pipe attachments, and be sufficiently strong to resist the strain they will be liable to in attachment.

*b.* Supply conductors, and especially the splices to fixture wires, must be kept clear of the grounded part of gas pipes, and where shells are used, the latter must be constructed in a manner affording sufficient area to allow this requirement.

*c.* When fixtures are wired outside, the conductors must be so secured as not to be cut or abraded by the pressure of the fastenings or motion of the fixture.

*d.* All conductors for fixture work must have a waterproof insulation that is durable and not easily abraded, and must not in any case be smaller than No. 18 B. & S., No. 20 B. W. G., No. 2 E. S. G.

*e.* All burrs or fins must be removed before the conductors are drawn into a fixture.

*f.* The tendency to condensation within the pipes should be guarded against by sealing the upper end of the fixture.

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*g.* No combination fixture in which the conductors are concealed in a space less than one-fourth inch between the inside pipe and the outside casing will be approved.

*h.* Each fixture must be tested for "contacts" between conductors and fixtures, for "short circuits," and for ground connections before the fixture is connected to its supply conductors.

*i.* Ceiling blocks of fixtures should be made of insulating material; if not, the wires in passing through the plate must be surrounded with hard-rubber tubing.

### 28. ARC LIGHTS ON LOW POTENTIAL CIRCUITS:—

*a.* Must be connected with main conductors only through a double-pole cut-out and a double-pole switch, which shall plainly indicate whether "on" or "off."

*b.* Must only be furnished with such resistances or regulators as are inclosed in non-combustible material, such resistances being treated as stoves. Incandescent lamps must not be used for resistance devices.

*c.* Must be supplied with globes and protected as in the case of arc lights on high-potential circuits.

### 29. ELECTRIC GAS LIGHTING:—

Where electric gas lighting is to be used on the same fixture with the electric light—

*a.* No part of the gas piping or fixture shall be in electrical connection with the gas-lighting circuit.

*b.* The wires used with the fixtures must have a non-inflammable insulation, or, where concealed between the pipe and shell of the fixture, the insulation must be such as required for fixture wiring for the electric light.

*c.* The whole installation must test free from "grounds."

*d.* The two installations must test perfectly free from connection with each other.

### 30. SOCKETS:—

*a.* No portion of the lamp socket exposed to contact with outside objects must be allowed to come into electrical contact with either of the conductors.

*b.* In rooms where inflammable gases may exist, or where the atmosphere is damp, the incandescent lamp and socket should be inclosed in a vapor-tight globe.

### 31. FLEXIBLE CORD:—

*a.* Must be made of two-stranded conductors, each having a carrying capacity equivalent to not less than a No. 16 B. & S. wire, and each covered by an *approved* insulation, and protected by a *slow-burning*, tough, braided outer covering.

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Insulation for *pendants* under this rule must be moisture and flame-proof. Insulation for *fixture* work must be waterproof, durable and not easily abraded.

Insulation for cords used for all other purposes, including portable lamps and motors, must be solid, at least  $\frac{3}{16}$  of an inch in thickness, and must show an insulation resistance between conductors and between either conductor and the ground of at least one megohm per mile, after one week's immersion in water at 70 degrees Fahrenheit, with a current of 550 volts, and after three minutes' electrification.

*b.* Must not sustain more than one light not exceeding 50 candle-power.

*c.* Must not be used except for pendants, wiring of fixtures and portable lamps or motors.

*d.* Must not be used in show windows.

*e.* Must be protected by insulating bushings where the cord enters the socket. The ends of the cord must be taped to prevent fraying of the covering.

*f.* Must be so suspended that the entire weight of the socket and lamp will be borne by knots under the bushing in the socket, and above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws.

*g.* Must be equipped with keyless sockets as far as practicable, and be controlled by wall switches.

### 32. DECORATIVE SERIES LAMPS:—

Incandescent lamps run in series circuits shall not be used for decorative purposes inside of buildings, except by special permission in writing from the Underwriters having jurisdiction.

## CLASS D, ALTERNATING SYSTEMS.

### CONVERTERS OR TRANSFORMERS.

### 33. CONVERTERS:—

*a.* Must not be placed inside of any building, except the Central Station, unless by special permission of the Underwriters having jurisdiction.

*b.* Must not be placed in any but metallic or other non-combustible cases.

*c.* Must not be attached to the outside walls of buildings, unless separated therefrom by substantial insulating support

### 34. IN THOSE CASES WHERE IT MAY NOT BE POSSIBLE TO EXCLUDE THE CONVERTERS AND PRIMARY WIRES ENTIRELY FROM THE BUILDING, THE FOLLOWING PRECAUTIONS MUST BE STRICTLY OBSERVED:—

Converters must be located at a point as near as possible to *that at which the primary wires enter the building*, and must be *placed in an inclosure constructed of, or lined with, fire-resisting*

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material; the inclosure to be used only for this purpose, and to be kept securely locked, and access to the same allowed only to responsible persons. They must be effectually insulated from the ground, and the inclosure in which they are placed must be practically air-tight, except that it shall be thoroughly ventilated to the out-door air, if possible, through a chimney or flue. There should be at least six inches air space on all sides of the converter.

### 35. PRIMARY CONDUCTORS:—

*a.* Must each be heavily insulated with a coating of moisture-proof material from the point of entrance to the transformer, and, in addition, must be so covered and protected that mechanical injury to them, or contact with them, shall be practically impossible.

*b.* Must each be furnished, if within a building, with a switch and a fusible cut-out where the wires enter the building, or where they leave the main line. These switches should be inclosed in secure and fireproof boxes, preferably outside the building.

*c.* Must be kept apart at least ten inches, and at the same distance from all other conducting bodies when inside a building.

### 36. SECONDARY CONDUCTORS:—

Must be installed according to the rules for "Low-Potential Systems."

## CLASS E, ELECTRIC RAILWAYS.

37. All rules pertaining to arc-light wires and stations shall apply (so far as possible) to street railway power stations and their conductors in connection with them.

### 38. POWER STATIONS:—

Must be equipped in each circuit as it leaves the station with an *approved* automatic "breaker," or other device that will immediately cut off the current in case the trolley wires become grounded. This device must be mounted on a fireproof base, and in full view and reach of the attendant.

Automatic circuit breakers should be submitted for *approval* before being used.

### 39. TROLLEY WIRES.—

*a.* Must be no smaller than No. 0 B. & S. copper or No. 4 B. & S. silicon bronze, and must readily stand the strain put upon them when in use.

*b.* Must be well insulated from their supports, and in case of the side or double pole construction the supports shall also be insulated from the poles immediately outside of the trolley wire.

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*c.* Must be capable of being disconnected at the power house, or of being divided into sections, so that in case of fire on the railway route the current may be shut off from the particular section and not interfere with the work of the firemen. This rule also applies to *feeders*.

*d.* Must be safely protected against contact with all other conductors.

### 40. CAR WIRING :—

Must be always run out of reach of the passengers, and must be insulated with a waterproof insulation.

### 41. LIGHTING AND POWER FROM RAILWAY WIRES :—

Must not be permitted, under any pretense, in the same circuit with trolley wires with a ground return, nor shall the same dynamo be used for both purposes, except in street railway cars, electric car houses, and their power stations.

### 42. CAR HOUSES :—

*a.* Must have the trolley wires properly supported on insulating hangers.

*b.* Must have the trolley hangers placed at such a distance apart that in case of a break in the trolley wire, contact cannot be made with the floor.

*c.* Must have cut-out switch located at a proper place outside of the building, so that all trolley circuits in the building can be cut out at one point, and line circuit breakers must be installed, so that when this cut-out switch is open the trolley wire will be dead at all points within 100 feet of the building. The current must be cut out of the building whenever the same is not in use, or the road not in operation.

*d.* Must have all lamps and stationary motors installed in such a way that one main switch can control the whole of each installation (lighting or power), independently of main feeder switch. No portable incandescent lamps or twin wire allowed, except that portable incandescent lamps may be used in the pits; connections to be made by two approved rubber-covered flexible wires, properly protected against mechanical injury; the circuit to be controlled by a switch placed outside of the pit.

*e.* Must have all wiring and apparatus installed in accordance with rules under Class B.

*f.* Must not have any system of feeder distribution centering in the building.

*g.* Must have the rails bonded at each joint with not less than *No. 2 B. & S.* annealed copper wire; also a supplementary wire *to be run for each track.*

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*h.* Must not have cars left with trolley in electrical connection with the trolley wire.

### 43. GROUND RETURN WIRES:—

Where ground return is used it must be so arranged that no difference of potential will exist greater than 5 volts to 50 feet, or 50 volts to the mile between any two points in the earth or pipes therein.

## CLASS F, ELECTRIC HEATERS.

### 44. ELECTRIC HEATERS:—

*a.* If stationary, must be placed in a safe situation, isolated from inflammable materials and treated as stoves

*b.* Must have double-pole *indicating* switches and double-pole cut-outs arranged as required for electric light or power of same potential and current.

*c.* Must have the attachments of feed wires to the heaters in plain sight, easily accessible, and protected from interference, accidental or otherwise.

*d.* The flexible conductors for portable apparatus, such as irons, etc., must have an insulation that will not be injured by heat, such as asbestos, which must be protected from mechanical injury by an outer substantial braided covering, and so arranged that mechanical strain will not be borne by the electrical connections.

## CLASS G, STORAGE OR PRIMARY BATTERIES.

### 45. STORAGE OR PRIMARY BATTERIES:—

*a.* When current for light and power is taken from primary or secondary batteries, the same general regulations must be observed as applied to similar apparatus fed from dynamo generators developing the same difference of potential.

*b.* All secondary batteries must be mounted on *approved* insulators.

Insulators for mounting secondary batteries, to be *approved*, must be non-combustible, such as glass, or thoroughly vitrified and glazed porcelain.

*c.* Special attention is directed to the rules for rooms where acid fumes exist.

*d.* The use of any metal liable to corrosion must be avoided in connections of secondary batteries.

## MISCELLANEOUS.

### 46. MISCELLANEOUS:—

*a.* The wiring in any building must test free from grounds:  
*i. e.*, each main supply line and every branch circuit should have

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an insulation resistance of at least 100,000 ohms, and the whole installation should have an insulation resistance between conductors and between all conductors and the ground (not including attachments, sockets, receptacles, etc.) of not less than the following:—

Up to	10 amperes			4,000,000
"	25	"		1,600,000
"	50	"		800,000
"	100	"		300,000
"	200	"		160,000
"	400	"		80,000
"	800	"		22,000
"	1,600	"		11,000

All cut-outs and safety devices in place in the above.

Where lamp sockets, receptacles and electroliers, etc., are connected, one-half of the above will be required.

*b.* Ground wires for lightning arresters of all classes, and ground detectors must not be attached to gas pipes within the building.

*c.* Where telephone, telegraph or other wires connected with outside circuits are bunched together within any building, or where inside wires are laid in conduit or duct with electric light or power wires, the covering of such wires must be fire-resisting, or else the wires must be inclosed in an air-tight tube or duct.

*d.* All aerial conductors and underground conductors, which are directly connected to aerial wires, connecting with telephone, telegraph, district messenger, burglar-alarm, watch-clock, electric time and other similar instruments, must be provided near the point of entrance to the buildings with some *approved* protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of fire hazard if crossed with another conductor, through which it may become charged with a relatively high pressure.

Protectors must have a non-combustible, insulating base, and the cover to be provided with a lock similar to the lock now placed on telephone apparatus or some equally secure fastening, and to be installed under the following requirements:—

1. The protector to be located at the point where the wires enter the building, either immediately inside or outside of the same. If outside, the protector to be inclosed in a metallic, waterproof case.

2. If the protector is placed inside of building, the wires of the circuit from the support outside to the binding posts of the protector to be of such insulation as is approved for service wires of electric light and power, and the holes through the *outer walls to be protected* by bushing the same as required for electric light and *power-service wires*.

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3. The wire from the point of entrance to the protector to be run in accordance with rules for high potential wires: *i. e.*, free of contact with building and supported on non-combustible insulators.

4. The ground wire shall be insulated, not smaller than No. 16 B. & S. gauge. This ground wire shall be kept at least three (3) inches from all conductors, and shall never be secured by uninsulated double-pointed tacks.

5. The ground wire shall be attached to a water pipe, if possible; otherwise may be attached to a gas pipe. The ground wire shall be carried to and attached to the pipe outside of the first joint or coupling inside the foundation walls, and the connection shall be made by soldering, if possible. In the absence of other good ground, the ground shall be made by means of a metallic plate or a bunch of wires buried in a permanently moist earth.

*e.* The metallic sheathes to cables must be permanently and effectively connected to "earth."

*f.* The following formula for soldering fluid is suggested:—

Saturated solution of zinc.....	5 parts
Alcohol.....	4 parts
Glycerine.....	1 part

### WIRES.

The following is a list of wires which have been tested and found to comply with the standard for *approved* wires, required for *all* high-potential work (300 volts or over); and for service wires, all classes of concealed wiring and wiring exposed to dampness in low potential work:—

<i>Name of Wire.</i>	<i>Manufacturer.</i>
Americanite .....	American Electrical Works.
Bishop .....	Bishop Gutta Percha Co.
Clark .....	Eastern Electric Cable Co.
Climax .....	Simplex Electric Co.
Simplex (caoutchouc) .....	Simplex Electric Co.
Crescent .....	John A. Roebling's Sons Co.
Crown .....	Washburn & Moen.
Globe .....	Washburn & Moen.
Salamander .....	Washburn & Moen.
Crefeld .....	Crefeld Electrical Works.
Grimshaw (White core) .....	N. Y. Insulated Wire Co.
Raven core .....	N. Y. Insulated Wire Co.
Requa (White core) .....	Safety Insulated Wire & Cable Co.
Safety (Black core) .....	Safety Insulated Wire & Cable Co.
Habirshaw (White core) .....	Ind. Rubber & Gutta Percha Ins. Co.
Habirshaw (Blue core) .....	Ind. Rubber & Gutta Percha Ins. Co.
Habirshaw (Red core) .....	Ind. Rubber & Gutta Percha Ins. Co.
Paranite .....	Indiana Rubber & Insulated Wire Co.
Liberty .....	Atlas Covering Works.
Kerite .....	W. R. Brixey.
Okonite .....	Okonite Co.
Paracore .....	Nat. India Rubber Co.
N. I. R. .....	Nat. India Rubber Co.
U. S. .....	Gen. Electric Co.
Columbia .....	C. S. Knowles.

NOTE.—The results of recent tests on these and other wires can be seen at inspection offices.

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### MATERIALS.

The following are given as a list of NON-COMBUSTIBLE, NON-ABSORPTIVE, INSULATING materials, and are listed here for the benefit of those who might consider hard rubber, fiber, wood and the like as fulfilling the above requirements. Any other substance, which it is claimed should be accepted, must be forwarded for testing before being put on the market:—

1. Glass.
2. Marble (filled).
3. Slate without metal veins.
4. Porcelain, thoroughly glazed and vitrified.
5. Pure Sheet Mica.
6. Lava (certain kinds of).
7. Alberene stone.