WISCONSIN STATE ELECTRICAL CODE

Volume No. 2

Electrical and Communication Equipment and Lightning Protection

Fifth Edition

Effective August 30, 1944

Except
Orders 13–3856 to 13–3859, inclusive,
Orders 13–3881 to 13–3885, inclusive.
Effective Dec. 21, 1944

Compiled by
Industrial Commission of Wisconsin
and
Public Service Commission of Wisconsin

Volume No. 1: Electrical and Communication Lines and Supply Stations.
Contains orders covering the following:

General Requirements, Definitions and Grounding of Electrical Facilities	Introduction
Electrical Supply Stations and Substations	Part 1
Supply and Communication Lines	Part 2
Operation of Electric and Communication Equipment and Lines	Part 4

Volume No. 2: Electrical and Communication Equipment and Wiring and Lightning Protection.
Contains orders covering the following:

General Requirements and Definitions	Introduction
Electrical and Communication Equipment and Wiring Including Grounding	Part 3
Protection of Buildings and Structures Against Lightning	Part 6

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Volume No. 2

WISCONSIN STATE ELECTRICAL CODE

The complete code (Volumes 1 & 2) covers the minimum fire and safety requirements for the construction and installation of all electrical, communication, and signal circuits and equipment including radio and lightning rod equipment; and rules to be observed in the operation of electric and communication equipment and lines.

FIFTH EDITION
Effective August 30, 1944
Except
Orders 13–3856 to 13–3859, inclusive,
Orders 13–3881 to 13–3885, inclusive.
Effective Dec. 21, 1944

Madison, Wisconsin

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BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

In the Matter of the Revision by the Commission of the Rules and Regulations Governing the Construction, Operation, and Maintenance of Lines and Equipment Owned, Managed, Operated, or Controlled by Every Public Utility and Every Railroad Along or Across any Public Highway or Private Right of Way over which Electrical Energy is Transmitted, or Messages are Transmitted or Conveyed. } U-2776

ORDER APPROVING ELECTRICAL CODE

WHEREAS a joint investigation has been conducted by the Industrial Commission of Wisconsin and the Public Service Commission of Wisconsin involving the revision of the standards of safe electrical construction and operation; and

WHEREAS all railroads and public utilities under the jurisdiction of this Commission and subject to the requirements of Chapters 195 and 196 of the Statutes have had due notice of the hearing held in connection with the aforesaid investigation; and

WHEREAS as a result of such investigation certain changes in, and additions to, the Wisconsin State Electrical Code have been adopted and promulgated by the Industrial Commission of Wisconsin as their General Orders Nos. 1000 to 1452 and 1600 to 1652 inclusive, effective August 30, 1944, as more particularly shown in said code;

FINDING

THE COMMISSION FINDS:

That the requirements set forth in the order herein made are proper and necessary to be prescribed for the railroads and public utilities of this state.

ORDER

IT IS THEREFORE ORDERED:

(1) That all railroads and public utilities subject to the jurisdiction of this Commission and subject to the requirements of Section 196.74 be and are hereby required to observe and conform to the standards of construction, maintenance, and rules of operation as established by the Wisconsin State Electrical Code adopted by the Industrial Commission, which is hereby approved and adopted as an order of this Commission and a copy of which is hereto attached.

(2) This order will supersede and take the place of the order of this Commission with reference to standards for the safe construction and operation of electric systems decided October 15, 1934, and

of amendments and additions which became effective July 22, 1936; July 25, 1936; September 7, 1940; September 26, 1942; November 16, 1942; and January 13, 1943.

Dated at Madison, Wisconsin, this 30th day of August, 1944.

PUBLIC SERVICE COMMISSION OF WISCONSIN

R. W. PETERSON
Chairman
W. F. WHITNEY
Commissioner
LYNN H. ASHLEY
Commissioner

SUPPLEMENTARY ORDER

WHEREAS the Industrial Commission published orders in the matter of the revision of the Wisconsin State Electrical Code, made effective as of August 30, 1944, and

WHEREAS the Industrial Commission has published the following additional orders: 13–3856, 13–3857, 13–3858, 13–3859, 13–3881, 13–3882, 13–3883, 13–3884, and 13–3885, and

WHEREAS this Commission issued a concurrent order effective as of the same date:

FINDING

THE COMMISSION FINDS:

That the above orders as enumerated should be a part of the Wisconsin State Electrical Code.

ORDER

IT IS THEREFORE ORDERED:

That the orders 13–3856 to 13–3859 inclusive and 13–3881 to 13–3885 inclusive are a part of the Wisconsin State Electrical Code adopted August 30, 1944. This supplementary order becomes effective December 21, 1944.

Dated at Madison, Wisconsin, this 21st day of November, 1944.

PUBLIC SERVICE COMMISSION OF WISCONSIN

R. W. PETERSON
Chairman
W. F. WHITNEY
Commissioner
LYNN H. ASHLEY
Commissioner

WISCONSIN STATE ELECTRICAL CODE

Preface

By Chapter 101 of the revised statutes, it is the duty of the Industrial Commission to fix standards of safety in all places of employment and to formulate rules and regulations relative to the enforcement of such standards. It is further the duty of the Industrial Commission to fix similar standards and formulate rules and regulations relating to fire hazards or to the prevention of fires in buildings so situated as to endanger other buildings or property.

The first electrical code was adopted in 1917. Between 1917 and the present date, the 1917 code orders were revised and changed a number of times. The fourth edition of the code became effective October 15, 1934 and changes made which became effective on July 22, 1936; July 25, 1936; and September 7, 1940. Later it became apparent that further revisions in the electrical code were necessary.

On September 26, 1942 an emergency amendment became effective as Order 1001 permitting the regulatory authorities to approve substitute wiring materials and methods during the war emergency and for a period six months thereafter. Changes under this emergency amendment were approved November 16, 1942 and January 13, 1943.

The following committee representing the organizations noted, together with the advisers given below, met with representatives of the Industrial and Public Service Commission at various times during 1941, 1942, and 1943.

CODE COMMITTEE

C. B. Hayden, Madison, Chairman of Committee, Public Service Commission of Wisconsin
John E. Wise, Madison, Secretary of Committee, Industrial Commission of Wisconsin
G. H. Andrae, Milwaukee, Wisconsin Electrical Association
E. J. Kallevang, Madison, Wisconsin Utilities Association
J. B. Wilkinson, Milwaukee, Fire Insurance Rating Bureau
F. H. Runkel, Madison, State Telephone Association
W. C. Lallier, Milwaukee, Wisconsin Telephone Company
E. W. Seeger, Milwaukee, Electrical Utilization Equipment Manufacturers
L. A. Wood, Chicago, C. B. and Q. Railroad
Wm. A. Haig, Milwaukee, Milwaukee Building Inspection Department
B. H. Barg, Milwaukee, Electrical Contractors Association, Milwaukee Chapter
J. J. Daly, Milwaukee, Wisconsin State Federation of Labor
George E. Cooper, West Allis, Wisconsin Manufacturers Association

The persons consulted as technical advisers were as follows:

V. H. Tousley, Chicago, Electric Field Engineer, National Fire Protection Association

C. B. Robertson, Milwaukee, Wisconsin Telephone Company

W. S. Wilder, Milwaukee, Wisconsin Electric Power Company

George Crowell, Milwaukee, Chief Engineer, Wisconsin Telephone Company

C. T. Reisz, Chicago, Western Union Telegraph Company

W. E. Gundlach, Milwaukee, Chief Electrical Engineer, Wisconsin Electric Power Company

A. L. St. Cyr, Chicago, Western Union Telegraph Company

E. H. Herzberg, Milwaukee, Manager, Electrical Contractors Association, Milwaukee Chapter

Walter Gerke, Milwaukee, Wisconsin State Federation of Labor

L. P. Works, Green Bay, Wisconsin Public Service Corporation

R. E. Purucker, Madison, Wisconsin Public Service Commission

Because some interests use certain parts of the code to the exclusion of others and the revision of some parts occurs more frequently than others it was deemed advisable to separate the code into two volumes. When reference is made to the Wisconsin State Electrical Code the complete code (both volumes) is meant.

The formal hearings were held at Madison on September 8, 1943; at Milwaukee on September 10, 1943; at Eau Claire on September 21, 1943; at Wausau on September 22, 1943; and at Green Bay on September 24, 1943 at which time the committee made a report to the two Commissions. After fully considering the committee's recommendations, the attached code was adopted by the Industrial Commission. The official publication of this action of the Industrial Commission took place in the official state paper on July 31, 1944 and hence became effective thirty days later; namely, August 30, 1944. The Public Service Commission's order became effective as of the same date.

Orders 13–3856 to 13–3859, inclusive, and 13–3881 to 13–3885, inclusive, were published November 21, 1944 and hence became effective December 21, 1944.

LOCAL ELECTRICAL REGULATIONS

Section 101.16 subsection 1 of the statutes provides that when any orders of the Industrial Commission have been filed with the clerk of any village or city it then becomes the duty of local officers to enforce such orders and thereafter no local officer shall make or enforce any order contrary to such orders.

However, nothing in this Electrical Code shall be understood to limit the power of any town, village or city to enact and enforce additional or more stringent local regulations, provided the same do not abridge or conflict with this code or any other orders of the Industrial Commission. The State Electrical Code sets forth the minimum construction requirements for the entire state, but where local regulations are more stringent, in whole or in part, the additional local requirements must also be met.

Less stringent local regulations are held to be amended or modified by similar orders of the Industrial Commission.

Statutes Affecting Interior Wiring, Transmission Lines, etc.

Section 167.16 of the Statutes requires the following regarding electric wiring.

> Regulation of Electric Wiring. 167.16(1) It is hereby made the duty of every contractor and other person who does any electric wiring in this state to comply with the Wisconsin State Electrical Code, and the company furnishing the electrical current shall obtain proof of such compliance before furnishing such service; provided, that nothing therein contained shall be construed as prohibiting any municipality from making more stringent regulations than those contained in the above mentioned code. Proof of such compliance shall consist of a certificate furnished by a municipal or other recognized inspection department or officer, or if there is no such inspection department or officer it shall consist of an affidavit furnished by the contractor or other person doing the wiring, indicating that there has been such compliance.
>
> (2) Any person who shall violate the provisions of this section shall be deemed guilty of a misdemeanor and shall be punished by a fine of not less than twenty-five dollars nor more than one hundred dollars, or by imprisonment in the county jail not less than thirty days nor more than six months.

The following forms of affidavit, one form for the contractor and one for the electrical inspector, are suggested:

SUGGESTED FORM OF AFFIDAVIT TO BE USED BY ELECTRICAL INSPECTOR

State of Wisconsin
---------- County
City / Village / Town } -------- } ss

I, ----------, do hereby certify that I am the duly appointed, qualified and acting electrical inspector of said city, village or town; that I have inspected the following described electric wiring installed by, ----------, on the premises occupied by ----------, and located at No. ---------- Street, in said city, village or town, and that said wiring complies with the Wisconsin State Electrical Code. Description of wiring inspected,

---

Dated ----------, 19----

Electrical Inspector

SUGGESTED FORM OF AFFIDAVIT TO BE USED BY ELECTRICAL CONTRACTOR

STATE OF WISCONSIN }
County of _____ } ss

_____, being duly sworn by oath, says that he is the person who *_____ the following described work of wiring for electricity in the **_____, occupied by _____, and located ***_____ in the County of _____, Wisconsin, and that all of said described electric wiring at the location above was done so as to comply, and does comply, with the Wisconsin State Electrical Code, and that this affidavit is made pursuant to and in compliance with the provisions of section 167.16 of the Statutes.

Description of wiring done _____

_____

(Signed) _____

Subscribed and sworn to before me, this _____ day of _____, 19___.

_____

Notary Public, _____ County, Wis.

The administrative authorities have considered the term "electric wiring" in the above as applying to all wiring installed on customer's premises to supply equipment with energy, except wiring used in Class 1 or Class 2 systems as defined in Order 13–8002.

Section 196.72(1) of the Statutes requires

> (1) Every public utility shall immediately report to the Commission (i.e. Public Service Commission) every fatal accident occurring upon its premises or directly or indirectly arising from or connected with its maintenance or operation.

Section 102.37 of the Statutes requires

> Every employer of three or more persons and every employer who is subject to the workmen's compensation act shall keep a record of all accidents causing death or disability of any employee while performing services growing out of and incidental to the employment, which record shall give the name, address, age and wages of deceased or injured employee, the time and causes of the accident, the nature and extent of the injury, and such other information as the Industrial Commission may require by general order. Reports based upon this record shall be furnished to the Industrial Commission at such times and in such manner as it may require by general order upon forms to be procured from the Commission (i.e. Industrial Commission).

In connection with Section 102.37 of the statutes quoted above, the Industrial Commission has issued the following rule 2 of its "Rules of Practice of Industrial Commission of Wisconsin."

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* Space left for the word "did" or "supervised." ** Specify residence, barn or other building in which wiring was done. *** in villages and cities insert street and number and name of city or village. In unincorporated territory insert section number and name of town.

> Employers under the provisions of the workmen's compensation act within one day after the fatal termination of an accident or industrial disease, shall make a brief report of this occurrence to the Industrial Commission by telegraph or by letter. They shall also make a report on Form A–12 on the fourth day after the accident or beginning of disability from occupational disease upon every accident or disease causing death or a disability which exists beyond the third day after the employee leaves work as a result of the accident.
>
> Self-insured employers and insurance companies on all accidents which require a first report must:
>
> 1. Make a supplementary report on Form A–13 on the eleventh day following that on which the accident occurred.
> 2. Make another supplementary report immediately when payments are stopped for any reason. This report must be accompanied by an explanatory memorandum, if there is a dispute with the injured man.
> 3. Make a final report on Form A–13 when final payment of compensation has been made, which must be accompanied by (a) a copy of the final receipt signed by the injured employee; and (b) a report from a physician, if the disability exceeds three weeks or if there is any permanent disability, unless there has been a hearing before the Commission.

Some of the other laws that have a bearing on electric construction and safety are as follows:

Section or Chapter Laws of 1943	*Subject Matter*
Chapter 101	Creation and duties of Industrial Commission
Chapter 102	Workmen's compensation act
Chapters 195 and 196	Creation and duties of Public Service Commission
Section 86.16	Poles on highways
Section 180.17	Transmission lines
Section 180.18	Wires over railroads
Section 196.171	Examination of meters, pipes, fittings, wires and works; entering buildings for
Section 180.19	Damages for non-delivery of message
Section 196.67	Transmission lines and warning signs
Section 196.74	Safety and interference
Sections 343.17 and 98.25	Diversion of current
Section 343.175	Fraudulent use of gas, electricity, water and steam
Section 343.724	Poles on private property
Section 343.43	Injury to property
Section 348.38	Injury to wires

The above is not a complete list of laws covering all the subject matter involved nor all the laws administered by the Public Service Commission and Industrial Commission.

Other Industrial Commission Publications

Flammable Liquids Code
Building Code
Elevator Code
Boiler Code
Industrial Lighting Code
School Lighting Code
Refrigerator Code
Heating and Ventilating Code
General Orders on Existing Buildings
General Orders on Dusts, Fumes, Vapors and Gases
General Orders on Safety in Construction
General Orders on Fire Prevention
General Orders on Sanitation
General Orders on Safety
General Orders on Spray Coating
General Orders on Quarries and Pits
General Orders on Mines
General Orders on Tunnel, Caisson and Trench Construction
General Orders on Explosives
General Orders on Electrical Fences

Enforcement

The authority for the enforcement of this code is vested in the Public Service Commission with respect to the installation and operation of circuits or equipment by public utilities in the exercise of their functions as utilities; and in the Industrial Commission with respect to the installation and operation of circuits or equipment affecting employees, employers, or the public.

INTRODUCTORY PART

VOLUME 2

GENERAL REQUIREMENTS AND DEFINITIONS

Order 1000. Scope of Code.

This code, consisting of two volumes, shall apply as minimum fire and safety requirements for the construction, installation, and maintenance of all electrical and communication circuits and equipment including signal, radio, and lightning rod equipment; and includes rules to be observed in the operation of electrical and communication equipment and lines.

Order 1001. Emergency Amendment.

The Industrial Commission of Wisconsin and the Public Service Commission of Wisconsin, recognizing the present war emergency and the shortages of critical electrical materials, hereby amend the Wisconsin State Electrical Code to permit the use of approved substitute electrical wiring materials and methods.

Lists of such approved substitute materials and methods shall, upon recommendation of a subcommittee of the Wisconsin State Electrical Code Advisory Committee, be issued by the Industrial Commission or the Public Service Commission from time to time as may be necessary and as promptly as possible.

This amendment is to remain in effect during the war emergency and for a period of 6 months thereafter, unless otherwise amended or repealed.

This amendment was published in the official state paper on August 27, 1942 and became effective September 26, 1942.

SECTION 101. GENERAL REQUIREMENTS

Order 1010. Character of Construction, Maintenance and Operation.

All electrical and communication equipment and lines shall be of such construction, and so installed, operated, and maintained as to minimize the life and fire hazard.

Order 1011. Use of Approved Materials and Construction Methods.

A. *Materials.* No materials, employed in construction covered by this code, shall be used which have not been approved by the Industrial Commission or Public Service Commission.

Exception: Materials which comply with the requirements of this code are hereby approved.

Note: It is the policy of the administrative authority to approve materials, devices, and systems which are listed as standard by the Underwriters' Laboratories if they do not conflict with the requirements of this or other state codes or the laws of the state.

B. *Methods of Installation.* No methods of installing electrical materials or devices in construction covered by this code shall be used which are not approved by the Industrial Commission or Public Service Commission.

Exception: Methods of installation which comply with the requirements of this code are hereby approved.

Order 1012. Construction, Inspection and Repairs.

All construction and equipment shall be cleaned when necessary and inspected at such intervals as experience has shown to be necessary. Any equipment or construction known to be defective so as to endanger life or property shall be promptly repaired, permanently disconnected, or isolated until repairs can be made. Construction, repairs, additions and changes to electrical equipment and conductors shall be made by qualified persons only. (See also Orders 1211 and 1213.)

Order 1013. Application of Orders.

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

B. *Application.* The intent of the orders will be realized (1) by applying the orders in full to all new installations, reconstructions, alterations, and extensions, except where any rule is shown to be impracticable for special reasons or where the advantage of uniformity with existing construction is greater than the advantage of construction in compliance with the orders, providing the existing construction is reasonably safe; (2) by bringing existing installations into conformity with these orders as far as may be directed by the Industrial Commission or Public Service Commission and within the time determined by them.

C. *Penalties.* The 1943 Statutes of the State of Wisconsin require

102.57 Where injury is caused by the failure of the employer to comply with any statute or any lawful order of the Commission, (i.e. Industrial Commission) compensation and death benefits as provided for in this chapter shall be increased fifteen percent.

102.58 Where injury is caused by the failure of the employe to use safety devices where provided and adequately maintained by the employer, or where injury results from the employe's wilful failure to obey any reasonable rule adopted by the employer for the safety of the employe, and of which the employe had notice, or where injury results from the intoxication of the employe, the compensation, and death benefit provided herein shall be reduced fifteen per cent.

196.64 Utilities, liability for treble damages. If any public utility shall do or cause to be done or permit to be done any matter, act or thing prohibited or declared to be unlawful by

chapter 196 or 197, or shall omit to do any act, matter or thing required to be done by it, such public utility shall be liable to the person injured thereby in treble the amount of damages sustained in consequence of such violation.

196.66 General penalty; utility responsible for agents. (1) If any public utility shall violate any provision of chapter 196 or 197, or shall do any act therein prohibited or shall fail or refuse to perform any duty enjoined upon it for which a penalty has not been provided, or shall fail, neglect or refuse to obey any lawful requirement or order made by the Commission (i.e. Public Service Commission) or the municipal council or any judgment or decree made by any court upon its application, for every such violation, failure or refusal such public utility shall forfeit not less than twenty-five dollars nor more than one thousand dollars.

(2) Every day during which any public utility or any officer, agent or employee thereof shall fail to observe and comply with any order or direction of the Commission or to perform any duty enjoined by chapter 196 or 197, shall constitute a separate and distinct violation.

D. *Temporary Installations.* It will sometimes be necessary to modify or waive certain of the orders in case of temporary installations or installations which are shortly to be dismantled or reconstructed. Such temporary construction may be used for a reasonable length of time provided it is under competent supervision while it or adjoining equipment is alive or if it is protected by suitable barriers or warning signs when accessible to any person, without fully complying with this code; but all such construction shall be made reasonably safe.

E. *Testing.* Rooms which are used exclusively for routine or special electrical test work and, therefore, are under the supervision of a qualified person, need comply with this code only insofar as is practicable for the character of the testing done.

F. *Emergency.* In case of emergency or pending decision of the administrator, the person responsible for the installation may decide as to modification or waiver of any order, subject to review by proper authority.

SECTION 102. DEFINITIONS OF SPECIAL TERMS

Order 1020. Definitions.

The following is a list of terms which it was deemed advisable to define. Terms defined only in Volume 1 are indicated. Terms not defined will be understood to have their customary meaning.

(1) *Accessible* (as applied to wiring methods) means not permanently closed in by the structure or finish of the building, capable of being removed without disturbing the building structure or finish; (as applied to equipment) admitting close approach because not guarded by locked doors, elevation or other effective means. (See also "Readily Accessible.")

(2) *Administrative Authority* means the Industrial and/or the Public Service Commissions.

(3) *Adjustable-Speed Motor* means one in which the speed can be varied gradually over a considerable range, but when once adjusted remains practically unaffected by the load, such as shunt motors designed for a variation of field strength.

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

(5) *Antenna Conflict.* See Volume 1.

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

(7) *Approved* means acceptable to the administrative authority enforcing this code. (See order 1011).

(8) *Armored Cable* means flexible metallic tubing in which the conductors have been inserted in the process of manufacture.

(9) *Authority.* See Administrative Authority.

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

(11) *Automatic Fire Door* means one which closes automatically by means of a device operated by heat.

(12) *Branch Circuit* means that portion of a wiring system extending beyond the final automatic overcurrent protective device of the circuit.

A device not approved for branch circuit protection, such as a thermal cutout or motor overload protective device, is not considered as the overcurrent device protecting the circuit.

(13) *Building* means a structure which stands alone or which is cut off from adjoining structures by unpierced fire walls. (See Building Code).

(14) *Cabinet* means an enclosure designed either for surface or flush mounting, and provided with a frame, matt or trim in which swinging or sliding doors are placed. (See cutout box).

(15) *Cable* means a combination of conductors which are bound together and insulated from each other. It also includes single conductors having the same insulation and outside protective covering as commonly used in multi-conductor cables.

(16) *Cable Vault.* See Manhole.

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

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

(19) *Climbing Space.* See Volume 1.

(20) *Common Use.* See Volume 1.

(21) *Communication Lines.* See Volume 1.

(22) *Concealed* means rendered inaccessible by the structure or finish of the building. Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them.

(23) A. *Conductor* means a metallic conducting material, usually in the form of a wire or cable, suitable for carrying an electric current.

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

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

D. *Line Conductor* means one of the wires or cables carrying electric current, supported by poles, towers, or other structures, but not including vertical or lateral connecting wires.

E. *Vertical Conductor* means, in pole wiring work, a wire or cable extending in an approximately vertical direction.

(24) *Conductor Conflict.* See Volume 1.

(25) A. *Conduit* means a tube or duct especially constructed for the purpose of enclosing electrical conductors.

B. *Rigid Steel Conduit* means a tubular raceway with threaded ends, for electric wires and cables, having a corrosion resistant coating on all surfaces, except threads, and a uniformly smooth interior coating of enamel or like material, made of mild steel pipe of circular cross section, having walls which in the various electrical trade sizes comply with the measurements and weights set forth in Order 13-93461.

C. *Flexible Metallic Conduit* means a flexible raceway of circular cross section especially constructed for the purpose of permitting drawing in or withdrawing of wires and cables after the conduit and its fittings are in place, and is made of metal strip, usually of steel with metallic corrosion resistant coating, helically wound and with interlocking edges.

D. *Electrical Metallic Tubing* means a thin-walled steel raceway of circular cross-section, constructed for the purpose of pulling in or withdrawing wires after it is installed in place, coated inside and out to be corrosion resistant and connected by means of threadless fittings. The interior diameters should be the same as for the corresponding trade sizes of rigid conduit. See Article 13-348 and Order 13-93481.

(26) *Conflict.* See Volume 1.

(27) *Connector, Pressure* (Solderless) means a connector in which contact between the conductor and the connector is obtained without the use of solder by means of mechanically applied pressure.

(28) *Controller* means a device or group of devices, which serve to govern, in some predetermined manner, electrical power delivered to the device governed.

(29) *Current-carrying Part* means a conducting part intended to be connected in an electric circuit. Non-current-carrying parts are those not intended to be so connected.

(30) *Cutout Box* means an enclosure designed for surface or flush mounting and having swinging or sliding doors or covers secured directly to and telescoping with the walls of the box proper. (See Cabinet).

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

(32) *Demand Factor* of any system or part of a system means the ratio of the maximum demand of the system, or part of a system, to the total connected load of the system, or of the part of the system under consideration.

(33) *Device* means a unit of an electrical wiring system which is intended to carry but not consume electrical energy.

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

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

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

(36) *Dustproof* means so constructed or protected that an accumulation of dust will not interfere with its successful operation.

(37) *Dusttight* means so constructed that dust will not enter the enclosing case.

(38) *Duty*:

Continuous. Continuous duty is a requirement of service that demands operation at a substantially constant load for an indefinitely long time.

Intermittent. Intermittent duty is a requirement of service that demands operation for alternate intervals of (1) load and no load; or (2) load and rest; or (3) load, no load and rest.

(39) *Effectively Grounded.* See Grounded.

Periodic. Periodic duty is a type of intermittent duty in which the load conditions are regularly recurrent.

Short-Time. Short-time duty is a requirement of service that demands operation at a substantially constant load for a short and definitely specified time.

Varying. Varying duty is a requirement of service that demands operation at loads, and for intervals of time, both of which may be subject to wide variation.

See table in order 13-4312 for illustrations of various types of duty.

(40) *Electrical Metallic Tubing.* See Conduit.

(41) *Electrical Supply Equipment.* See Equipment.

(42) *Electrical Supply Lines.* See Lines.

(43) *Electrical Supply Station* means any building, room, or separate space within which electrical supply equipment is located and the interior of which is accessible, as a rule, only to properly qualified persons.

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

(44) *Electric Sign* means a fixed or portable, self-contained electrically illuminated appliance with words or symbols designed to convey information or attract attention.

(45) *Enclosed* means surrounded by a case which will prevent accidental contact of a person with live parts. A solid enclosure means one which will neither admit accumulation of flyings or dust nor transmit spark or flying particles to the accumulations outside.

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

B. *Electrical Supply Equipment* means equipment which produces, modifies, regulates, controls, or safeguards a supply of electrical energy.

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

(47) *Explosion-proof* means enclosed in a case which is designed and constructed to withstand an explosion of a specified gas or dust which may occur within it, and to prevent the ignition of the specified gas or dust surrounding the enclosure, by sparks, flashes or explosions of the specified gas or dust which may occur within the enclosure.

(48) *Exposed* (A) (applied to circuits or lines) means in such a position that in case of failure of supports or insulation contact with another circuit or line may result.

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

(49) *Externally Operable* means capable of being operated without exposing the operator to contact with live parts. (This term is applied to equipment, such as a switch, that is enclosed in a case or a cabinet).

(50) *Factory Yard* means a plot containing an assemblage of buildings served by an isolated plant, or by a substation, or by a master service, and permitting access from building to building within the yard.

(51) *Feeder* means any conductors of a wiring system between the service equipment, or the generator switchboard of an isolated plant, and the branch circuit over-current device.

(52) *Fitting* means an accessory such as a locknut, bushing or other part of a wiring system which is intended primarily to perform a mechanical rather than an electrical function.

(53) *Flexible Metallic Tubing.* See Conduit.

(54) A. *Garage* means a building or portion of a building in which one or more self-propelled vehicles carrying volatile, flammable liquid for fuel or power are kept for use, sale, storage, rental, repair, exhibition or demonstrating purposes, and all that portion of a building which is on or below the floor or floors on which such vehicles are kept and which is not separated therefrom by tight, unpierced fire walls and fire-resistive floors.

B. *Commercial (Public) Garage* means any building where self-propelled vehicles are sold or serviced, or where three or more such vehicles are stored or serviced for hire or for commercial use.

(55) *General-use Switch*: See Switch.

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

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

C. *Grounded System* means a system of conductors in which at least one conductor or point (usually the middle wire, or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through a current limiting device. This ground connection may be at one or more points.

(57) *Grounding Conductor*. See Conductor.

(58) *Guarded* means covered, shielded, enclosed, or otherwise protected, by means of suitable covers, casings, barrier rails or screens, or by means of mats, or platforms, to remove the liability of dangerous contact or approach by persons or objects to a point of danger. Wires, which are insulated, but not otherwise protected, are not considered as guarded. (See Definition of Insulated).

(59) *Guard Zone*. See Volume 1.

(60) *Handhole*. See Volume 1.

(61) *Hazardous Locations* mean premises, locations, rooms or portions thereof in which (1) highly flammable gases, flammable volatile liquids, mixtures or other highly flammable substances are manufactured or used or are stored in other than original containers; or (2) where combustible dust or flyings are likely to be present in quantities sufficient to produce an explosive or combustible mixture; or (3) where it is impracticable to prevent dust from collecting in such quantities on or in motors, lamps or other electrical devices that they are likely to become overheated because normal radiation is prevented; or (4) where easily ignitible fibres or materials producing combustible flyings are handled, manufactured, stored or used.

(62) *Hoistway* means any shaftway, hatchway, wellhole, or other vertical opening or space in which an elevator or dumbwaiter is designed to operate.

(63) *Inclosed*. See Enclosed.

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

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

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

(66) *Isolated* means that an object is not readily accessible to persons unless special means for access are used. (See definition of exposed).

(67) *Isolated Plant* means a private electrical installation deriving energy from its own generator driven by a prime mover.

(68) *Isolating Switch*. See switch.

(69) *Isolation by Elevation* means elevated sufficiently so that persons may safely walk underneath. (See definition of exposed)

(70) *Joint Use* means simultaneous use by two or more kinds of utilities.

(71) *Lateral Conductor*. See Conductor.

(72) *Lateral Working Space*. See Volume 1.

(73) *Lighting Outlet* means an outlet intended for the direct connection of a lampholder, a lighting fixture or a pendent cord terminating in a lampholder.

(74) *Lightning Arrester* as applied to Supply Circuits means a device which has the property of reducing the voltage of a surge applied to its terminals, is capable of interrupting follow current if present, and restores itself to its original operating condition.

(75) *Line Conductor*. See Conductor.

(76) *Lines*. See Volume 1.

(77) *Location*:

Dry Location means a location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.

Damp Location means a location subject to a moderate degree of moisture, such as some basements, some barns, some cold storage warehouses, and the like.

Wet Location means a location subject to saturation with water or other liquids, such as locations exposed to the weather, wash rooms in garages, and like locations. Installations underground or in concrete slabs or masonry in direct contact with the earth, shall be considered as wet locations.

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

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

(80) *Manhole.* See Volume 1.

(81) *Manual* means capable of being operated by personal intervention.

(82) *Master Service* means the service conductors and service equipment supplying a group of buildings under one management.

(83) *Minor Communication Lines.* See Volume 1.

(84) *Motion Picture Studio* means any building or portion of a building in which motion picture films are manufactured, developed, printed, rewound, repaired, stored or otherwise exposed.

(85) *Motor Circuit Switch.* See Switch.

(86) *Movable Equipment* means electrical apparatus which is heavier than portable equipment as defined below, but which, nevertheless, is designed to be transported from place to place for use; equipment which is stationary when in use, but is designed for being transported from job to job. (See Definition of Portable Appliance).

(87) *Multi-outlet Assembly* means a type of surface metal raceway, designed to hold conductors and plug receptacles, assembled in the field or at the factory.

(87) *New Construction* means all new electrical installations and all extensions and renewals which constitute a substantial portion of the installation.

(89) *Open Wire.* See Volume 1.

(90) *Outlet* means a point on the wiring system at which current is taken to supply fixtures, lamps, heaters, motors and current-consuming devices generally.

(91) *Outline Lighting* means an arrangement of incandescent lamps or gaseous tubes to outline and call attention to certain features such as the shape of a building or the decoration of a window.

(92) *Panelboard* means a single panel, or group of panel units designed for assembly in the form of a single panel, including busses and with or without switches and/or automatic overload protective devices for the control of light, heat, or power circuits of small individual as well as aggregate capacity designed to be placed in a cabinet or cutout box placed in or against a wall, or partition, and accessible only from the front. (See Definition of Switchboard).

(93) *Permanently Grounded.* See Grounded, Effectively.

(94) *Pole Face.* See Volume 1.

(95) *Portable Appliance* means an appliance capable of being readily moved where established practice or the conditions of use make it necessary or convenient for it to be detached from its source of current by means of flexible cord and attachment plug. This includes apparatus which can be easily moved about or lifted and is intended to be so handled when in use.

(96) *Qualified* means familiar with the construction and operation of the apparatus and the hazards involved. Responsibility for the decision as to the qualifications of the employees rests with the employer or his agent.

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

(98) *Raintight* means so constructed or protected that exposure to a beating rain will not result in the entrance of water.

(99) *Rating*:

A. (*Of Fuse*). The current rating of a fuse is a designated value of current in amperes marked on the fuse.

B. (*Of Circuit-Breaker*). The current rating of a circuit-breaker is the current value in amperes marked on the breaker.

(100) *Readily Accessible* means capable of being reached quickly, for operation, renewal or inspection, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc.

(101) *Receptacle Outlet* means an outlet equipped with one or more receptacles, not of the screw-shell type, or provided with one or more points of attachment within one foot or less, intended to receive attachment plug caps.

(102) *Reconstruction* means replacement of a substantial portion of an existing installation by new equipment or construction. Does not include ordinary maintenance replacements.

(103) *Rural Districts.* See Volume 1.

(104) *Sag.* See Volume 1.

(105) *Sealable Equipment* means equipment enclosed in a case or cabinet that is provided with means for sealing or locking so that live parts cannot be made accessible without opening the enclosure. The equipment may or may not be operable without opening the enclosure.

(106) *Service.* A. Service means the conductors and equipment for delivering electric energy from the secondary distribution or street main or other distribution feeder, or from the transformer, to the wiring system of the premises served.

B. *Service Cable* means conductors made up in the form of a cable.

C. *Service Conductors* means that portion of the supply conductors which extends from the street main or duct or from transformers to the service equipment of the building supplied.

D. *Service Drop* means that portion of overhead service conductors between the pole and the first point of attachment to the building.

E. *Service Entrance Conductors* means that portion of service conductors between the terminals of service equipment and a point outside

the building, clear of building walls, where joined by tap or splice to the service drop or to street mains or other source of supply.

Where service equipment is located outside the building walls, there may be no service entrance conductors, or they may be entirely outside the building.

F. *Service Equipment* means the necessary equipment, usually consisting of circuit-breaker or switch and fuses, and their accessories, located near point of entrance of supply conductors to a building and intended to constitute the main control and means of cutoff for the supply to that building.

G. *Service Raceway* means the rigid steel conduit or electrical metallic tubing or other raceway that encloses service entrance conductors.

H. *Service Pipe* means conduit or pipe that contains underground service conductors and extends from the junction with outside supply wires into the consumers premises.

(107) *Shall* is used to indicate requirements.

(108) *Should* is used to indicate recommendations, or that which is advised but not required. In general, recommendations have the form of fine-print notes or paragraphs supplementing the preceding text.

(109) *Span Length.* See Volume 1.

(110) *Special Permission* means the written consent of the Industrial or Public Service Commission.

(111) *Structure Conflict.* See Volume 1.

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

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

A. *General-Use Switch* means a switch intended for use as a switch in general distribution and branch circuits. It is rated in amperes and is capable of interrupting its rated current at its rated voltage.

B. *Isolating Switch* means a switch intended for isolating a circuit from its source of power. It is to be operated only when the circuit has been opened by some other means.

C. *Motor-Circuit Switch* means a switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower as the switch at the rated voltage.

(114) *Switchboard* (Supply Station Switchboard) means a large single panel, frame, or assembly of panels, on which are mounted, on the face or back or both, switches, overload and other protective devices, busses, and usually instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. (See Panelboard).

(115) *Tags* mean tags or other markers of distinctive appearance, indicating that men are at work on the equipment or lines so designated.

(116) *Tension.* See Volume 1.

(117) *Totally Enclosed Motor* means a motor which is so completely enclosed by integral or auxiliary covers as to practically prevent the circulation of air through the interior. Such a motor is not necessarily air-tight.

(118) *Transformer Vault* means an isolated fire-resistant enclosure, either above or below ground, in which transformers and related equipment are installed and which is not continuously attended during operation.

(119) *Urban Districts* mean thickly settled areas, whether inside city limits or not.

(120) *Utilization Equipment.* See Equipment.

(121) *Vapor-tight* means so enclosed that vapor will not enter the enclosure.

(122) *Ventilated:* Provided with a means to permit circulation of the air sufficiently to remove an excess of heat, fumes or vapors.

(123) *Vertical Conductor.* See Conductor.

(124) *Voltage* (of a circuit) means the greatest effective difference of potential between any two conductors of the circuit concerned.

(to ground) in grounded circuits means the voltage between the given conductor and that point or conductor of the circuit which is grounded; in ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit.

Where one circuit is directly connected to another circuit of higher voltage (as in the case of auto transformers) both are considered of the higher voltage, unless the circuit of lower voltage is effectively grounded.

When the term "volts" or "voltage" is used without qualification in Volume 1 it means the voltage between conductors if no grounded conductor capable of carrying load is present. If such a grounded conductor is present, "volts" or "voltage" means volts to ground.

(125) *Waterproof* means so constructed or protected that moisture will not interfere with its successful operation.

(126) *Watertight* means so constructed that moisture will not enter the enclosing case.

(127) *Weatherproof* as applied to the protective covering on conductors means a covering made up of braids of fibrous material which are thoroughly saturated with a dense moisture-proof compound after they have been placed on the conductor or an equivalent protective covering designed to withstand weather conditions.

Weatherproof as applied to exterior installations means so constructed or protected that the weather will not interfere with successful operation.

(128) *Wire Gauges.* The American Wire Gauge (A.W.G.), otherwise known as Brown & Shape (B.&S.), is the standard gauge for copper, aluminum, and other conductors, excepting steel, for which the steel wire gauge (Stl.W.G.), is used throughout this code.

PART 3

ELECTRICAL AND COMMUNICATION EQUIPMENT AND WIRING INCLUDING GROUNDING

Chapter 1. General

SECTION 13-00—SCOPE OF ORDERS

In Part 3, the National Electrical Code has generally been followed. The number of the National Electrical Code rule corresponding to any order in this part may be determined by dropping the first two digits and the hyphen. In a few cases the orders differ from the wording of the National Electrical Code rule.

Note a. Throughout this part of the code are paragraphs which state only fundamentals or objectives of safeguarding. These are followed by paragraphs setting forth the recognized methods and detail by which the purpose and intent of the fundamental may be satisfied. Accordingly, when employed, the rules stating a fundamental only will appear as the first paragraph of a section or order.

Note b. The first four chapters of Part 3 are of general application to the equipment not exempted by Order 13-0001. Chapters 5, 6, and 7 apply to installations which involve special occupancies, special equipment or other special conditions. These chapters are supplementary to, or amendatory of, the general orders, and the latter apply under such circumstances except as so amended for the particular conditions. Chapter 8 governs installations of communication systems, and is independent of the preceding chapters except as they may be specifically referred to. Chapter 9 covers construction specifications. The larger tables, examples and the diagrams are collected in Chapter 10.

Order 13-0001. Application of Orders.

A. *General.* 1. Except as otherwise specified hereafter, the following orders, Chapters 1 to 10 inclusive, which have for their purpose the practical safeguarding of persons and buildings and their contents from electrical hazards arising from the use of electricity, apply to the electric and communication conductors and equipment installed within or on public and private buildings and other premises, including yards, carnival and parking lots, and industrial substations; also the conductors that connect the installations to a supply of electricity, and other outside conductors adjacent to the premises.

2. These orders do not apply to installations in ships, aircraft, railway cars or automotive equipment.

3. These orders do not apply to installations employed by a railway, electric or communication utility in the exercise of its function as a utility where the installations are located outdoors or in

quarters used exclusively for that purpose, but they do apply to wires used in such quarters to distribute a power supply for lighting, service outlets, and other utilization equipment.

4. Chapter 8 governs the installation of communication systems and certain control systems carrying small currents and voltages within the limits described therein. No other chapters of Part 3 apply to such installations, except as they may be specifically referred to in Chapter 8.

Note a. The provisions of this Code constitute a minimum standard. Compliance therewith and proper maintenance will result in an installation reasonably free from hazard but not necessarily efficient or convenient. This Code is to be regarded neither as a design specification nor an instruction manual for untrained persons. Good service and satisfactory results will often require larger sizes of wire, more branch circuits, and better types of equipment than the minimum which is here specified.

Note b. It is recommended that architects, when drawing plans and specifications, make provision for ample raceways for wiring, spaces for equipment, and allowances for future increases in the use of electricity. In laying out an installation for constant-potential systems, provision should be made for distribution centers located in easily accessible places for convenience and safety of operation.

Note c. It is elsewhere provided in this Code that the number of wires and circuits confined in a single enclosure be varyingly restricted. It is strongly recommended that architects and others provide similar restrictions wherever practicable, to the end that the effects of breakdowns from short-circuits or grounds, even though resulting fire and similar damage is confined to wires, their insulation and enclosures, may not involve entire services to premises nor interruptions of essential and independent services.

B. *Equipment of More than 600 Volts.* 1. All electrical equipment and conductors of more than 600 volts shall comply with the orders applying to electrical supply stations, Part 1. (See Order 1100).

2. If such equipment and conductors are installed in supply stations or other quarters accessible only to qualified persons, they need not comply with the orders of Part 3, but only with the orders of Part 1.

3. If such equipment and conductors are not installed in supply stations or other quarters accessible only to qualified persons, they shall comply with the orders of Part 3 for equipment of over 600 volts (See Section 13-710) and also with the orders of Part 1. In addition, all current-carrying parts shall be either incased in effectively grounded metal cases or conduit, or otherwise suitably guarded to prevent access (or too close approach) to such current-carrying parts by any but qualified persons.

C. *Equipment Accessible to Qualified Persons Only.* Electrical equipment and conductors, if installed in supply stations or other quarters accessible only to qualified persons, may be installed in conformity with the orders applying to electrical supply stations (Part 1), in which case only wiring used to distribute a power supply for lighting, service outlets and other utilization equipment need comply with the orders of Part 3. (See Order 1100).

SECTION 13-100. DEFINITIONS

The "definitions" will be found in Order 1020, Introductory Part.

SECTION 13-110. GENERAL

Order 13-1101. Approval.

The conductors and equipment required or permitted by this Code shall be acceptable only if approved. See definition of "Approved" in Order 1020.

Order 13-1102. Wiring Methods.

(a) Only wiring methods recognized as suitable are included in this Code. Special types of wiring may be used only where recognized as suitable under this and other sections of this Code. The recognized methods of wiring may be installed in any type of building or occupancy except as otherwise provided in this Code.

(b) All conductors shall be guarded in an approved manner when brought closer to floor or platform than 7 feet, or when exposed to mechanical injury above that level.

Exception: Trolley conductors, grounding conductors size No. 4 or larger, lightning arrester ground conductors, pendants and portable cords are exempt from this order.

(c) All conductors for light, heat or power for interior wiring systems in schools, theaters, assembly halls, hotels, hospitals, public garages, as well as apartments and office buildings of fire-proof construction, shall be guarded by enclosure in rigid or flexible conduit, electrical metallic tubing, armored cable, surface metal raceways or other approved raceways.

Exception: (1) Wiring for lighting purposes, except lightning arrester ground conductors, in schools and assembly halls of frame construction may be of concealed knob and tube construction or non-metallic sheathed cable when protected against mechanical injury.

(2) Pendants and portable cords are exempt from this order.

Note: (1) The Wisconsin State Building Code defines assembly halls as including all buildings or parts of buildings not included under theaters where 100 or more persons assemble for entertainment, instruction, worship or dining purposes.

(2) Communication equipment, connected to communication lines and all other communication, signal and low voltage (not over 30 volts) control systems, radio apparatus and similar apparatus are exempted except from Section 13-800. (This includes radio and public address systems.)

(d) Bus-bars and other open bare ungrounded conductors which are elevated less than eight feet above floor or platform, shall be enclosed by suitable guards.

Order 13-1103. Mandatory and Advisory Rules.

Mandatory rules of this Code are characterized by the use of the word "shall." Advisory rules are characterized by the use of the word "should," or are stated as recommendations of that which is advised but not required.

Order 13-1104. Special Chapters Amendatory of General Rules.

The provisions of Chapters 5, 6 and 7 of this Code are supplementary to, or amendatory of, the general provisions of Chapters 1 to 4, inclusive, and the latter apply under such circumstances except as so amended for particular conditions.

Order 13-1105. Mechanical Execution of Work.

Electrical equipment shall be installed in a neat and workmanlike manner and all unnecessary and complicated wiring avoided where practicable. Conductors, raceways, and equipment shall be carefully secured in place and attached to fittings.

Order 13-1106. Mounting of Equipment.

Electrical equipment shall be firmly secured to the surface on which it is mounted. Wooden plugs driven into holes in masonry, concrete, plaster or similar materials shall not be depended on for security.

Order 13-1107. Voltages.

Throughout this Code the voltage considered shall be that at which the circuit operates, whether the current is supplied by a battery, generator, transformer or rectifier.

Order 13-1108. Conductor Gauges.

Conductor sizes are given in American Wire Gauge (AWG).

Order 13-1109. Copper Conductors.

Where conductor sizes are given in this Code they shall apply to copper conductors of 98 per cent conductivity. If other materials are used the size shall be changed accordingly. See order 13-3006.

Order 13-1110. Light and Power from Railway Conductors.

Circuits for lighting and power shall not be connected to any system containing trolley wires with a ground return, except in electric railway cars, car houses, power houses, or passenger and freight stations operated in connection with electric railways.

Order 13-1111. Working Space About Electrical Equipment.

Suitable working space shall be provided and maintained about all electrical equipment.

A. *Horizontal Dimensions.* Except as elsewhere required or permitted in this Code, the horizontal dimensions of the working space in front of live parts, operating at not more than 600 volts, which must be handled while alive, shall not be less than:

1. For parts of more than 150 volts to ground on one side of the working space and no bare live or grounded parts on the other side of the working space, 2½ feet.

2. For parts of more than 150 volts to ground on one side of the working space and bare live or grounded parts on the other side of the working space, 4 feet.

3. For parts of 150 volts or less to ground on one side of the working space and no bare live or grounded parts on the other side of the working space, 1½ feet.

4. For parts of 150 volts or less to ground on one side of the working space and bare live or grounded parts on the other side of the working space, 2½ feet.

For higher voltages, see Section 13-710.

B. *Clear Spaces.* Working spaces adjacent to exposed live parts shall not be used as passageways.

C. *Elevation of Equipment.* The elevation of the equipment at least 8 feet above ordinarily accessible working platforms usually affords protection at least equivalent to that provided by the horizontal clearances of paragraph A and may be used in lieu thereof.

Order 13-1112. Guarding of Live Parts.

Except as elsewhere required or permitted by this Code, exposed live parts of electrical equipment operating at 50 volts or more shall be guarded against accidental contact by enclosure or by locating the equipment as follows:

A. In a room or enclosure which is accessible only to qualified persons;

B. On a suitable balcony, gallery, or platform, so elevated and arranged as to exclude unqualified persons;

C. Elevated 8 feet or more above the floor;

D. So that it will be protected by a guard rail if the equipment operates at 100 volts or less.

For motors see order 13-4432.

Order 13-1113. Enclosure of Arcing Parts.

Parts of electrical equipment, other than motors or generators, which in ordinary operation produce arcs, sparks, flames or molten metal, shall be enclosed unless separated and isolated from all combustible material. For hazardous locations see Section 13-500.

Order 13-1114. Interrupting Capacity.

Devices intended to break current shall have an interrupting capacity sufficient for the voltage employed and for the current which must be interrupted.

Order 13-1115. General Plans of Investigation.

Materials, devices, fittings, apparatus, and appliances designed for use under this Code shall be judged chiefly with reference to the following considerations which also determine the classification by types, sizes, voltages, current capacities, and specific uses:

A. Suitability for installation and use in conformity with the provisions of this Code.

B. Mechanical strength and durability, including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided.

C. Electrical insulation.

D. Heating effects under normal conditions of use and also under abnormal conditions liable to arise in service.

E. Arcing effects.

Order 13-1116. Connections to Terminals.

Connection of conductors to terminal parts shall insure a thoroughly good connection without damaging the conductors and shall be made by means of pressure connectors (including set screw type), solder lugs, or splices to flexible leads either soldered, brazed or welded, except that No. 8 or smaller solid conductors and No. 10 or smaller stranded conductors may be connected by means of clamps or screws with terminal plates having upturned lugs. Terminals for more than one conductor shall be of a type approved for the purpose.

Order 13-1117. Marking.

The maker's name, trademark, or other identification symbol shall be placed on all electrical equipment. Other markings shall be provided giving voltage, current, wattage, or other ratings as are prescribed elsewhere in this Code.

Chapter 2. Wiring Design and Protection

SECTION 13-200. POLARITY IDENTIFICATION OF SYSTEMS AND CIRCUITS

Order 13-2001. General.

All interior wiring systems, except as provided in orders 13-2007, 13-2512, 13-2514, 13-2515, 13-2516 and 13-2517 shall have a grounded conductor which is continuously identified throughout the system, except as permitted by paragraph B of order 13-2005.

Order 13-2002. Connection to Grounded System.

No interior wiring shall be electrically connected to a supply system unless the latter contains, for any grounded conductor of the interior system, a corresponding conductor which is grounded.

Order 13-2003. Circuits Derived from Auto-Transformers.

Wiring systems and circuits derived from transformers in which part of the turns are common to both primary and secondary circuits, ordinarily known as auto-transformers, shall not be permitted for any interior wiring system unless the system supplied contains an identified grounded conductor which is solidly connected to a similar identified grounded conductor of the system supplying the auto-transformers. See order 13-4508 regarding use of auto-transformers.

Order 13-2004. Connections to Screw-Shells.

An identified conductor, if run to a lampholder, shall be connected to the screw-shell.

Order 13-2005. Means of Identification of Conductors.

Identification for conductors shall be secured as follows:

A. Insulated conductors of No. 6 or smaller, except conductors of the weatherproof type, shall have an outer identification as specified in paragraph C of order 13-93001.

B. Insulated conductors larger than No. 6, and weatherproof conductors of all sizes if used indoors, shall have an outer identification as specified in Paragraph C of order 13-93001, or shall be identified by distinctive marking at terminals during process of installation.

C. Flexible cords shall be identified as provided in order 13-4013.

D. Terminals of devices shall be identified as provided in order 13-2008.

Order 13-2006. Identified Conductor in Identified Circuits Only.

Conductors having white or natural gray covering shall not be used other than as conductors for which identification is required by order 13-2001, except under the following conditions:

A. Identified conductors, rendered permanently unidentified by painting or other effective means at each outlet where the conductors are visible and accessible, may be used as unidentified conductors.

The foregoing permits the use of two-wire cable having one black and one white conductor on 2-wire circuits tapped from the outside legs of a 3-wire system or any two conductors of a multiwire system if the identified conductor of the two-wire cable is rendered permanently unidentified at terminals.

B. Cable containing an identified conductor may be used for single-pole, three-way or four-way switch loops if the connections are so made that the unidentified conductor is the return conductor from the switch to the outlet.

This exception makes it unnecessary to paint the terminal of the identified conductor at the switch outlet.

Order 13-2007. Unidentified Circuits.

Two-wire branch circuits and multi-wire A.C. circuits may be tapped from the ungrounded conductors of circuits having identified grounded neutrals. Switching devices in such circuits shall have a pole in each ungrounded conductor, except as provided for motor controllers in order 13-4384. Polyphase circuits need not have one conductor grounded and identified, except as required by order 13-2514, but if one conductor is grounded it shall be identified. Other unidentified ungrounded systems or circuits may be used only by special permission.

Order 13-2008. Identification of Terminals.

All devices provided with terminals for the attachment of conductors and intended for connection to more than one side of the circuit shall, unless specifically excepted, have a pair of connecting terminals properly marked for identification, unless the electrical connection between the pair of terminals intended to be connected to the grounded conductor is clearly evident.

A. *Panelboards and Devices.* The terminals of lighting panelboards and of devices having a normal current rating of over 30 amperes need not be marked for identification, except as required in paragraphs E and F of this order for polarized receptacles for attachment plugs and polarized attachment plug caps.

B. *Utilization Appliances.* The terminals of utilization appliances need not be marked to indicate the proper connection to the grounded conductor. If the terminals of utilization appliances, of which single-pole switches form an integral part, are marked for identification, the terminal connected to the switch shall be the unidentified terminal.

C. *Portable Appliances.* The terminals of portable appliances need not be marked for identification.

D. *Single-pole Devices.* Devices, to the terminals of which only one side of the line is connected, need not have terminals marked for identification.

E. *Two-wire Receptacles and Caps.* Two-wire attachment plug receptacles without screw-shells, and two-wire attachment plug caps, unless of the polarity type, need not have their terminals marked for

identification. Two-wire polarized receptacles for attachment plugs and polarized attachment plug caps shall have the terminal intended for connection to the grounded conductor marked for identification.

F. *Three-wire Receptacles and Caps.* Three-wire attachment plug receptacles and three-wire attachment plug caps, in which one terminal may be used for the connection of a grounding conductor, shall have such terminal identified in a manner differing from that specified in order 13-2009. The other terminals need not be marked for identification.

G. *Screw-shells.* In the case of devices with screw-shells, the identified terminal shall be the one connected to the screw-shell. This does not apply to screw-shells which serve as fuseholders.

H. *Screw-shell Devices with Leads.* In the case of screw-shell devices with attached leads, the conductor attached to the screw-shell shall have white or natural gray finish. The outer finish of the other conductor shall be of a solid color that will not be confused with the white or natural gray finish which is to indicate the grounded conductor.

Order 13-2009. Means of Identification of Terminals.

The marking of terminals shall be done by means of a metallic plated coating substantially white in color, as nickel or zinc, or the terminals may be of material substantially white in color. The other terminals shall be of a readily distinguishable different color.

SECTION 13-210. BRANCH CIRCUITS
GENERAL

Order 13-2101. Scope.

The branch circuits referred to in this section may supply one or more lighting or appliance outlets, or combinations of such outlets, and shall conform to the provisions of orders 13-2102 to 13-2175, inclusive.

Order 13-2102. Branch Circuit Required.

Every lamp, motor or other appliance shall be supplied by a branch circuit conforming to the provisions of this section, or as otherwise specified in the references in the following table:

	Order
Cranes and Hoists	13-6142
Elevators	13-6251
Instruments	13-93843
Motors	13-4341 to 13-4349
Organs	13-6506
Outside Festoons	13-7344
Signal and Control Systems	13-8006
Signs and Outline Lighting	13-6007
Sound Recording and Reproduction	13-6406
Systems over 600 Volts	13-7141 to 13-7144
Systems under 50 Volts	13-7?04
Theaters and Similar Occupancies	13-5241, 13-5286 and 13-5292

Order 13-2103. Motors.

If motors, or motor operated appliances, are connected to any of the branch circuits described in this section, which also supply lighting or other appliance outlets, the provisions of this section and section 13-430 both shall apply.

Order 13-2104. Multi-Wire Branch Circuits.

Color Code. A multi-wire branch circuit as referred to in this section is a circuit consisting of two or more ungrounded conductors having a potential difference between them, and an identified grounded conductor having equal potential difference between it and each ungrounded conductor of the circuit and which is connected to the neutral conductor of the system. Branch circuits of any of the types recognized in this section may be installed as multi-wire circuits. If installed in raceways, as open work, or as concealed knob and tube work, the conductors of such multi-wire branch circuit shall conform to the following color-code.

Color-Code. Three-wire circuits—one black, one white, one red; 4-wire circuits—one black, one white, one red, one blue; 5-wire circuits—one black, one white, one red, one blue, one yellow. If more than one multi-wire branch circuit is carried through a single raceway the ungrounded conductors of the additional circuit may be of colors other than those specified. All circuit conductors of the same color shall be connected to the same ungrounded feeder conductor throughout the installation.

Note. Pursuant to Order 1001, during the war emergency and for a period of six months thereafter, unless otherwise amended or repealed, the color coding provisions of Order 13-2104 shall be recommendations and not mandatory requirements. This modification does not affect the requirement for identification of the grounded conductors.

Order 13-2105. Voltage.

Branch circuits of any of the types recognized in this section, supplying lampholders, fixtures or receptacles of the standard 15-ampere or less rating, shall not exceed 150 volts to ground. In dwelling occupancies, the voltage between conductors supplying lampholders of the screw-shell type, receptacles, or appliances, shall not exceed 150 volts, except that the voltage between conductors supplying permanently connected appliances or portable appliances of more than 1650 watts may exceed 150 volts if connected to receptacles of such design that attachment plugs used on circuits of other voltages cannot be inserted in them.

Exception 1. Where a supply system having a voltage higher than 150 volts to ground or a 250 volt system not designed for grounded operation has been the regular supply, the same system may be continued and extended unless major reconstruction is involved; and for railway properties, construction as permitted in Order 13-1110 will not be regarded as a violation of this order.

Exception 2. Branch circuits in industrial establishments which supply only lighting fixtures which are not less than 8 feet from the floor and which do not have switch control as an integral part of the fixture and branch circuits which supply only fixtures which do not incorporate Edison base lampholders are not included.

Order 13-2106. Taps.

Taps to individual lampholders or fixtures, and taps not over 18 inches long to individual outlets supplying lampholders or fixtures, may be of smaller size than the branch-circuit conductor, but not less than the size of tap specified for each type of branch circuit, provided the load does not exceed the carrying capacity of the conductor as in Tables 1 and 2 of Chapter 10.

Order 13-2107. Determination of Circuits.

The minimum number of branch circuits shall be determined from the total load as computed by order 13-2108 and the types of circuits to be used, but the number of branch circuits shall in every case be sufficient for the specific load to be served. The total load shall be evenly proportioned among the branch circuits according to the capacity of the circuits, in so far as practicable. If circuits supply continuous loads, such as store lighting and similar loads, the load shall not exceed 80 per cent of the branch circuit rating.

See Example No. 2, Chapter 10.

Order 13-2108. Calculation of Load.

In calculating the load on the basis of watts per square foot, the floor area shall be computed from the outside dimensions of the building, apartment, or area involved, and the number of floors, not including open porches, garages in connection with dwelling occupancies, nor unfinished spaces in basements or attics. The total computed load shall be the sum of the loads computed in accordance with the following:

A. *General Lighting.* For general illumination in the occupancies shown in the following table, a load of not less than the "watts per square foot" as specified for each occupancy shall be included for each square foot of floor area:

Occupancy	Watts Per Square Foot
Apartments and Multi-Family Dwellings*	2
Armories and Auditoriums	1
Banks	2
Churches	1
Clubs*	2
Dwellings, Single-Family*†	2
Hospitals	2
Hotels*	2
Office Buildings	2
Restaurants	2
Schools	3
Stores	3
In any of the above listed occupancies, except single-family dwellings and individual apartments of multi-family dwellings:	
Assembly Halls and Auditoriums	1
Hallways, Corridors and Closets	½
Storage Spaces	¼

*It is recommended that in occupancies used for dwelling purposes, in addition to any branch circuit supplying appliances, a 15-ampere branch circuit be installed for each 500 square feet (approximately 3 watts per square foot) of floor area.

†In a single-family dwelling with a floor area of 500 square feet or less, the lighting load may be determined as specified in sub-paragraph D of this order.

For general illumination in occupancies not listed above, the load shall be computed in accordance with the provisions of sub-paragraph D of this order.

B. *Show-Window Lighting.* For show-window illumination, a load of not less than 200 watts shall be included for each linear foot of show-window, measured horizontally along its base.

C. *Small Appliances.* For small appliances, an additional load of not less than 1,500 watts shall be included for dining room, kitchen and laundry purposes in single-family dwellings, for individual apartments of multi-family dwellings having provisions for cooking by tenants, and in each hotel suite having a serving pantry; except that in single-family dwellings with a floor area of less than 1,000 square feet, the additional load may be 1,000 watts. For small appliances in other occupancies, see sub-paragraph D.

Order 13-2109 specifies that branch circuits supplying outlets in kitchen, laundry, pantry, dining room and breakfast room shall not supply other outlets. (For determination of circuits, see Examples 1 and 3, Chapter 10).

D. *Other Loads and Other Occupancies.* For other occupancies and for special lighting and appliance loads, capacity shall be included for the specific load to be served, but a load not less than specified below shall be included for each outlet:

Outlets supplying fixed appliances or special appliances	Amp. rating of appliance
Outlets supplying heavy-duty lampholders	6 amperes
Other outlets	1½ amperes

E. *Exceptions.* The minimum loads for outlets specified in sub-paragraph D shall be modified as follows:

1. Multi-Outlet Assemblies. Where fixed multi-outlet assemblies are employed, each five feet or fraction thereof of each separate and continuous length shall be considered as one outlet of not less than 1½ ampere capacity; except in locations where a number of appliances are likely to be used simultaneously when each one foot or fraction thereof shall be considered as an outlet of not less than 1½ amperes.

Busways so designed that loads can be connected at any point shall be limited in length as provided for multi-outlet assemblies; except that under conditions of operation where the load will not exceed that permitted for a branch circuit, the authority enforcing this code may permit busways of greater length.

2. Telephone Exchanges. Shall be waived for manual switchboards and switching frames in telephone exchanges.

F. *Existing Installations.* Additions to existing installations shall conform to the following:

1. Dwelling Occupancies. New circuits or extensions to existing circuits may be determined in accordance with sub-paragraph A or D of this order; except that portions of existing structures not previously wired, or additions to the building structure, either of which exceeds 500 square feet in area, shall be determined in accordance with sub-paragraph A of this order.

2. Other Than Dwelling Occupancies. When adding new circuits, or extensions to existing circuits, in other than dwelling occupancies, the provisions of sub-paragraphs A or D of this order shall apply.

Order 13-2109. Receptacle Circuits in Dwellings.

In dwelling occupancies, branch circuits which supply receptacle outlets in kitchen, laundry, pantry, dining room, and breakfast room, shall not supply other outlets, and such circuits shall have conductors not smaller than No. 12.

This does not apply to receptacles located more than 6 feet above the floor.

Order 13-2110. Receptacle Outlets.

In new buildings receptacle outlets shall be installed in every kitchen, dining room, breakfast room, living room, parlor, library, den, sun room, recreation room and bedroom. One receptacle outlet shall be provided for every 20 linear feet or major fraction thereof of the total (gross) distance around the room as measured horizontally along the wall at the floor line. The receptacle outlets shall, in so far as practicable, be spaced equal distances apart. At least one receptacle outlet shall be installed for the connection of laundry appliances. This order may be waived in the case of an old building where a large number of receptacles indicated might not be justified.

See Example No. 1, Chapter 10.

Note. Floor receptacles to be counted in the total of the required number shall be near the wall.

Order 13-2111. Receptacles.

Receptacles shall conform to the following:

A. *Where Required.* Fixed receptacles shall be installed where portable cords are used, except where the attachment of flexible cords by other means is specifically permitted.

B. *Rating.* Receptacles shall have a rating of not less than the rating of the load served.

C. *Interchangeability.* Receptacles supplied by circuits of more than 150 volts between conductors shall be of such design that attachment plugs used on circuits of other voltages cannot be inserted in them. Plug-in connections, or other devices for supplying appliances or lampholders from busways of 20 amperes capacity or less, shall not be interchangeable with such devices for use on busways of larger capacity, unless overcurrent protection rated at not exceeding 15 amperes is provided as an integral part of the plug-in connection or other attachment device.

Order 13-2112. Heavy Duty-Lampholders.

Heavy-duty lampholders as referred to in this section shall include lampholders of the mogul type, a lampholder of the medium-base type which is an integral part of a single lighting unit having also a heavy-duty lampholder, and other lampholding devices required for lamps exceeding the maximum rating of the medium-base lamp as provided in order 13-94201.

Order 13-2113. Classification.

Branch circuits recognized by this section shall be classified in accordance with the maximum permitted rating or setting of the overcurrent device as provided herein. When conductors of larger size than specified are used to provide for voltage drop, the specified rating or setting of the overcurrent device shall determine the circuit classification.

15-AMPERE BRANCH CIRCUIT

Order 13-2121. Scope.

In addition to the foregoing general requirements, the 15-ampere branch circuit shall conform to the provisions of orders 13-2122 to 13-2125 inclusive.

Order 13-2122. Conductors.

Conductors shall not be smaller than No. 14.

Order 13-2123. Overcurrent Protection.

Overcurrent devices shall have a rating or setting not exceeding 15 amperes.

Order 13-2124. Maximum Load.

The total load shall not exceed 15 amperes.

Order 13-2125. Permissible Load.

A 15-ampere branch circuit may supply only:

A. Lampholders. Permanently connected lampholders of all types.

B. Receptacles. Receptacles rated at not more than 15 amperes supplying:

1. Lampholders of all types.
2. Appliances with individual rating of not more than 12 amperes.

C. Fixed Appliances. Fixed appliances with a total rating of not more than:

1. Six amperes, if the circuit also supplies lampholders or portable appliances.
2. Twelve amperes, if the circuit supplies motor-operated appliances.
3. Fifteen amperes, if the circuit supplies only fixed appliances other than motor-operated appliances.

20-AMPERE BRANCH CIRCUIT

Order 13-2131. Scope.

In addition to the foregoing general requirements, the 20-ampere branch circuit shall conform to the provisions of orders 13-2132 to 13-2135 inclusive.

Order 13-2132. Conductors.

Conductors shall have a carrying-capacity of not less than 20 amperes, except that taps as provided in order 13-2106 may be of No. 14.

Order 13-2133. Overcurrent Protection.

Overcurrent devices shall have a rating or setting of not exceeding 20 amperes.

Order 13-2134. Maximum Load.

The total load shall not exceed 20 amperes.

Order 13-2135. Permissible Load.

A 20-ampere circuit may supply only:

A. *Lampholders.* Permanently connected heavy-duty lampholders, or a medium-base lampholder of the porcelain keyless type which is part of a lighting unit connected directly with the permanent wiring and controlled by a switch.

B. *Receptacles.* Receptacles rated at not less than 15 amperes supplying:

1. Lampholders of heavy-duty type.
2. Appliances with individual rating of not more than 15 amperes.

C. *Fixed Appliances.* Fixed appliances with a total rating of not more than:

1. Fifteen amperes, if the circuit also supplies lampholders or portable appliances.
2. Fifteen amperes, if the circuit supplies motor-operated appliances.
3. Twenty amperes, if the circuit supplies only fixed appliances other than motor-operated appliances.

25-AMPERE BRANCH CIRCUIT

Order 13-2141. Scope.

In addition to the foregoing general requirements, the 25-ampere branch circuit shall conform to the provisions of orders 13-2142 to 13-2145 inclusive.

Order 13-2142. Conductors.

Conductors shall have a carrying-capacity of not less than 25 amperes, except that taps as provided in order 13-2106 may be of less capacity but not smaller than No. 14.

Order 13-2143. Overcurrent Protection.

Overcurrent devices shall have a rating or setting not exceeding 25 amperes.

Order 13-2144. Maximum Load.

The total load shall not exceed 25 amperes.

Order 13-2145. Permissible Load.

A 25-ampere branch circuit may supply only:

A. Lampholders. Permanently connected heavy-duty lampholders.

B. Receptacles. Receptacles rated at not less than 20 amperes supplying:

1. Lampholders of heavy-duty type.
2. Appliances with individual rating of not more than 20 amperes.

C. Fixed Appliances. Fixed appliances with a total rating of not more than:

1. Twenty amperes, if the circuit also supplies lampholders or portable appliances.
2. Twenty amperes, if the circuit supplies motor-operated appliances.
3. Twenty-five amperes, if the circuit supplies only fixed appliances other than motor-operated appliances.

35-AMPERE BRANCH CIRCUIT

Order 13-2151. Scope.

In addition to the foregoing general requirements, the 35-ampere branch circuit shall conform to the provisions of orders 13-2152 to 13-2155 inclusive; and shall not be used in dwelling occupancies to supply lampholders, nor to supply portable appliances in any occupancy.

For portable appliances rated in excess of 20 amperes see "Individual Branch Circuits."

Order 13-2152. Conductors.

Conductors shall have a carrying capacity of not less than 35 amperes, except that taps as provided in order 13-2106 may be of less capacity but not smaller than No. 14.

Order 13-2153. Overcurrent Protection.

Overcurrent devices shall have a rating or setting not exceeding 35 amperes.

Order 13-2154. Maximum Load.

The total load shall not exceed 35 amperes.

Order 13-2155. Permissible Load. (See order 13-2151).

A 35-ampere branch circuit may supply only:

A. Lampholders. Permanently connected heavy-duty lampholders in other than dwelling occupancies.

B. Receptacles. Receptacles rated at not less than 30 amperes supplying:

1. Lampholders of the heavy-duty type in other than dwelling occupancies.
2. Appliances other than portable.

C. Fixed Appliances. Fixed appliances with a total rating of not more than:

1. Twenty-five amperes, if the circuit also supplies lampholders.

2. Twenty-five amperes, if the circuit supplies motor-operated appliances.

3. Thirty-five amperes, if the circuit supplies only fixed appliances other than motor-operated appliances.

50-AMPERE BRANCH CIRCUIT

Order 13-2161. Scope.

In addition to the foregoing general requirements, the 50-ampere branch circuit shall conform to the provisions of orders 13-2162 to 13-2165 inclusive. The 50-ampere branch circuit shall not be used to supply lampholders in dwelling occupancies, nor to supply portable appliances or combination lighting load and appliance load in any type occupancy.

For portable appliances rated in excess of 20 amperes see "Individual Branch Circuits."

Order 13-2162. Conductors.

Conductors shall have a carrying capacity of not less than 50 amperes, except that taps as provided in order 13-2106 may be of less capacity but not smaller than No. 12.

Order 13-2163. Overcurrent Protection.

Overcurrent devices shall have a rating or setting not exceeding 50 amperes.

Order 13-2164. Maximum Load.

The total load shall not exceed 50 amperes.

Order 13-2165. Permissible Load. (See order 13-2161).

A 50-ampere branch circuit may supply only:

A. Lampholders. Permanently connected heavy-duty lampholders in other than dwelling occupancies.

B. Receptacles. Receptacles rated at not less than 50 amperes supplying:

1. Lampholders of the heavy-duty type in other than dwelling occupancies.

2. Cooking appliances other than portable.

C. Fixed Appliances. A group of fixed cooking appliances, or a fixed range and water heater, with a total rating of not more than 50 amperes.

The demand factor for a single range in Table 29 of Chapter 10 may be applied to the range load when computing the total rating of range and water heater.

INDIVIDUAL BRANCH CIRCUIT

Order 13-2171. Scope.

In addition to the foregoing general requirements, the individual branch circuits, except branch circuits supplying motors and motor-operated appliances, shall conform to the provisions of orders 13-2172 to 13-2175 inclusive, and shall be used to supply only a single outlet or appliance. For motors, see section 13-430.

Order 13-2172. Conductors

Conductors shall have a carrying capacity sufficient for the load which they supply. Where such a circuit is to supply an electric range, the rating of which is not definitely known, it is recommended that the conductors shall be at least two No. 6 conductors and one No. 8 conductor.

Order 13-2173. Overcurrent Protection.

Overcurrent devices shall have a rating or setting not in excess of the carrying capacity of the conductors of the circuit and not exceeding 150 per cent of the rating of the appliance.

Order 13-2174. Maximum Load.

The load shall not be limited. If an individual branch circuit supplies a range, hot plate, or similar appliance with surface heating elements, having a rating of more than 70 amperes, the appliance shall have sub-divided circuits each provided with overcurrent protection not exceeding 50 amperes.

Order 13-2175. Permissible Load.

An individual branch circuit may supply only:

A. Lampholders. A single lampholder or lighting fixture.

B. Receptacles. A receptacle supplying:

1. A single lampholder or lighting fixture.

2. A single appliance of any rating, except as limited in order 13-2174.

C. Fixed Appliances. A single fixed appliance of any rating, except as limited in order 13-2174.

SECTION 13-220—FEEDERS

Order 13-2201. Feeder Size.

Feeder conductors shall not be smaller than specified in Tables 1 and 2 of Chapter 10 for the computed feeder load as determined by order 13-2203. A 2-wire feeder supplying two or more 2-wire branch circuits, or a 3-wire feeder supplying in excess of two 2-wire branch circuits, or two or more 3-wire branch circuits, shall be not smaller than No. 10. If a feeder carries the total current supplied by the service entrance

conductors, such feeder shall, for services of No. 8 and smaller, be of the same size as the service entrance conductors.

See examples Nos. 1, 2, 3 and 4 of Chapter 10.

Order 13-2202. Voltage Drop.

The size of the feeder conductors should be such that voltage drop up to the final distribution point for the load as computed by order 13-2203 will not be more than 3 per cent for power loads, and not more than 1 per cent for lighting loads or combined lighting and power loads.

Order 13-2203. Computation of Feeder Loads.

The computed load of a feeder shall be the sum of the computed loads as determined for branch circuits in accordance with section 13-210, subject to the following provisions:

A. *General Lighting.* The feeder load for general illumination in the following occupancies shall be computed according to the wattage per square foot specified:

Occupancy	Watts Per Square Foot
Industrial Commercial Loft Buildings	1.0
Garages, Commercial	.5
Storage Warehouses	.25

B. *Demand Factors.* Demand factors specified in the following table may be applied to the computed loads for general illumination as determined by sub-paragraph A of this order and sub-paragraph A of order 13-2108, for the occupancies listed:

Type of Occupancy	Wattage Based on Area Served	Demand Factor in Per Cent
Single-family dwellings*	2,500 or less	100
	Excess over first 2,500	30
Multi-family dwellings (other than hotels) and apartment houses with provisions for cooking by tenants*	3,000 or less	100
	Excess over first 3,000 but not more than 120,000	35
	Excess over 120,000	25
Hospitals†	50,000 or less	40
	Excess over first 50,000	20
Hotels*†	20,000 or less	50
	Excess over first 20,000 but not more than 100,000	40
	Excess over 100,000	30
Office buildings	20,000 or less	100
	Excess over first 20,000	70
Schools	15.000 or less	100
	Excess over first 15.000	50
Storage warehouses	12,500 or less	100
	Excess over first 12,500	50

*The small appliance load specified in sub-paragraph C of order 13-2108 may be included with the lighting load and subject to the demand factors specified. If the load in single-family dwellings, individual apartments of multi-family dwellings, and in hotel suites having serving pantries, is sub-divided through two or more feeders, the computed load for each shall include not less than 1,500 watts for small appliances.

†For sub-feeders to areas where entire lighting is likely to be used at one time, as in ballrooms, dining rooms, operating rooms, etc., a demand factor of 100 per cent shall be used.

1. The unit values of order 13-2108 and sub-paragraph A of order 13-2203, and the demand factors of the table, are based on minimum load conditions and may not provide sufficient feeder capacity for the installation contemplated. If at any time it is found that feeder conductors will be, or are, overloaded, they shall be increased to comply with the provisions of Tables 1 and 2 of Chapter 10.

In view of the trend toward higher intensity lighting systems and indirect lighting, and increased loads due to more general use of fixed and portable appliances, each installation should be considered as to the load likely to be imposed, and feeder capacity increased to permit of efficient and economical operation without expensive alterations and replacements in the system.

C. *Appliance Load* (other than motors). The demand factors of Table 29 of Chapter 10 may be applied to loads consisting of one or more household electric ranges and other household cooking and baking appliances that are individually rated at more than 1,650 watts.

For small appliances in dwelling occupancies, see note following table in paragraph B.

D. *Motor Load.* The load for motors shall be computed according to the provisions of orders 13-4314 and 13-4316.

E. *Neutral Feeder Load.* The neutral feeder load shall be subject to the provisions of order 13-2204.

See Examples Nos. 1, 2, 3 and 4 of Chapter 10.

Order 13-2204. Neutral Feeder Load.

The neutral feeder load shall be the maximum unbalance of the load determined by order 13-2203. The maximum unbalanced load shall be the computed load obtained by order 13-2203 less all loads tapped from the ungrounded feeders and not connected to the neutral; except that the load thus obtained shall be multiplied by 140 per cent for 5-wire two-phase systems. For 3-wire D.C. or single-phase A.C., 4-wire three-phase and 5-wire two-phase, a further demand factor of 70 per cent may be applied to that portion of the unbalanced load in excess of 200 amperes.

See Example No. 4, Chapter 10.

Order 13-2205. Common Neutral Feeder.

A common neutral feeder may be employed for two or three sets of 3-wire feeders, or two sets of 4-wire or 5-wire feeders. When in metal enclosures, all conductors of feeder circuits employing a common neutral feeder shall be contained within the same enclosure as provided in order 13-3052.

Order 13-2206. Diagram of Feeders.

If required by the authority enforcing this code, a diagram showing feeder details shall be supplied previous to installation. This diagram should show: Area in square feet; load (before applying demand factors); demand factors selected; computed load (after applying demand factors); and the size of conductors.

SECTION 13-230. SERVICES

GENERAL REQUIREMENTS

Order 13-2301. Service Conductors.

Service conductors shall be installed so as to be isolated from or protected from mechanical injury. Attachment of overhead conductors should be so made as to provide necessary clearance for the use of ladders and safety equipment.

Order 13-2302. One Set of Service Conductors Only.

In general, a building shall be supplied through only one set of service conductors, except:

A. Where more than one service drop is permitted by order 13-2321.

B. Buildings of multiple occupancy may have two or more separate sets of service entrance conductors which are tapped from one service drop, or two or more sub-sets of service entrance conductors may be tapped from a single set of main service conductors.

C. In a single occupancy, where a set of service conductors is already installed for one class of use, one additional set may be installed for a different class of use.

Order 13-2303. Service from One Building Through Another.

No overhead service, no underground service, and no service from an isolated plant shall supply one building through another, unless such buildings are under single occupancy or management. Conductors in conduit or duct placed under at least two inches of concrete beneath a building, or buried in two inches of brick masonry or in concrete within a wall, shall be considered outside the building.

Order 13-2304. Insulation of Service Conductors.

Service conductors extending from the service entrance to the first pole shall have an insulating covering which will normally withstand exposure to atmospheric and other conditions of use and which shall prevent any detrimental leakage of current to adjacent conductors, objects, or the ground.

A. *Uninsulated Neutral.* In the case of service conductors that have a nominal voltage to ground of not more than 208 volts, a grounded neutral service conductor without an insulating covering may be installed. Except in the service drop, such an uninsulated conductor shall be part of an approved type of service cable or shall be installed in a rigid metal raceway.

B. *Underground.* Except as provided in sub-paragraph A, underground service conductors up to the point of attachment to service equipment shall be covered with rubber, cambric, paper or other approved insulating material. Service conductors installed underground or in concrete slabs or masonry in direct contact with earth shall be lead covered or of other types specially approved for the purpose.

C. *Service Drops.* Except as provided in sub-paragraph A, service drop conductors in multiple-conductor cables shall be rubber covered, or have other approved insulation. Open individual conductors shall be rubber covered, or have other approved insulation, or be weatherproof (type WP).

D. *On Exterior of, or Entering Buildings.* Except as provided in sub-paragraph A, service conductors extending along the exterior of, or entering buildings shall be rubber covered, or have other approved insulation if in raceways, or in service cables. Open individual conductors which enter the building shall be rubber covered, or have other approved insulation, but where on the exterior of the building only may be weatherproof (type WP).

Order 13-2305. Size of Service Conductors.

Service conductors shall have adequate current-carrying capacity to safely conduct the current for the loads supplied without a temperature rise detrimental to the insulating covering of the conductors, and shall have adequate mechanical strength.

A. *Service Entrance Conductors.* Service entrance conductors, including underground services, shall have a current carrying capacity sufficient to carry the load as determined by order 13-2203, and in accordance with Tables 1 and 2 of Chapter 10. Service entrance conductors supplying installations of three or more branch circuits shall consist of at least two No. 6 insulated conductors and one No. 8 bare conductor. Installations having only one or two branch circuits may be served by two No. 8 conductors. The neutral of the service entrance conductors shall have a current carrying capacity in conformity with order 13-2204, and shall be the same size as the ungrounded conductor when the ungrounded conductors are No. 8 or smaller.

B. *Service Drops.* Conductors in service drops shall be not smaller than No. 10 if of soft copper, or No. 12 if of medium or hard drawn copper.

Order 13-2306. Master Services.

In a property comprising more than one building under single management, and which has a generating plant or is served by a master service, the conductors running from one building to another shall not be considered as service conductors; but the wiring in each building served shall be separately controlled and properly protected by overcurrent devices. The control should be a circuit-breaker or an enclosed externally operable switch, which may be located in the building served or in another building, provided it is accessible to the persons using the installation.

Order 13-2307. Service Entrance Conductors without Splice.

Service entrance conductors shall be without splice except as follows:

A. Clamped or bolted connections in a meter enclosure are permitted.

B. Taps to main service conductors are permitted as provided in sub-paragraph B of order 13-2302, or to individual sets of service equipment as provided in sub-paragraph A of order 13-2351.

C. A connection is permitted, if properly enclosed, where an underground service conductor enters a building and is to be extended to the service equipment or meter in another form of approved service raceway or service cable.

D. A connection is permitted where service conductors are extended from a service drop to an outside meter location and returned to connect to the service entrance conductors of an existing installation.

E. For extending existing services, special permission to make splices in fittings of the service run and to extend existing wire size may be granted.

Order 13-2308. Conductors in Service Raceway.

Conductors other than service conductors, grounding conductors, or control conductors from time switches having overcurrent protection, shall not be installed in the service raceway.

Water heater leads are to be considered as service entrance conductors.

UNDERGROUND SERVICES

Order 13-2311. Mechanical Protection.

Underground service conductors shall be protected against mechanical injury by being installed in duct, conduit, in the form of a cable approved for the purpose or by other approved means.

Order 13-2312. Protection on Poles.

If underground service conductors are carried up a pole the mechanical protection shall be installed to a point at least 8 feet above the ground.

Order 13-2313. Protection Where Entering Building.

Where underground service conductors enter a building, they shall have mechanical protection in the form of rigid or flexible conduit, electrical metallic tubing, auxiliary gutters, the metal tape of an approved service cable, or other approved means. The mechanical protection shall extend to the enclosure for the service equipment unless the service switch is installed on a switchboard, in which case a bushing shall be provided which, except where lead covered conductors are used, shall be of the insulating type.

Order 13-2314. Sealing End of Raceway.

Where a service raceway or duct enters from an underground distribution system, the end within the building shall be sealed with suitable compound so as to prevent the entrance of moisture or gases.

SERVICE DROP CONDUCTORS

Order 13-2321. Number of Drops.

No building shall be supplied from the same transformer, or from the same secondary distribution system, through more than one service drop, except as follows:

A. Fire Pumps. If a separate service is required for fire pumps.

B. Emergency Lighting. If a separate service is required for emergency lighting purposes.

C. Capacity Requirements. If capacity requirements make multiple services desirable.

D. Buildings of Large Area. By special permission, if more than one service drop is necessary due to the area over which a single building extends.

E. Multiple Occupancy Buildings. By special permission, in multiple occupancy buildings where there is no available space for service equipment accessible to all of the occupants.

F. Additional drops may be supplied if they are necessary because of voltage regulation, consumer classification or regulatory orders.

Order 13-2322. Clearance of Service Drop.

Service drop conductors shall be so installed that a distance not less than 8 feet will be maintained from buildings over which they pass. For clearance above ground, refer to orders 13-2325 and 13-7334.

Exception. Service drops operating at less than 300 volts need not be more than 3 feet above building roofs which cannot readily be walked upon.

Order 13-2323. Supports Independent of Building.

Where practicable, conductors passing over a building shall be supported on structures which are independent of the building. If necessary to attach conductors to roof they shall be supported on substantial structures.

Order 13-2324. Not Readily Accessible.

Service drops shall not be readily accessible. They shall have a clearance of not less than 36 inches from readily accessible windows, doors and porches.

Order 13-2325. Point of Attachment to Building.

In general, the point of attachment of a service drop to a building shall be not less than 10 feet above ground and shall be at a height to permit a minimum clearance for service drop conductors of 10 feet above sidewalks and 18 feet above driveways, alleys and public roads. The attachment should not be more than 30 feet above ground unless a greater height is necessary for proper clearance. Where the form of the building will not permit placing the attachment 10 feet or more above the ground, the attachment may be less than 10 feet provided all other clearances are obtained and all conductors and connections within 8 feet of the ground are properly insulated.

Order 13-2326. Means of Attachment.

Multiple conductor cables used for service drops shall be attached to buildings by fittings approved for the purpose.

SERVICE CONDUCTORS ON OR IN BUILDINGS

Order 13-2331. Wiring Methods.

Service conductors extending along the exterior, or entering buildings, may be installed as separate conductors, in cables approved for the purpose, or enclosed in rigid conduit, or, for circuits not exceeding 600 volts, in electrical metallic tubing or as busways.

Service-entrance conductors should not be run within the hollow spaces of frame buildings unless provided with automatic over-current protection at their outer end.

Order 13-2332. Mechanical Protection.

Individual open conductors or cables other than approved service-entrance cables, shall not be installed within 8 feet of the ground or where exposed to mechanical injury. Service-entrance cables, if liable to contact with awnings, shutters, swinging signs, installed in exposed places in driveways, near coal chutes or otherwise exposed to mechanical injury, shall be of the protected type or be protected by conduit, tubing or other approved means.

Order 13-2333. Individual Conductors Exposed to Weather.

Individual open conductors, if exposed to weather, shall be supported on insulators, racks, brackets, or other means, placed at intervals not exceeding 9 feet and separating the conductors at least 6 inches from each other and 2 inches from the surface wired over; or at intervals not exceeding 15 feet if they maintain the conductors at least 12 inches apart. For 300 volts or less, conductors may have a separation of not less than 3 inches if supports are placed at intervals not exceeding 4½ feet and conductors are not less than 2 inches from the surface wired over.

Order 13-2334. Individual Conductors Not Exposed to Weather.

Individual open conductors not exposed to the weather may be supported on glass or porcelain knobs placed at intervals not exceeding 4½ feet and maintaining the conductors at least one inch from the surface wired over and a separation of at least 2½ inches between conductors.

Order 13-2335. Individual Wires Entering Buildings.

Individual conductors entering buildings shall pass inward and upward through slanting non-combustible, non-absorptive insulating tubes, or shall enter through roof bushings, and shall conform to the provisions of Section 13-324. Drip loops shall be formed on the conductors before entering tubes.

Order 13-2336. Service Cables.

Service cables of a type not approved for mounting in contact with the wall shall have insulating supports at intervals not exceeding 15 feet, and maintaining a distance of at least 2 inches from the surface wired over. Service cables mounted in contact with the building shall be supported at intervals not exceeding 4½ feet.

Order 13-2337. Service Head.

Service raceways shall be equipped with a raintight service head. Service cables, unless continuous from pole to service equipment or meter, shall be equipped with an approved raintight service head, or be formed in a gooseneck, taped and painted and held securely in place by its connection to service drop conductors below the gooseneck or by a fitting approved for the purpose. Drip loops shall be formed on individual conductors. If service-entrance conductors are connected to service drop above the service head, the insulation shall be removed for ½ inch at the lower part of the drip loop to provide drainage.

Order 13-2338. Enclosing Raceways Made Raintight.

If rigid metal raceways are installed where exposed to weather the raceways shall be made raintight and arranged to drain.

Order 13-2339. Terminating Raceway at Service Equipment.

If conduit, electrical metallic tubing, or service cable is used for service conductors, the inner end shall enter a terminal box or cabinet, or be made up directly to an equivalent fitting, enclosing all live metal parts, except that if the service disconnecting means is mounted on a switchboard having exposed busbars on the back, the raceway may be equipped with a bushing which shall be of the insulating type unless lead covered conductors are used.

DISCONNECTING MEANS

Order 13-2351. General.

Each set of service-entrance conductors shall be provided with a readily accessible means of disconnecting all conductors from the source of supply.

A. *Switch and Circuit-Breaker.* The disconnecting means may consist of not more than six switches, or six manually operable circuit-breakers, in a common enclosure, or in a group of separate enclosures, located at a readily accessible point nearest to the entrance of the conductors, either inside or outside the building wall. The disconnecting means shall be of a type approved for the prevailing conditions such as exposure to weather. For service operating at not to exceed 250 volts and capacities up to and including 100 amperes, the service switch and service fuses, when not a part of a switchboard, shall be of the accessible fuse or deadfront type in which the fuses are dead when accessible and no live parts are exposed to accidental contact.

Exception. Where the meter is not of the socket type or where current transformers or large self-contained meters are used, the main disconnecting means may consist of not more than six switches or six manually-operable circuit-breakers, provided an approved disconnecting means is installed ahead of the meter or the metering current transformers. If such disconnecting means is incapable of being operated under full load, the service on which it is installed must be sealed or otherwise rendered inaccessible to other than qualified persons.

B. *Multiple-Occupancy.* In a multiple-occupancy building, each occupant shall have access to his disconnecting means. In a multiple-occupancy building supplied by a service in conformity with sub-para-

graph B of order 13-2302, and having a common readily accessible space available, the disconnecting means may consist of not more than six switches or circuit-breakers which shall conform to the requirements of sub-paragraph A of this order.

C. *Disconnection of Grounded Conductor.* If the switch or circuit-breaker does not interrupt the grounded conductor, other means shall be provided in the service cabinet or on the switchboard for disconnecting the grounded conductor from the interior wiring.

D. *Master Service.* For disconnecting means in buildings supplied by a master service, see order 13-2306.

Order 13-2352. Control.

The disconnecting means shall control all circuits and devices, except that service fuses, meters, high-impedance shunt circuits (such as potential coils of meters and control circuits of time switches), surge protective capacitors, and circuits for emergency lighting and for fire alarms as provided in order 13-2375, may be connected on the supply side of the disconnecting means. The wiring method for such a control circuit shall be one specified for service-entrance conductors.

For detailed service provisions for fire alarm, sprinkler supervisory, or watchman systems, see Standards of the National Board of Fire Underwriters.

Order 13-2353. Simultaneous Opening.

The disconnecting means shall simultaneously disconnect all ungrounded conductors, except for 3-wire direct-current or single-phase circuits or multi-wire lighting circuits.

Order 13-2354. Types Permitted.

The disconnecting means for ungrounded conductors may be a switch or manually operable circuit-breaker of the air-break or oil-immersed type, equipped with a handle or lever for mechanical operation by the hand.

A push-button type of electrical remote control may be used in addition to the manual handle.

Order 13-2355. Indicating.

The disconnecting means shall plainly indicate whether it is in the open or closed position.

Order 13-2356. Externally Operable.

An enclosed service switch or circuit-breaker shall be externally operable and readily accessible unless additional enclosed, externally operable switches or circuit-breakers are provided for control of all individual feeders and circuits supplied through it.

Note the requirement in order 13-2351.

It is recommended that where the current of a single circuit, or group of circuits, is separately metered, as in apartment house installations, devices be installed in a convenient location to control each separately metered installation, such devices being enclosed and the switch or circuit-breaker being externally operable.

Order 13-2357. Rating of Service Switch.

A service switch shall have a rating not less than that of the fuseholder in series with it. Except by special permission, 30-ampere switches shall not be used for a 2-wire service supplying more than two 15-ampere branch circuits.

It is recommended that the service switch have, in all cases, a rating not less than 60-amperes, and the circuit-breaker not less than 50 amperes.

Order 13-2358. Hazardous Locations.

Service equipment installed in hazardous locations shall comply with the requirements of section 13-500.

Order 13-2359. Service Equipment Grouped.

If supplied at the same side of the building by more than one overhead service drop or more than one set of underground service conductors, the service equipments, except for services as permitted in orders 13-2302-C and 13-2321, shall be grouped and each set of equipment marked to identify it.

OVERCURRENT PROTECTION

Order 13-2371. Where Required.

Each ungrounded service entrance conductor shall have overcurrent protection.

A. *In Ungrounded Conductor.* Such protection shall be provided by an overcurrent device in series with each ungrounded service conductor, having a rating or setting not higher than the allowable carrying capacity of the conductor, except as follows:

1. For motor-starting currents, ratings in conformity with orders 13-4342, 13-4362, or 13-4363 may be used.

2. Circuit-breakers may have a setting in conformity with orders 13-2422 and 13-2423.

3. Not more than six circuit breakers or six sets of fuses may serve as the overcurrent device.

4. In a multiple-occupancy building, (1) supplied by a service in conformity with sub-paragraph 13-2302-B, (2) having a readily accessible space available, and (3) having more than six separate subdivisions of the service, main overcurrent devices consisting of not more than six circuit-breakers or six sets of fuses shall be provided.

B. *Not in Grounded Conductor.* No overcurrent device shall be inserted in a grounded service conductor except a circuit-breaker which simultaneously opens all conductors of the circuit.

C. *Master Service.* For master services, see order 13-2306.

Order 13-2372. Location.

The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent thereto, unless located at the outer end of the service raceway.

Order 13-2373. Location of Branch-Circuit Overcurrent Devices.

If the service overcurrent devices are locked or sealed, or otherwise not readily accessible, branch-circuit overcurrent devices shall be installed on the load side, shall be mounted in an accessible location and shall be of lower rating than the service overcurrent device.

Order 13-2374. Protection of Special Circuits.

If necessary to prevent tampering, an automatic overcurrent device protecting service conductors supplying only a special load such as water heater, may be locked or sealed if located so as to be accessible.

Order 13-2375. Relative Location of Overcurrent Device and Other Service Equipment.

The overcurrent device shall protect all circuits and devices except as follows:

A. The service switch may be placed on the supply side.

B. High-impedance shunt circuits for measuring and control apparatus, such as potential coils of meters and control circuits of time switches, and surge protective capacitors, may be connected on the supply side of the service equipment. The wiring method shall be one specified in order 13-2331 for service-entrance conductors.

C. Circuits for emergency lighting may be connected on the supply side of the service overcurrent device if separately provided with over-current protection.

D. Circuits used only for the operation of fire alarm or other protective signaling systems may be connected on the supply side of the service overcurrent device if separately provided with over-current protection.

E. The meter may be placed on the supply side of the overcurrent device for alternating current supply not in excess of 300 volts between conductors, and provided the conductors between meter and service equipment are installed by any of the methods specified in order 13-2331 for service conductors.

GROUNDING AND GUARDING

Order 13-2381. Enclosure.

Live parts of service equipment shall be enclosed so that they will not be exposed to accidental contact, unless mounted on a switchboard, panelboard or controller accessible to qualified persons only and located in a room or enclosure free from easily ignitible material. Such an enclosure shall be provided with means for locking or sealing doors giving access to live parts.

This includes meter sockets.

Order 13-2382. Grounding.

Service equipment shall be grounded as follows:

A. Equipment. The meter and enclosure for service equipment shall be grounded in the manner specified in section 13-250, unless (1) the voltage does not exceed 150 volts to ground and such enclosures are

(2) isolated from conducting surfaces, and (3) unexposed to contact by persons or materials that may also be in contact with other conducting surfaces. The enclosure for metering equipment, installed on the supply side of the service equipment, may be grounded to the neutral conductor when the provisions of paragraph A of order 13-2304 are complied with.

B. Raceways. Service raceways, and the metal sheath of service cables, shall be grounded. Conduit and metal pipe from underground supply shall be considered sufficiently grounded if containing lead-sheathed cable bonded to a continuous underground lead-sheathed cable system.

C. Flexible Conduit. If a service run of rigid metal raceway is interrupted by flexible metal conduit, the sections of rigid metal raceway thus interrupted shall be bonded together by a copper conductor not smaller than No. 8, using clamps or other approved means. The conductor and bonding devices shall be protected from mechanical injury. If the flexible conduit runs to the service cabinet, similar bonding shall be installed between the cabinet and the rigid raceway.

SERVICES EXCEEDING 600 VOLTS

Secondary conductors, not the primary conductors, are regarded as constituting the service conductors to the building proper in the following cases:

1. Where step-down transformers are located outdoors.
2. Where step-down transformers are located in a separate building from the one served.
3. Where step-down transformers are located in the building served in a transformer vault conforming to the requirements of orders 13-4521 to 13-4528, and under the sole control of the supply company.

In no case will the provisions of this section apply to equipment not directly connected to service conductors, and consequently will not apply to equipment in vaults under the sole control of the supply company.

Order 13-2386. General.

Service conductors and equipment used on circuits exceeding 600 volts between conductors shall comply with orders 13-2301 to 13-2326 inclusive, orders 13-2335, 13-2381 and 13-2382, and also the following orders 13-2387 to 13-2392 inclusive.

Order 13-2387. Wiring Methods.

For services exceeding 600 volts between conductors, service conductors may be installed as open conductors, in rigid conduit, or as multiple conductor cable approved for the purpose. If the voltage exceeds 7,500 volts, the conductors shall enter a transformer vault conforming to the requirements of orders 13-4521 to 13-4528, except that when the service-entrance equipment consists of metal enclosed switch-gear not exceeding 15,000 volts between conductors, a vault is not required.

Conductors in conduit or duct and enclosed by concrete or brick not less than 2 inches thick shall be considered outside of the building.

A. *Open work.* If open work is employed, the service conductors shall be rigidly supported on glass, porcelain or other insulators approved for the purpose, which will keep them at least 8 inches apart, except at terminals of equipment. They shall be not less than 2 inches from the surfaces wired over and for voltages exceeding 2500 not less than 3 inches.

B. *Service Cable.* Where cable conductors emerge from a metal sheath, the insulation of the conductors shall be protected from moisture and mechanical injury by a pothead or other approved means.

C. *Conductor Size.* Service conductors shall be not smaller than No. 6 unless in cable. Conductors in cable shall be not smaller than No. 8.

D. *Supports.* Service conductors and their supports, including insulators, shall have strength and stability sufficient to insure maintenance of adequate clearance with abnormal currents in case of short-circuits.

E. *Guarding.* Open wires shall be guarded where accessible to unqualified persons.

Order 13-2388. Disconnecting Means.

The circuit-breaker or the alternatives for it specified in order 13-2389 will constitute the disconnecting means required by order 13-2351.

Order 13-2389. Overcurrent Protection.

Overcurrent devices shall be provided in accordance with the following:

A. In Vault. If the service equipment is installed in a transformer vault meeting the provisions of orders 13-4521 to 13-4528, the requirements for overcurrent protection and disconnecting means may be fulfilled by the following:

1. On circuits not exceeding 2500 volts to ground and rated at not more than 300 amperes; and on circuits not exceeding 7500 volts between conductors and rated at not more than 100 amperes; oil-filled or other fuses of a type that may be operated as a disconnecting means may be used without switch or circuit-breaker.
2. If the voltage is 25,000 volts or less, a non-automatic oil switch and suitable fuses may be used.
3. If above limitations are exceeded an automatic circuit-breaker shall be installed in compliance with requirements of paragraph B.

B. Not In Vault. If the overcurrent device is not in a vault meeting the provisions of orders 13-4521 to 13-4528, it shall consist of an automatic circuit-breaker of suitable current-carrying and interrupting capacity with an overcurrent unit in each ungrounded conductor, and so arranged that the operation of any one device will open all ungrounded conductors.

C. Fuses. Fuses used as permitted in paragraph A shall have an interrupting rating at least equal to the maximum short-circuit current possible in the circuit.

D. Circuit-Breakers. A circuit-breaker used as service equipment shall be located as near as possible to the point where the service conductors enter the building, or else on a pole outside the building, and shall be manually operable from a point which is readily accessible to qualified persons. Provision shall be made so that the circuit-breaker is free to open in case the circuit is closed on an overload. This can be accomplished by means such as trip-free breakers, by multiple breakers having an operating handle per pole, or, for an air circuit-breaker, by a switch in series with each pole of the breaker. A service circuit-breaker shall indicate clearly whether it is open or closed, and shall be capable of interrupting the maximum short-circuit current to which it may be subjected.

Order 13-2390. Isolating Switches.

Isolating switches shall be provided as follows:

A. Air-break isolating switches shall be installed between oil switches or circuit-breakers used as service switches and the supply conductor, except where such equipment is mounted on removable truck panels or metal-enclosed switch-gear units which cannot be opened unless the circuit is disconnected, and which, if removed from the normal operating position, automatically disconnects the circuit-breaker or switch from all live parts.

B. When the fuses used with non-automatic oil switches in accordance with 13-2389-A are of a type that may be operated as a disconnect switch, they may serve as the isolating switch if they completely disconnect the oil switch and all service equipment from the source of supply.

C. Air-break isolating switches shall be accessible to qualified attendants only. They shall be arranged so that a grounding connection on the load side can readily be made. Such grounding means need not be provided for duplicate isolating switches, if any, installed and maintained by the supply company.

Order 13-2391. Lightning Arrester.

A lightning arrester complying with the requirements of section 13-280 shall be placed on each ungrounded overhead service conductor on the supply side of the service equipment, if called for by the authority enforcing this code.

Order 13-2392. Equipment in Secondaries.

If the primary service equipment supplies one or more transformers whose secondary windings feed a single set of mains, and the primary circuit-breaker is manually operable from a point outside the transformer vault or accessible to qualified persons only, the disconnecting means and overcurrent protection may be omitted from the secondary circuit, provided the setting of the primary circuit-breaker is such

as to protect the secondary circuit. If not manually operable from outside the vault, means shall be provided to trip the breaker from outside the vault. In all other cases the secondary circuit shall be provided with a disconnecting means and overcurrent protection as required by various paragraphs of this section.

"Manually operable" calls for a mechanical, rather than only electrical, linkage between the circuit-breaker and the point of operation, and refers to both the opening and closing operations.

SECTION 13-240. OVERCURRENT PROTECTION INSTALLATION

Order 13-2401. General Requirement.

Overcurrent protection for conductors is provided for the purpose of opening the electric circuit if the current reaches a value which will cause an excessive or dangerous temperature in the conductor. A grounded conductor is considered to be protected from overcurrent if a protective device of a suitable rating or setting is provided in each ungrounded conductor of the same circuit.

Order 13-2402. Overcurrent Protection of Equipment.

Equipment shall be protected against overcurrent as specified in the references in the following table:

Branch Circuits	Section 13-210
Capacitors	Orders 13-4605-B-5 and 13-4608-A-3
Cranes and Hoists	Orders 13-6141 and 13-6142
Generators	Order 13-4454
Motors	Section 13-430
Over 600 Volts	Orders 13-7141, 13-7142 and 13-7143
Panelboards	Order 13-3882
Services	Orders 13-2371 to 13-2375
Signal and Control Equipment	Order 13-8006
Signs and Outline Lighting	Order 13-6007
Sound Equipment	Order 13-6406
Transformers	Orders 13-4531 and 13-4532

Order 13-2403. Carrying Capacity.

Conductors shall be protected in accordance with the carrying capacities of Tables 1 and 2, Chapter 10, except as follows:

A. If the allowable current carrying capacity of the conductor does not correspond to the standard sizes or ratings of overcurrent devices, the next larger size or rating may be used, but not exceeding 150 per cent of the allowable current carrying capacity of the conductor.

B. Fixture Wires and Cords. Fixture wire or flexible cord, sizes No. 16 or No. 18, and tinsel cord shall be considered as protected by 15-ampere overcurrent devices. Flexible cord No. 18 or larger, approved for use with specific appliances which may be used on the 15-, 20- or 25-ampere circuits described in section 13-210, shall be considered as protected by the overcurrent protection of such circuits.

C. Motor Circuits. The conductors supplying motors and motor-operated appliances shall be considered as protected by the over-current protective devices specified in orders 13-4322, 13-4324 and 13-4342.

D. Branch Circuits. The conductors supplying lampholders on branch circuits shall be considered as protected by the branch circuit overcurrent device when in accordance with the requirements of order 13-2106.

E. Remote Control. The conductors of the control circuits of remote control switches shall be considered as protected from overcurrent by overcurrent devices that are not of the so-called time-lag type and are rated or set at not more than 500 per cent of the carrying capacity of the remote control conductors, as specified in Tables 1 and 2 of Chapter 10.

F. Taps. A conductor tapped from a feeder shall be considered as properly protected from overcurrent if installed in accordance with order 13-2434 or 13-4349.

Order 13-2404. Thermal Devices.

Thermal cutouts, thermal relays, and other devices not designed to open short-circuits, shall not be used for overcurrent protection of conductors.

Order 13-2405. Ungrounded Conductors.

An overcurrent device (fuse or circuit-breaker) shall be placed in each ungrounded conductor, except that if circuit-breakers are used, the number and position of the overcurrent units such as trip coils or relays shall be as given in Table 28, Chapter 10, in which case the circuit-breaker shall open all ungrounded conductors of the circuit. Individual single-pole circuit-breakers may be used for the protection of each conductor of ungrounded 2-wire circuits, each ungrounded conductor of 3-wire direct-current or single-phase circuits, or for each ungrounded conductor of lighting or appliance branch circuits connected to 4-wire three-phase systems, or 5-wire 2-phase systems, provided such lighting or appliance circuits include a grounded conductor.

Order 13-2406. Services.

For services the number of overcurrent units shall be as specified in order 13-2371.

Order 13-2407. Motors.

For motor-running protection the number of overcurrent units shall be as specified in orders 13-4326 and 13-4327.

Order 13-2408. Feeders at Supply Stations.

Each conductor of a constant potential circuit entering or leaving a supply station, except grounded neutral conductors of three-wire systems, shall be protected from excessive current by a circuit-breaker, or by an equivalent device of approved design. Such protective devices shall be located as near as practicable to the point where the conductors enter or leave the building. For the outgoing circuits not connected with other sources of power, the protective devices may be placed on the supply side of transformers or similar devices.

Order 13-2409. Grounded Conductor.

No overcurrent device shall be placed in any permanently grounded conductor, except as follows:

A. Simultaneous Opening. If the overcurrent device simultaneously opens all conductors of the circuit.

B. Conductors of Branch Circuits. In locations where the conditions of grounding, or the likelihood of reversal of connection warrants, the authority enforcing this code may require, on systems having a grounded neutral or having one side grounded, that the conductors of 2-wire branch circuits shall have an overcurrent device in each conductor.

C. Unpolarized Installations. In existing unpolarized installations the conductors of 2-wire branch circuits shall have an over-current device in each conductor, unless all lampholders have the grounded conductor connected to the screw shell.

Order 13-2410. Change in Size of Grounded Conductor.

Where a change occurs in the size of the ungrounded conductor, a similar change may be made in the size of the grounded conductor.

Order 13-2411. Fuses in Multiple.

For the protection of conductors, except the conductors of motor branch circuits, having allowable carrying capacities exceeding the rated capacity of the largest approved cartridge type fuse, cartridge fuses arranged in multiple may be used, provided as few fuses as possible are used and the fuses are of the same type, characteristics, and rating, and provided the fuseholder terminals are mounted on a single continuous pair of bus bars, or have an equivalent arrangement that will eliminate any potential difference between the terminals of the fuses.

RATINGS AND SETTINGS

Order 13-2421. Fuses.

Fuses shall have ratings not greater than the allowable carrying capacity of the conductor as required by order 13-2403. Plug fuses and fuseholders shall not be used in circuits exceeding 125 volts between conductors, except circuits of a system having a grounded neutral and no conductor at more than 150 volts to ground.

Order 13-2422. Time-Delay Circuit-Breakers.

Circuit-breakers of the time-delay, thermal-trip type with fixed setting, shall be rated at not more than the allowable carrying capacity of the conductors as specified in order 13-2403. Circuit-breakers of the time-delay, magnetic-trip type shall have a setting of not more than 125 per cent of the allowable carrying capacity of the conductors as specified in order 13-2403.

Order 13-2423. Instantaneous Circuit-Breakers.

Circuit-breakers of the instantaneous type shall be set to operate at not more than 125 per cent of the allowable carrying capacity of the conductors as specified in order 13-2403.

Exception. Under certain limited conditions as provided for under specific uses and as covered in this and subsequent orders of this section, the above general requirements shall be modified. Some of these cases are covered under special headings, such as motors, and motor-circuits.

LOCATION

Order 13-2434. Location in Circuit.

Overcurrent devices shall be located at the point where the conductor to be protected receives its supply, except as follows:

A. Service Conductors. An overcurrent protective device for a service conductor may be located as specified in order 13-2372.

B. Smaller Conductor Protected. If the overcurrent device protecting the larger conductor also protects the smaller conductor in accordance with Tables 1 and 2 of Chapter 10.

C. Taps Not Over 5 Feet Long. If the smaller conductors have a current-carrying capacity of not less than the sum of the allowable current-carrying capacities for the conductors of the one or more circuits or loads, which it supplies, provided the tap is not over 5 feet long and does not extend beyond the switchboard, panelboard, or control devices which it supplies and is enclosed in conduit, electrical metallic tubing or in metal gutters when not a part of the switchboard or panelboard.

D. Taps Not Over 25 Feet Long. If the smaller conductors have a current-carrying capacity at least one-third that of the conductor from which they are supplied, and provided the tap is suitably protected from mechanical injury, is not over 25 feet long, (where feeders are at a greater elevation, this distance may be increased to 50 feet) and terminate in a single circuit-breaker or set of fuses which will limit the load on the tap to that allowed by Tables 1 and 2, Chapter 10. Beyond this point the conductors may supply any number of circuit-breakers or sets of fuses.

Order 13-2435. Location in Premises.

Overcurrent devices shall be located where they will be:

A. Readily accessible, except as provided in order 13-2372 for service equipment and order 13-3647 for busways.

B. Not exposed to mechanical injury.

C. Not in the vicinity of easily ignitible material.

ENCLOSURES

Order 13-2436. General.

Overcurrent devices shall be enclosed in cutout boxes or cabinets, unless a part of a specially approved assembly which affords equivalent protection, or unless mounted on switchboards, panelboards or

controllers located in rooms or enclosures free from easily ignitible material and dampness. The operating handle of a circuit-breaker may be accessible without opening a door or cover.

Order 13-2437. Damp or Wet Locations.

Enclosures for overcurrent devices in damp or wet locations shall be of a type approved for such locations and shall be mounted so there is at least one-half inch air space between the enclosure and the supporting surface.

Order 13-2438. Vertical Position.

Enclosures for overcurrent devices shall be mounted in a vertical position unless in individual instances this is shown to be impracticable.

Order 13-2439. Rosettes.

Fuses shall not be mounted in rosettes.

Order 13-2440. Disconnection of Fuses and Thermal Cutouts Before Handling.

Fuses and thermal cutouts, in circuits of more than 150 volts to ground, if accessible to other than qualified persons, and cartridge fuses operating at any voltage, shall be so arranged that all fuses or thermal cutouts in each individual circuit can be independently disconnected from all sources of electrical energy before they can be touched; except that a single disconnecting means may serve a group of fuses or thermal cutouts if a number of motors drive several parts of a single machine or piece of apparatus, such as metal and woodworking machines, cranes and hoists.

Order 13-2441. Arcing or Suddenly-Moving Parts.

Arcing or suddenly-moving parts shall comply with the following:

A. *Location.* Fuses and circuit-breakers shall be so located or shielded that persons will not be burned or otherwise injured by their operation.

B. *Suddenly-Moving Parts.* Handles or levers of circuit-breakers, and similar parts which may move suddenly in such a way that persons in the vicinity are liable to be injured by being struck by them, shall be guarded or isolated.

CONSTRUCTION OF OVERCURRENT DEVICES

Order 13-2451. Plug Fuses of the Edison-Base Type.

Plug fuses of the Edison-base type shall conform to the following:

A. *Classification.* Plug fuses of this type shall be classified at not over 125 volts, 0 to 30 amperes.

B. *Marking.* Plug fuses of 15 amperes rating or less shall be distinguished from those of larger rating by an hexagonal opening in the cap through which the mica or similar window shows, or by some other prominent hexagonal feature such as the form of the top or cap itself, or an hexagonal recess or projection in the top or cap.

Order 13-2452. Holders for Plug Fuses.

(Effective January 1, 1941) Holders for plug fuses of 30 amperes or less shall not be installed unless they comply with order 13-2453 or are made to comply with order 13-2453 by the insertion of an adapter.

Order 13-2453. Plug Fuses and Fuseholders of Type S.

Where Type S plug fuses are to be used as the overcurrent device required by this code, the fuses and fuseholders shall conform to the following requirements:

A. *Classification.* Plug fuses and fuseholders of Type S shall be classified at not over 125 volts; 0 to 15 amperes, 16 to 30 amperes.

B. *Fuses Usable Only in Fuseholders of the Same Classification.* Fuses of the 16 to 30 ampere classification shall not be usable with fuseholders or adapters of the 0 to 15 ampere classification.

C. *Fuseholders and Adapters.* Fuses, fuseholders, and adapters shall be so designed that a fuse other than a Type S fuse cannot be used in a fuseholder or adapter designed for Type S fuses.

D. *Tamperability.* Fuses, fuseholders and adapters shall be so designed as to be subject to tampering or bridging only with difficulty.

E. *Live Parts.* Fuses and fuseholders when installed and assembled together shall have no live parts exposed.

F. *Adapters to be Non-Removable.* Fuse adapters shall be so designed that when once inserted in a fuseholder they cannot be removed, except that adapters without the locking device may be used in installations existing before the effective date of order 13-2452.

G. *Interchangeability.* Fuses, fuseholders and adapters of various manufacturers should be interchangeable with each other, and the plugs with adapters shall be suitable for use in the Edison-base type fuseholder.

H. *Plug Type.* Fuses and fuseholders shall be of the plug type.

I. *Ampere Rating.* Each fuse, fuseholder and adapter shall be marked with its ampere rating.

J. *Marking.* Fuses of the 0 to 15 ampere rating shall be distinguished from those of larger rating by an hexagonal opening in the cap through which the mica or similar window shows, or some other prominent hexagonal feature such as the form of the top or cap itself, or an hexagonal recess or projection in the top or cap.

Order 13-2461. Cartridge Fuses and Fuseholders.

Cartridge fuses and fuseholders shall conform to the following:

A. *Classification.* Cartridge fuses and fuseholders shall be classified as regards current and voltage as follows:

Not Over 250 Volts Amperes	Not Over 600 Volts Amperes	Not Over 250 Volts Amperes	Not Over 600 Volts Amperes
0- 30	0- 30	101-200	101-200
31- 60	31- 60	201-400	201-400
61-100	61-100	401-600	401-600

B. *Non-Interchangeable.* Cartridge fuses and fuseholders shall be so designed that it will be impossible to put a fuse of any given class

into a fuseholder which is designed for a current lower, or voltage higher, than that of the class to which it belongs.

C. *Marking.* Each fuse shall be marked with its ampere and voltage ratings.

Order 13-2471. Link Fuses and Fuseholders.

Link fuses shall be mounted on approved fuseholders.

A. *Minimum Rating.* Link fuses and fuseholders shall be used only in sizes rated at more than 600 amperes, and only by special permission.

Order 13-2481. Circuit Breakers.

Circuit-breakers shall conform to the following:

A. *Manually Operated.* Circuit-breakers shall be manually operable.

B. *Injury to Operator.* Circuit-breakers shall be arranged and mounted so that their operation is not likely to injure the operator.

C. *Indication.* Circuit-breakers shall indicate whether they are in the open or closed position.

D. *Non-Tamperable.* An air circuit-breaker, used for the branch circuits described in Section 13-210, shall be of such design that any alteration of its trip point (calibration), or in the time required for its operation, will be difficult.

E. *Marking.* Circuit-breakers shall be marked with their rating in such a manner that the marking will be visible after installation.

SECTION 13-250. GROUNDING

Order 13-2501. Scope.

This section treats of protection of electric installations by grounding. Insulation, isolation, and guarding are suitable alternatives under certain conditions.

SYSTEMS AND CIRCUITS

Order 13-2511. Circuits.

Circuits are grounded for the purpose of limiting the voltage upon the circuit which might otherwise occur through exposure to lightning or other voltages higher than that for which the circuit is designed; or to limit the maximum potential to ground due to normal voltage.

For instrument transformer grounding, see Order 13-2621.

Order 13-2512. Two-Wire Direct-Current Systems.

Two-wire direct-current systems supplying interior wiring, and operating at not more than 300 volts between conductors, shall be grounded, unless such system is used for supplying industrial equipment in limited areas and the circuit is equipped with a ground detector.

It is recommended that 2-wire direct-current systems operating at more than 300 volts between conductors be grounded if a neutral point can be established such that the maximum difference of potential between the neutral point and any other point on the system does not exceed 300 volts. It is recommended that 2-wire direct-current systems be not grounded if the voltage to ground of either conductor would exceed 300 volts after grounding. See Order 13-2522.

Order 13-2513. Three-Wire Direct-Current Systems.

The neutral conductor of all 3-wire direct-current systems supplying interior wiring shall be grounded. See Order 13-2522.

Order 13-2514. Alternating-Current Systems.

Secondary alternating-current systems supplying interior wiring, and interior alternating-current wiring systems, shall be grounded if they can be so grounded that the maximum voltage to ground does not exceed 300 volts.

Higher voltage circuits may be grounded.

Order 13-2515. Furnace Circuits.

Electric furnace circuits need not be grounded.

Order 13-2516. Electric Crane Circuits.

Circuits for electric cranes operating over combustible fibers in Class III or Class IV hazardous locations shall not be grounded. See order 13-5082.

Order 13-2517. Circuits of Less Than 50 Volts.

Circuits of less than 50 volts need not be grounded, except as follows:

A. If supplied by transformers from systems of more than 150 volts to ground;

B. If supplied by transformers from ungrounded systems;

C. If run overhead outside of buildings.

LOCATION OF GROUNDING CONNECTIONS

Order 13-2521. Current Over Grounding Conductors.

The grounding of wiring systems, circuits, equipment, arresters, cable armor, conduit, or other metal raceways as a protective measure shall be so arranged that there will be no objectionable passage of current over the grounding conductors. The temporary currents set up under accidental conditions, while the grounding conductors are performing their intended protective functions, are not to be considered as objectionable. If an objectionable flow of current occurs over a grounding conductor, due to the use of multiple grounds, (1) one or more of such grounds shall be abandoned, or (2) their location shall be changed, or (3) the continuity of the conductor between the grounding connections shall be suitably interrupted, or (4) other means satisfactory to the authority enforcing this code shall be taken to limit the current.

Order 13-2522. Grounding Connection for Direct-Current Systems.

Direct-current systems which are to be grounded shall have the grounding connection made at one or more supply stations but not at individual services nor elsewhere on interior wiring.

Order 13-2523. Grounding Connection for Alternating-Current Systems.

Alternating-current circuits which are required by order 13-2514 to be grounded shall have a grounding connection at each individual service, except as provided for in order 13-2521. The connection shall be made on the supply side of the service disconnecting means. Each secondary distribution system shall have at least one additional grounding connection at the transformer or elsewhere. No grounding connection shall be made to the grounded circuit conductor on the load side of the service disconnecting means, except as provided for in order 13-2524.

Order 13-2524. Two or More Buildings Served by a Master Service.

In a property comprising more than one building under single management and served by a master service, the wiring system in any building supplied from such service may be grounded as near as practicable to the entrance of the conductors to the building, whether the switch controlling the particular building is inside or outside of the building.

When a metal raceway system is used in any such building supplied from a master service and this metal raceway or any connected non-current carrying metal part is accessible from any grounded surface, the metal raceway system and the neutral conductor shall be bonded together and connected to an approved ground electrode at the entrance to the building.

Order 13-2525. Conductor to be Grounded.

For alternating-current interior wiring systems the conductor to be grounded shall be as follows:

A. Single-phase, 2-wire: the identified conductor;

B. Single-phase, 3-wire: the identified neutral conductor;

C. Multi-phase systems having one wire common to all phases: the identified common conductor;

D. Multi-phase systems having one phase grounded: the identified conductor;

E. Multi-phase systems in which one phase is used as in (B): the identified neutral conductor. One phase only can be grounded.

The identified conductor is commonly known as "the white wire."

Order 13-2526. Isolated Systems.

For an interior wiring system or circuit which is required to be grounded and which is not connected to an exterior secondary distribution system, the grounding connection shall be made at the transformer, generator, or other source of supply, or at the switchboard, on the supply side of the first switch controlling the system.

CONDUCTOR ENCLOSURES

Order 13-2531. Exposed Metal.

Exposed conductive materials enclosing electric conductors are grounded for the purpose of preventing a potential above ground on the enclosures.

Order 13-2532. Service Conductor Enclosures.

Service raceways, service cable sheaths or armoring, if of metal, shall be grounded.

Order 13-2533. Other Conductor Enclosures.

Metal enclosures for conductors shall be grounded, except in runs of less than 25 feet which are free from probable contact with ground or grounded metal and which, if within reach from grounded surfaces, are guarded against contact by persons.

Order 13-2534. Spacing from Lightning Rods.

Metal enclosures of conductors shall, wherever practicable, be kept at least 6 feet away from lightning rod conductors. Where it is not practicable to secure 6 feet separation, they shall be bonded together.

EQUIPMENT

Order 13-2541. Exposed Metal.

Exposed conductive materials enclosing electric equipment, or forming a part of such equipment, are grounded for the purpose of preventing a potential above ground on the equipment.

Order 13-2542. Fixed Equipment.

General. Under any of the following conditions, exposed, non-current-carrying metal parts of fixed equipment, which are liable to become energized, shall be grounded:

A. If equipment is supplied by means of metal-clad wiring;

B. If equipment is located in a wet location and is not isolated;

C. If equipment is in a hazardous location; see Section 13-500;

D. If equipment is in electrical contact with metal or metal lath;

E. If equipment operates with any terminal at more than 150 volts to ground, except as follows:

1. Enclosures for switches or circuit breakers where accessible to qualified persons only;

2. Metal frames of electrically-heated devices, exempted by special permission, in which case the frames shall be permanently and effectively insulated from ground;

3. Transformers mounted on wooden poles at a height of more than 8 feet from the ground. See Order 1033-B, Volume 1.

Order 13-2543. Fixed Equipment.

Specific, Exposed, non-current-carrying metal parts of the following kinds of equipment, regardless of voltage, shall be grounded:

A. Frames of motors as specified in order 13-4436;

B. Controller cases for motors, except lined covers of snap switches;

C. Electric equipment of elevators and cranes;

D. Electric equipment in garages, theatres and motion picture studios, except pendent lamps on circuits of not more than 150 volts to ground;

E. Motion picture projection equipment;

F. Electric signs and associated equipment, unless these are inaccessible to unauthorized persons and are also insulated from ground and from other conductive objects;

G. Generator and motor frames in an electrically operated organ, unless the generator is effectively insulated both from ground and from the motor driving it;

H. Switchboard frames, except frames of direct-current, single-polarity switchboards, which are effectively insulated;

I. X-ray tubes used in therapy. For exceptions see order 13-6634.

For instruments, meters and relays, see Orders 13-2622 to 13-2624.

Order 13-2544. Non-Electrical Equipment.

The following metal parts shall be grounded:

A. Frames and tracks of electrically operated cranes;

B. The metal frame of a non-electrically driven elevator car to which electric conductors are attached;

C. Hand-operated metal shifting ropes or cables of electric elevators;

D. Metal enclosures such as partitions, grill work, etc., around equipment carrying voltages in excess of 750 volts between conductors, unless in substations or vaults under the sole control of the supply company.

Order 13-2545. Portable Equipment.

Under any of the following conditions, exposed non-current-carrying metal parts of portable equipment shall be grounded:

A. In hazardous locations;

B. If operated at more than 150 volts to ground, except:

1. Motors, if guarded;
2. Metal frames of electrically-heated appliances exempted by order 13-4237;
3. Enclosures for X-ray tubes used in therapy exempted by order 13-6634.

C. In other than residential occupancies, exposed metal parts of portable appliances used in damp or wet locations, or by persons standing on the ground or on metal floors or working inside of metal

tanks or boilers, shall be grounded, except where supplied through an insulating transformer with ungrounded secondary of not over 50 volts.

This paragraph shall not be construed to prohibit the use of an insulating transformer with a secondary voltage greater than 50 volts, if the exposed metal parts of the appliance connected to such a transformer are grounded, and provided other conditions of this section are fulfilled.

It is recommended that the non-current carrying metal parts of all portable motors and other electrically operated equipment which operate at more than 50 volts and less than 150 volts to ground be grounded.

Order 13-2546. Spacing from Lightning Rods.

Metal frames and cases of electric equipment shall, wherever practicable, be kept at least 6 feet away from lightning rod conductors. Where it is not practicable to secure 6 feet separation, they shall be bonded together.

METHODS OF GROUNDING

Order 13-2551. Effective Grounding.

The path to ground from circuits, equipment, or conductor enclosures shall be permanent and continuous and shall have ample carrying capacity to conduct safely any currents liable to be imposed on it, and shall have impedance sufficiently low to limit the potential above ground, and to facilitate the operation of the overcurrent devices in the circuit.

Order 13-2552. Grounding Conductor to Circuit.

The grounding conductor may be connected to the grounded circuit conductor at any convenient point on the premises on the supply side of the service disconnecting means.

Order 13-2553. Common Grounding Conductor.

The grounding conductor for circuits may also be used for grounding equipment, conduit and other metal raceways or enclosures for conductors, including service conduit or cable sheath and service equipment.

Order 13-2554. Underground Service.

Service conduit or metal pipe from underground supply is considered to be grounded if it contains metal-sheathed cable bonded to a continuous underground metal-sheathed cable system. The sheath or armor of service cable from underground supply is considered to be grounded if it is metallically connected to a continuous underground metal-sheathed cable system.

Order 13-2555. Short Sections of Raceway.

Isolated sections of metal raceway or cable armor, if required to be grounded, shall preferably be grounded by connecting to other grounded raceway or armor, but may be grounded in accordance with order 13-2556.

Order 13-2556. Fixed Equipment.

Metal boxes, cabinets and fittings, or non-current-carrying metal parts of other fixed equipment, if metallically connected to grounded cable armor or metal raceway, are considered to be grounded by such connection. If not so connected they may be grounded in one of the following ways:

A. By a grounding conductor run with circuit conductors in wire assemblies; this conductor may be uninsulated, but if an individual covering is provided for this conductor, it shall be finished to show a green color;

B. By a separate grounding conductor installed the same as a grounding conductor for conduit and the like;

C. By special permission, other means for grounding fixed equipment may be used.

For the purposes of this rule, electric ranges are considered as fixed equipment even though connected by flexible cord.

Order 13-2557. Equipment on Structural Metal.

Electric equipment secured to and in contact with the grounded structural metal frame of a building, shall be deemed to be grounded. Metal car frames supported by metal hoisting cables attached to or running over sheaves or drums of elevator machines shall be deemed to be grounded if the machine is grounded in accordance with this code.

Order 13-2558. Portable Equipment.

Non-current-carrying metal parts of portable equipment may be grounded in any one of the following ways:

A. By means of the metal enclosure of the conductors feeding such equipment, provided an approved multi-prong plug or equivalent is used, one prong for the purpose of grounding the metal enclosure, and provided, further, that the metal enclosure is attached to the plug and to the equipment by connectors approved for the purpose;

B. By means of a grounding conductor run with the circuit conductors in wire assemblies, provided an approved multi-prong plug or equivalent is used, one prong for the purpose of connecting such grounding conductor to the grounded metal raceway or cable armor; this conductor may be uninsulated but if an individual covering is provided for this conductor, it shall be finished to show a green color;

C. By means of a separate flexible wire or strap, insulated or bare, protected as well as practicable against mechanical injury.

Order 13-2559. Grounding Equipment to Circuit Conductor.

The grounded circuit conductor on the load side of the connection to ground shall not be used for grounding equipment, cable armor, or metal raceways, except by special permission as provided in sub-paragraph C of order 13-2556.

BONDING

Order 13-2571. Bonding at Service Equipment.

Where the supply is from an overhead distribution system the electrical continuity of the following equipment and enclosures shall be assured by one of the means given in order 13-2572:

A. The service raceways or service cable armor or sheath;

B. All service equipment enclosures containing service entrance conductors, including meter fittings, boxes or the like, interposed in the service raceway or armor;

C. Any conduit or armor which forms part of the grounding conductor to the service raceway.

Order 13-2572. Means of Assuring Continuity.

Electrical continuity at service equipment shall be assured by one of the following means:

A. Threaded fittings with joints made up tight, where rigid conduit is involved;

B. Threadless fittings, made up tight, for electrical metallic tubing;

C. Bonding jumpers meeting the other requirements of this section. Bonding jumpers shall be used around concentric or eccentric knockouts which are punched or otherwise formed so as to impair the electrical connection to ground;

D. Other devices (not locknuts and bushings) approved for the purpose.

Order 13-2573. Metal Armor or Tape of Service Cable.

With service cable having an uninsulated grounded service conductor in continuous electrical contact with its metallic armor or tape, the metal covering is considered to be adequately grounded.

Order 13-2574. Voltages Exceeding 150 Volts.

The electrical continuity of metal raceway or metal sheathed cable which contains any conductor of more than 150 volts to ground shall be assured by one of the methods specified in order 13-2572, or by one of the following methods:

A. Threadless fittings, made up tight, with conduit or armored cable;

B. Two locknuts, one inside and one outside of boxes and cabinets.

Order 13-2575. Loosely-Jointed Metal Raceways.

Expansion joints and telescoping sections of raceways shall be made electrically continuous by bonding jumpers or other approved means. Metal trough raceways used in connection with sound recording and reproducing, made up in sections, shall contain a grounding conductor to which each section shall be bonded.

Order 13-2576. Hazardous Locations.

In hazardous locations, regardless of the voltage involved, the electrical continuity of metallic raceway, boxes and the like, shall be assured by one of the methods specified in sub-paragraphs A, C and D of order 13-2572.

Order 13-2577. Bonding Jumpers.

Bonding jumpers shall conform to the following:

A. Material and Size. Bonding jumpers shall be of copper or other corrosion-resistant material and shall be of sufficient size to have current-carrying capacity not less than is required for the corresponding grounding conductor;

B. Attachment. Bonding jumpers shall be attached to cabinets and the like in a manner provided in order 13-2613; where used between grounding electrodes or around water meters, gas meters, and the like, they shall be attached in a manner provided for in order 13-2614.

GROUNDING ELECTRODES

Order 13-2581. Water Pipe.

A continuous metallic underground water piping system shall always be used as the grounding electrode where such piping system is available.

Order 13-2582. Other Electrodes.

Where such a water piping system is not available, the grounding connection shall be made in a manner to secure the most effective ground. Any one or combination of the following may be used:

A. The metal frame of the building, if effectively grounded;

B. A continuous metallic underground gas piping system;

C. A local metallic underground piping system, metal well casing, and the like;

Exception: Such a local metallic underground piping system, including a small water system, small sewage system, well, pump casing, small gas system, gas tanks or any small metallic system, parts of which are at times in contact with persons or animals shall not be used as a grounding electrode unless a permanently assured ground resistance of less than 3 ohms is obtained.

Note: It is advisable from a safety standpoint to keep lightning rod grounds free from such metallic structures as pumps, cow stanchions, etc., which are frequently in contact with persons or animals. It is advisable in installations such as farms, that the pump motor be insulated from the water pump unless a resistance of less than 3 ohms can be maintained.

D. An artificial ground whose electrode consists of a driven pipe, driven rod, buried plate, or other device approved for the purpose.

Order 13-2583. Artificial Electrodes.

Artificial ground electrodes, consisting of plates, pipes or rods, shall conform to the following:

A. *Plate Electrodes.* Each plate electrode shall present not less than 2 square feet of surface to exterior soil. Electrodes of iron or steel plates shall be at least ¼ inch in thickness. Electrodes of non-ferrous metal shall be at least 0.06 inch in thickness.

B. *Pipe Electrodes.* Electrodes of pipe or conduit shall be not less than ¾ inch internal diameter, and if of iron or steel shall be galvanized.

C. *Rod Electrodes.* Electrodes of rods of steel or iron shall be at least ⅝ inch in diameter. Approved rods of non-ferrous materials or their approved equivalent used for electrodes shall be not less than ½ inch in diameter.

D. *Installation.* Artificial electrodes shall, as far as practicable, be embedded below permanent moisture level. Except where rock bottom is encountered, pipes or rods shall be driven to a depth of at least 8 feet regardless of size or number of electrodes used. Pipes or rods when less than standard commercial length shall preferably be of one piece. Such pipes or rods shall have clean metal surfaces and shall not be covered with paint, enamel or other poorly conducting materials. Where rock bottom is encountered at a depth of less than 4 feet, electrodes shall be buried in a horizontal trench, and if pipes or rods are used as the electrode they shall comply with sub-paragraphs B and C of this order and shall not be less than 8 feet in length. Each electrode shall be separated at least 6 feet from any other electrode, including those used for signal circuits, radio, lightning rods, or any other purpose.

Exception: 1. In basements where an 8 foot rod or pipe cannot be driven because of the low ceiling height and where the basement floor level is at least 2 feet below the surrounding outside soil, a rod or pipe driven to a depth of 6 feet may be used.

Exception: 2. Where rock is encountered, rods may be driven obliquely for a length of at least 8 feet or plates shall be used.

Order 13-2584. Resistance.

Buried or driven electrodes shall, if practicable, have a resistance to ground not to exceed 25 ohms. If the resistance is not as low as 25 ohms, two or more electrodes connected in parallel shall be used.

Continuous metallic underground water or gas piping systems in general have a resistance to ground of less than 3 ohms. Metal frames of buildings and local metallic underground piping systems, metal well casings, and the like, have, in general, a resistance substantially below 25 ohms. It is recommended that in locations where it is necessary to use buried or driven electrodes for grounding interior wiring systems, additional grounds, such as connections to a system ground conductor be placed on the distribution circuit. It is also recommended that single electrode grounds when installed, and periodically afterwards, be tested for resistance.

Order 13-2585. Railway Tracks.

Rails or other grounded conductors of electric railway circuits shall not be used as a ground for other than railway lightning arresters and railway equipment, conduit, armored cable, metal raceway, and the like, if other effective grounds are available; and in no case shall such rails or other grounded conductors of railway circuits be used for grounding interior wiring systems other than those supplied from the railway circuit itself.

Order 13-2586. Use of Lightning Rods.

Lightning rod conductors and driven pipes, rods or other artificial electrodes used for grounding lightning rods, shall not be used for grounding wiring systems, equipment and the like.

GROUNDING CONDUCTORS

Order 13-2591. Material.

The material for the grounding conductors shall be as follows:

A. *For System or Common Grounding Conductor.* The grounding conductor of a wiring system shall be of copper or other corrosion-resistant material. The conductor may be solid or stranded, insulated or bare. Except in cases of bus bars, the grounding conductor shall be without joint or splice throughout its length. If the grounding conductor is not of copper, its electrical resistance per linear foot shall not exceed, and its tensile strength shall not be less than that of the allowable copper conductor for such a purpose.

B. *For Conductor Enclosures and Equipment Only.* The grounding conductor for equipment, and for conduit and other metal raceways or enclosures for conductors, may be a conductor, stranded or solid, insulated or bare, a bus bar or other conductor, or a rigid conduit, steel pipe or electrical metallic tubing, except that under conditions favorable to corrosion the grounding conductor shall be of copper or other corrosion-resistant material.

Order 13-2592. Installation.

A grounding conductor, No. 4 or larger, may be attached to the surface on which it is carried without the use of knobs, tubes or insulators. It need not have protection unless exposed to severe mechanical injury. A No. 6 grounding conductor, which is free from exposure to mechanical injury, may be run along the surface of the building construction without metal covering or protection, if it is rigidly stapled to the construction; otherwise, it shall be in conduit, electrical metallic tubing or cable armor. Grounding conductors smaller than No. 6 shall be in conduit, electrical metallic tubing or cable armor. Metallic enclosures for grounding conductors shall be continuous from the point of attachment to cabinets or equipment to the grounding electrode, and shall be securely fastened to the ground clamp or fitting. Where rigid metallic conduit or steel pipe is used as a grounding conductor, the installation shall comply with the requirements of Section 13-346; where electrical metallic tubing is used, the installation shall comply with the requirements of Section 13-348.

Order 13-2593. Direct-Current Circuits.

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

Order 13-2594. Alternating-Current Circuits and Service Equipment.

The size of the grounding conductor for an alternating-current system, a common grounding conductor, or a grounding conductor for service equipment shall be not less than given in the following table, except that where connected to artificial electrodes as described in subparagraph D of order 13-2582, the grounding conductor need not be larger than No. 6 copper or its equivalent:

Size of Largest Service Conductor	SIZE OF GROUNDING CONDUCTOR		
	Copper Wire No.	Conduit or Pipe (Inch)	Electrical Metallic Tubing (Inch)
2 or smaller	8	½	½
1 or 0	6	½	1
00 or 000	4	¾	1¼
Over 000 to 350,000 C. M.	2	¾	1¼
Over 350,000 to 600,000 C. M.	0	1	2
Over 600,000 to 1,100,000 C. M.	00	1	2
Over 1,100,000 C. M.	000	1	2

Conduit, pipe, or electrical metallic tubing cannot be used alone as the grounding conductor for a wiring system. See paragraph A of order 13-2591.

Order 13-2595. Interior Raceway and Equipment.

The size of the grounding conductor for conduit, cable sheath or armor, and other metal raceways or enclosures for conductors, and for equipment, shall be not less than given in the following table, except that where connected to artificial electrodes as described in sub-paragraph D of order 13-2582, the grounding conductor need not be larger than No. 6 copper or its equivalent:

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	SIZE OF GROUNDING CONDUCTOR		
	Copper Wire No.	Conduit or Pipe (Inch)	Electrical Metallic Tubing (Inch)
30	14	½	½
60	10	½	½
100	8	½	½
200	6	½	1
400	4	¾	1¼
600	2	¾	1¼
800	0	1	2
1000	00	1	2
1200	000	1	2

Order 13-2596. Portable and Pendent Equipment.

For grounding portable or pendent equipment, the conductors of which are protected by fuses or circuit-breakers rated or set at not exceeding 15 amperes, No. 18 copper wire may be used. For grounding portable or pendent equipment protected at more than 15 amperes, the table in order 13-2595 shall be followed.

Order 13-2597. Outline Lighting.

Isolated non-current-carrying metal parts of outline lighting systems may be bonded together by a No. 14 conductor protected from mechanical injury, if a conductor complying with order 13-2595 is used to ground the group.

Order 13-2598. Common Raceway.

A grounding conductor may be run in the same metal raceway with other conductors of the system to which it is connected.

Order 13-2599. Continuity.

No automatic cutout or switch shall be placed in the grounding conductor of an interior wiring system unless the opening of the cutout or switch disconnects all sources of energy.

GROUNDING CONDUCTOR CONNECTIONS

Order 13-2611. Grounding Conductor to Raceway.

The point of connection of the grounding conductor to interior metal raceways, cable armor and the like shall be as near as practicable to the source of supply and shall be so chosen that no raceway or cable armor is grounded through a run of smaller size than is called for in order 13-2595.

Order 13-2612. Grounding Conductor to Electrode.

The grounding connection to the electrode shall be located as follows:

A. *To Water Pipes.* System or common grounding conductors shall be attached to a water piping system on the street side of the water meter or on a cold water pipe of adequate current-carrying capacity as near as practicable to the water service entrance to the building. Where practicable, the point of attachment shall be accessible. If the point of attachment is not on the street side of the water meter, the water piping system shall be made electrically continuous by bonding together all parts between the attachment and the pipe entrance which are liable to become disconnected, as at meters and service unions. Equipment may be grounded to a cold water pipe near the equipment.

Note: It is strongly recommended that the grounding connection be made on the street side of the water meter.

B. *To Gas Pipes.* The point of attachment of a grounding conductor to gas piping shall always be on the street side of the gas meter, and shall be accessible where practicable.

C. *To Other Electrodes.* The grounding conductor shall be attached to other electrodes permitted in order 13-2582 at a point which will assure a permanent ground. Where practicable the point of attachment shall be accessible.

Order 13-2613. Attachment to Circuits and Equipment.

The grounding conductor, bond, or bonding jumper shall be attached to circuits, conduits, cabinets, equipment, and the like, which are to be grounded, by means of suitable lugs, pressure connectors, clamps, or other approved means except that connections which depend upon solder shall not be used.

Order 13-2614. Attachment to Electrodes.

The grounding conductor shall be attached to the grounding electrode by means of (1) an approved bolted clamp of cast bronze or brass or of plain or malleable cast iron, or (2) a pipe fitting, plug, or other approved device, screwed into the pipe or into the fitting, or (3) other equally substantial approved means. The grounding conductor shall be attached to the grounding fitting by means of suitable lugs, pressure connectors, clamps, or other approved means, except that connections which depend upon solder shall not be used. Not more than one conductor shall be connected to the grounding electrode by a single clamp or fitting, unless the clamp or fitting is of a type approved for such use.

Order 13-2615. Ground Clamps.

For the grounding conductor of a wiring system the sheet metal strap type of ground clamp is not considered adequate unless it has a rigid metal base seated on the water pipe or other electrode and the strap is of such material and dimensions that it is not liable to stretch during or after installation.

Order 13-2616. Protection of Attachment.

Ground clamps or other fittings, unless approved for general use without protection, shall be protected from ordinary mechanical injury (1) by being placed where they are not liable to be damaged or (2) by being enclosed in metal, wood, or equivalent protective covering.

Order 13-2617. Clean Surfaces.

If a non-conductive protective coating such as paint or enamel, is used on the equipment, conduit, couplings or fittings, such coating shall be removed from threads and other contact surfaces in order to insure a good electrical connection.

INSTRUMENT TRANSFORMERS, RELAYS, ETC.

Order 13-2621. Instrument Transformer Circuits.

The secondary circuits of current and potential instrument transformers shall be grounded if the primary windings are connected to circuits of 300 volts or more to ground, and, if on switchboards, shall be grounded irrespective of voltage.

Order 13-2622. Instrument Transformer Cases.

Cases or frames of instrument transformers shall be grounded, except as follows:

A. Cases or frames of transformers used to supply current to instruments or protective relays, if they are isolated by elevation or guarded as required for the maximum potential at which they operate.

B. Cases or frames of current transformers, the primaries of which are not over 150 volts to ground, and which are used exclusively to supply current to meters, need not be grounded.

Order 13-2623. Cases of Instruments, Meters and Relays.

Operating Voltage 750 or Less. Instruments, meters and relays which operate with windings or working parts at 750 volts or less shall be grounded as follows:

A. *Not on Switchboards.* Instruments, meters, and relays not located on switchboards, which operate with windings or working parts at 300 volts or more to ground, and accessible to other than qualified persons, shall have the cases and other exposed metal parts grounded;

B. *On Dead Front Switchboards.* Instruments, meters and relays (whether operated from current and potential transformers, or connected directly in the circuit) on switchboards having no live parts on the front of the panels shall have the cases grounded;

C. *On Live Front Switchboards.* Instruments, meters and relays (whether operated from current and potential transformers, or connected directly in the circuit) on switchboards having exposed live parts on the front of panels shall not have their cases grounded. Rubber mats, or other suitable floor insulation, shall be provided for the operator if the voltage to ground exceeds 150.

Order 13-2624. Cases of Instruments, Meters and Relays.

Operating Voltage Over 750. Where instruments, meters and relays have current-carrying parts over 750 volts to ground, they shall be isolated by elevation or protected by suitable barriers, grounded metal or insulating covers or guards. Their cases shall not be grounded, except as follows:

A. In electrostatic ground detectors the internal ground segments of the instrument are connected to the instrument case and grounded; the ground detector shall be isolated by elevation.

Order 13-2625. Instrument Grounding Conductor.

The grounding conductor for secondary circuits of instrument transformers and for instrument cases shall not be smaller than No. 12, if of copper, or, if of other metal, shall have equal conductance.

LIGHTNING ARRESTERS

Order 13-2631. On Secondary Services.

Where a lightning arrester is installed on a secondary service, the ground terminal shall be bonded to (1) the grounded service conductor, or (2) the common grounding conductor, or (3) the service equipment grounding conductor, or (4) a separate grounding conductor. The bonding or grounding conductor shall be of copper, not smaller than No. 6, or of equivalent corrosion resistant material. If run in steel or iron raceways, it shall be bonded to the raceway at both ends.

SECTION 13-280. LIGHTNING ARRESTERS
INDUSTRIAL STATIONS

Order 13-2801. Where Required.

Lighting arresters shall be provided in industrial stations in locations where thunder storms are frequent and adequate protection against lightning is not otherwise provided.

For lightning arresters in hazardous locations, see Section 13-500.

Order 13-2802. Number Required.

A lightning arrester shall be connected to each ungrounded overhead conductor entering or leaving the station, except that where there is more than one circuit, a single set of arresters may be installed on the station bus if means are provided to protect circuits that may remain disconnected from the bus.

Order 13-2803. Where Connected.

The arrester shall be connected on the line side of all connected station apparatus.

OTHER OCCUPANCIES

Order 13-2811. Utilization Equipment.

Lightning arresters installed for the protection of utilization equipment may be installed either inside or outside the building or enclosure containing the equipment to be protected. Arresters, unless isolated by elevation or made otherwise inaccessible to unqualified persons, shall be enclosed, and if the operating voltage of the circuit exceeds 750 volts between conductors they shall be inaccessible to unqualified persons.

GENERAL

Order 13-2821. Location.

Indoors. Arresters installed indoors shall be located well away from other equipment, passageways and combustible parts of buildings, and if containing oil shall be separated from other equipment by walls meeting the requirements of order 13-4523.

Order 13-2822. Location.

Outdoors. If arresters containing oil are located outdoors, provision shall be made to drain away any accumulation of oil.

Oil may be drained away by ditches and drains or the oil may be absorbed and danger of spreading removed by paving the yard with cinders or other absorbent material to a depth of several inches.

Order 13-2823. Choke Coils.

Choke coils are not required, but if used shall be installed between the lightning-arrester tap and the apparatus to be protected.

Order 13-2824. Connections.

Size and Material. The connections between the arrester and the line wire or bus, and between arrester and ground shall be of copper wire or cable or the equivalent, and shall not be smaller than No. 6, and shall be made as short and as straight as practicable, avoiding as far as possible all bends and turns, especially sharp bends.

Order 13-2825. Insulation.

Lightning-protection accessories such as gap electrodes, and choke coils if used, shall have an insulation from ground or from other conductors at least equal to the insulation required at other points of the circuit.

Order 13-2826. Isolating Switch.

If isolating switches or disconnecting devices are used, they shall withstand, in full open position, a voltage test between live parts 10 per cent in excess of the maximum voltage test they will withstand to ground.

Order 13-2827. Grounding.

Lightning arresters shall be grounded in the manner prescribed in Section 13-250.

Chapter 3. Wiring Methods and Materials

SECTION 13-300. GENERAL REQUIREMENTS FOR WIRING METHODS

On premises where a continuous extensive underground metallic water-piping system is not available as a grounding electrode, and where it is not practicable otherwise to secure a ground of permanently low resistance (below 3 ohms), the use of a wiring method which does not employ metal enclosures for the wires is recommended, unless the character or occupancy of the building is such as to require the use of a metal-enclosed wiring system. In general, metallic raceway systems should not be used for the interior wiring but may be used for the service entrance.

PROVISIONS APPLYING TO ALL WIRING INSTALLATIONS

Order 13-3001. General.

The intent and purpose of the following rules is to provide that conductors shall have mechanical strength, insulation, and carrying capacity adequate for the particular conditions under which they are to be used, and, that where subject to mechanical injury, they shall be adequately protected.

The provisions of this section are not intended to apply to the conductors which form an integral part of equipment such as motors, motor controllers and the like.

Order 13-3002. Scope.

The provisions of order 13-3003 to 13-3019 inclusive shall apply to all wiring installations, except for signal and control systems, for which see Section 13-800.

Order 13-3003. Voltage Limitations.

Wiring methods specified in Chapter 3 may be used for voltages not exceeding 600, unless specifically limited in some section of Chapter 3, and may be used for voltages over 600 where specifically permitted elsewhere in this code.

Order 13-3004. Temperature Limitations of Insulated Conductors.

Insulated conductors shall not be used where the maximum operating temperature will exceed the maximum temperature specified in order 13-3005 for the particular insulation; and the maximum current allowable at different room temperatures shall be determined by using appropriate correction factors on values given in the current carrying capacity tables, Tables 1 and 2 of Chapter 10.

Order 13-3005. Types of Conductor Insulation.

Only conductors with the following types of insulation, and under the limitations given, are approved for use in wiring methods in this

Chapter, except (1) for conductors which are not required to have insulating coverings; or (2) where special types of approved wiring material are specified elsewhere in this code.

Insulation	Type Letter	Maximum Operating Temperature	Other Limitations
Code grade rubber Performance grade rubber Heat-resistant rubber	R RP RH	50C (122F) 60C (140F) 75C (167F)	No other types permitted for concealed knob-and-tube work
Moisture-resistant rubber	RW	50C (122F)	General use or in wet locations. See order 13-3035
Small diameter building wire, heat-resistant	RHT	75C (167F)	See sub-paragraph d of this order
Small diameter building wire, performance	RPT	60C (140F)	See sub-paragraph e of this order
Type RU wire	RU	60C (140F)	See sub-paragraph e of this order
Synthetic	SN	60C (140F)	See sub-paragraph e of this order
Varnished cambric	V	85C (185F)	Dry locations only unless lead covered. Smaller than No. 6 by special permission
Asbestos varnished cambric	AVA	110C (230F)	General use. Dry locations
Asbestos varnished cambric	AVB	90C (194F)	General use. Dry locations
Asbestos varnished cambric	AVL	110C (230F)	General use. Wet locations
Asbestos	A	200C (392F)	Dry locations only. Not for general conduit installation. In raceways, only as leads to or within apparatus
Impregnated asbestos	A1	125C (257F)	
Paper		85C (185F)	As permitted by 13-2304-b, or by special permission
Slow-burning	SB	90C (194F)	For use only in dry locations where room temperature exceeds 85C (185F)
Slow-burning weatherproof	SBW	90C (194F)	For use only in dry locations where room temperature exceeds 85C (185F)
Weatherproof	WP	80C (176F)	May be used for interior wiring only by special permission

For allowable current carrying capacities see Tables 1 and 2 of Chapter 10.

For size of conductors recognized for the various insulating coverings, and for construction details, see order 13-93001.

The temperature limitation of the above table shall not apply to motor leads which are a part of the motor.

Synthetic insulation may stiffen at temperatures below freezing and care should be used in its installation at these temperatures.

A. *Other Limitations.* Slow-burning conductors (types SB and SBW) may be used only where the room temperature will exceed 85C (185F). Weatherproof conductors (type WP) may, by special permission, be used for open wiring in locations where other insulations are not suitable for existing conditions. Asbestos insulated conductors (Type A) and impregnated asbestos conductors (type AI), without outer braid or without moisture-resistant treatment, are limited to circuits not exceeding 300 volts.

B. *Other Insulating Coverings.* Where conditions exist which do not permit the use of the above types of insulation, as in the presence of fumes which are deleterious to the insulating covering of the conductor, other types of insulation that are suitable may be used by special permission.

C. *Corrosive Vapor Locations.* Conductors subject to corrosive vapors shall be weatherproof (type WP), varnished-cambric (types V, AVA, AVB or AVL), asbestos (types A and AI), rubber-covered (types R, RP, RH or RW), or other types as may be directed by the authority enforcing this code.

D. *Small Diameter Building Wire.* Heat-Resistant Insulation. Conductors having a heat-resistant rubber insulation with a thickness of not less than 1/32 inch for Nos. 14, 12, and 10, and not less than 3/64 inch for No. 8, and with a flame-retardant, moisture-resistant fibrous outer covering (type RHT), may be used wherever Types R, RP, or RH insulations are acceptable.

E. *Rewiring in Existing Raceways.* Where in rewiring for increased load, space is not available in raceways for conductors having the insulation thickness of Type R conductors as specified in order 13-93001, and it is impracticable to increase the size of the raceway due to structural conditions, the following types of conductors may be used: (1) rubber insulation of a grade not lower than type RP insulation, in sizes Nos. 14, 12 and 10, with an approved insulation thickness of not less than 1/32 inch, and with a flame-retardant, moisture-resistant outer fibrous covering; (2) type RU insulation of 90 per cent unmilled grainless rubber, with a temperature limitation of 60C (140F), in sizes Nos. 14, 12 and 10, with an insulation thickness of not less than 0.018 inch, and with a flame-retardant, moisture-resistant outer fibrous covering; (3) a flame-retardant, moisture-resistant approved solid synthetic insulation (type SN), with a temperature limitation of 60C (140F), in sizes Nos. 14 to 4/0, with an insulation thickness as shown in the table in order 13-93001, no outer fibrous covering being required.

F. *Identification of Rubber Insulation.* All rubber-covered conductors shall have a readily identifiable permanent marking to indicate the type of insulation.

G. *Ultimate Insulation Temperature.* In no case shall conductors be associated together in such a way with respect to kind of circuit, wiring method employed, or number of conductors, that the above limiting temperatures will be exceeded.

Order 13-3006. Carrying Capacity.

The intent and purpose of the following rules is to provide that conductors shall be of adequate size to carry their currents without reaching temperatures having a deleterious or hazardous effect upon insulating coverings or adjacent materials.

A. *Copper.* Tables 1 and 2 of Chapter 10 give the allowable continuous current-carrying capacities of copper wires and cables of 98 per cent conductivity.

B. *Aluminum.* For aluminum conductors the allowable carrying capacities shall be taken as 84 per cent of those given in Tables 1 and 2 of Chapter 10 for the same sizes of copper conductors with the same kind of insulation.

Order 13-3007. Minimum Sizes of Conductors.

Conductors, whether solid or stranded, shall not be of smaller size than No. 14, except as provided for flexible cords in order 13-4006; for fixture wire in order 13-4137; for printing press control circuits; for elevator control and signal circuits as provided in order 13-6205; for signal and control systems as provided in order 13-8006; and for fractional horsepower motors as provided in order 13-4312.

Order 13-3008. Conductors in Multiple.

Conductors may be placed in multiple only by special permission, except as permitted in orders 13-3052 and 13-6205. Where conductors are placed in multiple the conductors shall be joined together, both mechanically and electrically, at the terminals.

Exception: Conductors may be placed in multiple without special permission, where the conductors are No. 0, or larger, where the conductors are the same size, same length and are properly joined mechanically and electrically at the terminals.

Order 13-3009. Splices.

Conductors shall be so spliced or joined as to be mechanically and electrically secure without solder and, unless an approved splicing device is used, shall then be soldered with a fusible metal or alloy or brazed or welded. All joints and the free ends of conductors shall be covered with an insulation equal to that on the conductors.

Order 13-3010. Connections to Terminals and Set-Screw Type Terminals.

See order 13-1116.

Order 13-3011. Free Length of Conductors at Outlets.

At least six inches of free conductor shall be left at each outlet and switch point for the making up of joints or the connection of fixtures or devices, except where conductors are intended to loop without joints through lampholders, receptacles and similar devices.

Order 13-3012. Deflection of Conductors.

Conductors entering or leaving cabinets, boxes and the like shall conform to the following:

A. *Width of Gutters.* Vertical conductors No. 1 or larger in size, shall not be deflected where they enter or leave a cabinet unless a gutter having a width in accordance with the following table is provided:

Feeder Size	Minimum Width of Gutter in Inches
No. 1	3
No. 0 to 200,000 c. m.	4
211,600 c. m. to 500,000 c. m.	6
600,000 c. m. to 900,000 c. m.	8
1,000,000 c. m. to 1,400,000 c. m.	10
1,500,000 c. m. to 2,000,000 c. m.	12

B. *Insulation at Bushings.* Where ungrounded conductors of No. 1 or larger are deflected more than 30 degrees where entering a raceway in a cabinet, pull box, junction box or auxiliary gutter, the conductors shall be protected by a substantial bushing providing a smoothly rounded insulating surface, unless the conductors are separated from the raceway fitting by substantial insulating material securely fastened in place. If conduit bushings are constructed wholly of insulating material, a locknut shall be provided both inside and outside the enclosure to which the conduit is attached.

Order 13-3013. Conductors of Different Systems.

Conductors of signal or radio systems shall not occupy the same enclosure with conductors of light or power systems except as permitted for elevators in orders 13-6216 and 13-6217; for sound recording in order 13-6405; and for signal and control systems in orders 13-8012 and 13-8023. Conductors of light and power systems of 600 volts or less may occupy the same enclosure only if all conductors are insulated for the maximum voltage of any conductor within the enclosure. Conductors of light and power systems of over 600 volts shall not occupy the same enclosure with conductors of light and power systems of 600 volts or less.

Order 13-3014. Boxes at Outlets.

Except as permitted in order 13-3368, a box shall be installed at each outlet, switch, or junction point of conduit, electrical metallic tubing, surface metal raceway, armored cable, or non-metallic sheathed cable, and at each outlet and switch point of concealed knob-and-tube work. Boxes used at outlets for fixtures shall be designed for the purpose. At every outlet used exclusively for lighting, the box shall be so designed or installed that a fixture may be attached.

Order 13-3015. Boxes and Fittings Where Conductors Are Brought Out.

Except as provided in order 13-3016, a box or terminal fitting having a separately bushed hole for each conductor shall be used wherever a change is made from conduit, electrical metallic tubing, non-metallic sheathed cable, armored cable and surface metal raceway wiring to open wiring or to concealed knob-and-tube work. A fitting used for this purpose shall contain no taps or splices and shall not be used at fixture outlets.

Order 13-3016. Bushing in Lieu of Box or Fitting.

A bushing may be used in lieu of a box or terminal fitting at ends of conduit or electrical metallic tubing where conductors leave the conduit or tubing behind a switchboard, or where more than 4 conductors leave the conduit or tubing at control apparatus or in similar locations, in which case the conductors shall be bunched, taped and painted with insulating paint. Such a bushing shall be of the insulating type except for lead-covered conductors.

Order 13-3017. Through Studs, Joists and Rafters.

When, in exposed or concealed work, conductors in insulating tubes or cables are run through bored holes in studs, joists or similar wood members, holes shall be bored at the approximate centers of wood

members, or at least 2 inches from the nearest edge. Where there is no objection because of weakening the building structure, armored or non-metallic sheathed cable may be laid in notches in the studding or joists if the cable at those points is protected against the driving of nails into it by having the notch covered with a suitable metal plate before the building finish is applied.

Order 13-3018. Insulation Resistance.

All wiring shall be so installed that when completed the system will be free from short-circuits and grounds, and in order that a reasonable factor of safety may be provided the following table of insulation resistance is suggested as a guide where the insulation is subjected to test.

1. For circuits of No. 14 or No. 12 wire.....1,000,000 ohms
For circuits of No. 10 or larger conductor, a resistance based upon the allowable current-carrying capacity of conductors as fixed in Tables 1 and 2 of Chapter 10, of this code as follows:

25 to 50 amperes, inclusive	250,000 ohms
51 to 100 amperes, inclusive	100,000 ohms
101 to 200 amperes, inclusive	50,000 ohms
201 to 400 amperes, inclusive	25,000 ohms
401 to 800 amperes, inclusive	12,000 ohms
Over 800 amperes	5,000 ohms

2. The above values shall be determined with all switchboards, panelboards, fuseholders, switches and overcurrent devices in place.

3. If lampholders, receptacles, fixtures, or appliances are also connected, the minimum resistance permitted for branch circuits supplying same shall be one-half the values specified in paragraph 1.

4. Where climatic conditions are such that the wiring or equipment is exposed to excessive humidity, it may be necessary to modify the foregoing provisions.

Order 13-3019. Coated Materials.

Metal raceways, cable armor, and all metallic elbows, couplings, and fittings, unless made of corrosion-resistant material, shall be suitably protected against corrosion inside and outside (except threads of joints) by a coating of approved corrosion-resistant material such as zinc, cadmium or enamel; except that ferrous raceways and fittings protected from corrosion solely by enamel may be used only indoors and in occupancies not subject to severe corrosive influences.

Meat packing plants, tanneries, hide cellars, casing rooms, glue houses, fertilizer rooms, salt storage, some chemical works, metal refineries, pulp mills, sugar mills, round houses, some stables, and similar locations are judged to be occupancies where severe corrosive conditions are likely to be present.

PROVISIONS APPLYING TO ALL RACEWAY SYSTEMS

Order 13-3031. Scope.

All raceway systems shall comply with the following orders 13-3032 to 13-3041 inclusive.

Order 13-3032. Number of Conductors in Raceway.

In general the percentage of the total interior cross-sectional area of a raceway to be occupied by conductors shall not be more than will permit a ready installation or withdrawal of the conductors and dissipation of the heat generated without injury to the insulation of the conductors. See the following orders of this code: conduit, order 13-3466; electrical metallic tubing, 13-3487; surface metal raceways, 13-3524; underfloor raceways, 13-3545; cellular metal floor raceways, 13-3564; wireways, 13-3624; auxiliary gutters, 13-3745; theaters, 13-5211; signs, 13-6021-D; elevators, 13-6214; sound recording, 13-6403 and 13-6404; signal and control systems, 13-8006-A, and 13-8012-B.

Order 13-3033. Inserting Conductors in Raceways.

Raceways, except those used for exposed work and having a removable cover or capping, shall first be installed as a complete raceway system without the conductors. Conductors shall not be inserted until all mechanical work on the building which is liable to injure the conductors has been completed, as far as possible. Pull wires, if used, shall not be installed until the raceway system is in place. Graphite, talc, or an approved compound may be used as a lubricant in inserting conductors in raceways. Cleaning agents or lubricants having a deleterious effect on conductor coverings shall not be used.

Order 13-3034. Splices.

Conductors shall be continuous from outlet to outlet and, except as permitted for auxiliary gutters in order 13-3748, and for wireways in order 13-3625, there shall be no splice or tap within the raceway itself.

Order 13-3035. Types of Conductors for Wet Locations.

Conductors shall be lead-covered; or rubber-covered (Type RW), or of other type specially approved for the conditions, if installed in any of the following locations:

A. Underground.

B. In concrete slabs or other masonry in direct contact with earth.

C. In wet locations.

D. Where the condensation and accumulation of moisture within the raceway is likely to occur.

Order 13-3036. Stranded Conductors.

Except when used as bus bars, conductors of No. 6 and larger, installed in raceways, shall be stranded.

Order 13-3037. Supporting Conductors in Raceways.

Conductors in vertical raceways shall be supported at intervals not greater than those specified in the following table:

No. 18 to No. 0	not greater than 100 feet
No. 00 to No. 0000	not greater than 80 feet
250,000 c. m. to 350,000 c. m.	not greater than 60 feet
350,001 c. m. to 500,000 c. m.	not greater than 50 feet
500,001 c. m. to 750,000 c. m.	not greater than 40 feet
Above 750,000 c. m.	not greater than 35 feet

The following methods of supporting cables are recommended:

A. By clamping devices constructed of or employing insulating wedges inserted in the ends of the conduits.

B. By inserting boxes at the required intervals in which insulating supports are installed and secured in a satisfactory manner to withstand the weight of the conductors attached thereto, the boxes being provided with covers.

C. In junction boxes, by deflecting the cables not less than 90 degrees and carrying them horizontally to a distance not less than twice the diameter of the cable, the cables being carried on two or more insulating supports, and additionally secured thereto by tie wires if desired.

Order 13-3038. Raceways Continuous.

Raceways shall be continuous from outlet to outlet and from fitting to fitting.

Order 13-3039. Fittings Secured.

Fittings shall be mechanically secured to the raceway.

Order 13-3040. Raceways Secured.

Raceways shall be secured in place.

Order 13-3041. Raceways Exposed to Different Temperatures.

If portions of an interior raceway system are exposed to widely different temperatures, as in refrigerating or cold storage plants, provision shall be made to prevent circulation of air from a warmer to a colder section through the raceway.

PROVISIONS APPLYING TO ALL WIRING IN METAL ENCLOSURES

Order 13-3051. Scope.

The provisions of orders 13-3052 to 13-3055, inclusive, shall apply to all wiring in metal enclosures, including metal raceways; cable having a metal armor; auxiliary gutters; outlet, switch, and junction boxes; cutout boxes; and metal cabinets.

Order 13-3052. Alternating-Current Systems in Metal Enclosures.

Where run in metal raceway or cable armor, or where entering metal enclosures, the conductors of circuits operating on alternating-current shall be so arranged as to avoid overheating of the metal by induction. If the capacity of a circuit is such that it is impracticable to run all conductors in one enclosure, additional enclosures may be used provided the conductors in any one enclosure are balanced in size and include one from each phase.

Induced currents in an enclosure can be avoided by so grouping the conductors in one enclosure that the current in one direction will be substantially equal to the current in the opposite direction.

In the case of circuits supplying vacuum or gas-tube lighting systems or signs, or X-ray apparatus, and under-plaster extensions permitted by orders 13-3581 to 13-3584 inclusive, the currents carried by the conductors are so small that a single conductor may be placed in a metal raceway or cable armor without causing trouble from induction.

Order 13-3053. Electrical Continuity of Raceways.

Interior metal raceways, cable armor, and other metal enclosures for conductors, shall be metallically joined together into a continuous electrical conductor, and shall be so connected to all boxes, fittings and cabinets as to provide effective electrical continuity.

Order 13-3054. Grounding Metal Enclosures.

Metal raceways, cable armor and fittings shall be grounded if and as prescribed in Section 13-250.

Order 13-3055. Underground Runs.

Conductors run underground shall comply with the provisions of orders 13-2311, 13-2312 and 13-2313 as far as mechanical protection is concerned.

PROVISIONS APPLYING TO ALL CABLE ASSEMBLIES

Order 13-3071. To Be Continuous.

All cable assemblies used for interior wiring shall be continuous from outlet to outlet and from fitting to fitting, and shall be mechanically secured to boxes and fittings except as provided for non-metallic outlet boxes in order 13-3716.

Order 13-3072. Securely Mounted.

Cable assemblies shall be securely fastened in place.

SECTION 13-320—OPEN WIRING ON INSULATORS

Order 13-3201. Scope.

Open wiring on insulators shall comply with the provisions of orders 13-3001 to 13-3018 inclusive and shall also comply with the provisions of the following orders 13-3202 to 13-3215 inclusive.

Order 13-3202. Use.

Open wiring on insulators shall not be used (1) in commercial garages, (2) in theaters, (3) in motion picture studios, (4) in hoistways, and (5) in hazardous locations, except in storage compartments of Class IV locations as provided in order 13-5075.

Order 13-3203. Types of Conductors.

The type of conductor shall conform to the following:

A. In dry places, conductors shall be rubber-covered (types R, RP, RH, and RHT), slow-burning weatherproof (type SBW), varnished-cambric insulated (type V), slow-burning (type SB) or asbestos-covered (type A).

B. In damp or wet locations or in buildings specially subject to moisture, conductors shall be rubber-covered.

Order 13-3204. Supports.

Conductors shall be supported in accordance with the following:

A. Open conductors shall be rigidly supported on insulators, except as provided in order 13-3206.

B. Rigid supporting requires under ordinary circumstances, if wiring over flat surfaces, supports at least every 4½ feet, this interval being shortened if the conductors are liable to be disturbed. Conductors shall be supported by means of a knob or cleat within 6 inches of a tap. In buildings of mill construction, mains not smaller than No. 8, where not liable to be disturbed, may be separated about 6 inches and run direct from timber to timber, being supported from each timber only.

C. When nails are used to mount knobs they shall not be smaller than 10 penny. When screws are used to mount knobs, or when nails or screws are used to mount cleats, they shall be of a length sufficient to penetrate the wood to a depth equal to at least one-half the height of the knob and fully the thickness of the cleat. Cushion washers shall be used with nails.

Order 13-3205. Spacing.

Open conductors in dry places and for voltages not exceeding 300 volts shall be separated 2½ inches from each other and ½ inch from the surface wired over; and for voltages from 301 to 600 volts shall be separated 4 inches from each other and 1 inch from the surface wired over. In damp or wet locations a separation of at least 1 inch from the surface wired over shall be maintained for all voltages.

Order 13-3206. Flexible Tubing.

In dry locations, where not exposed to severe mechanical injury, conductors may be separately encased in flexible tubing. Tubing shall be in continuous length not exceeding 15 feet, and secured to the surface wired over by straps spaced not exceeding 4½ feet apart.

Order 13-3207. Dead Ends.

Open conductors shall not be dead-ended at a rosette, lampholder or receptacle unless the last support is within 12 inches of the same.

Order 13-3208. Tie Wires.

No. 8 or larger conductors supported on solid knobs shall be securely tied thereto. If conductors are used for tying, they shall have an insulation of the same type as that of the conductors which they confine.

Order 13-3209. Passing Through Walls and Floors.

Open conductors shall be separated from contact with walls, floors, timbers or partitions through which they pass by tubes or bushings of non-combustible, non-absorptive insulating material. If the bushing is shorter than the hole, a waterproof sleeve of non-inductive material shall be inserted in the hole and an insulating bushing slipped into the sleeve at either end in such a manner as to keep the conductors absolutely out of contact with the sleeve. Each conductor must be carried through a separate porcelain tube or sleeve.

Order 13-3210. Separation from Metal Work.

Open conductors shall be separated at least 2 inches from metallic conduit, piping, or other conducting material, or from any exposed lighting, power or signal conductor, unless separated therefrom by a continuous and firmly fixed non-conductor additional to the insulation of the conductor. If any insulating tube is used, it shall be secured at the ends. Deviation from this requirement may, if necessary, be allowed by the authority enforcing this code.

Order 13-3211. Separation from Piping in Damp Locations.

Open conductors located close to water pipes or tanks, or in other damp locations, shall be so placed that an air space will be permanently maintained between them and pipes which they cross. Where practicable, conductors shall be run over, rather than under, pipes upon which moisture is likely to gather or which may leak.

Order 13-3212. Protection from Mechanical Injury.

Where open conductors cross ceiling joists and wall studs, and are exposed to mechanical injury, they shall be protected by one of the following methods. Conductors within 7 feet from the floor shall be considered exposed to mechanical injury.

A. By guard strips not less than ⅞ inch in thickness and at least as high as the insulating supports, placed on each side of and close to the wiring.

B. By a substantial running board at least ½ inch thick back of the conductors with side protections. Running boards shall extend at least 1 inch outside the conductors, but not more than 2 inches and the protecting sides shall be at least 2 inches high and at least ⅞ inch thick.

C. By boxing made as above and furnished with cover kept at least 1 inch away from the conductors within. Where protecting vertical conductors on side walls the boxing shall be closed at the top and the holes through which the conductors pass shall be bushed.

D. By conduit, in which case the rules for conduit shall be followed, or by metal piping in which case the conductors shall be encased in continuous lengths of approved flexible tubing. The conductors passing through conduit or piping shall be so grouped that current in both directions is approximately equal.

Order 13-3213. In Accessible Attics.

Conductors in unfinished accessible attics or roof spaces shall be installed in accordance with the requirements of order 13-3247.

Order 13-3214. In Concealed Spaces.

Conductors shall not be in contact with any object other than their insulating supports. If run in concealed spaces they shall be installed as required for concealed knob-and-tube work in accordance with the provisions of orders 13-3241 to 13-3249, inclusive.

Order 13-3215. Entering Spaces Subject to Dampness, Wetness or Corrosive Vapors.

Conductors entering or leaving locations subject to dampness, wetness or corrosive vapors shall have drip loops formed on them and shall then pass upward and inward from the outside of buildings, or from the damp, wet, or corrosive location, through non-combustible, non-absorptive insulating tubes.

SECTION 13-324. CONCEALED KNOB-AND-TUBE WORK

Order 13-3241. Scope.

Concealed knob-and-tube work shall comply with the provisions of orders 13-3001 to 13-3018, inclusive, and shall also comply with the provisions of the following orders 13-3242 to 13-3249, inclusive.

Order 13-3242. Use.

Concealed knob-and-tube work may be used in the hollow spaces of walls and ceilings. It shall not be used (1) in commercial garages, (2) in theaters, (3) in motion picture studios, nor (4) in hazardous locations.

Order 13-3243. Type of Conductor.

Conductors shall be rubber-covered (types R, RP, or RH). Only single conductors shall be used.

Order 13-3244. Supports.

Conductors shall be supported at intervals not exceeding 4½ feet by knobs and tubes. There shall be a knob within 6 inches from each tap. Tie wires shall comply with order 13-3208. If such support is impracticable and the conductors are in a dry location, they may be fished if separately enclosed in flexible tubing extending in continuous lengths from one support to the next or to an outlet box, or from one outlet box to another. Otherwise, conduit, armored cable, electrical metallic tubing or non-metallic sheathed cable shall be used.

Order 13-3245. Conductor Separation.

Conductors shall be separated at least 3 inches and maintained at least 1 inch from the surface wired over. At distributing centers, meters, outlets, switches or other places where space is limited and the 3 inch separation cannot be maintained, each conductor shall be encased in a continuous length of flexible tubing. Where practicable, conductors shall be run singly on separate timbers or studding.

Order 13-3246. Separation from Other Objects and Protection.

Conductors shall be separated from other conductors and objects as follows:

A. The provisions as to rigid supporting and clearance from foreign wires and other objects, as specified for open wiring in orders 13-3209, 13-3210, 13-3211, and 13-3215 shall be complied with.

B. Conductors passing through cross timbers in plastered partitions shall be protected by an additional tube extending at least 3 inches above the timber.

Order 13-3247. In Unfinished Attics and Roof Spaces.

Conductors in unfinished attics or roof spaces shall comply with the following:

A. Conductors in unfinished attics and roof spaces shall be run through or on the sides of joists, studs and rafters, except in attics and roof spaces having head room at all points of less than 3 feet in buildings completed before the wiring is installed.

B. If conductors in accessible unfinished attics or roof spaces reached by stairway or permanent ladder are run through bored holes in floor joists or through bored holes in studs or rafters within 7 feet of the floor or floor joists, such conductors shall be protected by substantial running boards extending at least 1 inch on each side of the conductors and securely fastened in place.

C. If carried along the sides of rafters, studs or floor joists, neither running boards nor guard strips will be required.

Order 13-3248. Boxes of Insulating Material.

Non-metallic outlet boxes may be used as provided in order 13-3716.

Order 13-3249. Thermal Insulation in Walls.

If thermal insulation is used in the hollow spaces of walls and ceilings in which concealed knob-and-tube work is installed, only approved non-corrosive, non-combustible, non-conducting thermal insulation materials shall be used, and these shall be applied in a manner not liable to place a strain upon the conductors or supports.

SECTION 13-328. BARE-CONDUCTOR FEEDERS

Order 13-3281. Use.

By special permission, bare conductors installed in accordance with the provisions of orders 13-3001 to 13-3018, inclusive, and in accordance with the provisions of the following orders 13-3282 to 13-3287, inclusive, may be used for feeders only. Such bare conductors may be installed only in a chase, channel or shaft of non-combustible material in a building of fire-resistive construction; and only if the voltage between conductors does not exceed 600 volts. Bare conductors shall not be used in damp or wet locations, nor in any hazardous location, nor where subject to corrosive vapor, except in storage battery rooms as provided in order 13-4807.

Order 13-3282. Size and Capacity of Conductors.

The maximum permissible current shall be 1000 amperes per square inch of cross-sectional area of conductor in unventilated enclosures, and 1200 amperes per square inch in ventilated enclosures.

Order 13-3283. Branch Taps.

Branch taps from bare-conductor feeders may be installed as specified in order 13-2434; provided that the mechanical protection specified by sub-paragraphs C or D of order 13-2434 shall not be required for that portion of the conductor located in the chase, channel or shaft.

Order 13-3284. Accessibility.

The conductors shall not be accessible to other than qualified persons.

Order 13-3285. Supports.

Conductors shall be supported as follows:

A. Conductors shall be supported on non-combustible non-absorptive insulating supports of adequate mechanical strength.

B. Conductors shall be so supported that a separation between conductors, and between conductors and ground, of not less than that specified in order 13-93847 will be maintained under all conditions of operation.

Order 13-3286. Fire Cutoffs.

If floors are pierced, suitable cutoffs against vertical travel of fire shall be provided.

Order 13-3287. Special Safeguards.

In addition to the provisions of the preceding orders, the authority enforcing this code may require other safeguards in view of special conditions that may be met in a particular installation.

SECTION 13-334. ARMORED CABLE

Order 13-3341. Scope.

Installations of armored cable shall comply with the provisions of orders 13-3001 to 13-3019, inclusive, and orders 13-3051 to 13-3072, inclusive, and in addition shall comply with the provisions of the following orders 13-3342 to 13-3347, inclusive.

Order 13-3342. Use.

Armored cable (type AC) may be used for both exposed work and concealed work in dry locations; for underplaster extensions as provided in Section 13-358; and embedded in plaster finish on brick or other masonry, except in damp or wet locations. Armored cable shall contain lead covered conductors (type ACL) if used where exposed to the weather or to continuous moisture, for underground runs and embedded in masonry, concrete or fill in buildings in course of construction, and where exposed to oil, gasoline or other materials having a deteriorating effect on rubber. Armored cable shall not be used (1) in theaters; (2) in motion picture studios; (3) in any hazardous locations; (4) where exposed to corrosive fumes or vapors; (5) in storage battery rooms; (6) on cranes or hoists, except as provided in sub-paragraph 13-6113-C; nor (7) in hoistways or on elevators, except as provided in order 13-6206.

Order 13-3343. Supports.

Armored cable shall be secured by approved staples, straps, or similar fittings, so designed and installed as not to injure the cable. Cable shall be secured at intervals not exceeding 4½ feet and within 24 inches from every outlet box or fitting, except where cable is fished. Holes through studs, joists and similar members, shall be considered as cable supports.

Order 13-3344. Exposed Work.

Exposed runs of cable shall closely follow the surface of the building finish or of running boards, except:

A. Lengths of not more than 24 inches at terminals where flexibility is necessary.

B. In accessible attics and roof spaces, for which see order 13-3345.

C. On the underside of floor joists in basements where supported at each joist and so located as not to be subject to mechanical injury.

Order 13-3345. In Accessible Attics.

Cable in accessible attics or roof spaces shall be installed as follows:

A. If run across the top of floor joists, or within 7 feet of floor or floor joist across the face of rafters or studding, the cable shall be protected by substantial guard strips which are at least as high as the cable. If the attic is not accessible by permanent stairs or ladders, protection will only be required within 6 feet of the nearest edge of scuttle hole or attic entrance.

B. If carried along the sides of rafters, studs or floor joists, neither guard strips, nor running boards shall be required.

Order 13-3346. Protection at Cable Ends.

At all points where the armor terminates, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and in addition, an approved insulating bushing or its equivalent approved protection shall be provided between the conductors and the armor. The connector or clamp by which the armored cable is fastened to boxes or cabinets shall be of such design that the insulating bushing or its equivalent will be visible for inspection. This bushing will not be required with lead covered cables which shall be so installed that the lead sheath will be visible for inspection.

Order 13-3347. Bends.

All bends shall be so made that the armor of the cable will not be injured, and the radius of the curve of the inner edge of any bend shall be not less than 5 times the diameter of the cable.

SECTION 13-336. NON-METALLIC SHEATHED CABLE

Order 13-3361. Scope.

Installations of non-metallic sheathed cable shall comply with the provisions of orders 13-3001 to 13-3018, inclusive, 13-3071, 13-3072, and shall also comply with the provisions of the following orders 13-3362 to 13-3370, inclusive.

Order 13-3362. Use.

Non-metallic sheathed cable may be used for both exposed and concealed work. Non-metallic sheathed cable shall not be embedded in masonry, concrete, fill, or plaster. It shall not be installed (1) in commercial garages, (2) in theaters, (3) in motion picture studios, (4) in storage battery rooms, (5) in hoistways, (6) in any hazardous location; nor (7) in breweries, ice plants, cold storage warehouses, and similar wet locations where subject to mildly corrosive fumes and vapors, but not including dairy barns, chicken houses and similar locations.

Order 13-3363. Supports.

Non-metallic sheathed cable shall be secured by approved staples, straps, or similar fittings, so designed and installed as not to injure the cable. Cable shall be secured in place at intervals not exceeding 4½ feet and within 12 inches from every outlet box or fitting, except that in concealed work in finished buildings where such supporting is impracticable, the cable may be fished from outlet to outlet.

Order 13-3364. Exposed Work—General.

In exposed work, except as provided in orders 13-3365 and 13-3366, the cable shall be installed as follows:

A. The cable shall closely follow the surface of the building finish or of running boards.

B. It shall be protected from mechanical injury where necessary, by conduit, pipe, guard strips or other means. If passing through a floor the cable shall be enclosed in rigid conduit or pipe extending at least 6 inches above the floor.

Order 13-3365. In Unfinished Basements.

If the cable is run at angles with joists in unfinished basements, assemblies not smaller than two No. 6 or three No. 8 conductors may be secured directly to the lower edges of the joists; smaller assemblies shall either be run through bored holes in the joists or on running boards. Where run parallel to joists, cable of any size shall be secured to the sides or face of the joists.

Order 13-3366. In Accessible Attics.

Cable in accessible attics or roof spaces shall be installed as follows:

A. If run across the top of floor joists, or within 7 feet of floor or floor joists, across the face of rafters or studding, the cable shall be protected by substantial guard strips at least as high as the cable. If the attic is not accessible by permanent stairs or ladders, protection will only be required within 6 feet of the nearest edge of scuttle hole or attic entrance.

B. If carried along the sides of rafters, studs or floor joists, neither guard strips, nor running boards shall be required.

Order 13-3367. Bends.

Bends in cable shall be so made, and other handling shall be such, that the protective coverings of the cable will not be injured, and no bend shall have a radius less than 5 times the diameter of the cable.

Order 13-3368. Devices of Insulating Material.

Switch, outlet and tap devices of insulating material may be used without boxes in exposed cable wiring. Openings in such devices shall form a close fit around the outer covering of the cable and the device shall fully enclose that part of the cable from which any part of the covering has been removed. If connections to conductors are by binding screw terminals, there shall be available as many screws as conductors, unless cables are clamped within the structure, or unless terminals are of a type approved for the purpose.

Order 13-3369. Boxes of Insulating Material.

Non-metallic outlet boxes approved for the purpose may be used as provided in order 13-3716.

Order 13-3370. Thermal Insulation.

If thermal insulation is used in the hollow spaces of walls and ceilings in which non-metallic sheathed cable is installed, only approved non-corrosive, non-combustible, non-conducting materials shall be used, and these shall be applied in a manner not liable to place a strain upon the cable, its supports, or terminal connections.

SECTION 13-338. SERVICE-ENTRANCE CABLE

Order 13-3381. Scope.

Service-entrance cable used for interior wiring shall comply with the provisions of orders 13-3001 to 13-3018, inclusive, and orders 13-3071 and 13-3072. Cable with interlocking metal armor shall comply with orders 13-3341 to 13-3345, inclusive, and order 13-3347. Other cable shall comply with orders 13-3361 to 13-3370, inclusive. It shall also comply with the provisions of the following order 13-3382.

Order 13-3382. Use.

Approved service-entrance cables (Types SE and ASE) may be used in interior wiring systems if all the conductors of the cable are of the rubber covered type; but if without individual insulation on the grounded conductor may be used only for range circuits, or as feeders from a master service cabinet to supply other buildings, or as service conductors for such other buildings, if the following conditions are met.

A. The cable has a final non-metallic outer covering.

B. The supply is alternating current not exceeding 150 volts to ground.

SECTION 13-340. NON-METALLIC WATERPROOF WIRING

Order 13-3401. Scope.

Installations of non-metallic waterproof wiring shall comply with the requirements of orders 13-3001 to 13-3018, inclusive, 13-3071, 13-3072, and in addition to the following orders 13-3402 to 13-3409, inclusive.

Order 13-3402. Use.

Subject to the approval of the authority enforcing this code, non-metallic waterproof wiring may be used for exposed work in breweries, ice plants, cold storage warehouses or similar wet locations where subject to mildly corrosive fumes and vapors, if the voltage does not exceed 300 volts between conductors or 150 volts to ground.

Order 13-3403. Conductors.

Rubber-sheathed multiple-conductor cable approved for the purpose shall be used. The individual conductors of the cable shall not be smaller than No. 12, except that the cable may contain an approved size of conductor, with or without individual insulation, to be used for equipment grounding purposes only. See sub-paragraph A of Order 13-2556.

Order 13-3404. Supports.

The cable shall be supported on insulators approved for the purpose and spaced at intervals not exceeding 3 feet.

Order 13-3405. Attachment to Fittings.

The cable shall be securely fastened to all outlet boxes, fittings and cabinets. A moisture-proof seal shall be provided between the cable and all outlet boxes, fittings and cabinets.

Order 13-3406. Passing Through Walls.

The cable shall be enclosed in rigid conduit, electrical metallic tubing, or approved insulating tubing, where passing through walls, and where so enclosed, the enclosure shall be sealed with a suitable fitting.

Order 13-3407. Protection.

Where exposed to mechanical injury the cable shall be protected.

Order 13-3408. Boxes and Fittings.

Boxes and fittings shall conform to the following:

A. Outlet boxes, fittings and cabinets shall be constructed of cast metal, insulating material or other material approved for the purpose.

B. Switch plates, fixtures, and similar parts shall be of insulating material when mounted on boxes, fittings, and cabinets of insulating material.

Order 13-3409. Grounding.

Metal boxes, fittings, or cabinets if used shall be grounded in accordance with Section 13-250.

SECTION 13-342. NON-METALLIC SURFACE EXTENSIONS

Order 13-3421. Scope.

Installations of non-metallic surface extensions shall comply with the provisions of orders 13-3001 to 13-3018, inclusive, and in addition shall comply with the provisions of the following orders 13-3422 to 13-3429, inclusive.

Order 13-3422. Use.

Non-metallic surface extensions may be used only if all of the following conditions are met:

A. The extensions are from existing outlets on branch circuits.

B. The extensions are run exposed in dry locations.

C. The building is occupied for residential or office purposes.

D. The extensions are not in unfinished basements, attics, or roof spaces.

E. The voltage does not exceed 150 volts between conductors.

F. The extensions are not subject to corrosive vapors.

Order 13-3423. Outlets Per Circuit.

The total number of outlets supplied by one branch circuit, including those previously installed and those of the extension, shall be in conformity with the requirements of Section 13-310.

Order 13-3424. Not to Run Outside Room.

An extension shall not be run through a floor or partition, nor outside the room in which it originates.

Order 13-3425. Location in Room.

One or more extensions may be run in any direction from an existing outlet, but not on the floor or within 2 inches from the floor. An extension shall be attached only to woodwork or plaster finish, and shall not be in contact with any metal work or other conductive material except the metal plates on receptacles.

Order 13-3426. Supports.

Non-metallic surface extensions shall be secured in place by approved means at intervals not exceeding 8 inches, except that where connection to the supplying outlet is made by means of an attachment plug the first fastening may be placed 12 inches or less from the plug. There shall be at least one fastening between each two adjacent outlets supplied.

Order 13-3427. Splices and Taps.

Extensions shall consist of a continuous unbroken length of the assembly, without splices, and without exposed conductors between fittings. Taps may be made if fittings completely covering the tap connections are used.

Order 13-3428. Bends.

A bend in an assembly which reduces the normal spacing between the conductors shall be covered with a cap to protect the assembly from mechanical injury.

Order 13-3429. Fittings.

Each run of an assembly shall terminate in a fitting which covers the end of the assembly. All fittings and devices shall be of a type approved for the purpose.

SECTION 13-346. RIGID METAL CONDUIT

Order 13-3461. Scope.

Installations of rigid metal conduit shall comply with the provisions of orders 13-3001 to 13-3055, inclusive, and in addition shall comply with the provisions of the following orders 13-3462 to 13-3471, inclusive.

Order 13-3462. Use.

Rigid metal conduit may be used under all atmospheric conditions and occupancies, except that ferrous raceways and fittings protected from corrosion solely by enamel may be used only indoors and in occupancies not subject to severe corrosive influences. Conduits and fittings exposed to severe corrosive influences shall be of corrosion-resistant material suitable for the conditions. If practicable, the use of dissimilar metals throughout the system shall be avoided to eliminate the possibility of galvanic action.

Meat-packing plants, tanneries, hide cellars, casing rooms, glue houses, fertilizer rooms, salt storage, some chemical works, metal refineries, pulp and paper mills, sugar mills, round houses, some stables, and similar locations are judged to be occupancies where severe corrosive conditions are likely to be present.

Order 13-3463. Cinder Fill.

Conduit, unless of corrosion-resistant material suitable for the purpose, shall not be used in or under cinder fill where subject to permanent moisture unless protected on all sides by a layer of non-cinder concrete at least 2 inches thick or unless the conduit is at least 18 inches under the fill.

Order 13-3464. Wet Locations.

In portions of dairies, laundries, canneries, and other wet locations, and in locations where walls are frequently washed, the entire conduit system, including all boxes and fittings used therewith, shall be made watertight.

Order 13-3465. Minimum Size.

No conduit smaller than ½ inch, electrical trade size, shall be used, except as provided for under-plaster extensions in Section 13-358, and for enclosing the leads of fractional horsepower motors as permitted in order 13-4439.

Order 13-3466. Number of Conductors in Raceway.

One conduit shall not contain more conductors of a given size than are specified in Tables 4 to 11 of Chapter 10.

Order 13-3467. Reaming.

All ends of conduit shall be reamed to remove rough edges.

Order 13-3468. Bushings.

Where a conduit enters a box or other fitting, a bushing shall be provided to protect the wire from abrasion unless the design of the box or fitting is such as to afford equivalent protection. See sub-paragraph B of order 13-3012 for the protection of conductors at bushings.

Order 13-3469. Couplings.

Threadless couplings and connectors used with conduit shall be made up tight. They shall be of the water-tight type if buried in masonry, concrete or fill or if installed in wet places. Running threads shall not be used on conduit.

Order 13-3470. Bends—How Made.

Bends of rigid conduit shall be so made that the conduit will not be injured, and that the internal diameter of the conduit will not be effectively reduced. The radius of the curve of the inner edge of any field bend shall be not less than 6 times the internal diameter of the conduit where rubber covered conductors are used, and not less than 10 times the internal diameter of the conduit where lead covered conductors are used.

Order 13-3471. Bends—Number in One Run.

A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of 4 quarter bends, including those bends located immediately at the outlet or fitting.

SECTION 13-348. ELECTRICAL METALLIC TUBING

Order 13-3481. Scope.

Installations of electrical metallic tubing shall comply with the provisions of orders 13-3001 to 13-3055, inclusive, and in addition shall comply with the provisions of the following orders 13-3482 to 13-3491, inclusive.

Order 13-3482. Use.

Electrical metallic tubing may be used for both exposed and concealed work. Electrical metallic tubing shall not be used (1) where during installation or afterwards, it will be subject to severe mechanical injury; (2) in cinder concrete or fill unless protected on all sides by a layer of non-cinder concrete at least 2 inches thick or unless the tubing is at least 18 inches under the fill; (3) in any hazardous locations; (4) where exposed to corrosive vapor except as permitted in order 13-3483.

Order 13-3483. Corrosive Fumes.

If tubing is exposed to corrosive fumes or vapors such as may exist in meat packing plants, tanneries, hide cellars, casing rooms, glue houses, fertilizer rooms, salt storage, some chemical works, metal refineries, pulp mills, sugar mills, round houses, some stables, and similar locations tubing and fittings of corrosion-resistant material suitable for the conditions shall be used. If practicable, the use of dissimilar metals throughout the system shall be avoided to eliminate the possibility of galvanic action.

Order 13-3484. Wet Locations.

In portions of dairies, laundries, canneries, and other wet locations, and in locations where walls are frequently washed, the entire tubing system, including all boxes and fittings used therewith, shall be made watertight.

Order 13-3485. Conductor Size.

Tubing shall not be used to contain conductors larger than No. 0.

Order 13-3486. Minimum and Maximum Sizes.

No tubing smaller than ½ inch, electrical trade size, shall be used except as provided for underplaster extensions in Section 13-358 and for enclosing the leads of fractional horsepower motors as permitted in order 13-4439. The maximum size of tubing shall be the 2 inch electrical trade size.

Order 13-3487. Number of Conductors in Raceway.

One tubing shall not contain more conductors of a given size than are specified in Tables 4 to 11 of Chapter 10.

Order 13-3488. No Threads.

Tubing shall not be coupled together nor connected to boxes, fittings or cabinets, by means of threads in the wall of the tubing.

Order 13-3489. Couplings and Connectors.

Threadless couplings and connectors used with tubing shall be made up tight, and shall be of the watertight type if buried in masonry, concrete or fill or if installed in wet places.

Order 13-3490. Bends—How Made.

Bends in the tubing shall be so made that the tubing will not be injured and that the internal diameter of the tubing will not be reduced. The radius of the curve of the inner edge of any field bend shall be not less than 6 times the internal diameter of the tubing where unleaded conductors are used, and not less than 10 times the internal diameter of the tubing where lead covered conductors are used.

Order 13-3491. Bends—Number in One Run.

A run of electrical metallic tubing between outlet and outlet, between fitting and fitting, or between outlet and fitting, shall not contain more than the equivalent of four quarter bends, including those bends located immediately at the outlet or fitting.

SECTION 13-350. FLEXIBLE METAL CONDUIT

Order 13-3501. Scope.

Installations of flexible metal conduit shall comply with the provisions of orders 13-3001 to 13-3054, orders 13-3343, 13-3344, 13-3346, 13-3347, and of orders 13-3465 to 13-3469, inclusive, and in addition shall comply with the provisions of the following order 13-3502.

Order 13-3502. Use.

Flexible metal conduit shall not be used (1) in wet locations, unless conductors are of the lead covered type or of other type specially approved for the conditions; (2) in hoistways, except as provided in order 13-6206; (3) in storage battery rooms; (4) in any hazardous location except as permitted by orders 13-5014, 13-5056 and 13-5075 for flexible connection to motors; nor (5) where rubber covered conductors are exposed to oil, gasoline, or other materials having a deteriorating effect on rubber.

SECTION 13-352. SURFACE METAL RACEWAY

Order 13-3521. Scope.

Installations of surface metal raceways shall comply with the provisions of orders 13-3001 to 13-3054, inclusive, and in addition shall comply with the provisions of the following orders 13-3522 to 13-3527, inclusive.

Order 13-3522. Use.

Surface metal raceway may be used in dry locations. It shall not be used (1) where concealed, except that the back and sides of multioutlet assembly may be surrounded by the building finish; and metal raceways approved for the purpose may be used for under-plaster extensions; (2) where subject to severe mechanical injury unless approved for the purpose; (3) where the voltage is 300 volts or more between conductors unless the metal has a thickness of not less than .040 inches; (4) where subject to corrosive vapors; (5) in hoistways; (6) in storage battery rooms; nor (7) in any hazardous location.

Order 13-3523. Size of Conductors.

No conductor larger than No. 6 shall be installed in surface metal raceway.

Order 13-3524. Number of Conductors in Raceway.

The number of conductors installed in any raceway shall not be greater than the number for which the raceway is approved, and in

no case shall more than 10 conductors be installed in a single raceway compartment except as permitted for signal and control systems in sub-paragraphs 13-8006-A-1 and 13-8012-B-2.

Order 13-3525. Extension Through Walls and Floors.

Except in multi-outlet assemblies, raceways may be extended through dry walls, dry partitions and dry floors, if in unbroken lengths where passing through.

Order 13-3526. Combination Raceways.

If combination metal raceways are used both for signal and for lighting and power circuits, the different systems shall be run in separate compartments, identified by sharply contrasting colors of the interior finish, and the same relative position of compartments shall be maintained throughout the premises, in which case the provisions of order 13-3013 and of order 13-8012-B-2, shall be considered as having been observed.

Order 13-3527. Multi-Outlet Assembly.

Multi-outlet assembly, and all fittings used in connection with the assembly, shall be approved for the purpose.

SECTION 13-354. UNDERFLOOR RACEWAY

Order 13-3541. Scope.

Installations of underfloor raceways shall comply with the provisions of orders 13-3001 to 13-3054, inclusive, and in addition shall comply with the provisions of the following orders 13-3542 to 13-3556, inclusive.

Order 13-3542. Use.

Underfloor raceway may be used when installed beneath the surface of concrete or other flooring material. Open bottom type of raceways may be used in concrete fill between the rough and the finished floor only. Raceways laid flush with concrete floors and covered with linoleum not less than ⅛ inch in thickness or equivalent floor covering, may be used only for signal and control systems as covered by Section 13-800. Underfloor raceways shall not be used (1) where subject to corrosive vapors; (2) in any hazardous locations; (3) in commercial garages; nor (4) in storage battery rooms.

Order 13-3543. Covering.

Raceways of half round sections or of flat-top section not over 4 inches in width shall have at least ¾ inch of concrete or wood above the raceway, except in office occupancies metal flat-top raceways not over 2 inches in width may be laid flush with the concrete if covered with substantial linoleum not less than ⅛ inch in thickness or equivalent floor covering. Flat-top raceways over 4 inches in width and flat-top raceways placed less than ½ inch apart, shall be covered with concrete to a depth of at least 1½ inches.

Order 13-3544. Size of Conductors.

No conductor larger than No. 4 shall be installed in underfloor raceways.

Order 13-3545. Number of Conductors in Raceway.

The combined cross-sectional area of all conductors shall not exceed 40 per cent of the interior area of the raceway; except that if the raceway contains only armored cable or non-metallic sheathed cable, these requirements shall not apply.

Order 13-3546. Splices and Taps.

Splices or taps shall be made only in junction boxes.

Order 13-3547. Discontinued Outlets.

When an outlet is discontinued, the conductors supplying the outlet shall be removed from the raceway.

Order 13-3548. Open-Bottom Raceway—How Laid.

Open-bottom raceway shall be laid on a smooth pad of concrete extending at least 1 inch on each side of the raceway and at least 1 inch thick, except that this thickness may be reduced to ¼ inch where the raceway crosses a run of conduit, and except that in lieu of a concrete pad, fittings which will protect the conductors from contact with piping, structural steel and other obstructions may be used. Raceways shall be mechanically secured to the concrete pad.

Order 13-3549. Laid in Straight Lines.

Underfloor raceways shall be laid so that a straight line from the center of one junction box to the center of the next junction box will coincide with the center line of the raceway system. Raceways shall be made mechanically secure to prevent disturbing this alignment during construction.

Order 13-3550. Markers at Ends.

At every end of line of raceway, a fitting shall be installed extending through the floor to mark the line of the duct. Where a duct line is interrupted by another duct line, but continues in a straight line beyond, and has junction boxes or outlets on either side of the crossing line, no markers are necessary at the interrupting point.

Order 13-3551. Dead Ends.

Dead ends of raceways shall be closed.

Order 13-3552. Low Points.

Where practicable, raceways and their fittings shall be so arranged as to avoid low points that may form traps for water.

Order 13-3553. Special Fittings at Angles.

Where raceways are run at other than right angles, special fittings shall be provided, if in the judgment of the authority enforcing this code, these are necessary.

Order 13-3554. Junction Boxes.

Junction boxes shall be leveled to the floor grade and sealed against the entrance of water. Junction boxes used with metal raceways shall be metal and shall be electrically continuous with the raceways.

Order 13-3555. Inserts.

Inserts shall be leveled to the floor grade and sealed against the entrance of water. Inserts used with metal raceways shall be metal and shall be electrically continuous with the raceway. Inserts set in or on fiber raceways before the floor is laid shall be mechanically secured to the raceway. Inserts set in fiber raceways after the floor is laid shall be screwed into the raceway. In cutting through the raceway wall and setting inserts, chips and aother dirt shall not be allowed to fall into the raceway, and tools shall be used which are so designed as to prevent the tool from entering the raceway and injuring conductors that may be in place.

Order 13-3556. Connections to Cabinets and Wall Outlets.

Connections between raceways and distribution centers and wall outlets shall be made by means of rigid or flexible metal conduit or by means of fittings specially approved for the purpose.

SECTION 13-356. CELLULAR METAL FLOOR RACEWAYS

Order 13-3561. Scope.

Installations of cellular metal floor raceways shall comply with the provisions of orders 13-3001 to 13-3054, inclusive, and in addition shall comply with the provisions of the following orders 13-3562 to 13-3570. For the purposes of this section a "cellular metal floor raceway" shall be defined as the hollow spaces of cellular metal floors, together with suitable fittings, which may be approved as enclosures for electrical conductors; a "cell" shall be defined as a single, enclosed tubular space in a cellular metal floor member, the axis of the cell being parallel to the axis of the metal floor member; a "header" shall be defined as a transverse raceway for electrical conductors, providing access to predetermined cells of a cellular metal floor, thereby permitting the installation of electrical conductors from a distribution center to the cells.

Order 13-3562. Use.

Conductors shall not be installed in cellular metal floor raceways (1) where subject to corrosive vapor; (2) in any hazardous location; (3) in theaters; (4) in commercial garages, except for supplying ceiling outlets or extensions to the area below the floor but not above; nor (5) in storage battery rooms. No electric conductors shall be installed in any cell or header which contains a pipe for steam, water, air, gas, drainage, or other service than electrical.

Order 13-3563. Size of Conductors.

No conductor larger than No. 0 shall be installed, except by special permission.

Order 13-3564. Number of Conductors in Raceway.

The combined cross-sectional area of all conductors shall not exceed 40 per cent of the interior area of the header feeding the individual cells; except that if the raceway contains only armored cable or nonmetallic sheathed cable, these requirements shall not apply.

Order 13-3565. Splices and Taps.

Splices and taps shall be made only in header access units or junction boxes.

Order 13-3566. Discontinued Outlets.

When an outlet is discontinued, the conductors supplying the outlet shall be removed from the raceway.

Order 13-3567. Markers.

A suitable number of markers shall be installed extending through the floor for the future locating of cells and for system identification.

Order 13-3568. Junction Boxes.

Junction boxes shall be leveled to the floor grade and sealed against the entrance of water. Junction boxes used with these raceways shall be of metal and shall be electrically continuous with the raceway.

Order 13-3569. Inserts.

Inserts shall be levelled to the floor grade and sealed against the entrance of water. Inserts shall be of metal and shall be electrically continuous with the raceway. In cutting through the cell wall and setting inserts, chips and other dirt shall not be allowed to fall into the raceway, and tools shall be used which are designed to prevent the tool from entering the cell and injuring the conductors.

Order 13-3570. Connection to Cabinets and Extensions from Cells.

Connections to cabinets and extensions from cells to outlets shall be made by means of rigid or flexible conduit or by means of fittings approved for the purpose.

SECTION 13-358. UNDERPLASTER EXTENSIONS

Order 13-3581. Use.

Underplaster extensions, installed as permitted by orders 13-3582 to 13-3584, inclusive, may be used only for extensions of existing branch circuits, if laid on the face of masonry or other material and buried in the plaster finish of ceilings or walls, in buildings of fire-resistive construction.

Order 13-3582. Materials.

Such extensions shall be run in rigid or flexible conduit, armored cable, electrical metallic tubing or metal raceways approved for the purpose. Standard sizes of conduit, cable, tubing and raceways shall be used except that for single conductors only, conduit or tubing having not less than 5/16th inch inside diameter or single-conductor armored cable may be used.

Order 13-3583. Limit of Run.

No such extension shall extend beyond the floor on which it originates unless standard sizes of rigid conduit, electrical metallic tubing or armored cable are employed.

Order 13-3584. Methods of Installation.

The methods of installation for such extensions shall be as specified elsewhere in this code for the particular type of material used, except that when alternating current is to be employed, all of the conductors of a circuit need not be contained in a single raceway or cable.

SECTION 13-362. WIREWAYS

Order 13-3621. Scope.

Installations of wireways shall comply with the provisions of orders 13-3001 to 13-3054, inclusive, and in addition shall comply with the provisions of the following orders 13-3622 to 13-3630, inclusive.

Order 13-3622. Use.

Wireways may be used only for exposed work in dry locations in industrial occupancies and garages. Wireways shall not be used (1) where subject to severe mechanical injury or corrosive vapor; (2) in hoistways; (3) in any hazardous location; nor (4) in storage battery rooms.

Order 13-3623. Size of Conductors.

No conductor larger than 500,000 c.m. shall be installed in any wireway.

Order 13-3624. Number of Conductors in Raceway.

Wireways shall not contain more than 30 conductors at any cross section, unless the conductors are for signaling circuits or are control conductors between a motor and its starter and used only for starting duty. The sum of the cross-sectional areas of all contained conductors at any cross section of a wireway shall not exceed 20 per cent of the interior cross-sectional area of the wireway.

Order 13-3625. Splices and Taps.

Splices or taps, made and insulated by approved methods, may be located within the wireway if they are accessible by means of hinged covers. The conductors, including splices and taps, shall not fill the wireway to more than 75 per cent of its area.

Order 13-3626. Supports.

Wireways shall be securely supported at intervals not exceeding 5 feet, unless specially approved for supports at greater intervals, but in no case shall the distance between supports exceed 10 feet.

Order 13-3627. Extension Through Walls.

Wireways may extend transversely through dry walls if in unbroken lengths where passing through.

Order 13-3628. Dead-Ends.

Dead-ends of wireways shall be closed.

Order 13-3629. Extensions from Wireways.

Extensions from wireways shall be made with rigid or flexible metal conduit, electrical metallic tubing, surface metal raceway or armored cable.

Order 13-3630. Marking.

Wireways shall be marked so that their manufacturer's name or trade-mark will be visible after installation.

SECTION 13-364. BUSWAYS

Order 13-3641. Scope.

Installations of busways shall comply with the provisions of orders 13-3001 to 13-3054, inclusive, and in addition shall comply with the provisions of the following orders 13-3642 to 13-3648, inclusive.

Order 13-3642. Use.

Busways may be used for exposed work in any dry location. Busways shall not be used (1) where subject to severe mechanical injury or corrosive vapors; (2) in hoistways; (3) in any hazardous location; nor (4) in storage battery rooms.

Busways may be used for service-entrance conductors. See order 13-2331.

Order 13-3643. Support.

Busways shall be securely supported at intervals not exceeding 5 feet, unless specially approved for supports at greater intervals, but in no case shall the distance between supports exceed 10 feet.

Order 13-3644. Extension Through Walls.

Busways may extend transversely through dry walls if in unbroken lengths where passing through.

Order 13-3645. Dead-Ends.

Dead-ends of busways shall be closed.

Order 13-3646. Branches from Busways.

Branches from busways shall be made with busways or with rigid or flexible metal conduit, electrical metallic tubing, surface metal raceway, armored cable or, for portable appliances, with suitable cord assemblies approved for hard usage.

Order 13-3647. Overcurrent Devices.

Devices or plug-in connections used with cord assemblies for tapping off portable appliances from busways shall contain the overcurrent devices required for the appliance, unless the busway is supplied from one of the branch circuits of Section 13-210 and in accordance with the requirements therein specified. Other devices or plug-in connections for tapping off branches from busways shall contain the overcurrent devices required for the branch circuit, except as noted in order 13-2434. Devices or plug-in connections shall be of approved types and, where not readily accessible, the overcurrent unit shall be enclosed or guarded until it is disconnected from its supply.

Order 13-3648. Marking.

Busways shall be marked with the voltage and current rating for which they are designed, and with the manufacturer's name or trademark, in such a manner as to be visible after installation.

SECTION 13-370. OUTLET, SWITCH AND JUNCTION BOXES, AND FITTINGS, CABINETS AND CUTOUT BOXES

Order 13-3701. Required.

Outlet boxes or fittings shall be installed at all outlets and switch points as required by order 13-3014. Special types of boxes and fittings are required for hazardous locations under Section 13-500. Metallic outlet boxes used with knob and tube work or non-metallic sheathed cable, and mounted on metal or metal lath ceilings or walls, shall be insulated from their supports and from the metal or metal lath, or shall be grounded.

Order 13-3702. Use of Round Outlet Boxes.

Round outlet boxes shall not be used where conduits or connectors requiring the use of locknuts or bushings are to be connected to the side of the box.

Order 13-3703. Boxes Enclosing Flush Devices.

Boxes used to enclose flush devices shall be of such design that the devices will be completely enclosed on back and sides, and that substantial support for the devices will be provided. Screws for supporting the box shall not be used in attachment of the device contained therein.

Order 13-3704. Depth of Boxes for Concealed Work.

Outlet boxes for concealed work shall have an internal depth of at least 1½ inches, except that where the installation of such a box will result in injury to the building structure or is impracticable, a box not less than ½ inch internal depth may be installed.

Order 13-3705. Number of Conductors in a Box.

Boxes shall be of sufficient size to provide free space for all conductors enclosed in the box.

A. The maximum number of conductors, not counting fixture wires, permitted in outlet and junction boxes shall be as in the following tables with the exceptions noted:

DEEP BOXES

Box Dimensions Trade Size	Maximum Number of Conductors No. 14	No. 12	No. 10	No. 8
1½x3¼ octagonal	5	5	4	0
1½x4 octagonal	8	7	6	5
1½x4 square	11	9	7	5
1½x4 1/16 square	16	12	10	8
2⅛x4 1/16 square	20	16	12	10
1¾x2¾x2	5	4	4	
1¾x2¾x2½	6	6	5	
1¾x2¾x3	7	7	6	

SHALLOW BOXES OF LESS THAN 1½" DEPTH

Box Dimensions Trade Size	Maximum Number of Conductors No. 14	No. 12	No. 10
3¼	4	4	3
4	6	6	4
4 1/16	8	6	6

The above tables apply where no fittings or devices such as fixture studs, hickeys, cable clamps, switches or receptacles are contained in the box. Where a fixture stud, cable clamp or hickey is contained in the box, the number of conductors permitted shall be one less than shown in tables; and where a switch or receptacle is contained in the box the number of conductors permitted shall be two less than shown in tables. A conductor running through the box is counted as one conductor and each conductor terminating in a box is also counted as one conductor.

B. For combinations not shown in above tables the following table shall apply:

Size of Conductor	Free Space Within Box for Each Conductor
No. 14	2. cubic inches
No. 12	2.25 cubic inches
No. 10	2.5 cubic inches
No. 8	3. cubic inches

C. The limitations in sub-paragraphs A and B of this order shall not apply to terminal housings supplied with motors, nor to types of boxes or fittings without knockout and having hubs or recessed parts for terminal bushings and locknuts.

Paragraphs A and B of order 13-3705 do not apply to conductors of Types RHT, **RPT, RU, or SN.**

Order 13-3706. Pull Boxes.

Pull boxes shall conform to the following:

A. *Minimum Size.* For raceways of 1¼ inch trade size and larger, the dimensions of a pull box installed in a run of raceway shall conform to the following:

1. Straight Pulls. In straight pulls the length of the box shall be not less than 8 times the trade diameter of the largest raceway.

2. Angle or U Pulls. Where angle or U pulls are made, the distance between each terminal fitting of a raceway inside the box and

the opposite wall of the box shall not be less than 6 times the trade diameter of the raceway. This distance shall be increased for additional raceway entries by the amount of the sum of the diameters of all other raceway entries.

3. Exceptions. The limitations of sub-paragraphs 1 and 2 of this order are not intended to apply to terminal housings supplied with motors, nor to types of boxes or fittings without knockouts and having hubs or recessed ports for terminal bushings and locknuts.

B. *Conductors in Pull Boxes.* In large pull boxes all conductors shall be cabled or racked up in an approved manner.

Order 13-3707. Covers and Canopies.

In completed installations each outlet box shall be provided with a cover unless a fixture canopy is used.

A. If a fixture canopy is used, any combustible wall or ceiling finish exposed between the edge of the canopy and the outlet box shall be covered with non-combustible material.

B. Non-metallic covers and plates shall be used with non-metallic outlet boxes, except that a metal cover or plate may be used if covered on the exposed side with non-metallic material. Screws shall not be used for fastening such covers or plates to non-metallic boxes unless located in such position that they cannot come in contact with live parts or live conductors in the box, or unless the exposed screw heads are covered with non-metallic material.

Order 13-3708. Covers With Holes for Conductors.

Covers of outlet boxes and outlet fittings having holes through which flexible cord pendants pass, shall be provided with bushings designed for the purpose or shall have smooth, well rounded surfaces on which the cord may bear. So-called hard rubber or composition bushings shall not be used. If conductors other than flexible cord pass through a metal cover, there shall be provided a separate hole for each conductor, said hole being equipped with a bushing of insulating material.

Order 13-3709. Supports—General.

Boxes, fittings and cabinets shall be securely fastened in place. Boxes and fittings, not over 100 cubic inches in size, which are attached to firmly secured exposed raceway by threading or other connection designed for the purpose, are considered as so fastened.

A. *Concealed Work.* In concealed work, except as prescribed in paragraph B of this order, outlet boxes and fittings, unless securely held in place by concrete, masonry or other building material in which they are embedded, shall be secured to a stud, joist or similar fixed structural unit, or to a metal or wooden support which is secured to such a structural unit. Wooden supports shall be not less than ⅞ inch in thickness. Lath of wood, metal or composition shall not be considered a structural unit.

B. *Exposed Work.* In exposed work, and in concealed work in existing buildings where conductors or cables are fished and outlet

boxes cannot be secured as provided in paragraph A of this order without disturbing the building finish, the boxes may be mounted directly upon the plaster surface if securely fastened in place.

Order 13-3710. Fastened to Gas Pipes.

Outlet boxes used where gas outlets are present shall be so fastened to the gas pipes as to be mechanically secure.

Order 13-3711. Position in Wall.

In walls or ceilings of concrete, tile or other non-combustible material, boxes, fittings and cabinets shall be so installed that the front edge of the box or fitting will not set back of the finished surface more than ¼ inch. In walls and ceilings constructed of wood or other combustible material, outlet boxes, fittings and cabinets shall be flush with the finished surface or project therefrom.

Order 13-3712. Repairing Plaster.

Except on walls or ceilings of concrete, tile or other non-combustible material, a plaster surface which is broken or incomplete shall be repaired so that there will be no gaps or open spaces at the edge of the box or fitting.

Order 13-3713. Junction Boxes to Be Accessible.

Junction boxes shall be so installed that the wiring contained in them may be rendered accessible without removing any part of the building. In finished rooms, wiring and splices in a junction or outlet box having a blank cover, and not more than 6 inches back of the finished wall or ceiling surface, shall be considered accessible when one or more suitable markers extend through the plaster, paint or other finish for future location and identification of the box.

Order 13-3714. Conductors Entering Metal Boxes.

Where metal outlet boxes, fittings or cabinets are used with open wiring or knob-and-tube work, conductors shall enter through insulating bushings or, in dry places, through flexible tubing extending from the last insulating support and firmly secured to the box or fitting. Openings through which the conductors enter shall be adequately closed.

Order 13-3715. Raceways and Cable Entering Metal Boxes.

Where raceway or cable is used with metal outlet boxes, fittings or cabinets, the raceway or cable shall be secured to outlet boxes, fittings and cabinets. The conductors entering the box, fitting or cabinet shall be protected from abrasion and the openings through which the conductors enter shall be adequately closed.

Order 13-3716. Non-Metallic Outlet Boxes.

Non-metallic outlet boxes may be used only with open wiring on insulators, concealed knob-and-tube work, non-metallic sheathed cable, and with non-metallic waterproof wiring. In open wiring, and knob-and-tube work, the individual conductors shall enter the non-metallic box through individual holes. Where flexible tubing is used to encase

the conductor between the last support and the box, this may be run into the box or terminated at the wall of the box. Where non-metallic sheathed cable is used with non-metallic outlet boxes, the cable assembly shall enter the box through a knockout opening. Clamping of individual conductors or of cables to boxes is not required if supported within 6 inches of the box. Openings through which the conductors or cables enter boxes shall be adequately closed.

Order 13-3717. Enamel Coated Boxes and Fittings.

Ferrous metal boxes and fittings protected from corrosion solely by enamel may be used only indoors and in occupancies not subject to severe corrosive influences.

Meat packing plants, tanneries, hide cellars, casing rooms, glue houses, fertilizer rooms, salt storage, some chemical works, metal refineries, pulp mills, sugar mills, round houses, some stables, and similar locations are judged to be occupancies where severe corrosive conditions are likely to be present.

Order 13-3718. Unused Openings.

Unused openings in boxes, fittings and cabinets shall be effectively closed to afford protection substantially equivalent to that of the wall of the box, fitting or cabinet. Metal plugs or plates shall not be used with non-metallic boxes, fittings or cabinets unless recessed at least ¼ inch from the outer surface.

Order 13-3719. Exposed Extensions.

In making an exposed extension from an existing outlet of concealed wiring, a box, extension ring or blank cover shall be mounted over the original box and electrically and mechanically secured to it. The extension shall then be connected to this box in the manner prescribed for the method of wiring employed in making the extension.

Order 13-3720. Damp or Wet Locations.

In damp or wet locations, boxes, fittings and cabinets shall be so placed or equipped as to prevent moisture or water from entering and accumulating within the box, fitting or cabinet. Boxes, fittings and cabinets installed in wet locations shall be weatherproof. For boxes in floors, see order 13-4173.

It is recommended that boxes of non-conductive material be used with non-metallic sheathed cable when such cable is used in locations where there is likely to be moisture present.

Order 13-3721. Side or Back Wiring Spaces or Gutters.

Cabinets and cutout boxes shall be provided with back wiring spaces, gutters or wiring compartments as required by sub-paragraphs C and D of order 13-93706.

SECTION 13-374. AUXILIARY GUTTERS

Order 13-3741. Purpose.

Auxiliary gutters, used to supplement wiring spaces at meter centers, distribution centers, switchboards and similar points of interior wiring systems, may enclose conductors or bus bars, but shall not be used to enclose switches, overcurrent devices or other appliances or apparatus.

Order 13-3742. Extension Beyond Equipment.

An auxiliary gutter shall not extend a greater distance than 30 feet beyond the equipment which it supplements except in elevator work. Any extension beyond this distance shall comply with the provisions for wireways in Section 13-362 or with the provisions for busways in Section 13-364.

Order 13-3743. Supports.

Gutters shall be supported throughout their entire length at intervals not exceeding 5 feet.

Order 13-3744. Covers.

Covers shall be securely fastened to the gutter.

Order 13-3745. Number of Conductors in Raceway.

Auxiliary gutters shall not contain more than 30 conductors at any cross section unless the conductors are for signalling circuits or are control conductors between a motor and its starter and used only for starting duty. The sum of the cross sectional areas of all contained conductors at any cross section of an auxiliary gutter shall not exceed 20 per cent of the interior cross sectional area of the gutter.

For elevators see order 13-6215.

Order 13-3746. Carrying Capacity of Copper Bars.

The current carried continuously in bare conductors in auxiliary gutters shall not exceed 1000 amperes per square inch of cross section of the conductor.

Order 13-3747. Clearance of Bare Live Parts.

Bare conductors shall be securely and rigidly supported so that the minimum clearance between bare current carrying metal parts of opposite polarities mounted on the same surface shall be not less than 2 inches, nor less than 1 inch for parts that are held free in the air. A spacing not less than 1 inch shall be secured between bare current carrying metal parts and any metal surface. Adequate provision shall be made for expansion and contraction of copper bars.

Order 13-3748. Splices and Taps.

Splices and taps shall conform to the following:

A. Splices or taps, made and insulated by approved methods, may be located within gutters if they are accessible by means of removable covers or doors. The conductors, including splices and taps, shall not fill the gutter to more than 75 per cent of its area.

B. Taps from bare conductors shall leave the gutter opposite their terminal connections and conductors shall not be brought in contact with uninsulated current carrying parts of opposite polarity.

C. All taps shall be suitably identified at the gutter as to the circuit or equipment which they supply.

D. Tap connections from conductors in auxiliary gutters shall be provided with overcurrent protection in conformity with the provisions of order 13-2434.

Order 13-3749. Construction.

Auxiliary gutters shall be constructed in accordance with the following:

A. Gutters shall be so constructed and installed that adequate electrical and mechanical continuity of the complete raceway system will be secured.

B. Gutters shall be of substantial construction and shall provide a complete enclosure for the contained conductors. All surfaces, both interior and exterior, shall be suitably protected from corrosion. Corner joints shall be made tight and where the assembly is held together by rivets or bolts, these shall be spaced not more than 12 inches apart.

C. Suitable bushings, shields or fittings having smooth rounded edges shall be provided where conductors pass between gutters, through partitions, around bends, between gutters and cabinets or junction boxes and at other locations where necessary to prevent abrasion of the insulation of the conductors.

D. Gutters shall be constructed of sheet metal of thicknesses not less than in the following table:

Maximum Width of the Widest Surface of Gutters	Thickness (USS Sheet Steel Gauge)	
Up to and including 6 inches	No. 16	.0598 inch
Over 6 in. and not over 18 in.	No. 14	.0747 inch
Over 18 in. and not over 30 in.	No. 12	.1046 inch
Over 30 inches	No. 10	.1345 inch

SECTION 13-380. SWITCHES

Order 13-3801. Grounded Conductors.

No switch or circuit-breaker shall disconnect the grounded conductor of a circuit unless the switch or circuit-breaker simultaneously disconnects the ungrounded conductor or conductors, or unless the switch or circuit-breaker is so arranged that the grounded conductor cannot be disconnected until the ungrounded conductor or conductors have first been disconnected.

Order 13-3802. Three-Way and Four-Way Switches.

Three-way and four-way switches shall be so wired that all switching is done only in the ungrounded circuit conductor. Wiring between switches and outlets shall, if in metal enclosures, be run with both polarities in the same enclosure.

Order 13-3803. Enclosures.

Enclosures shall be selected which have sufficient space to accommodate all conductors installed therein. Switches and circuit-breakers, except pendent and surface type snap switches, unless of the oil immersed type, shall be of the externally operable type enclosed in metal boxes or cabinets.

Order 13-3804. Wet Places.

If a switch or circuit-breaker is located in a wet place or outside of a building, it shall be enclosed in a weatherproof box or cabinet.

Order 13-3805. Time Switches, Flashers.

Time switches, flashers, and similar devices shall be enclosed in metal boxes or cabinets but need not be of the externally operable type.

Order 13-3806. Position of Knife Switches.

Single-throw knife switches shall be so placed that gravity will not tend to close them. Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal as preferred, but if the throw be vertical a locking device shall be provided which will insure the blades remaining in the open position when so set.

Order 13-3807. Connection of Knife Switches.

If practicable, knife switches shall be so connected that the blades will be dead when the switch is open.

Order 13-3808. Accessibility and Grouping.

Switches and circuit-breakers shall be accessible and, so far as possible, shall be grouped.

Order 13-3809. Covers of Flush Snap Switches.

Flush snap switches, if mounted in ungrounded metal boxes and located within reach of conducting floors or other conducting surfaces, shall be provided with covers of non-conducting material.

Order 13-3810. Mounting of Surface Type Snap Switches.

Snap switches used with open wiring on insulators shall be mounted on sub-bases of insulating material which will separate the conductors at least ½ inch from the surface wired over.

Order 13-3811. Circuit-Breakers as Switches.

A circuit-breaker operable directly by applying the hand to a lever or handle may serve as a switch provided it has the number of poles required for such switch.

Order 13-3812. Grounding of Enclosures.

Enclosures for switches or circuit-breakers on circuits of over 150 volts to ground shall be grounded in the manner specified in Section 13-250, except where accessible to qualified operators only.

Order 13-3813. Knife Switches.

Knife switches rated for more than 1200 amperes at 250 volts or less, and for more than 600 amperes at 251 to 600 volts, shall be used only as isolating switches and shall not be opened under load. To interrupt currents greater than 1200 amperes at 250 volts or less, or 600 amperes at 251 to 600 volts, a circuit-breaker or a switch of special design approved for such purpose shall be used. Knife switches of lower rating may be used as general use switches and may be opened under load. Motor circuit switches (see definition) may be of the knife switch type.

Order 13-3814. Rating of Snap Switches.

For the special applications specified, snap switches shall be rated as follows:

A. A snap switch having a "T" rating may control a current equal to the rating of the total non-inductive load supplied through it, including tungsten lamps.

B. Snap switches used to control circuits supplying mercury vapor and gas tube lamps and their transformers should be either of a type approved with the assembly or have a current rating not less than twice the current requirement of the lamps or transformers.

For switches on signs and gas tube lighting, see order 13-6005.

SECTION 13-384. SWITCHBOARDS AND PANELBOARDS

Order 13-3841. Scope.

The requirements of this section shall apply to all switchboards, panelboards, and distribution boards used for the control of light and power circuits, except switchboards in utility company operated central stations and/or sub-stations, which directly control energy derived from generators or transforming devices, and except switchboards or portions thereof used exclusively to control signal circuits operated by batteries. The requirements of this section shall apply to battery charging panels if current is taken from light or power circuits.

Order 13-3842. Application of Other Sections.

Switches, circuit-breakers and overcurrent devices used on switchboards, panelboards and distribution boards, the boards and their enclosures, shall conform to the requirements of Sections 13-240, 13-370, 13-380 and other sections which apply. Switchboards and panelboards in hazardous locations shall conform to the requirements of Section 13-500.

Order 13-3843. Support of Bus Bars and Conductors.

Conductors and bus bars on a switchboard, panelboard or control board, shall be so located as to be free from mechanical injury and shall be held in such a manner as to be rigid.

SWITCHBOARDS

Order 13-3851. Location of Switchboards Over 150 Volts to Ground.

Switchboards which have any exposed live parts above 150 volts to ground, or live parts on ungrounded circuits exposed to voltages of more than 150 volts to ground, shall be located only where under competent supervision and accessible only to qualified persons.

Order 13-3852. Not to Be Exposed to Moisture.

Switchboards shall be so located that they will not be exposed to moisture.

Order 13-3853. Location Relative to Easily Ignitible Material.

Switchboards shall be so placed as to reduce to a minimum the probability of communicating fire to adjacent easily ignitible material.

Order 13-3854. Clearance from Ceiling.

Switchboards shall not be built up to a non-fireproof ceiling, a space of three feet being left between the ceiling and the board, unless an adequate fire-proof shield is provided between the board and the ceiling.

Order 13-3855. Clearance Back of Switchboard.

If the equipment or wiring on the back of the switchboard is accessible only from the space behind the board, there shall be a clear space of at least 18 inches between such equipment or wiring and the wall for a single panel switchboard not exceeding 42 inches in width, and at least 24 inches when the board consists of more than one panel. If the space behind the board is accessible only from one end, these spaces shall be increased by at least 6 inches. The space back of the board shall be kept clear of foreign material and shall not be used for storage purposes.

Reduction of clearances for short intervals by building columns behind the switchboard, or by equipment on a single panel in the switchboard, is permitted provided the clearances are not reduced below those required for a single panel board.

Some of the above dimensions are exceptions to order 13-1111.

Order 13-3856. Conductor Covering.

Insulated conductors where closely grouped, as on the rear of switchboards, shall each have a flame retardent outer covering. The conductor covering shall be stripped back a sufficient distance from the terminals so as not to make contact with them. Insulated conductors used for instrument and control wiring on the back of switchboards shall be flame retardant, either inherently or by means of an outer covering, and be one of the following types, R, RP, RH, V, AVA, AVB, SN or SNA.

Order 13-3857. Protection of Instrument Circuits.

See order 13-93843.

Order 13-3858. Grounding—Switchboard Frames.

Switchboard frames and structures supporting switching equipment shall be grounded, except that the frames for D.C. single-polarity switchboards may be insulated for the full voltage of the circuit in lieu of grounding.

Order 13-3859. Grounding of Instruments, Relays, Meters and Instrument Transformers on Switchboards.

Instruments, relays, meters and instrument transformers located on switchboards shall be grounded as specified in orders 13-2621 to 13-2624.

PANELBOARDS

Order 13-3881. Number of Circuits on One Panelboard.

The number of circuits of a lighting and appliance branch circuit panelboard installed in any one cabinet shall not exceed 42 where one over-current device per circuit is used, or 20 where two overcurrent devices per circuit are used.

Order 13-3882. Overcurrent Protection.

Panelboards supplying only lighting and/or appliance branch circuits, and supplied by conductors having overcurrent protection greater than 200 amperes shall be protected on the supply side by overcurrent devices having a rating not greater than that of the panelboard.

Order 13-3883. Enclosure.

Panelboards shall be mounted in cabinets or cutout boxes.

Order 13-3884. Panelboards in Damp or Wet Locations.

Panelboards in damp or wet locations shall be enclosed in weatherproof cabinets.

Order 13-3885. Relative Arrangement of Switches and Fuses.

Panelboards having switches on the load side of any type of fuses shall not be installed except for use as service equipment as provided in order 13-2375.

Chapter 4. Equipment for General Use

SECTION 13-400. FLEXIBLE CORDS

Order 13-4001. General.

Flexible cords shall be suitable for the conditions of use and location.

Order 13-4002. Types.

Cords of the several types shall conform to the descriptions of Table 31 of Chapter 10. Types of flexible cords other than those listed in Table 31, and other uses for types listed in the table, shall be the subject of special investigations and shall not be used before being approved.

Order 13-4003. Use.

Flexible cords shall be used only for pendants, wiring of fixtures, elevator cables, connection of portable appliances, or for the connection of approved stationary devices to facilitate their interchange or to prevent transmission of noise or vibration. They may also be used for specific purposes such as for temporary wiring or connections for short predetermined periods of time if proper precautions are observed to minimize life and fire hazards.

Order 13-4004. Splices.

Flexible cord shall be used only in continuous lengths without splice or tap.

Order 13-4005. Show-Windows and Show-Cases.

Flexible cords used in show-windows or in show-cases shall be of Type S or AFS, except for the wiring of chain fixtures, and for supplying current to portable lamps and other merchandise for exhibition purposes.

Order 13-4006. Minimum Size.

Flexible cords shall not be smaller than No. 18, except that tinsel cords, or cords having equivalent characteristics, of smaller size may be approved for use with specific appliances.

Order 13-4007. Insulation—Over 300 Volts.

If the voltage between any two conductors exceeds 300, but does not exceed 600, flexible cords of No. 10 and smaller shall have rubber insulation on the individual conductors at least 3/64 inch in thickness, unless Type S cord is used.

Order 13-4008. Overcurrent Protection.

Flexible cords not smaller than No. 18, and tinsel cords, or cords having equivalent characteristics, of smaller size approved for use with specific appliances, shall be considered as protected against over-

current by the overcurrent devices described in order 13-2403. Cords shall be not smaller than required by Tables 1 and 2, Chapter 10, for the rated current of the appliance.

Order 13-4009. Protection of Cord at Lampholder.

Flexible cords shall be protected by insulating bushings where they enter lampholders.

Order 13-4010. Protection of Cord at Boxes.

Flexible cords shall be protected by bushings where they pass through the cover of an outlet box, or the cover shall have a smooth, well rounded surface on which the cord will bear. So-called hard rubber or composition bushings shall not be used.

Order 13-4011. Pull at Joints and Terminals.

Flexible cords shall be so connected to devices and to fittings that tension will not be transmitted to joints or terminal screws. This shall be accomplished by a knot in the cord, winding with tape, by a special fitting designed for that purpose, or by other equivalent means.

Order 13-4012. Labels.

Flexible cords shall be examined and tested at the factory and shall be labeled before shipment.

Order 13-4013. Grounded Conductor Identification.

One conductor of flexible cords shall have a continuous marker readily distinguishing it from the other conductor or conductors. The identification shall consist of one of the following:

A. Colored Braid. A braid finished to show a white or natural gray color and the braid on the other conductor or conductors finished to show a readily distinguishable solid color or colors.

B. Tracer in Braid. A tracer in a braid of any color contrasting with that of the braid and no tracer in the braid of the other conductor or conductors. No tracer shall be used in the braid of any conductor of a flexible cord which contains a conductor having a braid finished to show white or natural gray, except that, in the case of types C, PD, and PO cords having the braids on the individual conductors finished to show white or natural gray, the identifying marker may consist of a tracer of any color in the braid of one conductor.

C. Colored Insulation. Cords having no braids on the individual conductors (except cords which have insulation on the individual conductors integral with the jacket), shall have white or natural gray insulation on one conductor and insulation of a readily distinguishable color or colors on the other conductor or conductors.

D. Colored Separator. Cords having insulation on the individual conductors integral with the jacket (types POSJ-64 and POSJ-32) shall have a white or natural gray separator on one conductor and a separator of a readily distinguishable solid color on the other conductor.

Order 13-4014. Grounding Conductor Identification.

A conductor intended to be used as a grounding conductor if provided with insulation shall have a continuous identifying marker readily distinguishing it from the other conductor or conductors. The identifying marker shall consist of one of the following:

A. Colored Braid. A braid finished to show a green color.

B. Colored Insulation. For cords having no braids on the individual conductors a green insulation on one conductor.

This shall not be construed as prohibiting the use of a conductor having a green finish as an ungrounded circuit conductor in cords having no conductor used as a grounding conductor.

SECTION 13-410. FIXTURES, LAMPHOLDERS, RECEPTACLES AND ROSETTES

GENERAL

Order 13-4101. Application of Other Articles.

Fixtures for use in hazardous locations shall conform to the requirements of Section 13-500.

Order 13-4102. Supports.

Fixtures, lampholders, rosettes and receptacles shall be securely supported. Where a gas pipe, outlet box or other fitting which will provide proper support is required by this code or is present, a fixture shall be attached thereto; otherwise a fixture shall be attached to a wooden base block not less than ¾ inch in thickness, supported independently of the screws that support the fixtures.

Note: Every outlet box to accommodate an outside fixture shall be equipped with a fixture stud substantially secured to the back of the box.

Order 13-4103. Outlet Box to Be Covered.

In a completed installation each outlet box shall be provided with a cover unless covered by means of a fixture canopy, a lampholder, a receptacle, a rosette or similar device.

Order 13-4104. Live Parts.

Fixtures, lampholders, receptacles and rosettes shall have no live parts normally exposed to contact, except in the case of cleat type lampholders, receptacles and rosettes which are located at least eight feet above the floor.

Order 13-4105. Ungrounded Fixtures.

Ungrounded metal lighting fixtures, lampholders and receptacles, including face plates, shall not be installed within reach of bath tubs and shower baths. Such fixtures and lampholders shall not be within reach of plumbing fixtures, steam piping, or other grounded metal work of the premises. Metal pull chains used at these locations shall be provided with insulating links.

Order 13-4106. Exposed to Moisture or Corrosive Vapors.

Fixtures installed in damp or wet locations or where they will be exposed to corrosive vapors shall be of the vaportight type. Lampholders, receptacles and rosettes installed in such locations shall be of the weatherproof type.

A. *Pendants.* Pendent lampholders with permanently attached leads, if used in other than festoon wiring, shall be hung from separate stranded rubber-covered conductors which are soldered directly to the circuit conductors but supported independently thereof. Such pendent conductors shall be not smaller than No. 14 for mogul or medium base lampholders nor, except for approved Christmas tree and decorative lighting outfits, smaller than No. 18 for intermediate or candelabra base lampholders. If the pendent conductors are longer than 3 feet they shall be twisted together.

B. *Fixtures.* Fixtures in damp or wet locations shall be so constructed that water cannot enter or accumulate in wireways, lampholders or other electrical parts.

Order 13-4107. Over Flammable Material.

Lampholders installed over specially flammable material shall be of the unswitched type and unless individual switches are provided, shall be located at least 8 feet above the floor, or shall be otherwise so located or guarded that the lamps cannot be readily backed out by hand.

FIXTURES

Order 13-4121. Cover Combustible Finish.

Any combustible wall or ceiling finish exposed between the edge of a fixture canopy and an outlet box shall be covered with non-combustible material.

Order 13-4122. Space for Wires and Splices.

Canopies and outlet boxes taken together shall provide ample space for conductors and their connecting devices.

Order 13-4123. Flush and Recessed Fixtures.

Fixtures which are designed to be installed in recessed cavities in walls and ceilings shall be of approved type. They shall be constructed or installed so that adjacent combustible material will not be subjected to temperatures in excess of 90C (194F). Recessed portions of enclosures, other than points of support, shall be spaced at least ½ inch from combustible material. Conductors with an insulation suitable for the temperature encountered shall be brought through at least four feet of metal raceway from the fixture to an outlet box which is at least one foot from the fixture. Conductors, unless approved for the purpose, shall not extend a distance of more than six feet from the fixture as measured along the raceway. For the construction of flush and recessed fixtures, see order 13-94102.

Order 13-4124. Show Windows.

No externally wired fixture other than of the chain type shall be placed in a show window. For use of cords in show windows see order 13-4005.

Order 13-4125. Shades and Enclosures.

Ample air space shall be provided between a lamp and a shade or enclosure of flammable material.

Order 13-4126. Combination Fixtures.

Combination gas and electric fixtures shall not be installed.

Order 13-4127. Grounding of Fixtures.

Fixtures shall be grounded as provided below:

A. Metallic Wiring Methods. Metal fixtures installed at outlets wired with grounded metal raceway or grounded armored cable shall be grounded.

B. Non-Metallic Wiring Methods. Metal fixtures installed at outlets wired with knob-and-tube work, or non-metallic sheathed cable, on circuits operating at not over 150 volts to ground, shall be grounded except as follows:

1. Fixtures mounted on metal or metal lath ceilings or walls may be insulated from their supports and from the metal lath by the use of insulating joints or fixture supports and canopy insulators. See order 13-4105.

2. Fixtures not mounted on metal or metal lath ceilings or walls need be neither insulated nor grounded. See order 13-4105.

Fixtures made of insulating materials, and lampholders with shells of insulating material, are recommended for use with wiring systems that do not afford a ready means for grounding the exposed noncurrent carrying parts of fixtures and lampholders.

C. Over 150 Volts to Ground. Metal fixtures on circuits operating at over 150 volts to ground shall be grounded.

Order 13-4128. Methods of Grounding Fixtures.

Fixtures shall be considered as grounded when mechanically connected in a permanent and effective manner to metal raceway, the armor of armored cable, a grounding conductor in non-metallic sheathed cable, a separate grounding conductor not smaller than No. 14, or to gas piping, provided that the raceway, armor, grounding conductor, or gas piping is grounded in the manner specified in Section 13-250.

Order 13-4129. Grounding Gas Piping.

Gas piping to which fixtures are attached shall be grounded in the manner specified in Section 13-250 unless the fixtures are insulated from the gas piping or are grounded by one of the methods specified in order 13-4127.

Order 13-4130. Gas Pipe to Be Covered.

If a gas pipe enters an outlet box, the pipe shall be covered with insulating tubing back of an insulating joint or blind hickey.

Order 13-4131. Canopy Insulators.

Canopy insulators, used where insulating joints are required, shall be of approved type and shall be securely fastened in place, so as to separate the canopies effectively and permanently from the conducting surfaces from which they are intended to be insulated.

A good grade of hard fiber is acceptable for this purpose. It may constitute a strip around the edge of the canopy separating it $\frac{3}{16}$ inch from the supporting surface; or a flat sheet having edges at least flush with the edges of the canopy.

Order 13-4132. Connections to Be Accessible.

Fixtures shall be so installed that the connections between the fixture conductors and the circuit conductors will be easily accessible for inspection without requiring the disconnecting of any portion of the wiring.

Order 13-4133. Exposed Terminals.

Lampholders, receptacles and switches having exposed terminals shall not be installed in metal fixture canopies or open bases of portable lamps. Exposed live parts within porcelain fixtures shall be suitably recessed and so located as to make it improbable that wires will come in contact with them. There shall be a spacing of at least ½ inch between live parts and the mounting plane of the fixture.

Order 13-4134. Installation of Conductors.

On chains or other movable parts, stranded conductors shall be used unless the conductors are completely enclosed in metal. If the fixture is externally wired, conductors shall be secured in a manner which will not tend to cut or abrade the insulation, and shall be protected from abrasion where they pass through sheet metal pans, canopies, and the like.

Order 13-4135. Chain Fixtures.

Chain fixtures shall be wired with flexible conductors so arranged that the weight of the fixture will not put tension on the conductor.

Order 13-4136. Splices and Taps.

A. Splices and taps shall be made mechanically and electrically secure without solder and, unless made with an approved splicing device, shall then be soldered with a fusible metal or alloy. The joints shall be covered with an insulation equal to that on the conductors. No splice or tap shall be located within an arm or a stem. Splices and taps shall be accessible for inspection.

B. A fixture shall be installed in a permanent manner and supported from at least one existing lighting outlet or an outlet installed for the purpose. Fixture conductors shall be connected to the circuit conductors by means of soldered joints or approved pressure connectors. The use of plug caps and receptacles is not approved.

C. Fluorescent fixtures designed so that they may be screwed or plugged into a lampholder or be connected to a shade or globe holder secured by means of metal clips or screws, thereby mechanically supporting the weight of the fixture on the lamp, shade or globe holder, shall not be permitted.

Order 13-4137. Types of Fixture Wires.

Conductors for fixtures shall conform to the following:

A. Fixture wires shall be one of several types as follows:

Type AF asbestos-covered, heat-resistant fixture wire.

Type CF cotton-covered, heat-resistant fixture wire.

Type RF-64 rubber-covered fixture wire—1/64 inch insulation—solid or stranded.

Type RF-32 rubber-covered fixture wire—1/32 inch insulation—solid or stranded.

Type FF-64 rubber-covered fixture wire—1/64 inch insulation—flexible stranding.

Type FF-32 rubber-covered fixture wire—1/32 inch insulation—flexible stranding.

Types R, RP and RH rubber-covered wires—3/64 inch insulation; Type RHT rubber-covered wire—2/64 inch insulation—solid or stranded.

B. No conductor shall be smaller than No. 18.

C. Type AF fixture wire shall have an approved asbestos covering with or without an outer braid.

D. The covering of type CF fixture wire shall consist of cotton or of other fibrous material, all the interstices of which shall be filled with material having fire-resistant and insulating properties. Its surface shall be finished smooth and hard. Outer braided coverings may be provided.

E. The rubber covering of Types RF-64, RF-32, FF-64, and FF-32 fixture wire shall consist of properly applied and properly vulcanized rubber compound. The thickness of this rubber covering shall be not less than 1/64 inch for No. 18 wire, not less than 1/32 inch for No. 16 wire, and not less than 3/64 inch for No. 14 wire. Coverings shall be of approved material sufficiently tenacious to withstand abrasion when being pulled into fixtures.

Order 13-4138. Insulation—Over 300 Volts.

If the voltage between any two conductors exceeds 300 but does not exceed 600, fixture conductors and flexible cords of No. 10 and smaller shall have rubber insulation on the individual conductors at least 3/64 inch in thickness, unless Type S cord is used.

Order 13-4139. Wiring of Fixtures.

Fixtures provided with mogul base lampholders shall be wired with Type AF fixture wire. Fixtures provided with other than mogul base lampholders and operating at not more than 300 volts between con-

ductors shall be wired with Type AF fixture wire or Type AFC, AFPO, or AFPD flexible cord, except that fixtures with which wires will not be subjected to temperatures in excess of 90C (194F) may be wired with Type CF fixture wire or Type CFC, CFPD, or CFPO flexible cord, and that fixtures of decorative type on which lamps of not over 60 watt rating are used in connection with imitation candles, and other fixtures with which wires will not be subjected to temperatures in excess of 49C (120F), may be wired with Type R rubber covered wire, Type RF-64, RF-32, FF-64 or FF-32 fixture wire, or with rubber covered flexible cord.

Order 13-4140. Polarization.

Each fixture shall be so wired that all screw shells of lampholders are connected to the same fixture stem conductor or supply conductor or terminal. A fixture stem conductor or supply conductor connected to the screw shells of lampholders shall be properly identified.

LAMPHOLDERS

Order 13-4161. Classification.

Lampholders shall be classed according to diameters of lamp bases, as Candelabra, Intermediate, Medium, Admedium, and Mogul base; having respectively ½ inch, 21/32 inch, 1 inch, 1 1/16 inch, and 1½ inch nominal sizes, with ratings, as specified in the following table:

Class	Nominal Diam.	Ratings-Switched			Ratings-Unswitched		
		Watts	Volts	Max. Amp. at any Voltage	Watts	Volts	Max. Amp. at any Voltage
Candelabra	½ in.	75	125	¾	75	125	1
Intermediate	21/32 in.	75	125	¾	75	250	1
Medium	1 in.	250	250	2½	660	250	6
		660(a)	250	6	660	600	
Admedium	1 1/16 in.				660	250	
Mogul	1½ in.	750	250		1500	250	
		1500	250		1500	600	

(a) This rating may be given only to lampholders having a switch mechanism which produces both a quick "make" and a quick "break" action.

Miniature lampholders and receptacles having screw shells smaller than the Candelabra size may be used for decorative lighting systems, Christmas-tree Lighting Outfits and similar purposes.

For exceptions for Medium Base Key Lampholders and Receptacles see Section 13-720.

Order 13-4162. In Clothes Closets.

Lampholders in clothes closets shall be installed on the ceiling or on the wall above the door. Drop cords shall not be installed in clothes closets.

Order 13-4163. Guards on Portable Lamps.

If portable lamps, supplied through flexible cords, can come in contact with flammable material, the lampholders shall be equipped with handles and substantial guards. The guards shall be attached to the lampholders or to the handles. Similar equipment shall be used to protect the portable lamps from breakage.

Order 13-4164. Double-Pole Switched Lampholders on 230-Volt Circuits.

If used on unidentified 2 wire circuits tapped from the ungrounded conductors of multi-wire circuits, the switching devices of lampholders of the switched type shall disconnect both conductors of the circuit. (See order 13-2007.)

Order 13-4165. Use of Screw Shell Type.

Receptacles of the screw shell type shall be installed only for use as lampholders.

Order 13-4166. Lampholder Bushings.

If a lampholder is attached to a flexible cord, the inlet shall be equipped with an insulating bushing which, if threaded, shall not be smaller than nominal ⅜ inch pipe size. The edges of the bushing shall be rounded and all inside fins removed in order to provide a smooth bearing surface for the conductors.

Bushings having holes 9/32 inch in diameter are suitable for use with plain pendent cord and holes 13/32 inch in diameter with reinforced cord.

RECEPTACLES

Order 13-4171. Screw Shell Type.

Receptacles installed for the attachment of portable cords shall be of a type not suitable for use with screw shell base devices.

Order 13-4172. Enclosure of Flush Receptacles.

Flush receptacles shall be enclosed in boxes in addition to the insulating enclosure of the receptacle mechanism. Flush receptacle plates, if of metal, shall be not less than 0.04 inch in thickness.

Order 13-4173. Receptacles in Floors.

Attachment plugs and receptacles located in floors shall be enclosed in floor boxes approved for the purpose.

ROSETTES

Order 13-4181. Fusible Rosettes.

Fusible rosettes or separable rosettes which make possible a change in polarity, shall not be installed.

SECTION 13-420. LAMPS

GENERAL

Order 13-4201. Scope.

The provisions of this section shall apply to lamps used on constant potential interior wiring systems and such outside lamps as may be connected thereto.

Order 13-4202. Hazardous Locations.

If installed in hazardous locations, the provisions of Section 13-500 shall be observed.

INCANDESCENT LAMPS

Order 13-4205. Lamps in Show Windows or Near Flammable Material.

Incandescent lamps located in show windows or where liable to contact with flammable material shall be installed in fixtures equipped with shades or guards or designed to operate at a safe temperature.

MERCURY VAPOR LAMPS

Order 13-4208. Grounding.

The exposed metal parts of mercury vapor lamps shall be grounded in the manner specified in Section 13-250 for grounding equipment, if located within reach from grounded objects or surfaces.

ARC LAMPS

Order 13-4211. Switching.

Each ungrounded conductor of a branch circuit supplying an arc lamp or a series of arc lamps shall be controlled by a switch or manually operable circuit-breaker.

Order 13-4212. Arc Lamp Leads.

Leads that are subject to movement when arc lamps are raised or lowered shall consist of stranded conductors.

Order 13-4213. Grounding.

Arc lamps shall be effectively isolated or guarded and all exposed metal parts shall be grounded, except on grounded circuits operating at not over 150 volts to ground.

Isolation will ordinarily be deemed sufficient when a vertical clearance of 8 feet is provided from floors or other accessible places within buildings, or 10 feet from footways outside buildings, and of 15 feet from roadways. Horizontal clearance from windows, porches, and other spaces accessible to the general public should be not less than 3 feet.

Order 13-4214. Resistors and Regulators.

Resistors and regulators for arc lamps shall be enclosed in non-combustible cases and treated as sources of heat. An incandescent lamp shall not be used as a resistor or regulator. Economy and compensator coils shall be mounted on non-combustible, non-absorptive insulating supports, such as glass or porcelain, that provide an air space of at least 1 inch between frame and support. Such coils shall be treated as sources of heat.

SECTION 13-422. APPLIANCES

Order 13-4221. Scope.

This section shall apply to electric appliances used in any occupancy.

Order 13-4222. Branch Circuit Required.

Every appliance shall be supplied by a branch circuit of one of the types specified in Section 13-210. Motor operated appliances shall also conform to the requirements of Section 13-430.

See Table 29 of Chapter 10 for the conductors of a household range branch circuit.

INSTALLATION

Order 13-4231. Insulation of Cords.

Flexible cords used to connect heating appliances shall comply with the following:

A. *Appliances Over 50 Watts.* Flexible cords used to connect smoothing irons, or to connect portable electrically heated appliances rated at more than 50 watts and which produce temperatures in excess of 120C (250F) on surfaces with which the cord is liable to be in contact, shall be one of the types of approved heater cords listed in Table 31, Chapter 10.

B. *Other Heating Appliances.* All other portable electrically heated appliances shall be connected by one of approved types of cord listed in Table 31, Chapter 10, selected in accordance with the usage specified in that table.

Order 13-4232. Insulation of Appliances.

Portable appliances shall be provided with an adequate dielectric interposed between current carrying parts and those external surfaces which persons can touch, except for toasters, grills or other heating appliances in which the current carrying parts at high temperature are necessarily exposed. In locations where the dielectric is exposed to mechanical injury, it shall be suitably protected.

Order 13-4233. Portable Immersion Heaters.

Electric heaters of the portable immersion type shall be so constructed and installed that current carrying parts are effectively insulated from electrical contact with the substance in which immersed. The authority enforcing this code may make exception of special applications of apparatus where suitable precautionary measures are followed.

Order 13-4234. Protection of Combustible Material.

Each electrically heated appliance that is obviously intended by size, weight and service to be located in a fixed position shall be so placed as to provide ample protection between the appliance and adjacent combustible material.

Order 13-4235. Stands for Portable Appliances.

Each smoothing iron and other portable electrically heated appliance which is intended to be applied to combustible material shall be equipped with an approved stand, which may be a separate device or may be a part of the appliance.

Order 13-4236. Signals for Heated Appliances.

In other than residence occupancies, each electrically heated appliance, or group of electrically heated appliances, intended to be applied to combustible material, shall be installed in connection with a signal unless the appliance is provided with an integral temperature limiting device.

Order 13-4237. Grounding.

Metal frames of portable and stationary electrically heated appliances, operating on circuits above 150 volts to ground, shall be grounded in the manner specified in Section 13-250; provided, however, that where this is impracticable, grounding may be omitted by special permission, in which case the frames shall be permanently and effectively insulated from the ground.

It is recommended that the frames be grounded in all cases.

CONTROL AND PROTECTION OF APPLIANCES

Order 13-4241. Disconnecting Means.

Each appliance shall be provided with a disconnecting means, which may be a switch, a separable connector or a plug receptacle. For appliances of more than 1650 watts rating the disconnecting means shall not be a part of the appliance, shall disconnect all ungrounded conductors, and shall be located as follows:

A. It shall be readily accessible to the operator of the appliance.

B. In other than dwelling occupancies it shall control only the appliance.

C. In multi-family (more than two) dwellings the switch shall be within the apartment, or on the same floor as the apartment in which the appliance is installed, and may control lamps and other appliances.

D. In two-family dwellings the switch may be outside of the apartment in which the appliance is installed but shall be readily accessible. This will permit an individual service switch for the apartment to be used, provided it is accessible to the user of the appliance.

E. In single-family dwellings the service switch may be used for this purpose.

Note: The switch may be mounted on the end of a range if it disconnects all ungrounded conductors.

Order 13-4242. Unit Switches.

Switches controlling the individual units of appliances shall not be considered as taking the place of the single disconnecting means required by order 13-4241.

Order 13-4243. Switch to Be Indicating.

If a switch is used as the disconnecting means it shall be of the indicating type.

Order 13-4244. Disconnecting Plugs and Connectors.

Disconnecting plugs and connectors shall conform to the following:

A. *Disconnect All Conductors.* Shall disconnect all poles from the live source of energy.

B. *Live Parts.* Shall be so constructed and installed as to guard against inadvertent contact with live parts.

C. *Interrupting Capacity.* They shall be capable of interrupting the rated current without hazard to the operator.

D. *Interchangeability.* Separable connectors and plug connectors shall be so designed that they will not fit into receptacles of lesser current rating.

Order 13-4245. Receptacle Rating.

An appliance shall only be connected to a receptacle, or be controlled by a separable connector, of a rating not less than the rating of the appliance, except that demand factors authorized elsewhere in this code may be applied.

Order 13-4246. Location of Disconnecting Switch.

If a switch serves as the disconnecting means for a motor-driven appliance it shall be within sight of the appliance, except as provided in order 13-4409.

Order 13-4247. Overcurrent Protection.

Appliances, other than such motor-operated appliances as are required by Section 13-430 to have additional overcurrent protection, shall be considered as protected against overcurrent when supplied by one of the circuits of Section 13-210 and in accordance with the requirements therein specified.

Order 13-4248. Automatic Flatirons.

It is recommended that electrically heated smoothing irons be equipped with an approved temperature limiting device.

MARKING

Order 13-4261. Name Plate.

Each electric appliance shall be provided with a name plate, giving the maker's name and the normal rating in volts and amperes, or in volts and watts.

Note: The name plate shall be in a place where it will be accessible when equipment is in use.

Order 13-4262. Marking of Heating Elements.

Individual heating elements which are a part of an electric appliance containing more than one heating element shall each be legibly marked with normal rating in volts and amperes, or in volts and watts.

SECTION 13-430. MOTORS AND CONTROLLERS

GENERAL

Order 13-4301. General.

It is intended that the following general provisions shall cover all provisions for motors and controllers which do not properly fall into the other divisions of this section.

Order 13-4302. Application of Other Articles.

Motors and controllers shall also comply with the provisions of the following:

Auto Transformers	Order 13-4508-B
Capacitors	Order 13-4608-A
Cranes and Hoists	Section 13-610
Elevators	Section 13-620
Garages	Order 13-5103
Hazardous Locations	Section 13-500
Motion Picture Projectors	Orders 13-5411, 13-5416
Motion Picture Studios	Orders 13-5310, 13-5311
Organs	Order 13-6503
Resistors and Reactors	Section 13-470
Theaters	Order 13-5246

Order 13-4303. Overheating From Dust Accumulations.

In locations where dust or flying material will collect on or in motors in such quantities as to seriously interfere with the ventilation or cooling of motors, and thereby cause dangerous temperatures, suitable types of enclosed motors which will not overheat under the prevailing conditions, shall be used. Especially severe conditions may require the use of enclosed pipe ventilated motors, or enclosure in separate dust-tight rooms, properly ventilated from a source of clean air.

Order 13-4304. Identification of Motors.

A motor shall be provided with a name plate which shall give the maker's name, the rating in volts and amperes, including those of the secondary if a wound-rotor type of motor, the normal full load speed and the interval during which it can operate at full load starting cold, before reaching its rated temperature. The time interval shall be 5, 15, 30, or 60 minutes, or continuous. For alternating current motors rated at ½ horsepower or larger, except polyphase wound-rotor motors, the name plate shall be marked with a code letter to show its input in kilovolt amperes with locked rotor, selected from the table given in order 13-94304, Chapter 9.

The code letter indicating motor input with locked rotor must be in an individual block on the name plate, properly identified. This code letter is to be used for determining branch circuit overcurrent protection by reference to Table 26, Chapter 10, as provided in order 13-4342.

Order 13-4305. Identification of Controllers.

A controller shall be marked with the maker's name or identification symbol, the voltage, the current or horsepower rating, and such other data as may be needed to properly indicate the motors for which it is suitable.

Order 13-4306. Identification of Terminals.

Terminals of motors and controllers shall be suitably identified, as by marking or color, where necessary to indicate the proper connections.

Order 13-4307. Drip Pans.

Motors shall be provided with suitable drip pans if required by the authority enforcing this code.

Order 13-4308. Enclosures.

Suitable guards or enclosures shall be provided to protect exposed current carrying parts of motors and the insulation of motor leads where installed directly under equipment, or in other locations where dripping oil, water, or other injurious liquid may occur, unless the motor is designed for the existing conditions.

SIZE OF CONDUCTORS FOR MOTOR CIRCUITS

Order 13-4311. General.

It is the intent of the following provisions to specify sizes of conductors capable of carrying the motor current without overheating under the conditions specified.

Note. The values of full load current for motors as given in Tables 21 to 24, inclusive, in Chapter 10, shall be used in all cases for determining sizes of conductors and overcurrent protective devices, except as indicated in the notes following these tables.

Order 13-4312. Individual Motor.

Branch circuit conductors supplying an individual motor shall have a carrying capacity not less than 125 per cent of the motor full load current rating; provided, that conductors for motors used for short time, intermittent, periodic, or varying duty, may have a carrying capacity not less than the percentage of the motor name plate current rating as shown in the following table, unless the authority enforcing the code grants special permission for conductors of smaller size.

	Percentages of Name Plate Current Rating			
Classification of Service	5-Minute Rating	15-Minute Rating	30 & 60-Minute Rating	Continuous Rating
Short-Time Duty				
Operating valves, raising or lowering rolls	110	120	150	...
Intermittent Duty				
Freight and passenger elevators, shop cranes, tool heads, pumps, drawbridges, turntables, etc.	85	85	90	140
Periodic Duty				
Hoists, rolls, ore and coal-handling machines	85	90	95	140
Varying duty	110	120	150	200

or lower at the discretion of the authorities enforcing the regulations.

The conductors between stationary motors, rated 1/3 H.P. or less, and the separate terminal enclosures permitted in sub-paragraph

13-4439-B, may be smaller than No. 14 but not smaller than No. 18, provided they have current carrying capacity as specified above.

The size of conductor calculated on the basis of 125 per cent of the motor full load current for the more usual motor ratings is shown in Table 20, Chapter 10.

For long runs, it may be necessary in order to avoid excessive voltage drop, to use conductors of sizes larger than the minimum sizes given in Table 20, Chapter 10.

See example No. 5, Chapter 10, and Diagram No. 15, Chapter 10.

Order 13-4313. Wound-Rotor Secondary.

The conductors connecting the secondary of a wound-rotor A.C. motor to its controller shall have a carrying capacity which is not less than 125 per cent of the full load secondary current of the motor if for continuous duty. For other than continuous duty, these conductors shall have a carrying capacity, in per cent of full load secondary current, not less than that specified in the table in order 13-4312. Where the secondary resistor is separate from the controller, the carrying capacity of the conductors between controller and resistor shall be not less than that given in the following table:

Resistor Duty Classification	Carrying Capacity of Wire in Per Cent of Full Load Secondary Current
Light starting duty	35
Heavy starting duty	45
Extra heavy starting duty	55
Light intermittent duty	65
Medium intermittent duty	75
Heavy intermittent duty	85
Continuous duty	110

Order 13-4314. Conductors Supplying Several Motors.

Conductors supplying two or more motors shall have a current carrying capacity of not less than 125 per cent of the full load current rating of the highest rated motor in the group plus the sum of the full load current ratings of the remainder of the motors in the group.

See example No. 5, Chapter 10, and Diagram No. 15, Chapter 10.

Order 13-4315. Combination Load.

Conductors supplying a motor load, and in addition a lighting or appliance load as computed from Section 13-220 and other applicable orders, shall have a current carrying capacity sufficient for the lighting or appliance load plus the required capacity for the motor load determined in accordance with order 13-4314, or, for a single motor, in accordance with order 13-4312.

Order 13-4316. Demand Factor.

Where a reduced heating of the conductors results from motors operating on a duty cycle, intermittently, or from all motors not operating at one time, the authority enforcing this code may grant permission for feeder conductors to be of a capacity less than specified in the orders 13-4314 and 13-4315, provided the conductor is of sufficient carrying capacity for the maximum load determined by the sizes and number of motors supplied and the character of their loads and duties.

MOTOR OVERCURRENT PROTECTION

Order 13-4321. General.

The following provisions specify overcurrent devices intended to protect the motors, the motor control apparatus, and the branch circuit conductors against excessive heating due to motor overloads.

Order 13-4322. Continuous Duty Motors.

Continuous duty motors shall be protected against overcurrent as follows:

A. *More than One Horsepower.* Continuous duty motors rated more than 1 horsepower shall have running overcurrent protection not greater than 125 per cent of the full load current rating of the motor. The overcurrent protection for a motor not exceeding 5 horsepower, specially designed and used as a part of approved refrigeration equipment, may exceed 125 per cent but shall not exceed 140 per cent of the rated current of the motor.

Overcurrent protection calculated for the more usual ratings is given in columns 5 and 6 in Table 20, Chapter 10.

See Example No. 5, Chapter 10, and Diagram No. 15, Chapter 10.

B. *One Horsepower or Less—Manually Started.* Motors of 1 horsepower or less which are manually started and which are in a location within sight of the operator, shall be considered as protected against overcurrent by the overcurrent device protecting the conductors of the branch circuit. This overcurrent device shall not be larger than that specified in Table 20, Chapter 10, except for motors used on the 15-, 20-, and 25-ampere branch circuits described in Section 13-210. Any such motor which is in a location out of sight of the operator shall be protected as specified in sub-paragraph C for automatically started motors.

C. *⅛ to One Horsepower—Automatically Started.* Motors of ⅛ to 1 horsepower inclusive which are started automatically shall be considered as protected against overcurrent under any of the following conditions:

1. If provided with overcurrent protection not greater than 140 per cent of the full load current rating of the motor. The overcurrent protective device shall have sufficient time delay to permit the motor to start and accelerate its load. Orders 13-4324 and 13-4325 do not apply to these motors.

2. If the motor is a type which cannot overheat due to overloads or failure to start.

This result may be secured by windings having sufficiently high impedance to prevent overheating, or by the use of an approved protective device which is an integral part of the motor.

3. If part of an approved assembly which does not normally subject the motor to overloads and which is also equipped with other safety controls (such as the safety combustion controls of a domestic oil burner) which protect the motor against damage due to stalled rotor

current. Where such protective equipment is used it shall be indicated on the name plate of the assembly where it will be visible after installation.

D. *Less than ⅛ Horsepower—Automatically Started.* Motors of less than ⅛ horsepower, automatically started, shall be considered as protected against overcurrent by the overcurrent device protecting the conductors of the branch circuit.

E. *Wound-Rotor Secondaries.* The secondary circuits of wound-rotor alternating current motors, including conductors, controllers, resistors, etc., shall be considered as protected against over-current by the motor running overcurrent device.

Order 13-4323. Intermittent and Similar Duty.

A motor used for a condition of service which is inherently short time, intermittent, periodic, or varying duty (as illustrated by the table in order 13-4312) is considered as protected against overcurrent by the branch circuit overcurrent device, provided the overcurrent protection does not exceed that specified in Tables 26 and 27, Chapter 10.

Order 13-4324. Selection of Size of Protective Device.

Where the values specified for motor running overcurrent protection do not correspond to the standard sizes or ratings of fuses, circuit-breakers, thermal cutouts, or thermal relays, or the heating elements of thermal trip motor switches, the next larger size or rating may be used, but not exceeding 150 per cent of the full load current rating of the motor.

Order 13-4325. Shunting During Starting Period.

Motor running overcurrent protection may be shunted or cut out of circuit during the starting period of a motor, provided the device by which the overcurrent protection is shunted or cut out cannot be left in the starting position, and the motor shall be considered as protected against overcurrent during the starting period if fuses or time delay circuit-breakers rated or set at not over 400 per cent of the full load current of the motor, are so located in the circuit as to be operative during the starting period of the motor.

Order 13-4326. Fuses—In Which Conductor.

If fuses are used for motor running protection, a fuse shall be inserted in each ungrounded conductor.

Order 13-4327. Devices Other Than Fuses—In Which Conductor.

If devices other than fuses are used for motor running protection, the following table shall govern the minimum allowable number and location of overcurrent units such as trip coils, relays, or thermal cutouts.

It is recommended that all ungrounded conductors be opened if devices capable of accomplishing this are available.

Kind of Motor	Supply System	Number and location of overcurrent units, such as trip coils, relays or thermal cutouts
1-phase A.C. or D.C.	2-wire, 1-phase A.C. or D.C., ungrounded	1 in either conductor
1-phase A.C or D.C.	2-wire, 1-phase A.C. or D.C., one conductor grounded	1 in ungrounded conductor
1-phase A.C. or D.C.	3-wire, 1-phase A.C. or D.C., grounded neutral	1 in either ungrounded conductor
2-phase A.C.	3-wire, 2-phase A.C., ungrounded	2, one in each phase
2-phase A.C.	3-wire, 2-phase A.C., one conductor grounded	2 in ungrounded conductors
2-phase A.C.	4-wire, 2-phase A.C., grounded or ungrounded	2, one per phase in ungrounded conductors
2-phase A.C.	5-wire, 2-phase A.C., grounded neutral or ungrounded	2, one per phase in any ungrounded phase wire
3-phase A.C.	3-wire, 3-phase A.C., ungrounded	2 in any 2 conductors
3-phase A.C.	3-wire, 3-phase A.C., one conductor grounded	2 in ungrounded conductors
3-phase A.C.	3-wire, 3-phase A.C., grounded neutral	2 in any 2 conductors
3-phase A.C.	4-wire, 3-phase A.C., grounded neutral or ungrounded	2 in any 2 conductors, except the neutral

Order 13-4328. Number of Conductors Disconnected by Overcurrent Device.

Motor running protective devices, other than fuses or thermal cutouts, shall simultaneously disconnect a sufficient number of ungrounded conductors to interrupt current flow to the motor.

Order 13-4329. Motor Controller as Running Protection.

A motor controller may also serve as the running overcurrent device if the number of overcurrent units complies with the foregoing order 13-4327; and if these overcurrent units are operative in both the starting and running position in the case of a D.C. motor, and in the running position in the case of an A.C. motor.

Order 13-4330. Thermal Cutouts and Relays.

Thermal cutouts, thermal relays, and other devices for motor running protection which are not capable of opening short circuits, shall be protected by fuses or circuit-breakers of not over 4 times the rating of the motor for which they are designed, unless approved for group installation, and marked to indicate the maximum size of fuse by which they must be protected.

Order 13-4331. Rating of Protective Device.

Motor running overcurrent devices other than fuses shall have a rating of at least 115 per cent of the full load current rating of the motor.

MOTOR-BRANCH-CIRCUIT OVERCURRENT PROTECTION

Order 13-4341. General.

The following provisions specify overcurrent devices intended to protect the motor branch circuit conductors, the motor control apparatus, and the motors against overcurrent due to short circuits or grounds. They are in addition to or amendatory of the provisions of Section 13-240.

Order 13-4342. Rating or Setting for Individual Motor.

The motor branch circuit overcurrent device shall be capable of carrying the starting current of the motor. Overcurrent protection shall be considered as being obtained when this overcurrent device has a rating or setting not exceeding the values given in Tables 26 or 27, Chapter 10; provided that where the overcurrent protection specified in the table is not sufficient for the starting current of the motor, it may be increased, but shall in no case exceed 400 per cent of the motor full load current.

Fuse ratings calculated on this basis are given in columns 7, 8, 9 and 10 of Table 20, Chapter 10.

See Example No. 5, Chapter 10, and Diagram No. 15, Chapter 10.

Order 13-4343. Several Motors on One Branch Circuit.

Two or more motors may be connected to the same branch circuit under the following conditions:

A. Two or more motors, each having a full load rated current not exceeding 6 amperes, may be used on a motor branch circuit protected at not more than 15 amperes at 125 volts, or 10 amperes at 250 volts, or with lamps and/or other appliances on the 15-, 20-, and 25-ampere branch circuits as specified in Section 13-210. Individual overcurrent protection for such motors is unnecessary unless required by the provisions of order 13-4322.

B. Two or more motors, each protected by a thermal cutout or other motor running overcurrent device approved for group installation and also equipped with controllers approved for group installation, may be connected to the same branch circuit, provided the branch circuit is protected by fuses of a rating equal to that specified in order 13-4342 for the largest motor connected to the circuit, plus an amount equal to the sum of the full load current ratings of the other motors connected to the circuit; and also provided the branch circuit fuse is not larger than allowed by order 13-4330 for the thermal cutout or relay protecting the smallest motor in the group. The conductors of any tap supplying a single motor need not have individual overcurrent protection, provided they have either (1) the same current carrying capacity as the motor branch circuit conductor, or (2) at least 1/3 the current carrying capacity of the motor branch circuit conductor with a minimum in accordance with order 13-4312, the conductors to the motor running protective device being not more than 25 feet long (where feeders are at a greater elevation, this distance may be increased to 50 feet) and being protected from mechanical injury.

Order 13-4344. Combined Overcurrent Protection.

Motor branch circuit overcurrent protection and motor running overcurrent protection may be combined in a single overcurrent device if the rating or setting of the device provides the running overcurrent protection specified in order 13-4322.

Order 13-4345. Fuses—In Which Conductor.

If fuses are used for motor branch circuit overcurrent protection, a fuse shall be placed in each ungrounded conductor.

Order 13-4346. Devices Other Than Fuses—In Which Conductor.

If devices other than fuses are used as motor branch circuit overcurrent protection, they shall open all ungrounded conductors and shall be equipped with overcurrent units in accordance with Table 28, Chapter 10.

Order 13-4347. Capacity of Fuseholder.

If fuses are used for motor branch circuit overcurrent protection, the fuseholders shall not be of a smaller size than required to accommodate the fuses specified by order 13-4342.

Order 13-4348. Rating of Circuit-Breaker.

Circuit-breakers for motor branch circuit protection shall have a continuous current rating of not less than 115 per cent of the full load current ratings of the motors.

Order 13-4349. Feeder Taps in Inaccessible Location.

If the location of a tap to the feeder conductors is not accessible, the motor branch circuit overcurrent device may be placed where it will be accessible, provided the conductors between the tap and the overcurrent device have the same current carrying capacity as the feeder; or provided they have a current carrying capacity of at least 1/3 that of the feeder and are not more than 25 feet long (where feeders are at a greater elevation, this distance may be increased to 50 feet) and are protected from mechanical injury.

MOTOR FEEDER OVERCURRENT PROTECTION

Order 13-4361. General.

The following provisions specify overcurrent devices intended to protect feeder conductors supplying motors against overcurrents due to short circuits or grounds.

Order 13-4362. Rating or Setting—Motor Load.

A feeder which supplies motors shall be provided with overcurrent protection which shall not be greater than the largest rating or setting of the branch circuit protective device, for any motor of the group (based on Tables 26 and 27, Chapter 10), plus the sum of the full load currents of the other motors of the group.

If two or more motors of equal horsepower rating are the largest in the group, one of these motors should be considered as the largest for the above calculations.

If two or more motors of a group must be started simultaneously, it may be necessary to install larger feeder conductors and correspondingly larger ratings or settings of feeder overcurrent protection.

See Example No. 5, Chapter 10, and Diagram No. 15, Chapter 10.

Order 13-4363. Rating or Setting—Power and Light Loads.

If a feeder supplies a motor load, and in addition a lighting or a lighting and appliance load, the feeder overcurrent protective device may have a rating or setting sufficient to carry the lighting or the lighting and appliance load as determined in accordance with Sections 13-210 and 13-220, plus, for a single motor, the rating permitted by order 13-4342; and, for two or more motors, the rating permitted by order 13-4362.

REMOTE CONTROL CIRCUITS

Order 13-4371. General.

The following deviations from the general requirements in this code are intended to provide for the peculiar conditions governing remote control circuits.

Order 13-4372. Overcurrent Protection.

Conductors of control circuits of remote controlled equipment shall be protected against overcurrent in accordance with order 13-2403, paragraph E, except that such conductors shall be considered as being properly protected by the branch circuit overcurrent devices under any one of the following conditions:

A. If the rating or setting of the branch circuit overcurrent device is not more than 500 per cent of the carrying capacity of the control circuit conductors.

B. If the controlled device and the point of control (start and stop buttons, pressure switch, thermostatic switch, etc.) are both located on the same machine and the control circuit does not extend beyond the machine.

C. If the opening of the control circuit would create a hazard; as for example, the control circuit of fire pump motors, and the like.

Order 13-4373. Mechanical Protection of Conductor.

Where damage to a remote control circuit would constitute a hazard, all conductors of such remote control circuit shall be installed in conduit or be otherwise suitably protected from mechanical injury outside the control device itself.

Order 13-4374. Switching.

Control circuits shall be so arranged that they will be disconnected from all source of supply when the disconnecting means specified in order 13-4406 is in the open position, except when a separate switch is used for the control circuit. If a transformer or other device is used to obtain a reduced voltage for control circuits, such transformer or other device shall be connected to the load side of the disconnecting means.

MOTOR CONTROLLERS

For the purpose of this section, the term "controller" includes any switch or device normally used to start and stop the motor.

Order 13-4381. General.

The following provisions are intended to require suitable controllers for all motors.

See Diagram No. 15, Chaper 10.

Order 13-4382. Suitability.

Each controller shall be capable of starting and stopping the motor which it controls, and for an alternating current motor shall be capable of interrupting the stalled rotor current of the motor.

Order 13-4383. Rating.

The controller shall have a horsepower rating, which shall not be lower than the horsepower rating of the motor, except as follows:

A. Stationary Motor of ⅛ Horsepower or Less. For a stationary motor rated at ⅛ horsepower or less, that is normally left running and is so constructed that it cannot be damaged by overload or failure to start, such as clock motors and the like, the branch circuit overcurrent device may serve as the controller.

B. Stationary Motor of 2 Horsepower or Less. For a stationary motor rated at 2 horsepower or less, and 300 volts or less, the controller may be a general use switch having an ampere rating at least twice the full load current rating of the motor.

C. Portable Motor of ¼ Horsepower or Less. For a portable motor rated at ¼ horsepower or less, the controller may be an attachment plug and receptacle.

D. Circuit-Breaker as Controller. A branch circuit type circuit-breaker, rated in amperes only, may be used as a controller. When this circuit-breaker is also used for overcurrent protection, it shall conform to the appropriate provisions of this section governing overcurrent protection.

Order 13-4384. Need Not Open All Conductors.

Except when it serves also as a disconnecting means (see order 13-4407), the controller need not open all conductors to the motor.

Order 13-4385. In Grounded Conductors.

One pole of the controller may be placed in a permanently grounded conductor provided the controller is so designed that the pole in the grounded conductor cannot be opened without simultaneously opening all conductors of the circuit.

Order 13-4386. In Sight of Motor.

A motor and its driven machinery shall be within sight of the point from which the motor is controlled, unless one of the following conditions is complied with:

A. The controller or its disconnecting means is capable of being locked in the open position.

B. A manually operable switch, which will prevent the starting of the motor, is placed within sight of the motor location. This switch may be placed in the remote control circuit of a remote control type of switch.

C. Special permission is given by the authority enforcing this code.

D. As otherwise specified in Section 13-500 of this code.

Order 13-4387. Number of Motors Served by Each Controller.

Each motor shall be provided with an individual controller, except that for motors of 600 volts or less a single controller may serve a group of motors under any one of the following conditions:

A. If a number of motors drive several parts of a single machine or piece of apparatus such as metal and woodworking machines, cranes, hoists, and similar apparatus.

B. If a group of motors is under the protection of one over-current device as permitted in paragraph A of order 13-4343.

C. If a group of motors is located in a single room within sight of the controller.

Order 13-4388. Adjustable Speed Motors.

Adjustable speed motors, if controlled by means of field regulation, shall be so equipped and connected that they cannot be started under weakened field, unless the motor is designed for such starting.

Order 13-4389. Speed Limitation.

Machines of the following types shall be provided with speed limiting devices, unless the inherent characteristics of the machines, the system, or the load and the mechanical connection thereto, are such as to safely limit the speed, or unless the machine is always under the manual control of a qualified operator.

A. Separately excited direct current motors.

B. Series Motors.

C. Motor generator and converters which can be driven at excessive speed from the direct current end, as by a reversal of current or decrease in load.

Order 13-4390. Fuseholder Rating.

The rating of a combination fuse-holder and switch used as a motor controller shall be such that the fuseholder will accommodate the size of fuse specified in Table 20, Chapter 10 for motor running protection.

Order 13-4391. Low-Voltage Protection.

Where the restarting of the motor on restoration of voltage may result in injury to any person or persons, low-voltage protection shall be furnished.

DISCONNECTING MEANS

Order 13-4401. General.

The following provisions specify disconnecting means for motors and controllers capable of disconnecting them from the circuit.

See Diagram No. 15, Chaper 10.

Order 13-4402. Type.

The disconnecting means shall be a motor circuit switch, rated in horsepower, or a circuit-breaker, except as follows:

A. *⅛ Horsepower or Less.* For stationary motors of ⅛ horsepower or less the branch circuit overcurrent device may serve as the disconnecting means.

B. *Two Horsepower or Less.* For stationary motors rated at 2 horsepower or less and 300 volts or less, the disconnecting means may be a general use switch having an ampere rating at least twice the full load current rating of the motor.

C. *Exceeding 50 Horsepower.* For stationary motors rated at more than 50 horsepower, the disconnecting means may be a motor circuit switch also rated in amperes, a general use switch, or an isolating switch.

It is recommended that isolating switches for motors exceeding 50 horsepower, not capable of interrupting stalled rotor currents, be plainly marked "Do not open under load."

D. *Portable Motors.* For portable motors an attachment plug and receptacle may serve as the disconnecting means.

Order 13-4403. Carrying Capacity.

The disconnecting means shall have a carrying capacity of at least 115 per cent of the name plate current rating of the motor.

Order 13-4404. Grounded Conductors.

One pole of the disconnecting means may be placed in a permanently grounded conductor if the disconnecting means is so designed that the pole in the grounded conductor cannot be opened without simultaneously disconnecting all conductors of the circuit.

Order 13-4405. To Be Indicating.

The disconnecting means shall plainly indicate whether it is in the open or closed position.

Order 13-4406. To Disconnect Both Motor and Controller.

The disconnecting means shall disconnect both the motor and the controller from all ungrounded supply conductors. The disconnecting means may be in the same enclosure with the controller.

Order 13-4407. Switch or Circuit-Breaker as Both Controller and Disconnecting Means.

A switch or circuit-breaker complying with the provisions of order 13-4383 may serve as both controller and disconnecting means if it

opens all ungrounded conductors to the motor, is protected by an overcurrent device (which may be a set of fuses) which opens all ungrounded conductors to the switch or circuit-breaker, and is one of the following types:

A. An air-break switch, operable directly by applying the hand to a lever or handle.

B. A circuit-breaker operable directly by applying the hand to a lever or handle.

C. An oil switch used on a circuit whose rating does not exceed 600 volts or 100 amperes, or on a circuit exceeding this capacity if under expert supervision and by special permission.

The oil switch or circuit-breaker specified above may be both power and manually operable. If power operable, provision should be made to lock it in the open position.

The overcurrent device protecting the controller may be part of the controller assembly or may be separate.

A compensator type of controller is not included above and will require a separate disconnecting means.

Order 13-4408. Service Switch as Disconnecting Means.

If an installation consists of a single motor, the service switch may serve as the disconnecting means, provided it conforms to the requirements of this section, and is within sight of the controller.

Order 13-4409. In Sight of Controller.

The disconnecting means shall be located within sight of the controller or be arranged to be locked in the open position.

Order 13-4410. Motors Served by a Single Disconnecting Means.

Each motor shall be provided with individual disconnecting means, except that for motors of 600 volts or less a single disconnecting means may serve a group of motors under any one of the following conditions. The disconnecting means serving a group of motors shall have a rating not less than is required by order 13-4402 for a single motor whose rating equals the sum of the horsepowers or currents of all the motors of the group.

A. If a number of motors drive several parts of a single machine or piece of apparatus such as metal and woodworking machines, cranes, and hoists.

B. If a group of motors is under the protection of one set of overcurrent devices as permitted by paragraph A of order 13-4343.

C. If a group of motors is in a single room within sight of the disconnecting means.

REQUIREMENTS FOR OVER 600 VOLTS

Order 13-4421. General.

The following provisions recognize the additional hazard due to the use of high voltage. They are in addition to or amendatory of the other provisions of this section. Other requirements for circuits and equipment operating at more than 600 volts are in Section 13-710.

Order 13-4422. More Than 7500 Volts.

Motors operating at more than 7500 volts between conductors shall be installed in fire resistive motor rooms.

Order 13-4423. Motor Overcurrent Protection.

Running overcurrent protection for a motor of over 600 volts shall consist either of a circuit-breaker, or of overcurrent units integral with the controller which shall simultaneously open all ungrounded conductors to the motor. The overcurrent device shall have a setting as specified elsewhere in this section for motor running protection.

Order 13-4424. Circuit Overcurrent Protection.

Motor branch circuits and feeders of more than 600 volts shall be protected against over-current by circuit-breakers or fuses, with a setting or rating as specified for this purpose elsewhere in this section. Fuses shall be oil-filled or other suitable type and shall only be used on circuits not exceeding 2500 volts to ground with the fuses rated at not more than 300 amperes, or not exceeding 7500 volts and 100 amperes. Fuses shall have a rating sufficient for the voltage employed and for the current which must be interrupted.

Order 13-4425. Disconnecting Means.

The circuit-breaker or the fuses specified in order 13-4424 shall constitute the disconnecting means.

PROTECTION OF LIVE PARTS—ALL VOLTAGES

Order 13-4431. General.

The following provisions specify that live parts shall be protected in a manner judged adequate to the hazard involved.

Order 13-4432. Where Required.

Exposed live parts of motors and controllers operating at 50 volts or more between terminals, except for stationary motors having commutators, collectors and brush rigging located inside of motor end brackets and not conductively connected to supply circuits operating at more than 150 volts to ground, shall be guarded against accidental contact by enclosure, or by location as follows:

A. By installation in a room or enclosure which is accessible only to qualified persons;

B. By installation on a suitable balcony, gallery or platform, so elevated and arranged as to exclude unqualified persons;

C. By elevation 8 feet or more above the floor;

D. So that it will be protected by a guard rail when the motor operates at 600 volts or less.

Order 13-4433. Guards for Attendants.

If the live parts of motors or controllers operating at more than 150 volts to ground are guarded against accidental contact only by location as specified in order 13-4432, and if adjustment or other attendance

may be necessary during the operation of the apparatus, suitable insulating mats or platforms shall be provided so that the attendant cannot readily touch live parts unless standing on the mats or platforms. Where necessary, steps and handrails should be installed on or about large machines to afford safe access to parts which must be examined or adjusted during operation.

GROUNDING

Order 13-4435. General.

The following provisions specify the grounding of motor and controller frames to prevent a potential above ground in the event of accidental contact between live parts and frames. Insulation, isolation, or guarding are suitable alternatives for motors under certain conditions.

Order 13-4436. Stationary Motors.

The frames of stationary motors shall be grounded if any of the following conditions exist:

A. If supplied by means of metal clad wiring.
B. If located in a wet place and not isolated or guarded.
C. If in a hazardous location. (See Section 13-500).
D. If the motor operates with any terminal at more than 150 volts to ground.

If the frame of the motor is not grounded, it shall be permanently and effectively insulated from the ground.

Order 13-4437. Portable Motors.

The frames of portable motors which operate at more than 150 volts to ground shall be guarded or grounded. See sub-paragraph C of order 13-2545 on grounding of portable appliances in other than residential occupancies.

It is recommended that the frames of motors which operate at less than 150 volts to ground be grounded if this can be readily accomplished.
See sub-paragraph B of order 13-2558 for color of grounding conductor.

Order 13-4438. Controllers.

Controller cases, except those attached to ungrounded portable equipment and except the lined covers of snap switches, shall be grounded regardless of voltage.

Order 13-4439. Method of Grounding.

Grounding where required shall be done in the manner specified in Section 13-250.

A. *Grounding Through Terminal Housings.* If the wiring to fixed motors is in armored cable or metal raceways, junction boxes to house motor terminals shall be provided. These housings shall be of ample size to properly make connections, they shall be of substantial metal construction, and the armor of the cable or the metal raceways shall be connected to them in the manner specified in Section 13-250.

B. *Motors of 1/3 Horsepower.* For a motor of 1/3 horsepower or smaller, the junction box required by sub-paragraph A may be separated from the motor not more than 6 feet, provided the leads to the motor are armored cable or armored cord, or are enclosed in flexible or rigid conduit or electrical metallic tubing not smaller than ⅜ inch electrical trade size, the armor or raceway being connected both to the motor and to the box.

SECTION 13-445. GENERATORS

Order 13-4451. Location.

Generators shall be located in dry places. Generators installed in hazardous locations as described in Section 13-500, or in other locations as described in Sections 13-510, 13-520, and 13-530, shall also comply with the provisions of those sections.

It is recommended that waterproof covers be provided for use in emergency.

Order 13-4452. Identification.

Each generator shall be provided with a name plate giving the maker's name, the rating in kilowatts or kilovolt amperes, the normal volts and amperes corresponding to the rating, and the revolutions per minute.

Order 13-4453. Drip Pans.

Generators shall be provided with suitable drip pans if required by the authority enforcing this code.

Order 13-4454. Overcurrent Protection.

Constant potential generators, except alternating current generators and their exciters, shall be protected from excessive current by circuit-breakers or fuses.

A. *Two-Wire Generators.* Two-wire, direct current generators may have overcurrent protection in one conductor only if the over-current device is actuated by the entire current generated, except that in the shunt field. The overcurrent device shall not open the shunt field.

B. *65 Volts or Less.* Generators operating at 65 volts or less and driven by individual motors shall be considered as protected by the overcurrent device protecting the motor if these devices will operate when the generators are delivering not more than 150 per cent of their full load rated current.

C. *Balancer Sets.* Two-wire, direct current generators used in conjunction with balancer sets to obtain neutrals for 3-wire systems shall be equipped with overcurrent devices which will disconnect the 3-wire system in the case of excessive unbalancing of voltages.

D. *3-Wire, Direct Current Generators.* Three-wire, direct current generators, whether compound or shunt wound, shall be equipped with overcurrent devices, one in each armature lead, and so connected as to be actuated by the entire current from the armature. Such overcurrent devices shall consist either of a double pole, double coil circuit-breaker, or of a 4-pole circuit-breaker connected in the main and equalizer leads

and tripped by two overcurrent devices, one in each armature lead. Such protective devices shall be so interlocked that no one pole can be opened without simultaneously disconnecting both leads of the armature from the system.

Order 13-4455. Size of Conductors.

The conductors from the generator terminals to supplied equipment shall have a carrying capacity not less than 115 per cent of the name plate current rating. Neutral conductors shall be the same size as the conductors of the outside legs.

Order 13-4456. Protection of Live Parts.

Live parts of generators of more than 150 volts to ground shall not be exposed to accidental contact if accessible to unqualified persons.

Order 13-4457. Guards for Attendants.

Where necessary for the safety of attendants the provisions of order 13-4433 shall be complied with.

Order 13-4458. Grounding.

If a generator operates at a terminal voltage in excess of 150 volts to ground, the frame shall be grounded in the manner specified in Section 13-250. If the frame is not grounded, it shall be permanently and effectively insulated from the ground.

SECTION 13-450. TRANSFORMERS AND TRANSFORMER VAULTS

Order 13-4501. Application.

This section shall apply to the installation of transformers of all voltages, except as follows:

A. *Hazardous Locations.* Transformers in hazardous locations, which shall comply with the provisions of this section, except as modified in Section 13-500.

B. *Signaling.* Transformers operating at a primary voltage not exceeding 250 volts and used for bell ringing or other signal or control purposes, which shall comply with Section 13-800.

C. *Signs and Outline Lighting.* Transformers used for signs and outline lighting, which shall comply with Section 13-600.

D. *Radio.* Transformers used with radio equipment, which shall comply with Section 13-810.

E. *X-Ray and High-Frequency.* Transformers used for X-Ray or High-Frequency, which shall comply with Section 13-660.

F. *Special Transformers.* Special air-cooled transformers constituting a component part of other apparatus and conforming with the requirements for such apparatus or devices.

G. *Current Transformers.* Current transformers used for metering or for protective relays.

H. *Control Circuit Transformers.* Control circuit transformers furnished with control equipment, which conform to the requirements for the equipment which they control.

Order 13-4502. In Generating Stations and Substations.

Transformers operating at more than 600 volts in generating stations and substations shall comply with the following:

A. *Location.* They shall be so located that fire and smoke from burning insulation or oil will be unlikely to do damage.

B. *Air-Blast Transformers.* Air-blast transformers should be isolated. Ducts for air blast shall be of noncombustible construction.

C. *Oil-Immersed Transformers.* Oil immersed transformers should be placed in vaults complying with orders 13-4521 to 13-4528, unless in a substation building used for no other purpose.

Order 13-4503. In Other Buildings—All Voltages.

In buildings other than generating stations and substations, transformers, except potential instrument transformers, shall comply with the following:

A. *Air-Cooled Transformers.* Transformers whose windings are cooled by exposure to the air shall have a separation of at least 12 inches from combustible material, unless separated therefrom by a barrier of incombustible heat insulating material, or unless of rating not exceeding 600 volts and completely enclosed except for ventilating openings. An air space of at least six inches shall be left between transformers and between each transformer and adjacent surfaces, except the surface upon which it is mounted.

B. *Liquid That Will Not Burn.* A transformer immersed in an approved liquid that will not burn and rated in excess of 25 kva shall be furnished with a pressure relief vent. If installed in a poorly ventilated place inside of a building it shall also comply with one of the following conditions:

1. It shall be furnished with a means for absorbing any gases generated by arcing inside the case, or
2. The pressure relief vent shall be connected to a chimney or flue which will carry such gases outside the building.

C. *Liquid That Will Burn.* Transformers immersed in a liquid that will burn shall be installed in a vault conforming to orders 13-4521 to 13-4528, inclusive, except by special permission as follows:

1. Transformers rated at not more than 600 volts and 10 kva may be installed without a vault in a building or room of other than fire resistive construction, if there is no combustible material in the vicinity of the transformer.

2. Transformers rated at not more than 600 volts and not more than 25 kva in any one unit, or not more than 75 kva total rating, may be installed without a vault in a building or room of fire resistive construction and containing no other combustible material in the vicinity of the transformer, if surrounded by concrete curbs not less than 6 inches high forming a basin of sufficient capacity to retain all the liquid used in the transformers.

See order 13-1111 on working space in front of live parts

Order 13-4504. In Other Buildings—Exceeding 600 Volts.

In buildings other than generating stations and substations, transformers operating at more than 600 volts, except potential instrument transformers, shall comply with order 13-4503 and also with the following:

A. *Special Permission.* They shall be installed only by special permission.

B. *Location.* They shall be located where the supply conductors enter the building or as near to this point as practicable.

C. *Enclosure.* Transformers immersed in a liquid that will burn shall comply with paragraph C of order 13-4503. Other transformers shall be installed so as to provide mechanical protection, ventilation, and inaccessibility to unauthorized persons. If exceeding 15,000 volts between terminals they shall be installed only in a vault conforming to orders 13-4521 to 13-4528 inclusive.

D. *Furnace Rooms.* In electric furnace rooms transformers immersed in a liquid that will burn, with total rating not exceeding 75 kva, may be installed in accordance with paragraph C-2 of order 13-4503.

Order 13-4505. Attached to or Adjacent to Building.

Transformers attached to the exterior of a building or in immediate proximity thereto shall be so located as not to interfere with the raising of fire ladders; shall be at least 4 feet from fire escapes and outside stairways; and shall comply with the following:

A. *Liquid That Will Burn.* If immersed in a liquid that will burn, they shall be placed against a blank wall of masonry or reinforced concrete. They shall not be directly under any combustible eaves or cornices.

It is recommended that wall openings within 10 feet be protected by standard fire doors or shutters. Under some circumstances openings distant more than 10 feet should be protected.

B. *Liquid That Will Not Burn.* If immersed in a liquid that will not burn, there shall be an air space of at least 6 inches between the transformer case and any adjacent combustible material.

C. *Under a Sidewalk.* If transformers immersed in a liquid that will burn are placed under a sidewalk in front of a building they shall be located in a vault complying with orders 13-4521 to 13-4528 inclusive.

Order 13-4506. Mounted on Roofs.

A transformer installed on the roof of a building shall comply with the following:

A. *Liquid That Will Burn.* If the transformer is immersed in a liquid that will burn, it shall be installed in a vault.

B. *Liquid That Will Not Burn.* A transformer immersed in a liquid that will not burn shall be mounted well away from doors. If located so that leaking liquid might reach a window or door, it shall be mounted on a metal pan or concrete basin large enough to retain the liquid.

Order 13-4507. Outdoor Transformers.

If transformers are located outdoors, the transformers, switches, and other apparatus shall comply with the following:

A. They shall not be accessible to unauthorized persons.

B. They shall be so placed as not to interfere with firemen.

C. They shall be isolated with respect to combustibility, window exposure, and nature of occupancy of adjacent buildings.

D. Unless isolated by elevation they shall be surrounded by an enclosure, grounded if of metal, and placarded with a warning sign which indicates the highest voltage involved.

E. If transformers are immersed in a liquid that will burn, drains for overflowing liquid shall not come in close proximity to combustible structures or materials.

Order 13-4508. Auto-Transformers.

Transformers in which a part of the turns are common to both primary and secondary alternating current circuits, ordinarily known as auto-transformers, may be connected to an interior wiring system only under one of the following circumstances:

A. *Identified Wire in Both Systems.* The system supplied contains an identified grounded conductor which is solidly connected to a similar identified grounded conductor of the system supplying the auto-transformer.

B. *Induction Motor Control.* The auto-transformer is used for starting or controlling an induction motor and may be included in a starter case or installed as a separate unit.

C. *In Apparatus.* The auto-transformer supplies a circuit wholly within apparatus which also contains the auto-transformer.

D. *Voltage Adjustment.* The auto-transformer is used for fixed voltage adjustment on an existing power circuit having no identified grounded conductor.

E. *Theater Dimmers.* The auto-transformer is installed in accordance with order 13-5225.

Order 13-4509. Potential Instrument Transformers.

Potential instrument transformers whose primaries operate at more than 5000 volts between conductors shall comply with the requirements of order 13-7135.

VAULTS

Order 13-4521. Location.

Transformer vaults shall be located at the point of entrance of the service conductors into the building or as near this point as practicable. They shall be located so they can be ventilated to the outside air without the use of ducts, wherever such an arrangement is practicable.

Order 13-4522. Design.

Vaults shall be of such design that an air space of not less than 6 inches is provided on every side of a transformer.

Order 13-4523. Construction.

The walls and roof of vaults shall consist of reinforced concrete not less than 6 inches in thickness, or of brick not less than 8 inches in thickness, or of load bearing hollow tile not less than 12 inches in thickness coated on the inside with cement plaster; except that if the total transformer capacity so enclosed is not more than 100 kva, reinforced concrete 4 inches thick may be employed. Where practicable, the outside walls of the building, if of standard vault construction, should form one of the walls of the vault. The vault shall have a floor of concrete at least 4 inches thick.

Order 13-4524. Doorways.

Any doorway leading from the vault into the building shall comply with the following:

A. *Type of Door.* Each doorway shall be provided with a tight fitting door of a type approved for openings in class A situations as defined in the 1939 edition of the standard of the National Board of Fire Underwriters for Protection of Openings in Walls and Partitions Against Fire. The authority enforcing this code may require such a door on each side of the wall if conditions warrant.

B. *Sills.* A door sill of sufficient height to confine within the vault the oil from the largest transformer shall be provided and in no case shall the height be less than 4 inches.

C. *Locks.* Entrance doors shall be equipped with locks, and doors shall be kept locked, access being allowed only to authorized persons. If spring or other automatic locks are used, they shall be so arranged that they may be readily and quickly opened from the inside.

Order 13-4525. Ventilation.

The vault shall be ventilated as follows:

A. *Limiting Temperature.* The ventilation shall be such as will prevent the development of room temperatures in excess of those prescribed by Standard No. 13 of the American Institute of Electrical Engineers (1930 edition). Ventilating openings should be proportioned to the kva capacity of the transformer and be so located as to facilitate air movement. In the case of vaults ventilated directly to the outside air by natural ventilation without the use of ducts, ventilating outlets having a combined area of not less than one square foot shall be provided for transformers of 50 kva or smaller. For installations larger than 50 kva, the area shall be not less than 3 square inches per kva of transformer capacity.

B. *Damper—Where Required.* Ventilating openings not connected to chimneys or flues or directly to outside air shall be provided with automatic dampers made of metal of thickness not less than No. 10 USS gauge.

C. *Louvers.* Openings for illumination or ventilation shall be protected by louvers, or by substantial fixed metal screens with mesh not

larger than ¾ inch, and shall be so constructed that snow or rain will not reach wiring or apparatus of other than weatherproof construction.

D. *Location of Ventilation Opening.* Openings for vault ventilation to the outside air shall be located as far away as practicable from doors, windows, and flammable material.

Order 13-4526. Drainage.

If practicable, the vault shall be provided with a drain which will carry off any accumulation of oil or water that may collect in the vault. Floor and drain shall have a pitch of not less than ¼ inch per foot. In vaults containing transformers having a total capacity of 100 kva or less, the drain may be omitted if the enclosure is so constructed as to retain all the oil used within the vault.

Order 13-4527. Water Pipes and Other Accessories.

Pipes for water, steam, gas, sewers, or other purposes, and such accessories as faucets and sprinkler heads and ducts for ventilating other parts of the building, should not be installed in transformer vaults. Where conditions are such that the presence of these pipes cannot be entirely avoided, they shall be so located or so protected by nonflammable waterproof barriers as to prevent any leakage or moisture from condensation reaching high voltage wiring or apparatus, and such pipes shall be installed without valves or traps within the vault.

Order 13-4528. Storage in Vaults.

Materials shall not be stored in transformer vaults.

OVERCURRENT PROTECTION

Order 13-4531. 600 Volts or Less.

If located inside building, each transformer or bank of transformers operating as a unit, except instrument transformers, shall be separately protected on the primary side by an automatic overcurrent device rated or set at not more than 200 per cent of the full load current rating of the transformer or bank of transformers. Potential instrument transformers should be protected in the primary circuit by fuses rated at not more than 5 amperes.

Order 13-4532. Exceeding 600 Volts.

Overcurrent protection for transformers of more than 600 volts, other than instrument transformers, shall comply with Section 13-710. Potential instrument transformers should be protected in the primary circuit by fuses rated at not more than 2 amperes.

It is recommended that an external resistor be placed in series with the primary winding of a potential instrument transformer of high voltage rating in order to limit the possible short circuit current to a value which can safely be interrupted by a fuse.

GROUNDING

Order 13-4541. Grounding.

Transformer cases shall be grounded in the manner prescribed in Section 13-250; except:

A. *Switchboard Instrument Transformers.* Cases or frames of transformers used exclusively to supply current to switchboard instruments or protective relays, if they are installed and guarded as required for the maximum potential at which they operate.

B. *Transformers on Poles.* Transformers mounted on wooden poles at a height of more than 8 feet from the ground.

GUARDING

Order 13-4546. Guarding.

If unqualified persons have access, all live parts of transformers which are connected to circuits of more than 600 volts between conductors shall be enclosed or isolated as provided in order 13-7161.

CONSTRUCTION

Order 13-4551. Name Plate.

Each transformer shall be provided with a name plate giving the maker's name, rating in kilo-volt-amperes, primary and secondary voltage ratings, frequency, and liquid capacity (if of the liquid immersed type) in gallons. If to be immersed in a liquid that will not burn, the liquid shall be specified.

Order 13-4552. Air-Cooled Transformers.

The construction of an air-cooled transformer shall be such that if mounted on a plane surface the casing will make contact with such surface only at the points of support, providing elsewhere an air space of at least ¼ inch between casing and surface. The enclosure of an air-cooled (natural draft) transformer shall be made of noncombustible, moisture resistant material.

SECTION 13-460. CAPACITORS

Order 13-4601. Application of Other Articles.

This section shall not apply to special capacitors constituting a component part of other apparatus and conforming with the requirements for such apparatus. Capacitors installed in hazardous locations shall comply with the provisions of this section except as modified by Section 13-500.

Order 13-4602. Location.

Capacitors shall be enclosed in vaults complying with the provisions of orders 13-4521 to 13-4528 inclusive, unless one of the following conditions is complied with:

A. The liquid will be of a type that will not burn.

B. If the liquid will burn, not more than 3 gallons shall be in each container and the container shall be made liquid tight without the use of solder, although solder may be used to prevent the slight seepage of liquid.

Order 13-4603. Enclosures.

Capacitors not in vaults shall be enclosed in metal boxes or cabinets if exposed to combustible dust or flyings, or if in the vicinity of easily ignitible material.

Order 13-4604. Mechanical Injury.

Capacitors shall not be exposed to mechanical injury.

Order 13-4605. Transformers Used with Capacitors.

Transformers for use with capacitors shall comply with the following:

A. *General.* They shall, except as herein provided, comply with the provisions of orders 13-4502 or 13-4503, 13-4541 and 13-4546.

B. *Enclosure Waived.* By special permission, transformers used exclusively in connection with capacitors need not be enclosed in a vault if the following conditions are complied with:

1. They shall be located in rooms of noncombustible construction and occupancy.

2. They shall not be subject to lightning disturbances.

3. They shall have sufficient capacity to allow for ordinary rise in voltage.

4. They shall be surrounded by concrete curbs not less than 6 inches high which form a basin of sufficient capacity to contain all the oil in the transformer.

5. They shall be controlled and have overcurrent protection with a rating or setting not exceeding 200 per cent of the rated ampere capacity of the capacitor.

Order 13-4606. Drainage of Stored Charge.

Capacitors shall be provided with a means of draining the stored charge.

A. *Time of Discharge.* The stored charge shall be drained from the capacitor to 50 volts or less within one minute after the capacitor is disconnected from the source of supply.

B. *Drainage Connections.* Capacitors connected directly to other equipment without switch or overcurrent device interposed, will be considered as properly drained. If the drain or discharge circuit is not permanently connected to the terminals of the capacitor or capacitor bank, automatic means shall be provided for connecting the capacitor to the discharge circuit on removal of voltage from the line. Manual means of connecting the discharge circuit to the capacitor shall not be used.

Order 13-4607. Size of Conductors and Disconnecting Means.

Conductors supplying capacitors shall have a current carrying capacity, and the equipment used to disconnect them shall have a current carrying capacity and interrupting capacity, not less than the full load current rating of the capacitors.

Order 13-4608. Capacitors for Power Factor Correction.

Capacitors used for power factor correction shall comply with the following:

A. *Used with an Individual Motor.* Capacitors 100 kva or less, if associated with an individual motor of 100 horsepower or less for power factor correction, and if the kva capacity of the capacitor does not exceed the horsepower capacity of the motor, may be connected at any point on the load side of the motor circuit switch and motor circuit overcurrent device, in which case:

1. Conductors to Capacitor. Conductors supplying the capacitor shall be of size not less than those supplying the motor starter.
2. Conductor to Motor. Conductors to motors need not be of a size greater than required by the motor without the capacitor.
3. Switches—Overcurrent Device. No overcurrent device and no disconnecting switch need be connected in the capacitor circuit. The overcurrent device and the switch in the motor circuit need not be of a rating greater than required by the motor without the capacitor.

B. *If Used Other Than with Individual Motors.* Capacitors used for power factor correction other than as in paragraph A shall comply with the following:

1. Disconnecting Means. A disconnecting means shall be provided in each ungrounded conductor. The disconnecting means need not open all ungrounded conductors simultaneously. The disconnecting means may be used for disconnecting the capacitor from the line as a regular operating procedure.
2. Overcurrent Protection. Overcurrent protection shall be provided in each ungrounded conductor.

Order 13-4609. Grounding.

Capacitor cases shall be grounded in accordance with Section 13-250.

Order 13-4610. Guarding.

All live parts of capacitors which are connected to circuits of more than 600 volts between conductors and are accessible to unqualified persons, shall be enclosed or isolated. For isolation by elevation, see order 13-7162.

Order 13-4611. Name Plate.

Each capacitor shall be provided with a name plate giving the maker's name, rated voltage, frequency, kva or amperes, number of phases, and if liquid filled, the amount of liquid in gallons, together with a statement that the liquid will or will not burn, as the case may be. Capacitors and capacitor transformer units used with individual A.C. motors shall be marked in addition with an identification symbol, which symbol shall also appear on the name plate of the motor with which the device is to be used.

SECTION 13-470. RESISTORS AND REACTORS

For Rheostats see orders 13-4305, 13-4306 and 13-94303.

Order 13-4701. Location.

Resistors and reactors shall not be placed where exposed to mechanical injury. If in the immediate vicinity of easily ignitible material they shall be of the oil immersed type or shall be enclosed in metal boxes or cabinets. See Section 13-500 for Hazardous Locations.

Order 13-4702. Space Separation.

Unless attached to a switchboard or other noncombustible material, or unless mounted as provided in order 13-4703, resistors and reactors shall be separated from combustible material by a distance of not less than 1 foot.

Order 13-4703. On or In Proximity to Combustible Material.

If placed within a distance of 1 foot from combustible material, resistors and reactors shall be installed as follows:

A. *Slab or Panel.* They shall be attached to a slab or panel of noncombustible, nonabsorptive material such as slate, soapstone, or marble.

B. *Size of Slab.* The slab shall extend beyond the edges of the device and shall have a thickness proportioned to the size and weight of the device but shall not be less than ½ inch thick.

C. *Supports.* The slab shall be secured in position by supports independent of those fastening the device to the slab. Bolts which support the device shall be countersunk at least ⅛ inch below the rear surface of the slab and shall be covered with insulating material.

Order 13-4704. Mounting.

Casings when mounted on plane surfaces shall make contact with such surfaces only at the point of support, an air space of at least ¼ inch being maintained between the casings and surfaces.

Order 13-4705. Conductor Insulation.

If insulated conductors are used for connection between resistance elements and controllers, the conductors shall be asbestos covered (type A), asbestos varnished cambric (type AVA) or, for temperatures not exceeding 90C (194F), slow burning (type SB); except that for motor starting service other conductor insulations may be used. For elevator motor starting service, see sub-paragraph B of order 13-6204.

Order 13-4706. Incandescent Lamps as Resistors.

Incandescent lamps may be used as protective resistors for automatic controllers, or may by special permission be used as resistors in series with other devices and shall conform to the following:

A. *Mounting.* They shall be mounted in porcelain receptacles on noncombustible supports.

B. *Voltage.* They shall be so arranged that they cannot have impressed upon them a voltage greater than that for which they are rated.

C. *Name Plate.* They shall be provided with a name plate, permanently attached, giving the wattage and voltage of the lamp to be used in each receptacle.

D. *Not Carry Main Current.* They shall not carry or control the main current nor constitute the regulating resistance of the device.

SECTION 13-480. STORAGE BATTERIES

Order 13-4801. Scope.

The provisions of this section shall apply to all stationary installations of storage batteries using acid or alkali as the electrolyte and consisting of a number of cells connected in series with a nominal voltage in excess of 16 volts.

Order 13-4802. Definition of Nominal Voltage.

The nominal battery voltage shall be calculated on the basis of 2.0 volts per cell for the lead acid type, and 1.2 volts per cell for the alkali type.

Order 13-4803. Wiring and Apparatus Supplied from Batteries.

Wiring, appliances, and apparatus supplied from storage batteries shall be subject to the requirements of this code applying to wiring, appliances, and apparatus operating at the same voltage, except as otherwise provided for signal and control systems in Section 13-800.

Order 13-4804. Insulation of Batteries of Not Over 250 Volts.

The provisions of this order shall apply to storage batteries having the cells so connected as to operate at a nominal battery voltage not exceeding 250 volts.

A. *Lead Acid Batteries.* Cells in lead lined wood tanks, where the number of cells in series does not exceed 25, shall be supported individually on glass or glazed porcelain insulators. If the number of the cells in series exceeds 25, the cells shall be supported individually on oil insulators.

B. *Alkali Type Batteries.* Cells of the alkali type in jars made of conducting material shall be installed in trays of non-conducting material, with not over 20 cells in a series circuit in any one such tray, or the cells may be supported singly or in groups on porcelain or other suitable insulators.

C. *Unsealed Jars.* Cells in unsealed jars made of nonconductive material shall be assembled in trays of glass or supported on glass or glazed porcelain insulators; or, if installed on a rack, shall be supported singly or in groups on glass or other suitable insulators.

D. *Sealed Rubber Jars.* Cells in sealed rubber or composition containers shall require no additional insulating support if the total nominal voltage of all cells in series does not exceed 150 volts. If the total voltage exceeds 150 volts, batteries shall be sectionalized into groups of 150 volts or less and each group shall have the individual cells installed in trays or on racks. If trays or racks are required for this type of cell, such trays or racks shall be supported on glass or glazed porcelain insulators or oil type insulators.

E. *Sealed Glass Jars.* Cells in sealed glass jars, with or without wood trays, require no additional insulation.

Order 13-4805. Insulation of Batteries of Over 250 Volts.

The provisions of order 13-4804 shall apply to storage batteries having the cells so connected as to operate at a nominal voltage exceeding 250 volts and, in addition, the provisions of this order shall also apply to such batteries.

A. Cells shall be installed in groups having a total nominal voltage of not over 250 volts, in trays or on racks supported on oil insulators; except that if each individual cell, or sub-group in the tray or rack, is supported on oil insulators, no additional insulation for the group need be provided; and except that cells of not over 10 ampere hour capacity in sealed glass jars may be grouped in trays, the total nominal voltage of all cells in such a group not to exceed 250 volts, and each such tray to be supported on glass or glazed porcelain insulators, the trays being mounted on racks supported on oil insulators with a total nominal voltage of not over 500 volts for all cells in series on each insulated rack.

Maximum protection is secured by sectionalizing high voltage batteries into cell groups insulated from each other.

Order 13-4806. Racks and Trays.

Racks and trays shall conform to the following:

A. *Racks.* Racks, as required in this section, refer to frames designed to support cells or trays. They shall be substantial, and made of:

1. Wood, so treated as to be resistant to deteriorating action by the electrolyte; or

2. Metal, so treated as to be resistant to deteriorating action by the electrolyte, and provided with non-conducting members directly supporting the cells or with suitable insulating material on conducting members; or

3. Other similar suitable construction.

B. *Trays.* Trays refer to frames such as crates or shallow boxes usually of wood or other nonconducting material, so constructed or treated as to be resistant to deteriorating action by the electrolyte.

Order 13-4807. Battery Rooms.

Battery rooms shall conform to the following:

A. *Use.* Separate battery rooms or enclosures shall be required only for batteries in unsealed jars and tanks where the aggregate capacity at the 8-hour discharge rate exceeds 5 kilowatt hours.

B. *Wiring Method.* In storage battery rooms, bare conductors, open wiring, or conductors in rigid conduit or electrical metallic tubing shall be used as the wiring method.

C. *Varnished Cambric Conductors.* Varnished cambric covered conductors, Type V, shall not be used.

D. *Bare Conductors.* Bare conductors shall not be taped.

E. *Raceway.* Rigid metal conduit, or electrical metallic tubing, if used, shall be of corrosion resistant material or shall be suitably protected from corrosion.

F. *Terminals.* If metal raceway or other metallic covering is used in the battery room, at least 12 inches of the conductor at the end connected to a cell terminal shall be free from the raceway or metallic covering and shall be bushed by a substantial glazed insulating bushing. The end of the raceway shall be sealed tightly to resist the entrance to electrolyte by spray or by creepage. Sealing compound, rubber insulating tape or other suitable material shall be used for this purpose.

G. *Ventilation.* Provision shall be made for sufficient diffusion and ventilation of the gases from the battery to prevent the accumulation of an explosive mixture in the battery room.

Chapter 5. Special Occupancies

SECTION 13-500. HAZARDOUS LOCATIONS

Equipment for use in hazardous locations is tested according to classes of hazardous vapor or gas and air, or dust and air atmosphere as follows:

Class I, Group A, Atmospheres containing acetylene;
Class I, Group B, Atmospheres containing hydrogen or gases or vapors of equivalent hazard such as manufactured gas;
Class I, Group C, Atmospheres containing ethyl ether vapor;
Class I, Group D, Atmospheres containing gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors, and natural gas;
Class II, Group E, Atmospheres containing metal dust;
Class II, Group F, Atmospheres containing carbon black, coal or coke dust;
Class II, Group G, Atmospheres containing grain dust.

Order 13-5001. Scope.

The provisions of this section apply to locations in which the authority enforcing this code judges the apparatus and wiring to be subject to the conditions indicated by the following classifications. If the apparatus and wiring are installed in rooms or sections of the building in which the particular hazardous conditions do not prevail, such wiring and apparatus may be of the type approved for such locations. For garages see Section 13-510. For recommendations for protection against static electricity hazards, refer to the standards of the National Fire Protection Association on this subject.

Note. If there is question or difference of opinion as to whether a particular location should be classed as a hazardous location under the provisions of one of the paragraphs of this section, it should be referred to the Industrial Commission or the Public Service Commission for a decision.

Order 13-5002. Special Precaution.

The intent of this section is to require a form of construction of equipment, and of installation that will insure safe performance under conditions of proper use and maintenance. It, therefore, is assumed that inspection authorities and users will exercise more than ordinary care with regard to installation and maintenance.

Order 13-5005. Class I, Classification.

Class I locations are those in which flammable volatile liquids, highly flammable gases, mixtures or other highly flammable substances are manufactured, used, handled, or stored in other than their original containers, in such manner and quantity as to create an explosive mixture.

This class may include such locations as some parts of dry-cleaning and dry-dyeing plants, pyroxylin plastic manufacturing plants, spray-painting establishments, flammable-gas plants, varnish-manufacturing plants, distilleries, rectifying and blending plants producing whiskey and other alcoholic beverage liquors, plants producing industrial alcohol, and establishments or industries involving similar hazardous processes or conditions.

Order 13-5006. Class II, Classification.

Class II locations are those in which (1) combustible dust is thrown, or is likely to be thrown, into suspension in the air in sufficient quantities to produce explosive mixtures, or (2) those where it is impracticable to prevent such combustible dust from collecting in such quantities on or in motors, lamps, or other electrical devices that they are likely to become overheated because normal radiation is prevented.

This class may include such locations as some parts of flour mills, feed mills, grain elevators, starch plants, sugar, cocoa and coal-pulverizing plants, and establishments or industries involving similar hazardous processes or conditions.

Order 13-5007. Class III, Classification.

Class III locations are those in which easily ignitible fibers or materials producing combustible flyings are handled, manufactured or used, and which are hazardous through such fibers or flyings collecting on or being ignited by arcing contacts, resistors, lamps or similar apparatus.

This class may include locations such as some parts of cotton and other textile mills, combustible-fibre manufacturing plants, cotton gins, clothing manufacturing plants, cotton-seed mills, woodworking plants and establishments or industries involving similar hazardous processes or conditions.

Order 13-5008. Class IV, Classification.

Class IV locations are those in which easily ignitible combustible fibers are stored or handled (except in rooms where in process of manufacture) and which are hazardous through such fibers being ignited by arcing contacts, resistors, lamps, or similar apparatus.

This class may include locations such as warehouses in which are stored or handled combustible fibers such as cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste, kapok, Spanish moss, excelsior, and other similarly readily ignitible fibers.

CLASS I—INSTALLATION

Order 13-5011. General.

In locations judged to be as described for Class I the following provisions shall be observed.

Order 13-5012. Transformers and Capacitors.

Transformers and capacitors containing a liquid that will burn, if located within buildings, shall be installed in a reinforced concrete vault conforming to orders 13-4521 to 13-4528, inclusive. The vault shall be provided with ample ventilation to remove hazardous vapors, and with explosion relief ducts. All vents and ducts shall be of reinforced concrete and shall extend to a safe location outside the building. There shall be no openings from the vault to the interior of the building. See Sections 13-450 and 13-460.

It is recommended that transformers and capacitors be located outside of the building proper, and when so placed shall be far enough away from explosive gases and vapors that a burnout would not ignite them. The latter principle is applicable to loading docks and tank farms.

Transformers and capacitors containing a liquid that will not burn may be (1) located within the hazardous area provided they are enclosed in explosion-proof enclosures, or (2) installed so as, in effect, to be removed from the hazardous location as by a room or vault of fire-resistive construction, with unpierced walls or partitions to exclude the entrance of hazardous vapors, and provided with ample ventilation to outside air.

Order 13-5013. Service Equipment, Panelboards, and Switchboards.

No service equipment, switchboard, or panelboard shall be installed unless of a type approved for use in explosive atmospheres.

Order 13-5014. Wiring Method.

Rigid conduit with threaded explosion-proof joints and explosion-proof fittings shall be employed as the type of wiring.

A. *Flexible Connection.* Where necessary to employ flexible connections, as at motor terminals, a flexible fitting of the explosion-proof type may be used.

B. *Sealing.* All conduit runs shall be sealed off in an approved manner (1) where conduit terminates in an enclosure in which arcing or sparking is likely to occur as at motor terminals, switch boxes, and the like; (2) wherever a conduit leads from a hazardous to a non-hazardous location; and (3) within 2 feet of terminal and junction boxes to which conduit runs 4 inch size or larger are connected. Seals shall be made by use of approved sealing fittings (unless the enclosure is provided with an approved means for sealing) and a sealing compound approved for the purpose which is not affected by the surrounding atmosphere or liquids, and which has a melting point of not less than 93C (200F). The sealing compound shall have a thickness of not less than ⅝ inch. In locating seals, due consideration shall be given to the possibility of water being trapped. If there is such a possibility, due to condensation or other causes, the conduit system shall be so arranged that water will collect in an explosion-proof sump which may be drained periodically. Splices shall not be made in fittings intended only for sealing purposes nor shall other fittings in which splices are made be filled with compound.

C. *Threaded Couplings.* Joints in rigid conduit made with threaded couplings shall have at least five full threads engaged.

Order 13-5015. Overcurrent Devices.

Circuit-breakers shall be of a type approved for use in explosive atmospheres. Fuses shall not be installed unless mounted within explosion-proof enclosures. The cutout bases and their enclosures shall be approved as unit devices for use in explosive atmospheres.

Order 13-5016. Motors and Generators.

Motors and generators shall be of types approved for use in explosive atmospheres.

Order 13-5017. Controllers and Resistance Devices.

Devices or apparatus, such as motor controllers, thermal cutouts, switches, relays, the switches and contactors of auto-transformer starters, resistance or impedance devices, which tend to create arcs, sparks, or high temperatures, shall not be installed unless such devices or apparatus are of a type approved for use in explosive atmospheres.

It is recommended that motor controllers be of the remote control type with the main contactors located at a point where the hazardous conditions of this class do not prevail. Auxiliary control push buttons or switches of a type approved for use in explosive atmospheres may then be placed in the most convenient locations.

Order 13-5018. Heating Appliances.

Electric heating appliances shall be of a type approved for the particular location.

Order 13-5019. Lighting Switches.

Switches controlling lighting circuits shall be of a type approved for use in explosive atmospheres.

Order 13-5020. Lighting Fixtures.

Lamps in fixed position shall be enclosed in a manner approved for explosive atmospheres, and shall be properly protected by substantial metal guards or other means where exposed to breakage. Lamps shall not be of the pendent type unless supported by and supplied through hangers of rigid conduit or flexible connectors approved for explosive atmospheres. If rubber-covered conductors are used, they shall have insulation not less than 3/64 inch thick. Rigidly mounted fixtures shall be strongly supported.

Order 13-5021. Portable Lamps.

Sufficient general illumination shall be provided by fixed lighting units to eliminate, so far as possible, the need for portable lamps. If portable lamps are necessary, they shall be enclosed in a manner approved for explosive atmospheres and shall be protected against breakage by approved types of guards. Lampholders for portable lamps shall be of moulded-composition or other approved material and of the keyless type with no exposed metal parts.

Order 13-5022. Flexible Cord.

If necessary to use portable lamps or portable appliances, flexible cord designed for hard usage such as Type S shall be used. Such a flexible cord shall contain one extra insulated conductor to form a grounding connection for metal lamp guards, motor frames, and all other exposed metal portions of portable lamps and appliances. The outer covering of the grounding conductor shall be finished to show a green color. Portable cords connected direct to supply conductors shall be securely supported so that the probability of a break in the conductors at this point will be minimized.

Order 13-5023. Receptacles and Attachment Plugs.

Receptacles and attachment plugs shall be so connected as a part of a unit device with an explosion-proof interlocking switch that the plug cannot be removed while the switch is in the "on" position, or approved devices in which the circuit is broken in an explosion-proof enclosure shall be used. Such receptacles and plugs shall be of the polarized type which provides a connection for the grounding conductor of the portable cord.

Order 13-5024. Spray Booths.

No motor, lamps, or lighting fixture of any type shall be located within spray booths, in ventilating ducts connected therewith, nor in any location where there is a possibility of the spray lodging upon them. The auxiliaries of mercury-vapor lamps shall be located at least ten feet from spray-booth working faces.

Motors in spray-painting establishments that are located outside of paint-spray booths and ventilating ducts and are judged by the authority enforcing this code to be outside of the hazardous area may be of any standard totally-enclosed type or of the open induction type having no brushes, make-and-break contacts, collectors, or other arcing or sparking parts.

Order 13-5025. Grounding.

The exposed non-current carrying metal parts of equipment such as the frames or metal exteriors of motors, fixed or portable lamps or appliances, fixtures, cabinets, cases, and conduit shall be grounded as provided in Section 13-250 of this code. The locknut-bushing and the double-locknut types of contact shall not be depended upon for bonding purposes, but bonding jumpers with proper fittings or other approved means shall be used.

Order 13-5026. Live Parts.

There shall be no exposed live parts.

Order 13-5027. Signal and Communication Systems.

All equipment of signaling and communication systems, irrespective of voltage, including bells, horns, sirens, relays, push buttons and the like, shall be of a type approved for use in explosive atmospheres. All wiring shall be installed in accordance with order 13-5014 of this section.

CLASS II—INSTALLATION

Order 13-5051. General.

Where conditions are judged to be as described for Class II, the following provisions shall be observed.

Order 13-5052. Transformers and Capacitors.

Transformers and capacitors containing a liquid that will burn, if located within buildings, shall be installed in a reinforced concrete vault conforming to orders 13-4521 and 13-4528, inclusive. The vault shall be provided with air cooling vents and pressure-relief openings of

noncombustible construction extended to the outside of the building. Any openings into the building shall be protected by double standard fire doors. See Sections 13-450 and 13-460.

It is recommended that transformers and capacitors be located outside the building proper and in such a manner that they and their combustible supports are at least ten feet horizontally from any exposed combustible parts or unprotected openings of all buildings.

Transformers and capacitors containing a liquid that will not burn may be located within the hazardous area provided they are of dusttight construction with dusttight terminal enclosures, or are enclosed in dusttight fire resistive rooms. Such transformers shall be equipped with pressure relief devices.

In plants producing aluminum bronze powder, transformers and capacitors shall be installed outside of, and at a safe distance from, the dust-making buildings.

Order 13-5053. Surge Protection.

In locations where lightning disturbances are prevalent, power services shall be suitably protected against high-voltage surges. This protection shall include suitable lightning arresters, interconnection of all grounds, and surge-protective capacitors.

Order 13-5054. Service Equipment, Panelboards, and Switchboards.

Service equipment, panelboards, or switchboards shall not be placed in these locations unless it is impracticable to locate them elsewhere. If placed in these locations all live parts shall be enclosed in dusttight metal cases or cabinets with provisions for external operation only, or shall be placed in separate rooms built of or lined with substantial non-combustible materials constructed so as to adequately exclude dust and having self-closing doors.

Order 13-5055. Overcurrent Devices.

Overcurrent devices, whether fuses or circuit-breakers, placed in locations of this class shall be enclosed in dusttight metal cabinets or cases, or shall be placed in separate rooms built of or lined with substantial non-combustible materials, constructed so as to exclude dust and having self-closing doors.

Order 13-5056. Wiring Method.

Rigid conduit with threaded joints shall be the wiring method employed.

A. *Flexible Connections.* If it is necessary to employ flexible connections, as at motor terminals, a short length of flexible steel conduit may be used.

B. *Fittings.* Conduit boxes and other fittings used in locations where dusts are of an electrically conducting nature shall be of the dusttight type.

Order 13-5057. Motors and Generators.

Motors and generators shall comply with the following:

A. *Brush Type.* Where explosive dusty atmospheres are likely to be present, as in (1) of order 13-5006, motors or generators having brushes or sliding contacts shall have such brushes or sliding contacts enclosed in substantial dusttight housings, or shall be of the totally-enclosed, totally-enclosed fan-cooled, or totally-enclosed pipe-ventilated type, or shall be enclosed in separate rooms or housings built of or lined with substantial non-combustible materials, constructed so as to adequately exclude dust and properly ventilated from a source of clean air.

It is recommended that all motors installed in dusty locations be of the enclosed type or enclosed in rooms such as described.

B. *Where Excessive Dust Is Present.* Where it is impracticable to prevent combustible dust from collecting in dangerous quantities on or in motors and generators, as in (2) of order 13-5006, all motors and generators shall be of the totally-enclosed, totally- enclosed fan-cooled, or totally-enclosed pipe-ventilated type, or shall be enclosed in separate rooms or housings built of or lined with substantial non-combustible materials, constructed so as to adequately exclude dust, and properly ventilated from a source of clean air.

C. *Ventilating Piping.* If motors and generators of the pipe ventilated type are used, or if they are enclosed in rooms or housings, the vent pipes shall extend to the outside of the building to a source of clean air. The vent pipes shall be of metal, substantially constructed and with each section attached to the next by riveting, welding or other approved methods. The outer ends of vent pipes shall be suitably screened to prevent the entrance of animals or birds. If motors or generators are intended to be moved on their bases, a slip or universal joint, tight enough to prevent the entrance of dust, shall be provided in the vent pipes.

D. *Aluminum Bronze Powder Plants.* Motors and generators regardless of type, in plants producing aluminum bronze powder shall preferably be placed outside the dust-making buildings, but if within such buildings they shall be of a type approved for such locations.

Order 13-5058. Control Equipment.

Devices or apparatus, such as motor controllers, thermal cutouts, switches, relays, switches and contactors of auto-transformer starters, resistance and impedance devices, which tend to create arcs, sparks or high temperatures, if installed in locations of this class shall be enclosed within dusttight cases or cabinets or be of the dusttight type, and be so designed that the device may be operated without opening the cabinet or case.

It is recommended that motor control devices be of the remote control type with main contactors located in separate rooms or compartments built of or lined with substantial non-combustible materials so constructed as to exclude dust, flyings or lint. The remote control push buttons or switches may then be placed in the most convenient locations.

Order 13-5059. Electric Heating.

Electric heating appliances shall be of a type approved for dusty atmospheres.

Order 13-5060. Illumination.

Sufficient general illumination shall be provided by fixed units to eliminate so far as possible any need for portable lamps.

A. *Lighting Fixtures.* Lamps in fixed positions shall be enclosed in a manner approved for excluding dust, and where exposed to mechanical injury, shall be protected by substantial guards. Heavy fixtures used as pendants shall be supported by conduit hangers or chains. If rubber covered conductors are used, they shall have insulation not less than 3/64 inch thick. Lampholders shall be of the keyless type.

If light is required for the interior of bins, hoppers, elevators, conveyors, and similar equipment or construction, it is recommended that such light shall, if practicable, be supplied by lamps enclosed in dust-tight globes properly protected against mechanical injury and mounted flush in the walls or floors of the equipment or construction. No wiring or fixtures should be permitted inside of bins, hoppers, elevators, or conveyors.

B. *Portable Lamps.* Portable lamps shall be enclosed in dusttight globes properly protected by substantial metal or other approved types of guards. Lampholders for portable lamps shall be of molded composition or other approved material and of the keyless type with no exposed metal parts.

Order 13-5061. Cords for Portables.

If necessary to use portable lamps or portable appliances, flexible cord approved for hard usage, such as Type S, shall be used. Such a flexible cord shall contain one extra insulated conductor, which shall be properly connected to form a grounding connection for metal lamp guards, motor frames, and all other exposed metal portions of such portable lamps and appliances. The outer covering of the grounding conductor shall be finished to show a green color. Cords connected directly to supply conductors shall be securely supported so that the probability of a break in the conductors at this point will be minimized.

Order 13-5062. Receptacles and Attachment Plugs.

Receptacles and attachment plugs shall be so connected as a part of a unit device with a dusttight interlocking switch that the plug cannot be removed while the switch is in the "on" position, or an approved device in which the circuit is broken in a dusttight enclosure shall be used. Such receptacles and plugs shall be of the polarized type which provide a connection for the grounding conductor of the portable cord.

Order 13-5063. Grounding.

The exposed non-current-carrying metal parts of equipment such as the frames or metal exteriors of motors, fixed or portable lamps or appliances, lighting fixtures, cabinets, cases, and conduit, shall be

grounded as specified in Section 13-250 of this code. The locknut bushing and double locknut types of contact shall not be depended upon for bonding purposes, but bonding jumpers with proper fittings or other approved means shall be used. If flexible conduit is used as permitted in order 13-5056, bonding jumpers with proper fittings shall be provided around such flexible conduit.

Order 13-5064. Live Parts.

There shall be no exposed live parts.

CLASSES III AND IV—INSTALLATION

Order 13-5071. General.

In locations judged to be as described for Classes III and IV, the following provisions shall be observed.

Order 13-5072. Transformers and Capacitors.

Transformers and capacitors containing a liquid that will burn, if located within buildings, shall be installed in a reinforced concrete vault conforming to orders 13-4521 and 13-4528, inclusive. The vault shall be provided with air cooling vents and pressure relief openings of non-combustible construction extended to the outside of the building. Any openings into the building shall be protected by double standard fire doors. See Sections 13-450 and 13-460.

It is recommended that transformers and capacitors be located outside the building proper and in such a manner that they and their combustible supports are at least ten feet horizontally from any exposed combustible parts or unprotected openings of all buildings.

Transformers and capacitors containing a liquid that will not burn may be located within the hazardous area provided they are of dusttight construction with dusttight terminal enclosures, or are enclosed in dusttight fire-resistive rooms. Such transformers shall be equipped with pressure relief devices.

Order 13-5073. Service Equipment, Panelboards, and Switchboards.

Service equipment, panelboards, or switchboards shall not be placed in these locations unless it is impracticable to locate them elsewhere. If placed in these locations all live parts shall be enclosed in dusttight metal cases or cabinets with provision for external operation only, or shall be placed in separate rooms built of or lined with substantial non-combustible materials constructed so as to exclude flyings or lint, and having self-closing doors.

Order 13-5074. Overcurrent Devices.

Overcurrent devices, whether fuses or circuit-breakers, placed in locations of this class shall be enclosed in dusttight metal cabinets or cases, or shall be placed in separate rooms built of or lined with substantial non-combustible materials constructed so as to exclude flyings or lint, and having self-closing doors.

Order 13-5075. Wiring Method.

Rigid conduit with threaded joints shall be the type of wiring employed in all Class III locations and in any sections of Class IV locations where compresses or other machinery is located. In the storage compartments or sections of Class IV locations, open wiring on insulators may be employed, installed in accordance with requirements of Section 13-320, but only on condition that protection as required in order 13-3212 be provided where conductors are not run in roof spaces, and well out of reach of sources of mechanical injury. Locknuts and bushings may be used at boxes and cabinets provided bonding is in accordance with order 13-5085 of this section.

A. *Flexible Connections.* If it is necessary to employ flexible connections, as at motor terminals, a short length of flexible steel conduit may be used.

It is recommended that pilot lights be installed on the outside of storage rooms to indicate when the current in the room is "on" or "off."

Order 13-5076. Motors and Generators.

Motors and generators shall comply with the following:

A. *Motors and Generators in Class III Locations.* Where it is impracticable to prevent lint and flyings from collecting in dangerous quantities on or in motors or generators, as in cotton gins or the seed cleaning and linter rooms of cotton seed oil mills, all motors and generators shall be of the totally-enclosed, totally-enclosed fan-cooled, or totally-enclosed pipe ventilated type, or shall be enclosed in separate rooms or housings built of or lined with substantial non-combustible materials so constructed as to exclude lint or flyings and be properly ventilated from a source of clean air. Elsewhere in locations of this class, if motors or generators having brushes or sliding contacts are used, they shall:

1. Be of the totally-enclosed, totally-enclosed fan-cooled, or totally-enclosed pipe-ventilated type; or
2. Be enclosed in separate rooms or housings as specified above; or
3. Have brushes or sliding contacts enclosed in substantial tight metal housings.

B. *Motors and Generators in Class IV Locations.* Motors and generators shall be of the totally-enclosed, totally-enclosed fan-cooled, or totally-enclosed pipe-ventilated type, or shall be enclosed in separate rooms or housings built of or lined with substantial non-combustible materials and so constructed as to exclude flyings or lint and be properly ventilated from a source of clean air.

C. *Ventilating Piping.* If motors and generators of the pipe-ventilated type are used, or if they are enclosed in rooms or housings, the vent pipes shall extend to the outside of the building to a source of clean air. The vent pipes shall be of metal, substantially constructed and with each section attached to the next by riveting, welding or other approved methods. The outer ends of vent pipes shall be screened to prevent the entrance of animals or birds. If motors or generators

are intended to be moved on their bases, a slip or universal joint, tight enough to prevent the entrance of flyings or lint, shall be provided in the vent pipes.

Order 13-5077. Control Equipment.

Devices or apparatus, such as motor controllers, thermal cutouts, switches, relays, switches and contactors of auto-transformer starters, and resistance and impedance devices, which tend to create arcs, sparks or high temperatures, if installed in locations of these classes shall be enclosed within dusttight cases or cabinets or be of the dusttight type, and so designed that the device may be operated without opening the cabinet or case, or be placed in separate rooms built of or lined with substantial non-combustible materials constructed so as to exclude flyings or lint and having self-closing doors. Enclosing cases shall be so built that ignition of flyings or lint by direct contact with the case, whether in normal operation or in event of accident, is avoided.

Order 13-5078. Electric Heating.

Electric heating appliances shall be of a type approved for use where combustible flyings or lint are present.

Order 13-5079. Illumination.

Sufficient general illumination shall be provided by fixed units to eliminate so far as possible any need for portable lamps.

A. *Lighting Fixtures.* Where there is a possibility of lint or flyings collecting on lamps in fixed positions, the lampholders and lamps shall be enclosed in dusttight fixtures so designed that in the event of a burnout of the lamp or lampholder no spark or hot metal can escape from the enclosure. When exposed to mechanical injury, a substantial metal or other approved type of guard shall be provided to prevent breakage. Lamps shall not be of the pendent type unless supported by and supplied through hangers of rigid conduit or other metal tubing of equivalent thickness. Lampholders shall be of the keyless type and shall be wired with wire not less than No. 14 gauge in such a manner that no conductors will be exposed.

B. *Portable Lamps.* Portable lamps shall be enclosed in dusttight globes properly protected by substantial metal or other approved types of guards. Lampholders for portable lamps shall be of molded composition or other approved material and of the keyless type with no exposed metal parts.

Order 13-5080. Cords for Portables.

If necessary to use portable lamps or portable appliances, flexible cord approved for hard usage, such as Type S, shall be used. Such a flexible cord shall contain one extra insulated conductor, which shall be properly connected to form a grounding connection for metal lamp guards, motor frames, and all other exposed metal portions of such portable lamps and appliances. Cords connected directly to supply

conductors shall be securely supported so that the probability of a break in the conductors at this point will be minimized. The outer covering of the grounding conductor shall be finished to show a green color.

Order 13-5081. Receptacles and Attachment Plugs.

Receptacles and attachment plugs shall be of an approved type which confines any arc by means of a dusttight enclosure. Such receptacles and plugs shall be of the polarized type that provides a connection for the grounding conductor of the flexible cord.

It is recommended that attachment plugs and receptacles be so connected, as a part of a unit device with a dusttight interlocking switch, that the plug cannot be inserted or removed while the switch is in the "on" position.

Order 13-5082. Electric Cranes.

Electric cranes may be installed under the following conditions. Electric cranes operating over combustible fibers shall not be operated on a system with a grounded conductor. Feeders for electric cranes shall be furnished with a recording ground detector, and protected by a relay which will automatically open the feeder circuit-breaker in the event of the insulation of the system falling below 1000 ohms. Bare conductors for cranes operating in rooms used for the storage of combustible fibers, shall be protected by barriers so arranged as to prevent any escape of sparks or hot particles, and the moving current collectors shall be so designed as to minimize sparking at sliding contacts.

It is recommended that where the distance of travel permits, current to the crane be supplied through Type S flexible conductors equipped with approved type of reel or take-up device.

Order 13-5083. Electric Trucks.

Electric trucks used in Class IV locations shall have wheels equipped with rubber tires or made of non-conducting material. Electric trucks shall have their batteries charged only in rooms meeting the requirements of the following order.

Order 13-5084. Storage Battery Charging Equipment.

Storage battery charging equipment shall be located in separate rooms built of or lined with substantial non-combustible materials so constructed as to adequately exclude flyings or lint, and shall be well ventilated.

Order 13-5085. Grounding.

The exposed non-current-carrying metal parts of equipment such as the frames or metal exteriors of motors, fixed or portable lamps or appliances, lighting fixtures, cabinets, cases, and conduit, shall be grounded as specified in Section 13-250 of this code. The locknut bushing and double locknut types of contact shall not be depended upon for bonding purposes, but bonding jumpers with proper fittings or other approved means shall be used. If flexible conduit is used as permitted in order 13-5075, bonding jumpers with proper fittings shall be provided around such conduit.

Order 13-5086. Live Parts.

There shall be no exposed live parts except as permitted for electric cranes in Classes III and IV.

SECTION 13-510. GARAGES

Order 13-5101. General.

This section provides additional required precautions in the installation of electrical equipment in garages (see definition, order 1020) where volatile or flammable liquids are used for fuel or power in self-propelled vehicles.

Note. Definitions covering garages and private garages and construction requirements for such buildings will be found in the Wisconsin State Building Code.

Order 13-5102. Type of Wiring.

In commercial garages, conduit, electrical metallic tubing, surface metal raceways, armored cable, wireways, busways, or cellular metal floor raceways as permitted by order 13-3562, shall be employed.

Order 13-5103. Type of Equipment.

Equipment which tends to produce arcs or sparks, shall conform to the following:

A. *Generators, Motors, or Controllers Within Four Feet of the Floor.* Generators, motors and controllers, having commutators, collector rings, or other make-and-break or sliding contacts, located within 4 feet of the floor, shall be of the totally enclosed type.

B. *Generators, Motors, or Controllers Located More Than Four Feet Above the Floor.* Generators, motors, controllers, and the like, having commutators, collector rings, or make-and-break or sliding contacts, located 4 feet or more above the floor, shall be of the totally enclosed type or shall have wire screens or perforated metal with openings not exceeding 0.05 inch in one dimension, placed at commutator or brush ends of motors and generators to prevent falling of particles.

C. *Other Equipment.* All other equipment which tends to produce arcs or sparks, such as cutouts, switches, receptacles, fixed lampholders, and charging panels, if within 4 feet of the floor shall be of a type approved for use in Class I locations as defined in Section 13-500.

D. *Show Rooms and Switchboard Rooms.* Equipment located in a show room separated by a partition from the garage proper, or in a room or enclosure provided for the purpose, need not conform to the requirements of paragraphs A, B, or C of this order.

Order 13-5104. Cord for Pendants.

For pendants, reinforced cord, including types S, SJ, AFS and AFSJ shall be used.

Order 13-5105. Cord for Portables.

For the connection of portable lamps, motors, or other appliances, flexible cord shall be of Type S as specified in Table 31 of Chapter 10.

Order 13-5106. Polarization of Pendants and Portables.

If the wiring system is identified, as provided in Section 13-200, flexible cords shall be identified and the identified conductor shall be connected to the screw shell of all lampholders on portables or pendants. Receptacles, attachment plugs, connectors, and similar devices shall be of the polarized type.

Order 13-5107. Connectors.

Cords used for the connection of portable appliances shall carry the male end of a polarity-type pin plug connector, or equivalent; the female end being of such design or so hung that the connector will break apart readily at any position of the cable. The connector shall be kept at least 4 feet above the floor.

Order 13-5108. Lampholders and Guards for Portables.

Portable lamps shall be equipped with handle, lampholder, hook, and substantial guard attached to the lampholder or the handle. Lampholders shall be of the keyless type. Lampholders shall be of molded composition, or other type approved for the purpose. Brass shell paper lined lampholders, either key or keyless, shall not be used.

Order 13-5109. Battery Charging.

Equipment for battery charging shall conform to the following:

A. *Type of Cord.* Type S cord shall be used for charging purposes.

B. *Connectors.* Connectors shall be of at least 50 amperes capacity, and shall be so designed or so hung that at least one will break apart readily at any position of the charging cable. Live parts shall be guarded from accidental contact. If plugs for direct connection to vehicles are suspended from overhead wiring, they shall hang at least 6 inches above the floor and no connector need be placed in the cable or at the outlet.

Order 13-5110. Live Parts.

Live parts of equipment shall be guarded to prevent accidental contact.

Order 13-5111. Grounding.

All metallic conductor enclosures and the exposed metal parts of fixed equipment, except pendent or portable lamps operating on grounded systems of not more than 150 volts to ground, shall be grounded in the manner prescribed in Section 13-250.

SECTION 13-520. THEATERS, INCLUDING MOTION PICTURE HOUSES

Order 13-5201. Scope.

The requirements of this section shall apply to all buildings, or part of a building, designed, intended, or used for dramatic, operatic, motion picture or other shows.

Note. The Wisconsin State Building Code contains definitions covering theaters and assembly halls.

Order 13-5202. Emergency Lighting.

An emergency lighting system shall be provided where the seating capacity of the auditorium exceeds 100 persons. When electricity is used for emergency lighting, this system shall conform to the requirements of Section 13-700.

Order 13-5203. Motion Picture Projectors.

Motion picture projectors shall comply with Section 13-540.

Order 13-5204. Sound Reproduction.

Sound reproducing equipment shall comply with Section 13-640.

INSTALLATION

Order 13-5211. Method of Wiring.

The wiring method shall be metal conduit or other approved metal raceway system, except as provided in Sections 13-640 and 13-800. The number of conductors permitted in any conduit or electrical metallic tubing, for border or stage pocket circuits, shall not exceed that permitted by Table 9 of Chapter 10. Portable cables or flexible cords may be used on the stage or elsewhere where fixed wiring methods are impracticable.

STAGE SWITCHBOARD

Order 13-5221. Dead Front.

Stage switchboards shall be of the dead-front type.

Order 13-5222. Guarding.

Stage switchboards having exposed live parts on the back of such boards shall be enclosed by the building walls, wire mesh grills, or by other approved methods. The entrance to this enclosure shall be by means of a self-closing door.

Order 13-5223. Control and Overcurrent Protection of Receptacle Circuits.

Means shall be provided at the stage switchboard for the control and individual overcurrent protection of branch circuits to stage and gallery receptacles.

Order 13-5224. Metal Hood.

Stage switchboard shall be provided with a metal hood extending the full length of the board to protect all equipment on the board from falling objects.

Order 13-5225. Dimmers.

Dimmers shall conform to the following:

A. *Disconnection from Supply.* A dimmer shall be disconnected from all ungrounded supply conductors when the switch or circuit-breaker controlling the supply is open.

B. *Resistance or Reactor Type Dimmers.* Resistance or series reactor type dimmers may be placed in either leg of the circuit. If designed to open either the supply circuit to the dimmer or the circuit controlled by it, the dimmer shall then comply with order 13-3801.

It is recommended that resistance or reactor type dimmers be placed in the grounded neutral conductor of the circuit provided they do not open the circuit.

C. *Auto-Transformer Type Dimmers.* An auto-transformer type dimmer shall be energized by a circuit operating at not more than 150 volts between conductors, and one conductor shall be connected to the required identified grounded conductor of the wiring system.

STAGE EQUIPMENT—FIXED

Order 13-5241. Circuit Loads.

Footlights, border lights, and proscenium side lights shall be so arranged that no branch circuit supplying such equipment will carry a load exceeding 15 amperes; provided that where heavy duty lampholders only are used for border lights, such circuits may conform to the provisions of Section 13-210 for circuits supplying heavy duty lampholders.

Order 13-5242. Footlights.

If the metal trough construction specified in order 13-5281 is not used, footlights shall consist of individual outlets with lampholders, wired with rigid or flexible metal conduit. The circuit conductors shall be soldered to the lampholder terminals. Disappearing footlights shall be so arranged that the current supply shall be automatically disconnected when the footlights are replaced in the recess designed therefor.

Order 13-5243. Cables for Border Lights.

Cables for border lights shall be Type K or Type S flexible cord. See Table 31 of Chapter 10. The cables shall be suitably supported. Such cables shall be employed only where flexible conductors are necessary.

Order 13-5244. Receptacles.

Receptacles intended for the connection of arc lamps shall have not less than 35 amperes capacity and shall be supplied by conductors not smaller than No. 6. Receptacles intended for the connection of incandescent lamps shall have not less than 15 amperes capacity and shall be supplied by conductors not smaller than No. 12. Plugs for arc and incandescent receptacles shall not be interchangeable.

Order 13-5245. Lamps in Scene Docks.

Lamps installed in scene docks shall be so located and guarded as to be free from mechanical injury and as to provide an air space of not less than 2 inches between such lamps and any combustible material.

Order 13-5246. Curtain Motors.

Curtain motors having brushes or sliding contacts shall comply with order 13-5310.

Order 13-5247. Flue Damper Control.

If stage flue dampers are released by an electrical device, the circuit operating the latter shall be normally closed and shall be controlled by at least 2 single pole switches enclosed in iron boxes having self-closing doors without locks or latches, one switch being placed at the electrician's station and the other where designated by the inspection authority. The device shall be designed for the full voltage of the circuit to which it is connected, no resistance being inserted. It shall be located in the loft above the scenery and shall be enclosed in a suitable iron box having a tight, self-closing door.

STAGE EQUIPMENT—PORTABLE

Order 13-5251. Arc Lamps.

Arc lamp frames and standards shall be so installed and guarded as to prevent their becoming grounded. A qualified operator shall be employed for each lamp, or for each 2 lamps not more than 10 feet apart and so placed that one operator can properly watch and care for both.

Order 13-5252. Lights on Scenery.

Brackets on scenery shall be wired internally and the fixture stem shall be carried through to the back of the scenery where a bushing shall be placed on the end of the stem, except that externally wired brackets or other fixtures may be used when wired with Type P or other cords designed for hard usage which shall extend through scenery and without joint or splice in canopy of fixture back and terminate in an approved type stage connector located within 18 inches of the fixture. Fixtures shall be securely fastened in place.

Order 13-5253. Festoons.

Joints in festoon wiring shall be staggered where practicable. Lamps enclosed in lanterns or similar devices of combustible material shall be equipped with approved guards.

Order 13-5254. Special Effects.

Electrical devices used for simulating lightning, waterfalls, and the like, shall be so constructed and located that flames, sparks, or hot particles, cannot come in contact with combustible material.

Order 13-5255. Connectors for Flexible Conductors.

Connectors for flexible conductors shall be so constructed that tension on the cord or cable will not be transmitted to the connections. The female half of the connector shall be attached to the live end of the cord or cable.

Order 13-5256. Conductors for Portables.

Flexible conductors used to supply portable stage equipment shall be type K or type S cord, except that reinforced cord may be used to supply stand lamps if the cord is not liable to severe mechanical injury and is protected by a fuse rated at not over 15 amperes.

DRESSING ROOMS

Order 13-5261. Pendants.

Pendent lamps shall not be installed in dressing rooms.

Order 13-5262. Lamp Guards.

All incandescent lamps in dressing rooms, if less than 8 feet from the floor, shall be equipped with open end guards riveted to the outlet box cover or otherwise sealed or locked in place.

GROUNDING

Order 13-5271. Grounding.

All metal raceways shall be grounded. The metal frames and enclosures of equipment including border lights shall be grounded, except the frames and enclosures of portable equipment on grounded circuits operating at not over 150 volts to ground or on ungrounded circuits not exposed to any voltage higher than 150 volts to ground. Grounding, if employed, shall be done in the manner specified in Section 13-250.

CONSTRUCTION

Order 13-5281. Footlights.

If metal trough construction is employed for footlights, the trough containing the circuit conductors shall be made of sheet metal not lighter than No. 20 USS sheet metal gauge (.0359 inch in thickness) treated to prevent oxidation. Lampholder terminals shall be kept at least ½ inch from the metal of the trough. The circuit conductors shall be soldered to the lampholder terminals.

Order 13-5282. Borders and Proscenium Sidelights.

Borders and proscenium sidelights shall be constructed as prescribed in order 13-5281, shall be suitably stayed and supported, and shall be so designed that the flanges of the reflectors or other adequate guards

will protect the lamps from mechanical injury and from accidental contact with scenery or other combustible material. Borders shall be wired with asbestos covered (type A), asbestos varnished cambric (types AVA, AVB), or, if the temperature does not exceed 90C (194F), slow-burning (type SB) conductors.

Order 13-5283. Pockets.

Receptacles intended for the connection of portable lighting equipment shall be mounted in suitable pockets or enclosures, and shall comply with the requirements of order 13-5244.

Order 13-5284. Arc Lamps.

Arc lamps shall comply with the following:

A. *General.* Portable arc lamps shall be substantially constructed entirely of metal not less than No. 20 USS sheet metal gauge (.0359 inch), except where approved insulating material is necessary. The design shall be such as to provide proper ventilation while retaining sparks, and to prevent carbons or other live parts of lamp from making contact with metal of hood.

B. *Hoods.* Hoods for other than lens lamps shall have the front opening equipped with a self-closing hinged door frame carrying either wire gauze or glass. Hoods for lens lamps may have a stationary front, and a solid door on either back or side.

C. *Insulation.* Mica shall be used for the insulation of the lamp frame.

D. *Switch.* The switch on the standard shall be of such design that accidental contact with any live part will be impossible.

E. *Rheostats.* Rheostats shall be enclosed in a substantial, properly ventilated metal case affording a clearance of at least 1 inch between case and resistance element. If the rheostat is mounted on the standard, a clearance of 3 inches above the floor shall be maintained.

F. *Terminals.* If stranded conductors are used, they shall be connected to lamp, rheostat and switch terminals by means of approved lugs or connectors; provided that approved pressure connectors shall be used at arc lamp terminals.

Order 13-5285. Portable Strips.

Portable strips shall be constructed in accordance with the requirements for border lights and proscenium side lights in order 13-5282. The supply cable shall be protected by bushings where it passes through metal and shall be so arranged that tension on the cable will not be transmitted to the connections.

Order 13-5286. Portable Plugging Boxes.

Portable plugging boxes shall conform to the following:

A. *Enclosure.* The construction shall be such that no current-carrying part will be exposed.

B. *Receptacles and Fuses.* Each receptacle shall have a current-carrying capacity of not less than 30 amperes, and shall be protected

by over-current devices installed in an approved enclosure equipped with selfclosing doors.

C. *Busbars and Terminals.* Busbars shall have a current-carrying capacity equal to the sum of the ampere ratings of all the receptacles. Lugs shall be provided for the connection of the master cable.

PORTABLE SWITCHBOARDS ON STAGE

Order 13-5291. Supply.

Portable switchboards shall be supplied only from outlets especially provided for this purpose. Such outlets shall consist of externally operable, enclosed fused switches or circuit-breakers mounted on the stage wall or at the switchboard in locations readily accessible from the stage floor.

Order 13-5292. Overcurrent Protection.

Circuits from portable switchboards directly supplying apparatus containing incandescent lamps shall be provided with overcurrent devices with a rating or setting of not more than 15 amperes. Other circuits shall be provided with overcurrent devices with a rating or setting not higher than the current required for the connected load.

Order 13-5293. Construction.

Portable switchboards for use on stages shall comply with the following:

A. *Enclosure.* Portable switchboards shall be placed within an enclosure of substantial construction which may be so arranged that the enclosure is open during operation. Enclosures of wood shall be completely lined with sheet metal of not less than No. 24 USS gauge (.0239 inch), and if not of corrosion-resistant type shall be well galvanized, enamelled, or otherwise properly coated to prevent corrosion.

B. *Live Parts.* Except as provided for dimmer face plates in paragraph E, there shall be no exposed live parts within the enclosure.

C. *Switches.* All switches shall be of the externally-operable, enclosed type.

D. *Circuit Protection.* Overcurrent devices shall be provided in each ungrounded conductor of every circuit supplied through the switchboard. Enclosures shall be provided for all overcurrent devices in addition to the switchboard enclosure.

E. *Dimmers.* The terminals of dimmers shall be provided with enclosures, and dimmer face plates shall be so arranged that accidental contact cannot be readily made with the face plate contacts.

F. *Interior Conductors.* All conductors within the switchboard enclosure shall be stranded and, except for cables feeding to or from the switchboard, shall be asbestos-covered (type A). Each conductor shall have a current-carrying capacity at least equal to the rating of the circuit-breaker, switch or cutout which it supplies, except for conductors for incandescent lamp circuits having overcurrent protection

not exceeding 15 amperes. Conductors shall be enclosed in metal troughs or securely fastened in position and shall be bushed where they pass through metal.

G. *Pilot Light.* A pilot light shall be provided within the enclosure and shall be so connected to the circuit supplying the board that the opening of the master switch will not cut off the supply to the lamp. This lamp shall be on an independent circuit having over-current protection of a rating or setting of not more than 15 amperes.

H. *Supply Connections.* The supply to a portable switchboard shall be by means of flexible cord (types K or S) terminating within the switchboard enclosure or in an externally operable fused master switch or circuit-breaker. The supply cable shall have sufficient current-carrying capacity to carry the total load on the switchboard and shall be protected by overcurrent devices.

I. *Cable Arrangement.* Cables shall be protected by bushings where they pass through enclosures and shall be so arranged that tension on the cable will not be transmitted to the connections.

J. *Terminals.* Terminals to which stage cables are connected shall be so located as to permit convenient access to the terminals. At terminals not provided with approved pressure connectors the following construction shall be employed:

1. For conductors of No. 6 or larger, solder lugs shall be used.

2. For conductors smaller than No. 6, the strands shall be soldered together when connected to clamps or binding screws not specifically approved as pressure connectors.

SECTION 13-530. MOTION PICTURE STUDIOS AND SIMILAR LOCATIONS

Order 13-5301. Scope.

The requirements of this section shall apply to a motion picture studio, exchange, factory or laboratory building, or a portion of the building in which motion picture films are manufactured, exposed, developed, printed, rewound, repaired or stored. This section shall not apply where only approved slow-burning (cellulose acetate or equivalent) film is used.

Note. The Wisconsin State Building Code covers the requirements as to construction for buildings of this class.

Order 13-5302. Sound Recording.

Installations for sound recording shall conform to the provisions of Section 13-640.

Order 13-5303. Wiring Methods.

The wiring method shall be rigid metal conduit or other approved type of metal raceway. Portable cables or flexible cord may be used on studio stages and at other locations where fixed wiring methods are impracticable.

Order 13-5304. Side Wall Lamps.

Lampholders on fixtures if less than 8 feet from the floor shall be equipped with vaportight globes or shall be provided with open end guards riveted to the outlet box cover or otherwise sealed or locked in place.

Order 13-5305. Pendent Lamps.

Pendent lamps shall not be installed in permanent dressing rooms.

Order 13-5306. Lamps at Patching Tables.

At patching tables, composition or metal sheathed porcelain keyless lampholders shall be employed and shall be equipped with guards to protect the lamps from mechanical injury.

Order 13-5307. Lamps in Film Vaults.

In film storage vaults, lamps shall be installed on rigid fixtures and enclosed in vaportight globes. Lamps shall be controlled by a double-pole switch located outside the vault. Electric motors or portable lamps shall not be placed in the vault.

Order 13-5308. Portable Lamps.

For portable lamps, composition or metal-sheathed porcelain keyless lampholders shall be used. The cord shall carry the male end of a pin-plug connector or equivalent, the female end being of such design or so hung that the connector will readily break apart at any position of the cord. The connector shall be kept at least 1 foot from the floor. The lampholder shall be provided with a guard, hook, and handle. The provisions of this order shall not apply to portable lamps used as properties in a motion picture set on a studio stage or similar location.

Order 13-5309. Flexible Cords.

Type S cord shall be used on portable lamps and equipment, except that portable lamps used as stage properties in a motion picture set on a studio stage or similar location may be used with any approved type of cord with which they may be equipped. See Table 31 of Chapter 10.

Order 13-5310. Motors and Generators.

If motors or generators having brushes or sliding contacts are used they shall meet one of the following conditions:

A. Be of the totally-enclosed, enclosed-fan-cooled, or enclosed-pipe-ventilated types.

B. Be enclosed in separate rooms or housings built of non-combustible materials so constructed as to exclude flyings or lint, and properly ventilated from a source of clean air.

C. Have brush or sliding-contact end of motor enclosed by solid metal covers.

D. Have brushes or sliding-contacts enclosed in substantial, tight, metal housing.

E. Have upper half of brush or sliding-contact end of the motor enclosed by a wire screen or perforated metal and the lower half enclosed by solid metal covers.

F. Have wire screens or perforated metal placed at the commutator or brush ends. No dimension of any opening in the wire screen or perforated metal shall exceed .05 inch, regardless of the shape of the opening and of the material used.

Order 13-5311. Motor and Generator on Studio Stages.

The provisions of order 13-5310 shall not apply to motors or generators used on studio stages, but the live parts of such motors or generators shall be otherwise guarded or enclosed in conformity with the provisions of order 13-5313.

Order 13-5312. Switches.

Switches shall be of the externally-operable type.

Order 13-5313. Live Parts.

Live parts shall be enclosed to prevent accidental contact by persons or objects. Rheostats shall be enclosed and externally operable.

Order 13-5314. Grounding.

All metal raceways, cable armor, and the exposed metal frames of all equipment and enclosures shall be grounded, except pendent and portable lamps operating at not more than 150 volts to ground.

SECTION 13-540. MOTION PICTURE PROJECTORS

Order 13-5401. Professional-Type Projectors.

The professional type of projector, such as is commonly used in theaters and motion picture houses, shall be located in an approved enclosure. Such enclosure shall not be considered as a Hazardous Location as defined in Section 13-500.

The professional projector employs a 35 millimeter film which is 1⅜ inch wide and has on each edge 5.4 perforations per inch. (This includes any projector using nitro-cellulose film.)

Note. The Wisconsin State Building Code contains requirements for enclosures or booths to use with professional type projectors.

Order 13-5402. Non-Professional Type Projectors.

Projectors of the non-professional or miniature type, if employing only approved slow-burning (cellulose acetate or equivalent) film, may be operated without a booth.

Order 13-5403. Sound Recording and Reproduction.

Sound recording and reproduction equipment shall comply with section 13-640.

EQUIPMENT AND PROJECTORS OF THE PROFESSIONAL TYPE

Order 13-5411. Motor-Driven Projectors.

Motor-driven projectors shall be approved for the purpose as an assembly or shall comply with all of the following conditions:

A. An approved projector shall be used.

B. An approved projector lamp shall be used.

C. Motors shall be so designed or guarded as to prevent ignition of film by sparks or arcs.

D. Projectors shall be in charge of a qualified operator.

Order 13-5412. Conductor Size.

Conductors supplying outlets for projectors of the professional type shall not be smaller than No. 8 and shall be of sufficient size for the projector employed.

Order 13-5413. Conductor Insulation.

Asbestos covered conductors (Type A) shall be used on arc lamps and other equipment where the ambient temperature at the conductor as installed will exceed 49C (120F).

Order 13-5414. Flexible Cords.

Hard service cords, Types K, S, or SJ shall be used on portable equipment.

Order 13-5415. Lamp Guards.

Incandescent lamps in projection rooms or booths shall be provided with an approved lamp guard unless otherwise protected by non-combustible shades or other enclosures.

Order 13-5416. Location of Equipment.

Motor generator sets, transformers, rectifiers, rheostats, and similar equipment, for the supply or control of current to arc lamps on projectors shall, if practicable, be located in separate rooms. If placed in the projector room, they shall be so located or guarded that arcs or sparks cannot come in contact with film, and motor generator sets shall have the commutator end or ends protected as provided in order 13-5310.

Order 13-5417. Rewinding, Examination and Storage of Extra Films.

It is recommended that the authority having jurisdiction refer to the standards of the National Board of Fire Underwriters. See Publication No. 40, Nitrocellulose Motion Picture Film.

Note. Any requirements in the Wisconsin State Building Code shall be observed.

CONSTRUCTION

Order 13-5431. Equipment and Projectors of the Professional Type.

Equipment and projectors of the professional type shall comply with the following:

A. *Approved Type.* Projectors and enclosures for arc or incandescent lamps, rectifiers, transformers, rheostats, and similar equipment, shall be of an approved type.

B. *Name Plate.* Projectors and other equipment as set forth in subparagraph A of this order, shall be marked with the name or trademark of the maker and with the voltage and current for which they are designed.

Order 13-5432. Projectors of the Non-Professional Type.

Projectors of the non-professional type shall comply with the following:

A. *Approved Type.* Projectors, lamp enclosures, and current controlling devices and similar devices shall be approved as component parts of the projector equipment.

B. *Name Plate.* Projectors shall be marked with name or trademark of the maker, with the current and voltage for which they are designed, and with the wording "For use with slow-burning films only."

C. *Source of Illumination.* The source of illumination shall be a lamp of a type approved for stereopticon use or for motion picture projection.

D. *Film to Be Marked.* The slow-burning (cellulose acetate or equivalent) film shall have a permanent distinctive marker for its entire length identifying the manufacturer and the slow-burning character of the film stock.

Order 13-5433. Booths for Projectors of the Professional Type.

Note. Requirements for booths to be used with projectors of the professional type will be found in the Wisconsin State Building Code.

Chapter 6. Special Equipment

SECTION 13-600. SIGNS AND OUTLINE LIGHTING

Order 13-6001. Scope.

The provisions of this section shall apply to the installation of conductors and equipment for signs and outline lighting as defined in order 1020 and for inside lighting with high voltage gas tubes.

Order 13-6002. Enclosure for Devices.

Cutouts, flashers and similar devices shall be enclosed in metal boxes.

Order 13-6003. Switch Required.

Each outline lighting installation, and each sign of other than the portable type, shall be controlled by an externally-operable switch which will open all ungrounded conductors.

Note. The intent of this rule is to prohibit one sign enclosure being used as a pull box or raceway for conductors supplying other signs or equipment.

Order 13-6004. In Sight of Sign.

The switch required by order 13-6003 shall be within sight of the sign or outline lighting which it controls or may be located elsewhere if capable of being locked in the open position.

Order 13-6005. Rating.

Switches, flashers, and similar devices controlling transformers shall be either of a type approved for the purpose, or have a current rating not less than twice the current rating of the transformers.

Order 13-6006. Grounding.

Signs, troughs, tube terminal boxes and other metal frames shall be grounded in the manner specified in Section 13-250 of this code, unless they are insulated from ground and from other conducting surfaces and are inaccessible to unauthorized persons. This does not apply to signs of the portable incandescent lamp type. Isolated non-current-carrying metal parts of outline lighting may be bonded by No. 14 conductors and grounded in accordance with Section 13-250.

Order 13-6007. Load of Branch Circuit.

Circuits shall be so arranged that the number of outlets, lamps, and transformers connected to them, shall in no case place more than 15 amperes on a branch circuit.

Order 13-6008. Portable Gas Tube Signs.

All gas tube signs not coming within the definition of portable shall be wired in accordance with the code rule. Satisfactory portable signs may be installed by connection with portable cord.

Note. As applied to Neon or gas tube signs, portable means less than 75 pounds in weight and 10 square feet over the largest surface, with all high tension wires and tube terminals within the sign enclosure proper, and the tubes or lamps fastened only to and not extending beyond the sign surface or background. All portable gas tube signs shall have the metal enclosure grounded by a three-wire cord connected to a three-point receptacle and the portable cord shall be limited to six feet in length.

INSIDE LIGHTING

Order 13-6011. Transformers.

Transformers shall be of the enclosed type and shall be so installed as to be accessible after installation. They shall have a secondary voltage rating of not over 15,000 volts with an allowance on test of 1,000 volts and, for use in residences, shall have a secondary current rating of not over 60 milliamperes. They shall be of a type approved for the purpose, and after installation the high-voltage terminals shall be enclosed so that access to them will result in opening the primary circuit or will necessitate the use of other than ordinary tools such as pliers or screw-drivers.

Order 13-6012. High-Voltage Wiring.

Standard gas tube sign cable suitable for the voltage of the circuit shall be used. It shall be run in standard metal raceways, in metal enclosures not less in thickness than specified in paragraph 13-6037-F, or on insulators in channels lined with non-combustible material and used for no other purpose, except that the primary wiring in recognized types of cable and solely used for supplying the lighting transformers may be placed in the same channels. Insulators shall be of non-combustible, non-absorptive material such as porcelain or glass, and shall insure at least 1½ inches separation of the conductors from each other and from other objects. Where the voltage between conductors is in excess of 5,000 volts, mounting on insulators is recommended.

Order 13-6013. Tube Terminals.

The terminals shall be so designed that the tubing can be replaced without the necessity of exposing uninsulated live parts. If the spring contact type of receptacle is used, it shall be so designed that, even with the tube removed, the live spring will be recessed a distance equal to three times the diameter of the receptacle opening. It is recommended that the primary circuit be controlled by a relay that will open the circuit when a tube in the secondary circuit is broken or removed. Live parts shall be protected by barriers which require other than ordinary tools such as pliers and screw-drivers for removal unless access to the parts requires the disconnection of the primary circuit.

Order 13-6014. Grounding.

The transformer enclosure and all exposed metal parts shall be grounded.

Order 13-6015. Tubing.

The tubing shall be free from contact with flammable material and shall not be located where normally exposed to mechanical injury. It

shall be supported on non-combustible, non-absorptive insulating supports, and when operating in excess of 7,500 volts shall be kept at least ¼ inch from metal.

SIGNS AND OUTLINE LIGHTING—600 VOLTS OR LESS

Order 13-6021. Installation of Conductors.

Conductors shall be installed as follows:

A. *Method of Wiring.* Conductors shall be installed as open conductors on insulators, or in rigid metal conduit, flexible metal conduit, electrical metallic tubing, armored cable, or metal troughing.

B. *Insulation and Size.* Conductors shall be of the rubber covered type, and, except in portable signs, shall be not smaller than No. 14.

C. *Exposed to the Weather.* Conductors in rigid conduit, electrical metallic tubing, flexible metal conduit, armored cable, or in metal troughing exposed to the weather, shall be of the lead covered type or other type specially approved for the conditions, except where rigid conduit, electrical metallic tubing, or enclosures are made raintight and arranged to drain.

D. *Number of Conductors in Raceway.* For sign flashers the number of conductors in conduit or tubing may be in accordance with Table 9 of Chapter 10.

E. *Open Conductors.* Open conductors on insulators shall comply with the provisions of orders 13-3002 to 13-3018 inclusive, Section 13-320, and, if outdoors, Section 13-730, except that the separation between conductors need be only 2 inches; provided, that open conductors may be supported by lampholders located not more than 1 foot apart.

F. *Conductors Soldered to Terminals.* Where the conductors are fastened to lampholders other than of the pin type, they shall be soldered to the terminals and the exposed parts of conductors and terminals shall be treated to prevent corrosion. Where the conductors are fastened to pin type lampholders which protect the terminals from the entrance of water, and which have been found acceptable for sign use, the conductors shall be of the stranded type but need not be soldered to the terminals.

Order 13-6022. Lampholders.

Lampholders shall be of the keyless porcelain or molded composition type and shall be so constructed and installed as to prevent turning. Miniature lampholders shall not be employed for outdoor signs and outline lighting.

SIGNS AND OUTLINE LIGHTING—EXCEEDING 600 VOLTS

Order 13-6031. Installation of Conductors.

Conductors shall be installed as follows:

A. *Wiring Method.* Conductors shall be installed as open work, as concealed conductors on insulators, or in rigid or flexible metal conduit or electrical metallic tubing. Conductors may be run from the ends of

tubing to the grounded midpoint of transformers specifically designed for the purpose and provided with terminals at the midpoint. Where such connections are made to the transformer grounded midpoint, the connections between the high voltage terminals of the transformer and the line ends of the tubing shall be as short as possible.

B. *Insulation and Size.* Conductors shall be of a type approved for the purpose and for the voltage of the circuit, and shall be not smaller than No. 14.

C. *Bends in Conductors.* Sharp bends in the conductors shall be avoided.

D. *Open Conductors—Indoor.* Open conductors indoors shall be mounted on non-combustible, non-absorptive insulators. Insulators of porcelain shall be glazed on all exposed surfaces. A separation of at least 1½ inches shall be maintained between conductors and between conductors and other objects. Conductors shall not be located where subject to mechanical injury.

E. *Concealed Conductors on Insulators—Indoors.* Concealed conductors on insulators shall be separated at least 1½ inches from each other, and from all objects other than the insulators on which mounted. They shall be installed in channels lined with non-combustible material and used for no other purpose, except that the primary circuit conductors may be in the same channel. The insulators shall be of non-combustible, non-absorptive material.

F. *Show Windows and Similar Locations.* If conductors hang freely in the air, away from combustible material, and if not subject to mechanical injury, as in some show window displays, they need not be otherwise protected.

G. *Conductors in Raceways.* Conductors in rigid or flexible metal conduit or electrical metallic tubing shall be lead covered if required by the authority enforcing this code. If the conductors are covered with lead or other metal sheathing, this covering shall extend beyond the end of the conduit and the surface of the cable shall not be injured where the covering terminates. The insulation on all conductors leaded and unleaded shall extend at least 4 inches beyond the end of the lead or the raceway, except for conductors at grounded midpoint terminals. Any single run of cable in metal raceway shall not exceed 20 feet where the voltage between the cable and the raceway is in excess of 5000 volts.

H. *Open Conductors—Outdoors.* Open conductors outdoors shall be mounted on non-combustible, non-absorptive insulators. Insulators of porcelain shall be glazed on all exposed surfaces. A separation of at least 2 inches shall be maintained between conductors and between conductors and other objects. Where subject to mechanical injury or where within reach from ground, roof, or window, conductors shall be enclosed in raceways or suitably guarded. If guarded, a spacing of not less than 1½ inches shall be maintained between conductors and the enclosure unless the enclosure is non-conducting and non-combustible.

Order 13-6032. Transformers.

Transformers shall comply with the following:

A. *Voltage.* The transformer secondary open circuit voltage shall not exceed 15,000 volts with an allowance on test of 1000 volts additional.

B. *Type.* Transformers shall be of a type approved for the purpose. Open core and coil type transformers shall not be used except in small portable indoor type of gas tube signs.

C. *Exposure to Weather.* Transformers exposed to the weather shall be of the weatherproof type or be otherwise protected from the weather.

D. *Transformer Secondary Connections.* The high voltage windings of transformers shall not be connected in series or parallel.

E. *Accessibility.* Transformers shall be accessible.

Order 13-6033. Tubing.

Gas tubing shall conform to the following:

A. *Design.* The tubing shall be of such length and design as not to cause a continuous over-voltage on the transformer.

B. *Support.* The tubing shall be adequately supported on non-combustible, non-absorptive insulating supports so placed as to maintain a separation of not less than ¼ inch from metal parts including barriers through which the tube passes. Tubing supports should, if practicable, be adjustable.

C. *Contact With Flammable Material and Metal.* The tubing shall be free from contact with flammable material, and shall not be in contact with metal if the voltage exceeds 7,500.

D. *Mechanical Injury.* The tubing shall not be located where normally exposed to mechanical injury.

Order 13-6034. Terminals and Receptacles for Gas Tubing.

Terminals and receptacles for gas tubing shall comply with the following:

A. *Terminals.* The terminals of gas tubing shall be inaccessible to unqualified persons and isolated from combustible material and grounded metal or shall be enclosed. If enclosed they shall be separated from grounded metal by non-absorptive, non-combustible insulating material approved for the purpose, or by 1½ inch of air. Terminals shall be relieved from stress by the independent support of the tubing.

B. *Tube Connections Other Than With Receptacles.* If tubes do not terminate in receptacles designed for the purpose, all live parts of tube terminals and conductors shall be so supported as to maintain a separation of at least 1½ inches between conductors or between conductors and any grounded metal.

C. *Receptacles.* Electrode receptacles for gas tubing shall be of non-combustible, non-absorptive insulating material approved for the purpose.

D. *Bushings.* Where electrodes enter the enclosure of outdoor signs or of an indoor sign operating at a voltage in excess of 7500 volts, bushings shall be used unless receptacles are provided or the sign is wired with bare wire mounted on approved supports which maintain the tubing in proper position. Bushings shall be of non-combustible, non-absorptive material. Where bare wiring is used, the conductor shall be not less than No. 14 solid copper, shall be supported so as to prevent sagging and lessening of the spacing required elsewhere in this section, and electrode terminal assemblies shall be of an approved type and supported not more than 6 inches from the electrode terminals.

E. *Show Windows.* In the exposed type of show window signs, terminals shall be (1) enclosed by receptacles approved for the purpose or (2) where hanging in air, free from grounded surfaces, enclosed in sleeves of vulcanized fiber, phenolic composition, or other suitable material which overlaps all live parts by at least ½ inch.

F. *Receptacles and Bushing Seals.* A flexible, non-conducting seal may be used to close the opening between the tubing and the receptacle or bushing against the entrance of dust or moisture. This seal shall not be in contact with grounded conductive material and shall not be depended upon for the insulation of the tubing.

G. *Enclosures of Metal.* Metal enclosures for electrodes shall be of not less than No. 24 USS gauge (.0239 inch) sheet metal.

H. *Enclosures of Insulating Material.* Enclosures of insulating material shall be non-combustible, non-absorptive and approved for the voltage of the circuit.

Order 13-6035. Switches on Doors.

Doors or covers giving access to uninsulated parts of indoor signs or outline lighting exceeding 600 volts and accessible to the general public, shall either be provided with interlock switches which on the opening of the doors or covers disconnect the primary circuit, or shall be so fastened that the use of other than ordinary tools will be necessary to open them.

Order 13-6036. Marking.

All signs shall be marked with the maker's name, and for incandescent lamp signs with the number of lampholders, and for gas tube signs with input rating in amperes or volt amperes. Transformers shall be marked with the maker's name, and transformers for gas tube signs shall be marked with the input rating in amperes or volt amperes, the input voltage and the open circuit high tension voltage. The marking of the sign shall be visible for inspection after installation.

Order 13-6037. Enclosures.

Enclosures for signs and outline lighting shall conform to the following:

A. *Conductors and Terminals.* Sign boxes, cabinets, and outline troughs shall have conductors and terminals, except the supply leads, enclosed.

B. *Cutouts, Flashers, Etc.* Cutouts, flashers, and similar devices shall be enclosed in metal boxes, the doors of which shall be arranged so that they can be opened without removing obstructions or finished parts of the enclosure.

C. *Enclosures Exposed to Weather.* Enclosures for outside use shall be weatherproof and shall have an ample number of drain holes, each not larger than ½ inch or smaller than ¼ inch.

D. *Material.* Except for portable signs of the indoor type, signs and outline lighting shall be constructed of metal or other non-combustible material. Wood may be used for external decoration if placed at least 2 inches from the nearest lampholder or current carrying part.

E. *Strength.* Enclosures shall have ample strength and rigidity.

F. *Thickness of Metal.* Sheet copper shall be at least 20 ounce (0.028 inch). Sheet steel may be of No. 28 USS gauge (.0149 inch) except that for outline lighting and for gas tube signs sheet steel shall be of No. 24 USS gauge (.0239 inch), unless ribbed, corrugated or embossed over its entire surface, when it may be of No. 26 USS gauge (.0179 inch).

G. *Protection of Metal.* All metallic parts of enclosures shall be galvanized or otherwise protected from corrosion.

SECTION 13-610. CRANES AND HOISTS

Order 13-6101. Scope.

The provisions of this section shall apply to the installation of cranes and hoists. Cranes or hoists installed in hazardous locations shall comply with the provisions of order 13-5082.

WIRING

Order 13-6111. Types of Conductors.

Conductors shall be of the rubber covered type except:

A. *Exposed to High Temperatures.* Conductors exposed to severe external heat, and those between resistors and contact plates shall, if not exposed to moisture, be asbestos insulated (type A), or, if the temperature does not exceed 90C (194F), slow-burning (type SB). If exposed to moisture, such conductors shall be rubber covered and, if grouped, the group shall be taped with a flameproof covering.

B. *Collector Conductors.* Collector conductors along runways and crane bridges may be bare and may be in the form of steel tees, angles, tee rails, or other stiff shapes.

C. *Varnished Cambric Conductors.* Varnished cambric conductors (type V) or asbestos varnished cambric (type AVA and AVB) may be used in dry locations.

Order 13-6112. Conductor Sizes.

Conductors shall be of the following sizes:

A. *Minimum No. 12.* Rubber covered conductors shall not be smaller than No. 12 except on pilot circuits of controllers where No. 14 may be used.

B. *Collector Conductors.* The size of collector wires shall not be less than the following:

Distance Between Rigid Supports	Size of Wire
0—30 feet	No. 6
31—60 feet	No. 4
over 60 feet	No. 2

Order 13-6113. Wiring Method.

Conductors shall be enclosed in rigid metal conduit or electrical metallic tubing, except:

A. *Bare Collector Conductors.* Bare conductors may be used as collectors.

B. *Open Conductors.* Short lengths of open conductors at resistors and collectors need not be enclosed.

C. *Flexible Connections.* Where flexible connections are necessary at motors and similar equipment, flexible metallic conduit or armored cable may be employed.

D. *Flexible Tubing.* In dry locations where space is limited, individual conductors may be separately encased in flexible tubing securely fastened in place.

E. *Auxiliary Gutters.* Short runs of wiring for control equipment located in a cab or on the bridge may be enclosed in auxiliary gutters.

F. *Flexible Cord.* Flexible cord may be used for connecting small portable hoists or small cranes where the horizontal movement is limited. Approved take-up reels or other approved methods of protecting flexible cords against injury shall be provided.

Order 13-6114. Raceway Terminal Fittings.

Conductors leaving raceways shall comply with the provisions of orders 13-3015 and 13-3016.

Order 13-6115. Common Return.

If a crane or hoist is operated by more than one motor, a common return conductor of proper current carrying capacity may be used.

COLLECTORS

Order 13-6121. Installation of Collector Conductors.

Bare collector conductors shall conform to the following:

A. *Collector Wires.* If wires are used as collector conductors they shall be secured at the ends by means of approved strain insulators and shall be so mounted on approved insulators that the extreme limit of displacement of the wire will not bring the latter within less than 1½ inches from the surface wired over.

B. *Supports Along Runways.* Main collector conductors carried along runways shall be supported on insulating supports placed at intervals not exceeding 20 feet, and these supports shall be insulating except for grounded rail conductors as provided in paragraph E of this order. If run on the same horizontal plane such conductors shall be separated not less than 6 inches, except for monorail hoists where

a spacing of not less than 3 inches may be used; if run otherwise, the spacing shall be not less than 8 inches. Where necessary, intervals between insulating supports may be increased up to 40 feet, the separation between conductors being increased proportionately.

C. *Supports on Bridges.* Bridge collector conductors shall be kept at least 2½ inches apart and, if the span exceeds 80 feet, insulating saddles shall be placed at intervals not exceeding 50 feet.

It is recommended that the distance between wires be greater than 2½ inches where practicable.

D. *Supports for Rigid Conductors.* Conductors along runways and crane bridges, if of the rigid type specified in order 13-6111-B, shall be carried on insulating supports spaced at intervals of not more than 80 times the vertical dimension of the conductor, but in no case greater than 15 feet, and spaced apart sufficiently to give a clear electrical separation of conductors or adjacent collectors of not less than 1 inch.

E. *Tracks as Circuit Conductor.* Monorail, tram-rail or crane runway tracks may be used as a conductor of current for one phase of a three phase alternating current system furnishing power to the carrier, crane or trolley, provided the following conditions are fulfilled:

1. The conductors for supplying the other two phases of the power supply shall be insulated.
2. The power for all phases shall be obtained from an insulating transformer.
3. The voltage shall not exceed 300 volts.
4. The rail serving as a conductor shall be effectively grounded at one point only, preferably at the transformer.

F. *Electrical Continuity of Collectors.* All sections of bare rigid collector conductors shall be mechanically joined to provide a continuous electrical connection.

G. *Not to Supply Other Equipment.* Collector conductors shall not be used as feeders for any equipment other than the crane or cranes which they are primarily designed to serve.

H. *Isolating or Guarding Collectors.* Except in locations to which only qualified persons are admitted, collector conductors should be so isolated by elevation or be provided with suitable guards so arranged that persons cannot inadvertently touch the current carrying parts while in contact with the ground or with conducting material connected to the ground.

Order 13-6122. Collectors.

Collectors shall be so designed as to reduce to a minimum sparking between them and the conductor, and when operated in rooms used for the storage of easily ignitible combustible fibers and materials the requirements of order 13-5082 shall be complied with.

CONTROL

Order 13-6131. Switch on Collectors.

The main conductors shall be controlled by a switch or circuit-breaker rated in amperes, readily operable from the ground and within sight of the collector conductors and arranged to be locked in the open position.

Order 13-6132. Switch in Cab.

If cranes are operated from cabs, a switch or circuit-breaker rated in amperes shall be provided in the leads from the main collector conductors. The switch or circuit-breaker shall be capable of interrupting the circuit under heavy loads and shall be capable of ready control by the operator.

Order 13-6133. Capacity of Switch.

On both alternating current and direct current crane protective panels, the continuous ampere rating of the main line switch or circuit-breaker, and main line contactors, shall be not less than 50 per cent of the combined short time ampere ratings of the motors, nor less than 75 per cent of the short time ampere rating of the largest individual motor.

Order 13-6134. Limit Switch.

A limit switch shall be provided for upper limit of travel of crane hoists.

Order 13-6135. Phase Protection.

Cranes and hoists operated by polyphase alternating current motors shall be provided with a device which will prevent starting of the motor if,

1. The phase rotation is in the wrong direction, or
2. There is a failure in any phase.

This protection may be placed ahead of the runway feeders.

Order 13-6136. Control of Movement.

It is recommended that the control levers of travelling cranes be located in the same relative position each to the other in all the cages of cranes.

OVERCURRENT PROTECTION

Order 13-6141. Main Collectors.

The main collector conductors shall be protected by an overcurrent device.

Order 13-6142. Crane Motors.

If more than one motor is employed on a crane, each motor shall have individual overcurrent protection as provided in Section 13-430, except that if two motors operate a single hoist, carriage, truck, or

bridge, and are controlled as a unit by one controller, the pair of motors with their leads may be protected by a single overcurrent device which shall be located in the cab if there is one.

Order 13-6143. Resistors—Enclosure.

If a crane operates over readily combustible material, the resistors shall be placed in a well ventilated cabinet composed of non-combustible material so constructed that it will not emit flames or molten metal, except where the resistors are located in a cab constructed of non-combustible material which encloses the sides of the cab from the floor to a point at least 6 inches above the top of the resistors.

Order 13-6144. Grounding.

Motor frames, tracks and the entire frame of the crane shall be grounded in the manner specified in Section 13-250.

SECTION 13-615. TROLLEY CONDUCTORS

Order 13-6151. Scope.

The provisions of this section shall apply to installations of trolley wires and feeders for supplying electric locomotives and cars.

Order 13-6152. Insulation of Trolley Wires.

Trolley wires shall have at least two separate and distinct insulations from the ground. A wooden pole or structure shall be considered as one insulation.

Order 13-6153. Control of Trolley Wires and Feeders.

Trolley wires and feeders shall be provided with a means by which they can be disconnected from their source of current.

SECTION 13-620. ELEVATORS

(See Wisconsin State Elevator Code for construction requirements.)

Order 13-6201. Scope.

This section shall apply to the electrical equipment and wiring used in connection with elevators and dumbwaiters. Installations in hazardous locations shall also comply with Section 13-500. Installations in garages shall also comply with Section 13-510.

Order 13-6202. Voltage Limitations.

The following voltage limitations shall apply to elevator control and operating equipment:

A. *Car Control System.* No part of any electric circuit having a voltage in excess of 750 shall be used on any car control system. Circuits of higher voltage may be used in machine rooms or penthouses for the operation of motors and brakes, provided that all control and signal wiring is thoroughly insulated from such power circuits, and all machine frames and metal, hand operated ropes are permanently grounded.

B. *Elevator Control Device.* The maximum voltage permitted on elevators hereafter installed shall not exceed 300 volts to ground on any elevator operating devices in the car, or at the landing, including push buttons of the elevator signalling circuit.

C. *Push Buttons.* The maximum voltage permitted on the push buttons of elevator signalling circuits shall be 300 volts to ground.

Order 13-6203. Live Parts Enclosed.

All live parts of electrical apparatus in or on elevator cars or in elevator hoistways shall be enclosed to protect against accidental contact.

Order 13-6204. Insulation of Conductors.

The insulation of conductors installed in or on elevator equipment shall comply with the following:

A. *In Auxiliary Gutters.* In auxiliary gutters used in machine rooms, under controllers, starters and similar apparatus for elevator machines, conductors shall be of the rubber covered type.

B. *Control Panel Wiring.* Conductors between main circuit resistors and the back of control panels shall be of the slow-burning type (type SB), asbestos varnished cambric type (type AVA), or of the all asbestos covered type (type A). All other wiring on control panels, unless subjected to a temperature exceeding 49C (120F) shall be of the rubber covered type having a flame retardant, moisture resistant outer cover or shall be of other type especially approved for the purpose.

C. *Elevator Controller Circuits.* Conductors or groups of conductors having flame retardant outer cover shall not be used as connections for the operating circuits of elevator controllers unless such outer covering is also moisture resistant.

Asbestos and other moisture absorbing coverings are not recommended for the operating circuit, as the covering when damp may carry enough current to cause the controller to function incorrectly and this incorrect functioning may be a life hazard.

D. *Traveling Cables.* Traveling cables used as flexible connections between the car and the hoistway shall be type E elevator cable, or other approved type, and shall have a flame retardant and moisture resistant outer cover.

Order 13-6205. Minimum Size of Conductors.

The minimum size of conductors for elevator wiring shall be as follows:

A. For lighting circuits, No. 14, except that for flexibility two or more No. 16 conductors may be used in parallel in traveling cables and on the car.

B. For elevator operating and control circuits, No. 16, Type RF-32 or FF-32 fixture wire.

C. For signal circuits and for fixtures, No. 18, Type RF-32 or FF-32 fixture wire.

Order 13-6206. Wiring Method.

The following wiring methods shall be employed:

A. *In Hoistways.* Conductors located in the hoistway, except traveling cables and conductors used in signal systems of Classes 1 or 2, shall be installed in rigid conduit or electrical metallic tubing, except that flexible conduit or armored cable may be used between riser and limit switches, interlocks, push buttons or similar devices.

B. *On the Car.* Conductors and traveling cables on the car shall be run in rigid conduit, electrical metallic tubing or wireways; except that short runs of:

1. Flexible conduit or armored cable may be used if so located as to be kept free from oil, and securely fastened in place.

2. Type S cord may be used as the flexible connection between the fixed wiring on the car and the switch on the car door or gate if securely fastened in a position not liable to mechanical injury.

C. *Between Motors and Control Panels.* The conductors of motor circuits between motors and control panel may be grouped without any additional insulation of the separate conductors, provided the complete group is either taped or corded, and painted in a manner to make same a rigid, self-supporting form, not over 3 feet long, and not in a position liable to mechanical damage or subject to a temperature in excess of 49C (120F).

Where continuity of elevator service is of vital importance, it is recommended that feeders serving such elevators be so installed that the elevator service is not likely to be interrupted in case of a fire in the building.

INSTALLATION OF CONDUCTORS

Order 13-6211. Raceway Terminal Fittings.

Conductors leaving raceways shall comply with the provisions of orders 13-3015 and 13-3016, but in no case shall the raceway terminate less than 6 inches from the floor.

Order 13-6212. Split Fittings.

Split fittings or clamp fittings may be used on exposed conduit or electrical metallic tubing except where the conduit or tubing contains feeders.

Order 13-6213. Supports.

Supports for pipes, conduits, and armored cable shall be securely fastened to the guide rail or hoistway construction.

Order 13-6214. Number of Conductors in Raceway.

The number of operating and control circuit conductors installed in a raceway may be in accordance with Table 9 of Chapter 10.

Order 13-6215. Auxiliary Gutters.

The restrictions of order 13-3742 as to length of auxiliary gutters, and of order 13-3745 as to number of conductors in auxiliary gutters, shall not apply.

Order 13-6216. Lighting and Signal Circuits Separate.

Conductors of car lighting circuits, and signal systems when not an integral part of the elevator wiring system, shall be separated and run in separate traveling cables and raceways.

Order 13-6217. Different Systems in One Cable or Raceway.

Conductors for elevator circuits, including operating, control and power conductors, and signal conductors when an integral part of the wiring system, may be run in the same traveling cable or raceway system when the power supply is from the same source, even though the characteristics of the voltage and/or current may be changed within the system by rectifying, transforming or other converting devices supplied from the elevator feeder circuit; provided that all conductors are insulated for the maximum voltage found in the cable or raceway system, and the live parts of the equipment are insulated from ground for this maximum voltage. Such a traveling cable or raceway may also include a pair of telephone conductors to serve a telephone in the car, provided such conductors are insulated for the maximum voltage found in the cable or raceway system.

Order 13-6218. Foreign Wires.

No electric conduit or cables, except those used to furnish or control power, light, heat or signals for the elevator or hoistways, shall have an opening, terminal, outlet or junction within the hoistway, but shall be continuous between outlets or terminals situated entirely outside the hoistway.

It is not intended to prohibit the interruption of long runs for the purpose of supporting or pulling in conductors, and pull boxes may be installed for this purpose.

TRAVELING CABLES

Order 13-6231. Cable Assembly.

Traveling cables for circuits other than signal, shall be of a composite assembly of copper and steel wires, unless one or more supporting fillers of cotton or hemp rope, or of cotton covered or rubber covered steel wire, are laid up with the conductors under the outer covering of the cable. In cables containing 6 or more conductors the supporting fillers shall be run straight through and not cabled with the conductors.

Order 13-6232. Suspension.

Traveling cables for all signal circuits, and for all other circuits not over 100 feet in length, may be suspended by suitable clamps if the cables are so constructed that the weight of the cable is not carried by the individual conductors.

Order 13-6233. Protection for Swinging Cables.

Wherever the traveling cables in swinging may come in contact with projections or corners of the building construction in the hoistway, such

as I-beams, ledges and the like, such irregular surfaces shall be made smooth by covering with heavy gauge sheet metal or other suitable means.

CONTROL

Order 13-6241. Disconnecting Means.

A manually operated circuit-breaker or disconnecting switch of the enclosed type opening all conductors shall be installed separately in the supply circuit of every electrically driven elevator machine, dumbwaiter or motor generator set hereafter installed. This switch shall be provided with proper overcurrent protection. No provision shall be made to close the disconnecting switch from any other part of the building. This switch shall be located where visible from the elevator machine or motor generator set, unless special permission is given to locate it elsewhere.

Note. It is recommended that this switch be located in the machine room at the lock jamb side of the entrance door.

Order 13-6242. Limit Switches.

A limit switch shall be provided for upper and lower limits of travel for all elevators. See Section 13-510 for elevators located in garages.

Order 13-6243. Phase Protection.

Electric elevators used to convey persons, if operated by a polyphase alternating current motor, shall be provided with a device which will prevent starting the motor if:

A. The phase rotation is in the wrong direction, or
B. There is a failure in any phase.

OVERCURRENT PROTECTION

Order 13-6251. No. 18 Conductors.

If No. 18 conductor is used for signal circuits, it shall be protected by fuses rated at not to exceed 3 amperes.

MACHINE ROOM

Order 13-6261. Guarding Equipment.

The elevator machine and controller shall be installed in a room set aside for that purpose, or isolated by elevation or by means of an enclosure or wire grille or the like, to prevent accidental contact by persons or objects. This room may also contain other machinery used for the control and signaling of the elevator.

Order 13-6262. Clearance Around Control Panels.

The following clearances shall be provided:

A. *Grouped Panels.* If a group of three or more elevator control panels having wiring on the rear is located in a single machine room, there shall be a working space of at least 36 inches back of the live

parts, and not less than 18 inches on at least one side of the group. There shall also be at least 36 inches of working space in front of the panels.

B. *Single or Double Panels.* An installation consisting of one or two panels shall have at least 24 inches working space in the rear, and at least 36 inches working space in the front of the panel or panels; and there shall be at least 18 inches working space on one side if the panel is single, and on each side if the panel is a double one. Smaller clearances may be authorized in certain specific cases by special permission.

This is not intended to forbid mounting controllers on the machine, enclosing the rear of control panels in removable cabinets, nor the placing of auxiliary equipment in front or rear of control panels, provided the working space is not appreciably restricted. If such cabinets are installed, the prescribed dimensions of clear space apply when the back of the cabinet is removed.

GROUNDING

Order 13-6271. Metal Raceways Attached to Cars.

Conduit or armored cable attached to elevator cars shall be bonded to grounded metal parts of the car with which they come in contact.

Order 13-6272. Electric Elevators.

For electric elevators, the frames of all motors, elevator machines, controllers and the metal enclosures for all electrical devices in or on the car or in the hoistway shall be grounded.

Order 13-6273. Non-Electric Elevators.

For elevators other than electric, if any electrical conductors are attached to the car, the metal frame of the car, if normally accessible to persons, shall be grounded.

Order 13-6274. Hand-Operated Cables.

All hand-operated metallic shifting ropes or cables shall be grounded.

Order 13-6275. Inherent Ground.

Equipment mounted on members of the structural metal frame of a building, shall be deemed to be grounded. Metal car frames supported by metal hoisting cables attached to or running over sheaves or drums of elevator machines shall be deemed to be grounded when the machine is grounded in accordance with Section 13-250.

SECTION 13-640. SOUND RECORDING AND SIMILAR EQUIPMENT

Order 13-6401. Scope.

This section shall apply to installations of equipment and wiring used for sound recording and reproduction, centralized distribution of sound, public address, speech-input systems and electronic organs.

Order 13-6402. Application of Other Articles.

Except as modified by this section, wiring and equipment from source of power to and between devices connected to the interior wiring systems shall comply with the requirements of Chapters 1 to 4, inclusive, of this code, and wiring and equipment for public-address, speech-input, radio-frequency, audio-frequency systems, and amplifying equipment associated with radio receiving stations in centralized distribution systems, shall comply with Section 13-800.

Order 13-6403. Number of Conductors in Raceway.

The number of conductors in a conduit or other raceway shall comply with Tables 4 to 11 of Chapter 10 except as follows:

A. Special permission may be granted for the installation of two 2-conductor lead covered cables in ¾ inch conduit, provided the cross sectional area of each cable does not exceed .11 square inch.

B. Special permission may be granted for the installation of two 2-conductor No. 19 lead covered cables in ½ inch conduit, provided the sum of the cross sectional areas of the cables does not exceed 32 per cent of the internal cross sectional area of the conduit.

Order 13-6404. Wireways and Auxiliary Gutters.

Wireways and auxiliary gutters shall comply with the requirements of sections 13-362 and 13-374 with the following exceptions where used for sound recording and reproduction:

A. *Number of Conductors in Raceway.* Conductors in wireways or gutters shall not fill the raceway to more than 75 per cent of its depth.

B. *Auxiliary Gutter Covers.* If the cover of auxiliary gutters is flush with the flooring and is subject to the moving of heavy objects it shall be of steel at least ¼ inch in thickness; if not subject to moving of heavy objects, as in the rear of patch or other equipment panels, the cover shall be at least No. 10 USS gauge (.1345 inch).

C. *Metal Trough Raceways.* Metal trough raceways may be installed in concealed places if run in a straight line between outlets or junction boxes. Covers of boxes must be accessible. Edges of metal must be rounded at outlet or junction boxes and all rough projections smoothed to prevent abrasion of insulation or conductors. Raceways made of sections shall be bonded and grounded as prescribed in order 13-2575.

D. *Grounding Wireways and Auxiliary Gutters.* Metal wireways and auxiliary gutters shall be grounded in accordance with the requirements of Section 13-250. If the wireway or auxiliary gutter does not contain power supply wires, the grounding conductor need not be larger than No. 14 copper or its equivalent. If the wireway or auxiliary gutter contains power supply wires, the grounding conductor shall not be smaller than the size called for in order 13-2595.

Order 13-6405. Grouping of Conductors.

Conductors of different systems grouped in the same conduit or other metallic enclosure, or in portable cords or cables, shall comply with the following requirements:

A. *Power Supply Conductors.* Power supply conductors shall be properly identified and shall be used solely for supplying power to the equipment to which the other conductors are connected.

B. *Leads to Motor Generator or Rotary Converter.* Input leads to a motor generator or rotary converter shall be run separately from the output leads.

C. *Conductor Insulation.* The conductors shall be insulated individually, or collectively in groups, by insulation at least equivalent to that on the power supply and other conductors, except where the power supply and other conductors are separated by a lead sheath or other continuous metallic covering.

D. *Flexible Cords.* Flexible cords and cables shall be of types P, K, S, SJ, or other types specifically approved for the purpose for which they are to be used. The conductors of flexible cords, other than power supply conductors, may be of a size not smaller than No. 26 provided such conductors are not in direct electrical connection with the power supply conductors and are equipped with current limiting means so that the maximum power under any condition will not exceed 150 watts.

E. *Terminals.* Terminals shall be marked to show their proper connections. Terminals for conductors other than power supply conductors shall be separated from the terminals of the power supply conductors by a spacing at least as great as the spacing between power supply terminals of opposite polarity.

Order 13-6406. Storage Batteries.

Storage batteries shall comply with the following:

A. *Installation.* Storage batteries shall be installed in accordance with Section 13-480.

B. *Conductor Insulation.* Storage battery leads shall be rubber covered.

C. *Overcurrent Protection.* Overcurrent protection shall be provided as follows:

1. "A" circuit, when supplied by branch lighting circuits, or by storage batteries of more than 20 ampere hour capacity, shall have overcurrent protection not exceeding 15 amperes.

2. "B" circuits shall have overcurrent protection not exceeding 1 ampere. The overcurrent protection shall be placed in each positive lead.

3. "C" circuits may be without overcurrent protection.

4. Overcurrent devices shall be located as near as practicable to the battery.

Order 13-6407. Equipment.

Amplifiers and rectifiers shall be so located as to be readily accessible. They shall be suitably housed and shall be of a type approved for the purpose unless otherwise expressly permitted by the authority enforcing this code. Equipment used in hazardous locations shall be specifically approved for the purpose.

A. *Ventilation.* Amplifiers and rectifiers shall be so located as to provide sufficient ventilation to prevent undue temperature rise within the housing.

B. *Protection Against Mechanical Injury.* Amplifiers, rectifiers, loud-speakers and other equipment shall be so located or protected as to guard against mechanical injury such as might result in fire or personal hazard.

SECTION 13-650. Organs.

Order 13-6501. General.

This section shall apply to those electric circuits and parts of electrically operated organs which are employed for the control of the sounding apparatus and keyboards. Electronic organs shall comply with the appropriate provisions of Section 13-640.

Order 13-6502. Source of Energy.

The source of energy shall be a self-excited generator of not over 15 volts, or a primary battery.

Order 13-6503. Insulation—Grounding.

The generator shall be effectively insulated from the ground and from the motor driving it, or both the generator and the motor frames shall be grounded in the manner prescribed in Section 13-250.

Order 13-6504. Conductors.

Conductors shall comply with the following:

A. *Size.* No conductor shall be smaller than No. 26, and the common return conductor shall be not smaller than No. 14.

B. *Insulation.* Conductors shall have rubber, asbestos, cotton, or silk insulation, except the common return conductor which shall be rubber covered, asbestos covered (type A), or slow-burning (type SB). The cotton or silk may be saturated with paraffine if desired.

C. *Conductors to Be Cabled.* Except the common return conductor, and conductors inside the organ proper, the organ sections and the organ console, conductors shall be cabled. The common return conductor may be placed under an additional covering enclosing both cable and return conductor, or may be installed as a separate conductor and may be in contact with the cable.

D. *Cable Covering.* The cable shall be provided with one or more braided outer coverings, provided that a tape may be used in place of an inner braid. Unless installed in metal raceways the outer braid shall be flame-retardant or shall be covered with a closely wound fireproof tape.

Order 13-6505. Installation of Conductors.

Cables shall be securely fastened in place and may be attached directly to the organ structure without insulating supports. Cables shall not be placed in contact with other conductors.

Order 13-6506. Overcurrent Protection.

Circuits shall be so arranged that all conductors, except the main supply conductors and the common return conductor, shall be protected from overcurrent by an overcurrent device of not greater than 15 ampere rating.

SECTION 13-660. X-RAY AND HIGH FREQUENCY EQUIPMENT

Order 13-6601. Scope.

The provisions of this section shall apply to all apparatus embodying X-ray operating at any frequency, or high frequency equipment, for medical use, examination of fabrics, metals, fruits, or any other purpose. High frequency as used in this section shall include those above normal commercial frequencies.

Order 13-6602. Overhead Conductors.

Overhead stationary conductors shall not be less than 7 feet 6 inches from the floor unless guarded from contact.

Order 13-6603. On Fluoroscope Tables.

Leads on fluoroscope tables shall be adequately insulated or provided with barriers which will guard against inadvertent contact.

Order 13-6604. Milliammeter.

If one side of the high voltage circuit is grounded, the milliammeter shall be connected in the grounded lead and need not be guarded.

CONTROL

Order 13-6611. Stationary Equipment.

The low voltage circuit of a step-up transformer shall contain a manually-operable circuit-breaker having no exposed live parts.

Order 13-6612. Portable Equipment.

Portable equipment shall comply with order 13-6611, except that no circuit-breaker is required when the high voltage parts, including the X-ray tube, are within the same metallic enclosure which is provided with a means for grounding. The circuit-breaker, when required, shall be located in or on the portable equipment.

Order 13-6613. X-Ray Apparatus—Radiographic Type.

In addition to complying with order 13-6611 or 13-6612, as the case may be, the low voltage circuit shall, in all cases, contain a switch which shall be so designed as to open automatically except when held closed by the operator.

Order 13-6614. X-Ray Apparatus—Therapy and Industrial Type.

A manual type of switch shall be provided to open and close the circuit at the operator's option. It is recommended that a time switch shall be provided which will open automatically after a definite time for which it has been set.

Order 13-6615. Foot Switch.

Switches operated by foot pressure should be provided with a shield over the contact button to avoid accidental closing, unless the equipment is of the fully-enclosed shock-proof type.

Order 13-6616. Independent Control.

If more than one piece of apparatus is operated from the same high voltage circuit, each shall be provided with a high voltage switch or equivalent disconnecting means provided so as to give independent control.

Order 13-6617. Operating Parts.

All operating parts, such as spark gap of high frequency machines, shall be insulated, and all regulating handles shall be made of insulating material, or adequately grounded where non-insulating material is used, and shall be operable from outside of barriers.

TRANSFORMERS AND CAPACITORS

Order 13-6621. General.

Transformers and capacitors which are a part of an X-ray or high frequency apparatus shall not be required to conform to the requirements of Sections 13-450 and 13-460.

Order 13-6622. Draining Capacitor Charge.

Unless all current-carrying parts of capacitors, and of the conductors connected therewith, are at least 7 feet 6 inches from the floor and are inaccessible to unauthorized persons, or unless when within 7 feet 6 inches from the floor are within enclosures of grounded metal or insulating material, capacitors shall be provided with an automatic means for discharge and grounding the plates whenever the transformer primary is disconnected from the source of supply.

GUARDING

Order 13-6631. General.

High voltage parts within 7 feet 6 inches from the floor, including X-ray equipment tubes and their leads, shall be protected against contact by barriers of grounded metal or by insulating material approved for the purpose.

Order 13-6632. Tube Terminals.

Unless tube terminals and high voltage leads are separated from the patient by grounded metal or insulating barriers, the terminals and

conductors connected to them shall be insulated for a distance of 12 inches, and the leads shall be carried away from the patient as directly as practicable.

Order 13-6633. Enclosures of Wood.

Wooden cabinets containing high voltage parts shall be lined inside with approved fire resistive material. The high voltage parts shall have adequate spacing from walls of the cabinet. High voltage equipment containing oil shall not be installed in wooden cabinets. Cabinets shall provide sufficient ventilation for safe operation of the equipment therein.

Order 13-6634. Therapy Tubes and Equipment.

X-ray tubes used in therapy shall be mounted in enclosures of grounded metal or insulating material approved for the purpose unless otherwise expressly permitted by the authority enforcing this code. Unless fully enclosed in cabinets or cases of grounded metal or of approved insulating materials, all high voltage parts of generators, rectifiers, filters and cooling equipment shall be installed in a separate room or enclosure. Suitable arrangements shall be provided whereby the switch controlling the supply circuit to such equipment will necessarily be open, except while the door of such room or enclosure is locked from the outside.

Order 13-6635. Low Frequency Parts.

Low frequency current-carrying parts of machines of the quench-gap or open-gap type shall be insulated or guarded so that they cannot be touched during operation. This applies to all parts except the high frequency circuit proper which delivers high frequency current normally for therapeutic purposes.

GROUNDING AND INSULATION

Order 13-6641. Grounding.

Non-current-carrying metal parts of tube stands, fluoroscopic and other apparatus shall be grounded in the manner prescribed in Section 13-250.

Order 13-6642. Insulation.

Insulating floors, mats, or platforms shall be provided for operators in proximity to high voltage parts.

Non-metallic tables and chairs are recommended. Floors of concrete or other conducting material should be completely covered with linoleum or other insulating material lapped at joints and without the use of metal for securing in place.

SECTION 13-670. MACHINE TOOLS

GENERAL

Order 13-6701. Scope.

The provisions of this section apply to the electrical equipment for motor-driven, complete metal working machines, not portable by hand, having one or more tool and work holding devices used for progressively removing metal in the form of chips.

Order 13-6702. Application of Other Sections.

The following provisions cover the requirements for electrical wiring and equipment on machine tools within the scope of this section. They are in addition to or amendatory of the applicable provisions of other sections of this code, which apply except as modified in this section.

WIRING METHODS

Order 13-6711. Conduit.

Conductors shall be in rigid metal conduit or electrical metallic tubing except as provided in orders 13-6712 to 13-6714, inclusive.

Order 13-6712. Flexible Metal Conduit.

Flexible metal conduit may be used only where necessary to employ flexible connections for small or infrequent movements, as at motor terminals, and provided that the flexible metal conduit is not subject to oil or moisture.

Order 13-6713. Continuously Moving Parts.

Wiring connections to continuously moving parts of a machine tool shall be of approved type, extra flexible, non-metallic covered, multi-conductor cable. Conductors shall conform to order 13-6722.

Order 13-6714. Compartments and Raceways.

Compartments and raceways within the framework of a machine tool may be used to enclose conductors, provided they are isolated from coolant and oil reservoirs and are entirely enclosed. Conductors in machine compartments and raceways shall be secured and so arranged that they will not be subject to mechanical injury or abrasion.

Order 13-6715. Number of Bends in Conduit.

If a run of rigid metal conduit does not exceed 25 feet in length, and the conductor fill does not exceed 30 per cent of the cross sectional area of the conduit, the requirements of order 13-3471 shall not apply.

CONDUCTORS

Order 13-6721. Sizes Permitted.

Branch circuit and control conductors shall not be smaller than No. 14, except that control conductors in flexible, non-metallic, multi-conductor cable to continuously moving parts may be as small as No. 16 if all such conductors are insulated for the maximum voltage of any conductor in the cable.

Order 13-6722. Type.

Conductors shall be of a type suitable for conditions of use. Type SN wire shall be used where subject to oil or coolant. Flexible, non-metallic, multi-conductor cable shall have an oil- and moisture-resistant insulation with a flame-retardant outer covering.

Order 13-6723. Identification of Conductors.

Conductors shall be identified either by color code or by other distinctive means. White or natural gray coloring shall be used only for a grounded conductor, and green only for a conductor used to ground the frame of equipment.

CONTROL EQUIPMENT

Order 13-6731. Mounting.

Controllers shall be mounted in such a manner as to guard against mechanical injury, oil, coolant, dust, and dirt.

Order 13-6732. In Machine Compartments.

Compartments in the column or base of a machine may serve as enclosures for control equipment if the following provisions are complied with:

A. *Thickness of Metal.* The wall thickness shall be not less than No. 14 USS sheet metal gauge if of sheet steel, not less than ⅛ inch if of cast metal, or not less than 3/32 inch if of malleable iron.

B. *Covers.* Compartments shall have tight fitting hinged covers, not thinner than specified in paragraph A. Covers shall have adequate means for fastening securely in a closed position.

C. *Control Enclosures.* Compartments used for control enclosures shall be readily accessible and shall not contain moving parts not directly connected to electrical control equipment, and shall be so located as to guard the control devices against oil, coolant, chips, and dirt.

D. *Ventilation.* A compartment enclosing group control equipment with branch circuit fusing as specified in paragraph B of order 13-6742, shall have a clear opening of at least 2 square inches, vented to another compartment within the column or base and having at least one-half the volume of the control compartment.

E. *No Floor Opening.* Compartments enclosing control equipment shall not be open to the floor or foundation upon which the machine rests.

MOTOR BRANCH CIRCUIT OVERCURRENT PROTECTION

Order 13-6741. One Branch Circuit.

The conductors supplying all motors on a single machine tool may be considered a single branch circuit, which must comply with the provisions for motor branch circuits in Section 13-430 except as modified in order 13-6742.

Order 13-6742. Several Motors on One Branch Circuit.

Controllers and running overcurrent protective devices for two or more motors connected to the branch circuit of a single machine tool need not comply with the provisions of order 13-4343, if all of the following provisions are complied with:

A. *Motor Running Protection.* Each motor shall be protected by a motor running overcurrent protective device.

B. *Rating of Overcurrent Devices.* The branch circuit shall have overcurrent protection of a rating equal to that specified in order 13-4342 for the largest motor connected to the circuit, plus an amount equal to the sum of the full load current ratings of the other motors on the machine tool connected to the same circuit, but in no case larger than 200 amperes at 250 volts or less, or 100 amperes at 600 volts or less.

C. *Enclosure.* The control equipment and running protective devices are enclosed in compartments complying in all respects with the provisions of order 13-6732.

D. *Conductors.* The conductors of the branch circuit shall comply with the provisions of paragraph B of order 13-4343.

PROTECTION AND GROUNDING

Order 13-6751. Protection Against Damage.

If the failure of one motor to operate while others continue to run could cause damage, they shall be so connected that the tripping of any overload or under-current device will result in stopping all of these motors.

Order 13-6752. Grounding.

All machine tools within the scope of this section, including connected portable equipment shall be effectively grounded as specified in Section 13-250.

Order 13-6753. Moving Parts.

A machine part that moves on grounded metal guides or supporting ways shall be considered as adequately grounded if the movable part may not readily be removed by hand.

SECTION 13-690. TRAILERS

Order 13-6901. Wiring of Trailers.

The wiring in a trailer which is to be connected to a regular outside distribution system shall conform to the appropriate orders in this code.

Order 13-6902. Connection of Trailer.

Whenever a trailer is parked and its wiring system connected to the regular distribution system, proper fusing and grounding shall be provided. The acceptable means of supplying this protection is as follows:

For each trailer an outlet and conductors shall be provided for the connection of the trailer wiring system. The outlet and conductors on the regular distribution system shall consist of a fused switch, fused only on the ungrounded wire, approved receptacle, cable for supplying the energy, and a separate insulated conductor for grounding purposes. The cable and ground conductor shall be of approximately the same length. The ground conductor shall be attached to ground and to the neutral wire at the outlet and provided with a means of attaching to the trailer frame.

Note. Cable should be not over 20 feet in length and conductors should be at least No. 14 A.W.G.

Chapter 7. Special Conditions

SECTION 13-700. EMERGENCY LIGHTING

Order 13-7001. Where Required.

The provisions of this section shall apply to systems or circuits for supplying emergency illumination only when such systems or circuits are required elsewhere in this code or by municipal, state, (such as Building, School Lighting or Industrial Lighting) or other codes. See order 13-5202.

Note. See the National Fire Protection Association Building Exits Code for other recommendations.

Order 13-7002. Systems of Less Than 50 Volts.

If a source of supply at less than 50 volts is employed as one of the systems, the installation shall also comply with the provisions of Section 13-720 of this code.

Order 13-7003. Scope.

Emergency lighting shall include all required exit lights and all other lights specified as necessary to provide sufficient illumination to enable persons to see their way out of the building.

Order 13-7004. Tests and Maintenance.

Systems shall be operated and tested sufficiently frequently to assure their maintenance in proper operating condition, and batteries shall be maintained in fully charged condition.

It is recommended that inspection authorities having jurisdiction conduct a test on the complete system upon installation and periodically afterward.

CURRENT SUPPLY

Order 13-7011. Source.

Current supply shall be such that in event of emergency within the building or group of buildings concerned, emergency lighting shall be available. Services may comprise:

A. One service, and a storage battery of sufficient capacity to supply and maintain at not less than 91 per cent full voltage the total load of the circuits carrying lights for emergency illumination for a period of at least ½ hour. Automobile batteries, or lead batteries of other than the sealed, glass-jar type, are not considered suitable.

B. One service and a generator set, driven by some form of prime mover and of capacity sufficient to supply circuits carrying emergency illumination load, with suitable means for automatically starting the generator on failure of the normal service.

C. Services as widely separated, electrically and physically, as the available facilities allow.

D. Connection on supply side of the main service if sufficiently separated from main service to prevent simultaneous interruption of supply through an occurrence within the building or group of buildings served.

Note. Separation shall be by walls or clear spaces and to an extent that will prevent simultaneous interruption of supply through an occurrence within the building.

It is recommended that where available, and in such locations as hospital operating rooms, separate and individual services be required for emergency lighting.

Order 13-7012. Derangement Signals.

Audible and visual signal devices shall be provided, where possible, to give warning of derangement of emergency illumination current sources jeopardizing their proper functioning, and to indicate when batteries or generator sets are carrying the emergency illumination load.

CIRCUITS

Order 13-7021. Provision for Lights.

Lights shall be provided and so located and supplied as to provide, with one service interrupted, emergency illumination without appreciable delay. The installation of lights would ordinarily require either one of the following:

A. An emergency lighting system, independent of the general lighting system, with provisions for automatically transferring, by means of devices approved for the purpose, the emergency system from a defective supply to another supply.

B. Two or more separate and complete systems with independent current supply each providing emergency lighting. Unless both systems are kept lighted, means shall be provided for automatically lighting either system upon failure of the other. Either or both systems may be a part of the general house lighting system if circuits carrying lights for emergency illumination are installed in accordance with other orders of this section.

Order 13-7022. Independent Wiring.

Wiring shall be kept entirely independent of all other wiring and equipment and shall not enter the same fixture, raceway, box or cabinet with other wiring except as permitted in sub-paragraph B of order 13-7021.

Order 13-7023. Connection of Appliances.

No appliances or lamps, other than those specified as required for emergency illumination, shall be supplied by such circuits except as provided in sub-paragraph B of order 13-7021.

CONTROL

Order 13-7031. Switch Required.

Circuits for emergency illumination shall be controlled through one switch accessible only to authorized persons.

Order 13-7032. Location.

This switch shall be located preferably in the lobby; otherwise at a place convenient to the main entrance to the building.

Order 13-7033. Other Switches.

In addition to the above switch, there may be:

A. A switch at the main service or on the control panel of a special current source.

B. A switch located adjacent to the emergency switch, or an automatic light actuated device approved for the purpose, to control separately those lights on the exterior of the building which are not required for illumination when there is sufficient daylight.

Order 13-7034. Stage Control Prohibited.

Circuits shall not be connected to or controlled by a stage lighting control.

OVERCURRENT PROTECTION

Order 13-7041. Service.

Service overcurrent devices only may be placed ahead of the branch-circuit overcurrent devices.

Order 13-7042. Accessible Only to Authorized Persons.

The branch-circuit overcurrent devices shall be accessible to authorized persons only.

SECTION 13-710. CIRCUITS AND EQUIPMENT OPERATING AT MORE THAN 600 VOLTS BETWEEN CONDUCTORS

Order 13-7101. General.

This section shall apply to installations operating at more than 600 volts between conductors. See order 13-0001-B.

Order 13-7102. Application of Other Sections.

Except as modified by this section, services of more than 600 volts shall conform to orders 13-2386 to 13-2392; motors shall conform to orders 13-4421 to 13-4425; transformers shall conform to Section 13-450; capacitors shall conform to Section 13-460; gas-tube signs shall conform to Section 13-600; X-ray and high-frequency equipment shall conform to Section 13-660; and outside wires to Section 13-730.

Order 13-7103. Insulation and Interrupting Capacity.

Conductors, devices and equipment shall have an insulation or separation between parts of different potential and between live parts and the ground, sufficient for the particular voltage employed. Devices which break current shall have an interrupting capacity sufficient for the voltage and current employed.

Order 13-7104. Constant-Current Systems.

Elsewhere than in substations and transformer vaults, constant-current systems shall not be installed in buildings, and lamps or fixtures on series circuits shall not be attached to exterior of building walls unless the walls are of fire-resistive construction.

INSTALLATION OF CONDUCTORS

Order 13-7111. Wiring Method.

Except in generator, transformer, switching and motor rooms, and in service runs, conductors shall be in rigid conduit, duct, or armored cable specially approved for the voltage.

Order 13-7112. Conductor Location.

All circuits of more than 7500 volts between conductors shall be installed only in transformer vaults, substations, and fire-resistive motor rooms, except as permitted for gas-tube signs in Section 13-600, and for X-ray and high-frequency equipment in Section 13-660. Conductors in conduit or duct and enclosed by concrete, brick, or equivalent fire-resistive material not less than 2 inches thick shall be considered outside the building. Connections from duct end to terminals or enclosures of apparatus, installed as permitted by orders 13-4504-C and 13-7135, shall be as short as practicable and may be run in rigid conduit without covering of concrete or brick.

Order 13-7113. Open Conductors—Supports and Separation.

If open work is employed, the conductors shall be supported on insulators of glass, porcelain, or other material approved for the purpose. Open conductors shall be separated not less than 8 inches from each other, except at apparatus and devices. They shall be not less than 2 inches from the surface wired over, and for voltages exceeding 2500 not less than 3 inches. Conductors and their supports, including insulators, shall have the strength and stability to insure maintenance of the required clearance in case of short-circuit current.

Order 13-7114. Flame-Retardant Covering.

Open insulated conductors shall have a flame-retardant outer covering. The conductor covering shall be stripped back one inch from the terminals so as not to touch them.

Order 13-7115. Lead-Covered Conductors.

Where conductors emerge from a lead sheath, they shall be protected from moisture and mechanical injury by a pothead or by other

means which will give equivalent protection. The lead sheath need not be continued over splices where moisture is not present, but the ends of the lead sheath shall be belled out and the sheath bonded around the splice by No. 6 copper wire and ground clamps.

Order 13-7116. Conduit to Enter Fitting.

Conduits shall enter and be secured to the casing, shields or enclosures of apparatus or to terminal boxes bolted or otherwise secured to the casing, shield, or enclosure, except in generator, transformer, switching and motor rooms and in substations.

CONTROL

Order 13-7131. General.

Orders 13-7132 to 13-7144 shall apply only to circuits and apparatus supplied through service equipment. They shall not apply to equipment in vaults accessible only to qualified persons.

Order 13-7132. Separate Control.

Each transformer or bank of transformers operating as a unit, and each other operating unit of apparatus shall, except as provided in order 13-7143, be separately controlled.

Order 13-7133. Step-Up or Step-Down Units.

If a generator operates with a transformer or a bank of transformers as a unit for stepping up or stepping down the voltage, they may be controlled as an operating unit.

Order 13-7134. Series Trip Coils.

Series trip coils connected directly to the circuit, unless guarded or isolated by elevation, should not be used with panel or panel-frame-mounted oil circuit-breakers on circuits exceeding 750 volts.

Order 13-7135. Enclosure of Apparatus Exceeding 5,000 Volts.

Switches, circuit-breakers, and control apparatus on circuits exceeding 5000 volts between conductors shall have a metal enclosure such as metal-clad switch-gear, trucks, and cubicles, or be installed remotely controlled in a fire-resistive switchroom or motor room or in a vault complying with orders 13-4521 to 13-4528 inclusive.

If live parts of equipment in such metal enclosures carry more than 600 volts and are accessible by means of a door, the door shall be provided with a lock so that it cannot be opened by unauthorized persons, or with an interlock which will prevent opening unless the parts thereby exposed are de-energized.

If connected to a circuit exceeding 15,000 volts between conductors, such apparatus shall be installed only in a vault which complies with orders 13-4521 to 13-4528 inclusive.

Order 13-7136. Oil Circuit-Breakers and Oil Switches to Be Isolated.

Oil circuit-breakers and oil switches shall be isolated from other apparatus wherever practicable. If mounted in a closed compartment, means shall be provided to indicate whether the breaker is open or closed.

It is recommended that oil switches used to control transformers be outside the vaults containing the transformers.

Order 13-7137. Switches to Be Safely Accessible.

All switches shall be so located that the point from which they are operated is safely accessible to qualified and authorized persons. Isolating switches shall be accessible to qualified persons only. Barriers should be provided on both sides of isolating switches.

Order 13-7138. Warning Signs.

Unless isolating switches are so interlocked that they cannot be opened under load, signs shall be installed at isolating switches warning against opening them while they are carrying current.

OVERCURRENT PROTECTION

Order 13-7141. General.

Each transformer, or bank of transformers operating as a unit, except instrument transformers, and each other operating unit of apparatus, shall be protected from overcurrent by a manually-operable circuit-breaker which will interrupt all ungrounded conductors, except as provided in order 13-7143. Transformers operating in multiple, except in the case of two transformers of equal capacity, shall be separately protected on both primary and secondary sides. For potential instrument transformers see order 13-4532.

Order 13-7142. Number of Overcurrent Units.

The number of overcurrent units shall be as specified in Table 28, Chapter 10.

Order 13-7143. Fuses.

Oil-filled or other suitable types of fuses may be used on circuits not exceeding 2500 volts to ground and rated at not more than 300 amperes, or not exceeding 7500 volts and 100 amperes, for the following purposes:

A. For the protection of individual feeder or branch circuits at the point where they receive their supply. If there is more than one such circuit, there shall be a manually-operable circuit-breaker between the point of origin of such circuits and the source of supply.

B. For the protection of individual transformers, or banks of transformers operating as a unit when such transformers are supplied by a common feeder, provided that such feeder at the point where it receives its supply, shall be protected by a circuit-breaker which can

be operated manually by either mechanical or electrical means. A circuit supplying a single transformer or bank of transformers need not have circuit-breaker protection.

C. For the protection of other classes of apparatus by special permission.

Order 13-7144. Injury From Fuses.

Fusible cutouts shall be so installed that the blowing of the fuse will not result in injury to persons or damage to other equipment. They shall be accessible to qualified attendants only.

MOTORS

Order 13-7151. General.

Motors operating at more than 600 volts shall comply with the provisions of Section 13-430.

SERVICES AND SERVICE EQUIPMENT

Order 13-7152. General.

Services and service equipment shall comply with Section 13-230.

GUARDING

Order 13-7161. Live Parts to Be Guarded.

If accessible to unqualified persons, all live parts, including conductors, shall be enclosed or isolated.

Order 13-7162. Isolation by Elevation.

To secure isolation by elevation, the distances above the floor or working surface shall be not less than given in Table 32, Chapter 10.

Order 13-7163. Working Space.

Except in stations, substations and vaults, under the sole control of the supply company, adequate working space shall be provided adjacent to current-carrying parts upon which repairs or adjustments must be made while such parts are alive. The clear space when removable guards are taken away shall be not less than given in Table 33 of Chapter 10. If live parts are exposed on opposite sides of the working space, a clear space of not less than 4 feet shall be provided.

Order 13-7164. Air-Break Switches and Fuses.

Air-break isolating switches and fuses shall be accessible to qualified persons only.

Order 13-7165. Generator, Switching, and Motor Rooms to be Locked.

Generator, switching, and motor rooms shall be securely locked except while a qualified operator is present.

GROUNDING

Order 13-7171. General.

Except in stations, substations and vaults under the sole control of the supply company, enclosures of metal and all non-current-carrying parts of equipment or apparatus shall be grounded in the manner specified in Section 13-250.

SECTION 13-720. CIRCUITS AND EQUIPMENT OPERATING AT LESS THAN 50 VOLTS

Order 13-7201. General.

This section shall apply to installations operating at less than 50 volts, direct current or alternating current, except such as are treated in Sections 13-650 and 13-800.

Order 13-7202. Larger Current at Lower Voltage.

Conductors, devices, and equipment shall have current ratings sufficient for the greater current required to deliver equal power at the lower voltage than at usual voltages.

Order 13-7203. Conductors.

Conductors shall be not smaller than No. 12, and for appliance branch circuits supplying more than one appliance or appliance receptacle, conductors shall be not smaller than No. 10.

Order 13-7204. Branch Circuit.

Not more than 8 lampholders or receptacles, nor a total load of more than 320 watts, shall be connected to a branch circuit. Motors or appliances of rating more than 320 watts shall have a separate branch circuit.

Order 13-7205. Lampholders.

Standard lampholders of rating not less than 660 watts shall be used.

Note. This requirement does not apply to limited low voltage industrial lighting systems. Smaller lampholders may be used for low voltage lamps in connection with sewing machines and similar devices.

Order 13-7206. Receptacle Rating.

Receptacles shall have a rating not less than 15 amperes.

Order 13-7207. Receptacles Required.

Receptacles of not less than 20 ampere rating shall be provided in kitchens, laundries, and other locations where portable appliances are likely to be used.

Order 13-7208. Overcurrent Protection.

Overcurrent protection shall comply with the provisions of Section 13-240.

Order 13-7209. Batteries.

Batteries shall conform to the following:

A. Location. Batteries shall be located in rooms or spaces having natural ventilation.

B. Support. Battery jars and cells, if not composed of insulating material such as glass or hard rubber, shall be mounted on insulating supports of glass or porcelain.

Order 13-7210. Grounding.

Equipment and circuits shall be grounded as follows:

A. *Machines.* The grounding of frames of engines or generators is not required.

B. *Conductors.* One of the circuit conductors shall be grounded if conductors are run overhead between buildings, or if the circuit is supplied through a transformer from an ungrounded circuit or from a grounded circuit of more than 150 volts.

SECTION 13-730. OUTSIDE WIRING

For detailed rules covering line work, reference is made to Part 2 of the Wisconsin State Electrical Code.

For signs and outline lighting, see Section 13-600.

For signal and control wiring, see Section 13-800.

ON EXTERIOR OF BUILDINGS

Order 13-7301. Wiring.

Wiring on exterior of building walls shall comply with following orders 13-7302 to 13-7308, except service conductors, for which see Section 13-230. For circuits exceeding 600 volts, conductors shall be in rigid conduit, or in cable approved for the purpose, except that electrical metallic tubing may be used for signs or outline lighting as provided in Section 13-600.

Order 13-7302. Conductor Covering.

Open conductors on insulators shall have rubber or weatherproof covering. Conductors in raceways or cables shall have rubber covering.

Order 13-7303. Supports and Clearances.

Open conductors not exposed to the weather may be rigidly supported on glass or porcelain knobs, placed at intervals not exceeding 4½ feet, and shall be separated not less than 2½ inches from each other and 1 inch from the surface wired over. Where exposed to the weather, conductors shall be supported on insulators, racks, or brackets designed for the purpose, placed at intervals of not exceeding 9 feet, separating the conductors at least 6 inches from each other and at least 2 inches from the surface wired over; provided that supports may be placed at intervals not exceeding 15 feet if conductors are separated at least 12 inches from each other.

Order 13-7304. Separation from Other Conductors.

Open conductors shall be separated from open conductors of other circuits or systems by not less than 4 inches.

Order 13-7305. Mechanical Protection.

Open conductors shall not be within 8 feet from the ground, shall not be readily accessible and shall not be subject to mechanical disturbance. Conductors within 8 feet from the ground, when readily accessible, or when subjected to mechanical disturbance, shall be protected by conduit, electrical metallic tubing, or equivalent protection.

Order 13-7306. Drip Loops.

Open conductors where they enter or leave a building shall pass upward and inward through slanting non-combustible, non-absorptive insulating tubes. Drip loops shall be formed on the conductors before they enter the tube.

Order 13-7307. Raceways.

Conduit and electrical metallic tubing on exterior of buildings shall be made rain-tight and suitably drained.

Order 13-7308. Multiple-Conductor Cables.

Multiple-conductor cables shall be of types approved for exposure to the weather and unless of a type approved as service entrance-cable shall be protected where within 8 feet of the ground or where subject to mechanical disturbance.

OVERHEAD WIRING IN PUBLIC ROADS, STREETS, AND ALLEYS

Order 13-7321. General.

In order to facilitate the operation of fire departments and to avoid fire hazards due to the exposure of adjacent buildings to such overhead wiring, overhead wiring in public roads, streets, and alleys, shall comply with orders 13-7322 and 13-7323.

Order 13-7322. Clearance from Building.

Overhead wires on roads, streets, or alleys shall comply with the following:

A. *Zone for Fire Ladders.* If buildings exceed 3 stories, or 50 feet in height, overhead lines shall be arranged where practicable so that a clear space (or zone) at least 6 feet wide will be left either adjacent to the buildings or beginning not over 8 feet from them, to facilitate the raising of ladders when necessary for fire fighting.

B. *Less than 7500 Volts.* Open conductors of less than 7500 volts between conductors shall be at least 3 feet horizontally from buildings unless 8 feet higher than the roof.

C. *Exceeding 7500 Volts.* Open conductors of voltages between 7500 and 15,000 volts between conductors shall be kept at least 8 feet horizontally, and open conductors of more than 15,000 volts between con-

ductors shall be kept at least 10 feet horizontally, from all buildings except those which they serve or central stations, sub-stations, and transformer vaults.

Order 13-7323. Use of Common Crossarm.

Telephone, telegraph, or other communication conductors shall not enter any building from a pole line where these conductors are supported on a crossarm used also to support electric light and power conductors, except communication conductors used for operating purposes by an operating utility and entering buildings used for such purposes.

OVERHEAD CONDUCTORS ON PRIVATE PREMISES

Order 13-7331. Application.

Overhead conductors on private premises, other than in yards and other premises of public utilities used for operating purposes, shall comply with the requirements of orders 13-7322 and 13-7323, and shall also comply with the orders 13-7332 to 13-7337 inclusive.

Order 13-7332. Separation and Supports.

Conductors shall be mounted so as to comply with the following:

A. Conductors shall be so placed that moisture is not liable to form a cross connection between them.

B. Line conductors shall be not less than one foot apart except when placed on racks or brackets, and shall not come in contact with anything but their supports.

Order 13-7333. Vertical Clearance from Building.

Conductors shall be at least 8 feet above the nearest point of buildings over which they pass, and if attached to roofs the roof structures shall be substantially constructed. Wherever practicable, conductors crossing over buildings shall be supported on structures which are independent of the buildings.

Exception. Conductors operating at less than 300 volts to ground may have a clearance of not less than 3 feet from the highest point of roofs that cannot be readily walked upon.

Order 13-7334. Clearance from Ground.

Conductors shall be mounted with a clearance from ground as follows:

A. *Over Driveways.* Conductors above alleys and above driveways on other than residence property shall have a clearance above ground of not less than 18 feet, and if more than 600 volts, 20 feet.

B. *Over Lots.* Conductors supplying lights in automobile parking lots and other similar commercial areas shall have a clearance above ground of not less than 12 feet.

C. *Over Footwalks, Etc.* On residential properties, and elsewhere across spaces accessible to pedestrians only, conductors between buildings shall have a clearance above ground of not less than 10 feet for

wires not more than 150 volts to ground, and 12 feet for higher voltages to ground. Greater clearances shall be provided if, in the judgment of the authority enforcing this code, it is necessary to prevent disturbance of the conductors.

Order 13-7335. Climbing Space.

Conductors supported on poles shall be mounted so as to provide a climbing space adjacent to the pole with not less than the following horizontal dimensions:

Power conductors, below communication conductors ..... 30 in.
Power conductors alone or above communication conductors:
Less than 300 volts ..... 24 in.
Exceeding 300 volts ..... 30 in.

Communication conductors below power conductors—
The climbing space shall be the same as required for the supply conductors immediately above with a maximum of 30 inches, except that a climbing space of 16 inches across the line may be employed for communication cables or conductors where the only supply conductors of a higher level are secondaries (0 to 750 volts) supplying airport or airway marker lights or crossing over the communication lines and attaching to the pole top or to a pole top extension fixture.
Communication conductors alone or above power conductors—
No requirement.

Order 13-7336. Protection on Poles.

Conductors running up a pole shall be protected from mechanical injury to a point at least 8 feet from the ground.

Order 13-7337. Conductor Size.

Overhead conductors shall not be smaller than No. 10 for spans up to 50 feet in length, and not smaller than No. 8 for longer spans.

OUTDOOR AREA AND FESTOON LIGHTING

Order 13-7341. General.

Conductors used for outside festoon lighting shall comply with the following orders 13-7342 to 13-7348 inclusive.

Order 13-7342. Insulation.

Conductors shall be rubber-covered.

Order 13-7343. Size of Conductors.

Conductors shall be not smaller than No. 14, except that if lampholders of the intermediate or smaller sizes are used, the conductors shall be not smaller than No. 18, and that Christmas tree and other decorative lighting outfits shall be approved for outdoor use.

Order 13-7344. Overcurrent Protection.

Conductors may have over-current protection in accordance with Table 2, Chapter 10.

Note. If No. 14 conductors are used, overcurrent protection rated at not more than 15 amperes shall be provided. For No. 12 conductors, this may be increased to 20 amperes.

Order 13-7345. Conductor Supports.

Conductors for festoon lighting shall be supported as follows:

A. *Spans Exceeding 40 Feet.* In spans exceeding 40 feet the conductors shall be supported by a messenger wire substantially fastened at each end.

B. *Strain Insulators.* Conductors and messenger wires shall be supported by secure attachments to buildings, poles, or other adequate supports by means of strain insulators. Conductor or messenger wires shall not be attached to any fire escape, downspout or plumbing equipment.

Order 13-7346. Clearance from Ground.

Conductors in spans shall clear the ground by at least 10 feet on residential properties accessible to pedestrians only, and in all other cases by at least 12 feet.

Order 13-7347. Lampholders.

Lampholders shall be of approved molded composition, weatherproof type, and if they are attached as pendants shall have the connections to the circuit wires staggered. If lampholders have terminals of a type which puncture the insulation and make contact with the conductors, they shall be attached only to conductors of the stranded type.

Order 13-7348. Splices and Taps.

All splices and taps shall be made mechanically and electrically secure by one of the methods described in order 13-1116. They shall then be covered with both rubber and friction tape and painted with an insulating paint.

OUTDOOR AREA LIGHTING

Order 13-7351. General.

Electrical equipment for the illumination of outdoor athletic or similar fields, in addition to complying with the general rules of this section, shall conform to the following orders 13-7352 and 13-7353, inclusive.

Order 13-7352. Common Neutral.

For lighting equipment installed on a single pole or structure, a common neutral may be employed for the branch circuits, provided not more than 8 ungrounded conductors are used. The common neutral shall have a carrying capacity sufficient for the maximum unbalanced load.

Order 13-7353. Location of Lamps.

Lamps shall be located below all live conductors, transformers, or other electric equipment, unless clearances or other safeguards are provided for relamping operations, or unless the installation is controlled by a disconnecting means which can be locked in the open position.

UNDERGROUND CONDUCTORS

Order 13-7361. Mechanical Protection.

Underground conductors shall be protected against mechanical injury by being installed in duct, in the form of a cable approved for the purpose or by other approved means.

Order 13-7362. Draining.

Underground conduits or ducts, when not located below the frost line, shall be arranged to drain.

Order 13-7363. Protection on Poles.

If underground conductors are carried up a pole, mechanical protection shall be installed to a point at least 8 feet above the ground.

Order 13-7364. Protection Where Entering Building.

Where underground conductors enter a building, they shall have mechanical protection in the form of rigid or flexible conduit, electrical metallic tubing, auxiliary gutters, or cables approved for the purpose, or other approved means.

Order 13-7365. Type of Conductor.

Conductors shall be lead-covered, rubber-covered Type RW, or of other type specially approved for the condition.

For Trailer and Trailer Camp Wiring, see Section 13-690.

Chapter 8. Communication and Control Systems

SECTION 13-800. SIGNAL AND CONTROL SYSTEMS

Order 13-8001. Scope.

The provisions of this section shall apply to electric circuits for transmitting intelligence, including telephone, telegraph, district messenger, call bell, and similar circuits. Circuits carrying small currents at low voltage within the limits described in this section, used for other than signaling purposes, as for example, for temperature or other control devices, shall be considered as coming within the scope of this section. Circuits or apparatus coming within this scope and installed in Class I hazardous locations shall comply with order 13-5027 of Section 13-500.

Order 13-8002. Classification.

Systems shall be classified as follows:

A. *Class* 1. Systems used for protective purposes such as fire alarm, burglar alarm and similar systems.

Systems of Class 1 are further regulated by separate codes.
For detailed service provisions for Fire Alarm Sprinkler Supervisory, or Watchman Systems, see standards of the National Board of Fire Underwriters.

B. *Class* 2. Systems in which the power is limited in accordance with order 13-8003.

C. *Class* 3. Systems of not more than 30 volts, where the current is not limited as in Class 2.

D. *Class* 4. Systems other than those defined in Class 1, 2, or 3.

Order 13-8003. Limitations of Class 2 Systems.

Class 2 systems shall be limited as follows:

A. *Central Station Circuits.* Circuits operated as a part of a central station system such as telephone, telegraph, district messenger, and the like.

B. *Local Circuits.* Local circuits which may extend beyond one building and which meet any one of the following requirements:

1. Maximum 15 Volts; 5 Amperes. Circuits operating at not exceeding 15 volts and fused at not more than 5 amperes. If the current supply is from transformers or other devices having inherent current limiting characteristics and approved for the purpose, or from primary batteries, the fuse may be omitted.

2. 15 to 30 Volts; 3 Amperes. Circuits operating at more than 15 volts but not exceeding 30 volts, and fused at not more than 3 amperes. If the current supply is from transformers or other devices having inherent current limiting characteristics and approved for the purpose, or from primary batteries, the fuse may be omitted.

3. 30 to 60 Volts; 1⅓ Amperes. Circuits operating at more than 30 volts but not exceeding 60 volts, and fused at not more than 1⅓ amperes. If the current supply is from a transformer or other device having inherent current limiting characteristics and approved for the purpose, the fuse may be omitted. If current limiting means other than fuses are installed between the wiring and the source of supply which will limit the current at a fault to not exceeding 1 ampere, a three-ampere fuse may be used in place of the 1⅓ ampere fuse.

4. More than 60 Volts; 1 Ampere. Circuits operating at more than 60 volts and fused at not more than 1 ampere, provided that such circuits are equipped with current limiting means other than fuses which will limit the power as a result of a fault to not exceeding 150 watts.

C. *Transformer Rating.* Transforming devices supplying local circuits covered in paragraph B of this order shall be restricted in their rated output to not exceeding 100 volt amperes.

Order 13-8004. Installation of Class 1.

Systems of Class 1 shall comply with the requirements of orders 13-8011 to 13-8031, inclusive.

Order 13-8005. Installation of Class 2.

Systems of Class 2 shall comply with the requirements of orders 13-8011 to 13-8031, inclusive.

Order 13-8006. Installations of Class 3.

Systems of Class 3 shall comply with the requirements of orders 13-8011 to 13-8031, inclusive, and shall in addition comply with the following:

A. *Wiring Method.* Conductors and equipment shall be installed in accordance with the requirements of Section 13-240 and Chapter 3 of this code, except as follows:

1. Number of Conductors in Raceway. The number of conductors in a raceway shall be limited only by the requirement that the cross-sectional area of all the conductors shall not exceed 40 per cent of the area of the raceway.

2. Branch Circuit Conductors. Branch circuit conductors need not be individually protected against overcurrent if in conduit or other approved metallic raceways, in non-combustible raceways or in cable approved for use without fuses. Circuits which are fused may be installed in cable approved for use with fuses, in lieu of the requirements of paragraph C of this order.

B. *Feeder Conductors.* Main or Feeder conductors shall not be in the same cable with branch circuit conductors unless the branch circuit conductors are provided with overcurrent protection. Main or feeder conductors may be in contact with the cable or placed under an additional covering which encloses both the cable and the main or feeder conductors.

C. *Conductor Insulation.* Conductors Nos. 18 and 16 shall have an insulation at least equal to that of Type RF-32 rubber covered fixture wire or of other approved type. Conductors larger than No. 16 shall be rubber covered Type R or other approved type. Main and feeder conductors shall have a flame-retardant, moisture-resistant outer cover unless in metal or other non-combustible raceways or enclosures.

D. *Conductor Size.* Conductors shall not be smaller than No. 18 and shall be in accordance with Tables 1 and 2 of Chapter 10.

E. *Overcurrent Protection.* Conductors shall be protected against overcurrent in accordance with the requirements of Section 13-240. Conductors of No. 18 or No. 16 shall be considered as protected by overcurrent devices of 15 ampere rating or setting, except as provided in order 13-6251. Branch signal or control circuits shall be protected by not over 15 ampere fuses, except as provided in sub-paragraph A-2 of this order.

F. *Rating of Power Supply.* The rating of the power supply shall not exceed 1 K.W.

Order 13-8007. Installation of Class 4.

Systems of Class 4 shall comply with the requirements of Chapters 1, 2 and 3 of this part of this code, except as to the number of outlets on a lighting branch circuit.

PROTECTION

Order 13-8011. Protective Devices.

A protector approved for the purpose shall be provided on each circuit, aerial or underground, so located within the block containing the building served as to be liable to accidental contact with light or power conductors operating at a potential exceeding 250 volts, and on each circuit run partly or entirely in aerial wire or cable not confined within a block.

A. *Location.* The protector shall be located in or on the building as near as practicable to the point where the conductors enter. In the case of an underground entrance the protector may be located at the junction of the underground and the aerial wires.

B. *Hazardous Locations.* The protector shall not be located in any hazardous location as defined in Section 13-500, nor in the vicinity of easily ignitible material.

The word "block" as used in orders 13-8011 and 13-8021 shall be construed to mean a square or portion of a city, town, or village enclosed by streets and including the alleys so enclosed but not any street.

C. *Protector Requirements.* The protector shall be mounted on a non-combustible, non-absorptive insulating base and shall consist of an arrester between each line conductor and the ground, and a fuse in each line conductor, the fuses protecting the arrester. The protector terminals shall be plainly marked to indicate line, instrument, and ground.

D. *Metal Sheathed Cable.* Fuses protecting the arrester may be omitted on circuits entering a building through metal sheathed cable, provided the metal sheath of the cable is grounded and the conductors in the cable are No. 24 or smaller.

Order 13-8012. Installation of Conductors.

Conductors from the protector to the equipment or, where no protector is required, conductors attached to the outside of, or inside, the building shall comply with the following:

A. *Neatly Arranged.* Conductors shall be neatly arranged and shall be secured in place in a workmanlike manner.

B. *Separation From Other Conductors.* Conductors shall be separated from conductors of electric light and power circuits as follows:

1. Open Conductors. Conductors shall be separated at least 2 inches from any light or power conductors not in conduit unless permanently separated from the conductors of the other system by a continuous and firmly fixed non-conductor, additional to the insulation on the wire, such as porcelain tubes or flexible tubing.

2. In Raceways and Boxes. Conductors of signal and control circuits shall not be placed in any raceway, compartment, outlet box, junction box or similar fitting with conductors for light and power circuits, unless the conductors of the two systems are separated by a partition; provided, that this shall not apply to conductors in outlet boxes, junction boxes or similar fittings or compartments where such conductors are introduced solely for power supply to signaling equipment or for connection to remote control equipment, nor to conductors associated with light and power supply facilities and having the same insulation as the light and power conductors. The number of conductors in a raceway shall be limited only by the requirement that the cross-sectional area of all conductors shall not exceed 40 per cent of the area of the raceway.

3. In Shafts. Conductors may be run in the same shaft with conductors for light and power if the conductors of the two systems are separated at least 2 inches, or if the conductors of either system are encased in non-combustible tubing.

C. *Vertical Runs.* Conductors bunched together in a vertical run shall have a fire-resistant covering capable of preventing the carrying of fire from floor to floor, except where conductors are encased in non-combustible tubing or are located in a fireproof shaft having fire stops at each floor.

The conductors referred to in this order would ordinarily be insulated but, except for Class 1, 3, and 4 systems, the kind of insulation is not specified as reliance is placed on the protective device to stop all dangerous voltages and currents.

Order 13-8013. Transformers or Other Current Supply.

Controllers, transformers or other devices supplying current from electric light and power circuits shall be of a type approved for the purpose. Devices approved for supplying or controlling current to

Class 2 circuits shall be marked where plainly visible to show the voltage applied to the circuit, and whether or not of the current limiting type.

Order 13-8014. Safety Control Circuits.

Circuits to safety control devices, the failure of operation of which would introduce a fire or life hazard, shall be installed in accordance with Section 13-300 or in cable approved for the purpose.

OUTSIDE CONDUCTORS

Order 13-8021. Overhead Conductors.

Overhead conductors entering buildings shall comply with the following:

A. *On Poles.* Where signal and control conductors and light or power conductors are supported by the same pole, the following conditions shall be met:

1. Relative Location. The conductors should preferably be located below the light or power conductors.

2. Attachment to Cross Arms. Conductors shall not be attached to a crossarm which carries light or power conductors.

3. Climbing Space. The climbing space through signal conductors shall comply with the requirements of order 13-7335.

B. *On Roofs.* Conductors shall be kept at least 8 feet above the roofs of buildings over which they pass, except small auxiliary buildings such as garages and the like.

C. *Circuits Requiring Protectors.* Circuits which require protectors (see order 13-8011) shall comply with sub-paragraph A of order 13-8012, and also the following:

1. Insulation, Single or Paired Conductors. Each conductor, from the last outdoor support to the protector, shall have 1/32 inch rubber insulation, except that when such conductors are entirely within a block the insulation on the conductor may be less than 1/32 inch, but not less than 1/40 inch in thickness. In addition, the conductor, either individually or over the pair, shall be covered with a substantial fibrous covering. Conductors with rubber insulation of a thickness less than specified above, or conductors with other kinds of insulation, approved for the purpose, may be used.

2. Insulation, Cables. Conductors within a cable of the metal sheathed type, or within a cable having a rubber sheath of at least 1/32 inch thickness and covered with a substantial fibrous covering, may have paper or other suitable insulation. If the metal or rubber sheath is omitted, each conductor shall be insulated as required in sub-paragraph C-1 of this order, and the bunched conductors shall be covered with a substantial fibrous covering.

3. On Buildings. Open conductors shall be separated at least 4 inches from light or power conductors not in conduit or cable, unless permanently separated from conductors of the other system by a continuous and firmly fixed non-conductor additional to the insulation on the wires, such as porcelain tubes or flexible tubing. Open conductors exposed to accidental contact with light or power conductors operating at over 250 volts, and attached to buildings, shall be separated from woodwork by being supported on glass, porcelain or other insulating material approved for the purpose.

4. Entering Buildings. Except when a protector is installed on the outside of the building, or the entering conductors are in a cable or pass through masonry, the conductors shall enter the building either through non-combustible, non-absorptive insulating bushings, or through a metal raceway. Raceways or bushings shall slope upward from the outside or where this cannot be done drip loops shall be formed in the conductors immediately before they enter the building. Raceways shall be equipped with an approved service head. More than one conductor may enter through a single raceway or bushing. Conduits or other metallic raceways located ahead of the protector shall be grounded.

Order 13-8022. Lightning Conductors.

A separation of at least six feet shall be maintained between signal and control conductors on buildings and lightning conductors.

Order 13-8023. Underground Circuits.

Underground conductors of signal and control circuits entering buildings shall comply with the following:

A. *Not With Electric Light or Power Conductors.* Underground conductors shall not be placed in a duct, handhole, or manhole containing electric light or power conductors, except in a section separated from such conductors by means of brick, concrete, or tile partitions.

B. *Underground Block Distribution.* Where the entire street circuit is run underground and the circuit within the block is so placed as to be free from liability of accidental contact with electric light or power circuits of over 250 volts, the insulation requirements of sub-paragraphs C-1 and C-4 of order 13-8021 shall not apply, the conductors need not be placed on insulating supports and no bushings shall be required where the conductors enter the building.

GROUNDING

Order 13-8031. Grounding.

Equipment shall be grounded as follows:

A. *Cable Sheath.* The metal sheath of aerial cables entering buildings and which are liable to contact with electric light or power conductors shall be grounded or shall be interrupted close to the entrance to the building by an insulating joint or equivalent device.

B. *Protector Ground.* The protector ground shall comply with the following:

1. Insulation. The grounding conductor shall have a 1/32 inch rubber insulation and shall be covered by a substantial fibrous cover-

ing. Conductors approved for the purpose having less than 1/32 inch rubber insulation or having other kinds of insulation may be used.

2. Size. The grounding conductor shall not be smaller than No. 18 copper.

3. Run in Straight Line. The grounding conductor shall be run in as straight a line as practicable to the grounding electrode.

4. Mechanical Injury Where necessary, the grounding conductor shall be guarded from mechanical injury.

5. Electrode. The grounding conductor shall preferably be connected to a water pipe electrode. In the absence of a water pipe, connection may be made to a continuous and extensive underground gas piping system, to an effectively grounded metallic structure, or to a ground rod or pipe driven into permanently damp earth. Steam or hot water pipes, or lightning rod conductors shall not be employed as electrodes for protectors. A driven rod or pipe used for grounding power circuits shall not be used for grounding signal and control circuits. The requirement for a separate driven electrode for signal and control circuits and for power supply circuit grounding does not prohibit bonding together such grounding electrodes where bonding seems desirable.

6. Electrode Connection. The grounding conductor shall be attached to a pipe electrode by means of a bolted clamp to which the conductor is soldered or otherwise connected in an effective manner. If a gas pipe electrode is used, connection shall be made between the gas meter and the street main. In every case the connection to the grounding electrode shall be made as close to the earth as practicable.

SECTION 13-810. RADIO EQUIPMENT

Order 13-8101. Scope.

This section shall apply to radio receiving equipment and to amateur radio transmitting equipment, but shall not apply to equipment and antennas used for coupling carrier current to power line conductors, or to police or emergency radio systems.

It is recommended that the authority enforcing this code be freely consulted as to the specific methods to be followed in any case of doubt relative to installation of antenna and counterpoise conductors and that the National Electrical Safety Code, Part 5, be followed.

Such additional requirements applying to outside line conductors as are found in Part 2 of the code must be observed.

Order 13-8102. Application of Other Sections.

Wiring from the source of power to and between devices connected to the interior wiring system shall comply with Chapters 1 to 4, inclusive, except as modified by orders 13-6403, 13-6404, and 13-6405. Wiring for radio-frequency and audio-frequency equipment and loud speakers shall comply with Section 13-640.

ANTENNA SYSTEMS—GENERAL

Order 13-8111. Material.

Antenna, counter-poise and lead-in conductors shall be of hard drawn copper, bronze, copper-clad steel or other high strength, corrosion resistant material. Soft drawn or medium drawn copper may be used for lead-in conductors where the maximum span between points of support is less than 35 feet.

Order 13-8112. Supports.

Outdoor antenna and counter-poise and lead-in conductors shall be securely supported. They shall not be attached to poles or similar structures carrying electric light or power wires or trolley wires of more than 250 volts. Insulators supporting the antenna or counter-poise conductors shall have sufficient mechanical strength to safely support the conductors. Lead-in conductors shall be securely attached to the antenna.

Order 13-8113. Avoidance of Contacts with Conductors of Other Systems.

Outdoor antenna, counter-poise and lead-in conductors from an antenna to a building shall not cross over electric light or power circuits and shall be kept well away from all such circuits so as to avoid the possibility of accidental contact. Where proximity to electric light and power service conductors of less than 250 volts cannot be avoided, the installation shall be such as to provide a clearance of at least two feet. It is recommended that antenna and counter-poise conductors be so installed as not to cross under electric light or power conductors.

Order 13-8114. Splices.

Splices and joints in antenna and counter-poise span shall be made with approved splicing devices or by such other means as will not appreciably weaken the conductors.

Soldering may ordinarily be expected to weaken the conductor. Therefore, when soldering is employed it should be independent of the mechanical support.

Order 13-8115. Indoor Antenna.

There are no requirements for indoor antennas except that they shall have the same clearance from the conductors of electric light and power circuits and signaling circuits as is required for lead-in conductors.

ANTENNA SYSTEMS—RECEIVING STATION

Order 13-8121. Size of Antenna and Counter-poise.

Outdoor antenna and counter-poise conductors for receiving stations shall be of a size not less than given in the following table;

Material	Minimum Size of Conductors When Maximum Open Span Length Is Less than 35 feet	35 feet to 150 feet	Over 150 feet
Hard-drawn copper	19	14	12
Copper-clad steel, bronze or other high strength material	20	17	14

For very long span lengths larger conductors will be required, depending on the length of the span and the ice and wind loading.

Order 13-8122. Size of Lead-In.

Lead-in conductors from outside antenna, and counter-poise for receiving stations, shall, for various maximum open span lengths, be of such size as to have a tensile strength at least as great as that of the conductors for antenna as specified in order 13-8121. When the lead-in consists of two or more conductors which are twisted together or are enclosed in the same covering or are concentric, the conductor size shall, for various maximum open span lengths, be such that the tensile strength of the combination will be at least as great as that of the conductors for antenna as specified in order 13-8121.

Order 13-8123. On Buildings.

Lead-in conductors attached to buildings shall be so installed that they cannot swing closer than two feet to the conductors of circuits of 250 volts or less or ten feet to the conductors of circuits of more than 250 volts, except in the case of circuits not exceeding 150 volts, if all conductors involved are supported so as to insure permanent separation, the clearance may be reduced but shall not be less than four inches. The clearance between lead-in conductors and any conductor forming a part of a lightning rod system shall be not less than six feet.

Order 13-8124. Electric Supply Circuits Used in Lieu of Antenna.

If an electric supply circuit is used in lieu of an antenna, the device by which the radio receiving set is connected to the supply circuit shall be specially approved for the purpose.

ANTENNA SYSTEM—TRANSMITTING STATIONS

Order 13-8131. Size of Antenna.

Antenna and counter-poise conductors for transmitting station shall be of a size not less than given in the following table:

Material	Minimum Size of Conductors When Maximum Open Span Length Is Less than 150 feet	Over 150 feet
Hard-drawn copper	14	10
Copper-clad steel, bronze or other high strength material	14	12

For very long span length larger conductors will be required, depending on the span length and the ice and wind loading.

Order 13-8132. Size of Lead-In Conductors.

Lead-in conductors for transmitting stations shall, for various maximum span lengths, be of a size at least as great as that of conductors for antenna as specified in order 13-8131.

Order 13-8133. Clearance on Buildings.

Antenna and counter-poise conductors for transmitting stations, attached to buildings, shall be firmly mounted at least 3 inches clear of the surface of the building on non-absorptive insulating supports, such as treated pins or brackets, equipped with insulators having not less than 3 inch creepage and air-gap distances for transmitters having a licensed power of 1000 watts or less. For transmitters having a licensed power of more than 1000 watts, the clearance from the building and the creepage and air-gap distances, shall be sufficiently increased to be safe. Lead-in conductors attached to buildings shall also conform to these requirements, except when they are enclosed in a continuous metallic shield which is permanently and effectively grounded. In this latter case the metallic shield may also be used as a conductor.

Order 13-8134. Entrance to Building.

Except where protected with a continuous metallic shield which is permanently and effectively grounded, lead-in conductors for transmitting station shall enter buildings by one of the following methods:

A. Through a rigid, non-combustible, non-absorptive insulating tube or bushing.

B. Through an opening provided for the purpose in which the entrance conductors are firmly secured so as to provide a clearance of at least 2 inches.

C. Through a drilled window pane.

PROTECTORS

Order 13-8141. Lightning Arresters—Receiving Stations.

Each conductor of a lead-in from an outdoor antenna shall be provided with a lightning arrester approved for the purpose, except where the lead-in conductors from antenna to entrance to building are protected by a continuous metallic shield which is permanently and effectively grounded. Lightning arresters shall be located outside the building, or inside the building between the point of entrance of the lead-in and the radio set or transformers, and as near as practicable to the entrance of the conductors to the building. The lightning arrester shall not be located near combustible material nor in a hazardous location.

Order 13-8142. Lightning Arresters—Transmitting Stations.

Except where protected by a continuous metallic shield which is permanently and effectively grounded, or the antenna is permanently and effectively grounded, each conductor of a lead-in for outdoor an-

tenna shall be provided with a lightning arrester or a grounding switch or other suitable means which will drain static charges from the an tenna system.

GROUNDING CONDUCTORS—GENERAL

Order 13-8151. Material.

The grounding conductor shall, unless otherwise specified, be of copper, copper-clad steel, bronze, or other corrosion-resistant material.

Order 13-8152. Insulation.

The grounding conductors may be uninsulated.

Order 13-8153. Supports.

The grounding conductors shall be securely fastened in place and may be directly attached to the surface wired over without the use of insulating supports.

Order 13-8154. Mechanical Protection.

The grounding conductor shall be protected where exposed to mechanical injury.

Order 13-8155. Run in Straight Line.

The grounding conductor shall be run in as straight a line as practicable from the equipment to the grounding electrode.

Order 13-8156. Ground Electrode.

The grounding conductor shall be connected to a grounding electrode as specified in orders 13-2581 and 13-2582 of Section 13-250.

GROUNDING CONDUCTORS—RECEIVING STATIONS

Order 13-8161. Inside or Outside Building.

The grounding conductor may be run either inside or outside the building.

Order 13-8162. Size of Protective Ground.

The protective grounding conductor for receiving stations shall be not smaller than No. 14 copper or No. 17 copper clad steel or bronze, provided that where wholly inside the building it shall not be smaller than No. 18.

Order 13-8163. Common Ground.

A single grounding conductor may be used for both protective and operating purposes.

If a single conductor is so used, the ground terminal of the equipment should be connected to the ground terminal of the protective device.

GROUNDING CONDUCTORS—TRANSMITTING STATIONS

Order 13-8171. Size of Protective Ground.

The protective ground conductor for transmitting stations shall be as large as the lead-in, but not smaller than No. 14 copper, bronze, or copper-clad steel.

Order 13-8172. Size of Operating Grounding Conductor.

The operating grounding conductor for transmitting stations shall be not less than No. 14 copper or its equivalent.

INTERIOR INSTALLATION—GENERAL

Order 13-8181. Clearance from Other Conductors.

Except as provided in Section 13-640, all conductors inside the building shall be separated at least 4 inches from the conductor of any other light or signal circuit unless separated therefrom by conduit or some firmly fixed non-conductor such as porcelain tubes or flexible tubing.

TRANSMITTING STATIONS

Order 13-8191. General.

Transmitters shall comply with the following:

A. *Enclosing.* The transmitter shall be enclosed in a metal frame or grille, or separated from the operating space by a barrier or other equivalent means, all metallic parts of which are effectually connected to ground.

B. *Grounding of Controls.* All external metallic handles and controls accessible to the operating personnel shall be effectually grounded.

No circuit in excess of 150 volts should have any parts exposed to direct contact. A complete deadfront type of switchboard is preferred.

C. *Interlocks on Doors.* All access doors shall be provided with interlocks which will disconnect all voltages in excess of 350 volts when any access door is opened.

D. *Audio-Amplifiers.* Audio-amplifiers which are located outside the transmitter housing shall be suitably housed and shall be so located as to be readily accessible and adequately ventilated.

Chapter 9. Construction Specifications

This chapter of the code describes the general characteristics of fittings, materials, and devices of the types commonly employed in installations for which provisions are given in other chapters of this code. It is intended as a guide to the classification and identification of types. Such details of construction as are included in this chapter are given as descriptive information and not as a complete basis for judgment of devices or materials.

The order numbers of this chapter are derived from the chapter number, the section number to which the order refers, and a serial number. In the order number 13-92401, the prefix (13) indicates Part 3; the figure (9) indicates the chapter number; the next three figures (240), indicates that the section refers to Section 13-240, Overcurrent Protection; and the last number (1), that this is the first item in this series. Cross references are therefore omitted as the group of three digits following the figure 9 indicates the section referred to.

CARTRIDGE FUSES AND FUSEHOLDERS

Order 13-92401. Dimensions.

Cartridge fuses and fuseholders shall conform to the dimensions shown in Table 34 of Chapter 10.

Order 13-92402. Terminals.

The terminals of standard cartridge fuses and fuseholders shall be of the ferrule type for ratings of 0-60 amperes, and of the knife-blade type for ratings of 61-600 amperes.

Order 13-92403. Marking.

Fuses shall be plainly marked with the ampere rating and the name or trade-mark of the maker, and the voltage for which the fuse is designed shall be provided on a paper label which shall be navy blue for 250-volt fuses rated at 15 amperes or less, green for 250-volt fuses rated at more than 15 amperes, and red for 600-volt fuses.

LINK FUSES AND FUSEHOLDERS

Order 13-92405. Dimensions.

Link fuses and fuseholders shall have the following dimensions in inches:

Amperes Capacity	Minimum Separation of Nearest Metal Parts of Opposite Polarity	Minimum Break Distance
Not over 125 volts—600-1500	1½	1½
Not over 250 volts—600-1500	2¾	2

For 3-wire systems, link fuses, and fuseholders shall have the break distance required for circuits of the potential of the outside wires, except that in 125-250-volt systems with grounded neutral the fuses and fuseholders in 2-wire, 125-volt branch circuits may have the spacing specified for not over 125 volts.

Order 13-92406. Spacing.

A space shall be maintained between the fuse terminals of link fuses of the same polarity of at least ½ inch for voltages up to 125, and of at least ¾ inch for voltages from 126 to 250. This is the minimum distance allowable and greater separation shall be provided if practicable.

Order 13-92407. Marking.

Link fuses shall be stamped with 80 per cent of the maximum current which they can carry indefinitely.

Order 13-92408. Material.

Contact surfaces or tops of link fuses shall be of copper or aluminum having good electrical connections with the fusible part of the strip.

CONDUCTORS

Order 13-93001. General.

Insulated conductors shall conform to the following:

A. *Marking.* Wires, cables and cords of all kinds except weatherproof and paper-insulated wire shall have a continuous distinctive marking so that their maker may be readily identified. All wires, cables and cords shall also be plainly tagged or marked as follows:

1. The maximum working voltage for which the wire was tested or approved. This may be omitted for slow-burning, slow-burning weatherproof, weatherproof and asbestos-covered switchboard wires.

2. Name of the manufacturing company, and if desired, trade name of the wire.

3. Month and year when manufactured. This may be omitted for slow-burning, slow-burning weatherproof, and weatherproof wires.

4. The proper type letter for the particular style of wire or cable as given in the following sections.

B. *Classification.* In addition to the type letters specified in the table in sub-paragraph D of this order, the following letters shall apply:

1. A type letter or letters used alone indicates a single insulated conductor.

2. D. The Letter "D" used as a suffix indicates a twin wire with two insulated conductors laid parallel under an outer fibrous covering.

3. M. The letter "M" used as a suffix indicates an assembly of two or more insulated conductors twisted together under an outer fibrous covering.

4. L. The letter "L" used as a suffix indicates an outer covering of lead.

5. Voltage. Type letters, when used alone, indicate conductors for use at not more than 600 volts. Conductors for use at higher voltages shall be indicated by adding numerical suffixes to the type letters as follows:

10—for use at not more than 1000 volts.
20—for use at not more than 2000 volts.
30—for use at not more than 3000 volts.
40—for use at not more than 4000 volts.
50—for use at not more than 5000 volts.

The working voltages referred to in the tables are the operating voltages between phases of single and two-phase systems, and three-phase systems with grounded or ungrounded neutral.

6. Label. All standard rubber-covered conductors shall be examined and tested at the factory and, if approved, shall be labeled before shipment.

C. *Identified Conductors.* Single insulated conductors of No. 6 or smaller, intended for use as identified conductors of circuits, except conductors of the weatherproof type (type WP and SBW), shall have an outer identification of a white or natural gray color. Twin and twisted-pair conductors and three-conductor cables shall have one conductor, and four-conductor cables shall have at least one conductor identified in this manner.

Wires having their outer covering finished to show a white or natural gray color but having colored tracer threads in the braid, identifying the source of manufacture, are considered as meeting the provisions of this paragraph.

1. Single conductors, intended for use as unidentified conductors, and conductors other than the identified conductor in multi-conductor cables, shall be finished to show a color or combination of colors other than, and contrasting with, white or natural gray. For identification requirements for conductors larger than No. 6 see sub-paragraph B of order 13-2005.

D. *Conductor Construction.* Insulated conductors for use at 600 volts or less shall conform to the provisions of the following tables:

Conductor Insulations—600 Volts

Trade Name	Type Letter	Maximum Operating Temperature	Insulation	Thickness of Insulation	Outer Covering	Use
Code	R	50C (122F)	Code Grade Rubber	14-10 .....3/64 8-2 .....4/64 1-4/0 .....5/64 250-500 .....6/64 501-1000 .....7/64 Over 1000 .....8/64	Moisture-Resistant Flame-Retardant Fibrous Covering	General Use
Moisture Resistant	RW	50C (122F)	Moisture Resistant Rubber	Same as Type R	Moisture-Resistant Flame-Retardant Fibrous Covering	General Use or in Wet Locations. See Order 13-8035
Performance	RP	60C (140F)	Performance Grade Rubber	Same as Type R	Moisture-Resistant Flame-Retardant Fibrous Covering	General Use
Heat-Resistant	RH	75C (167F)	Heat-Resistant Grade Rubber	Same as Type R	Moisture-Resistant Flame-Retardant Fibrous Covering	General Use
Small Diameter Building Wire (Heat-Resistant)	RHT	75C (167F)	Heat-Resistant Grade Rubber	14-10 .....2/64 8 .....3/64	Moisture-Resistant Flame-Retardant Fibrous Covering	General Use See 13-3005-D
Small Diameter Building Wire (Performance)	RPT	60C (140F)	Performance Grade Rubber	14-10 .....2/64	Moisture-Resistant Flame-Retardant Fibrous Covering	Rewiring Existing Raceways See 13-3005-E
Type RU Wire (See Note)	RU	60C (140F)	90 Per Cent Unmilled Grainless Rubber	14-10 .....18 Mils	Moisture-Resistant Flame-Retardant Fibrous Covering	Rewiring Existing Raceways See 13-3005-E
Solid Synthetic (See Note)	SN	60C (140F)	Solid Flame-Retardant Moisture-Resistant Synthetic Compound	14-10 .....2/64 8 .....3/64 6-2 .....4/64 1-4/0 .....5/64	None	Rewiring Existing Raceways See 13-3005-E
Asbestos Synthetic	SNA	90C 194F)	Synthetic and Felted Asbestos	14-8 ..... Synthetic .....20 Mils Asbestos .....20 Mils	Cotton Braid Thickness, 20 Mils	Switchboard Wiring
Varnished Cambric	V	85C (185F)	Varnished Cambric	Same as Type R Except 8 .....3/64	Fibrous Covering or Lead Sheath	Dry Locations Only Unless Lead Sheathed. Smaller than No. 6 by Special permission.
Asbestos Varnished Cambric	AVA	110C (230F)	Impregnated Asbestos and Varnished Cambric	14-8 Sol .....45 Mils 6-2 Sol .....65 Mils 1-4/0 Sol .....75 Mils 14-2 Str .....60 Mils 1-4/0 Str. .....80 Mils 250-1000 Str.....110 Mils	Asbestos Braid Braid .....45 Mils	General Use Dry Locations

Conductor Insulations—600 Volts (Continued)

Trade Name	Type Letter	Maximum Operating Temperature	Insulation	Thickness of Insulation	Outer Covering	Use
Asbestos Varnished Cambric	AVB	90C (194F)	Same as Type AVA	14-8 Sol .....50 Mils 6-4/0 Sol .....80 Mils 14-2 Str .....60 Mils 1-4/0 Str .....80 Mils 250-1000 Str .....110 Mils	Flame Retardant Cotton Braid 14-250 .....20 Mils 300-1000 .....26 Mils	General Use Dry Locations
Asbestos Varnished Cambric	AVL	110C (230F)	Same as Type AVA	Solid or Stranded 14-2 .....75 Mils 1-4/0 .....80 Mils 250-1000 .....110 Mils	Lead Sheath 14-3 .....3/64 in. 2-4/0 .....4/64 in. 250-500 .....5/64 in. 550-1000 .....6/64 in.	General Use Wet Locations
Asbestos	A	200C (392F)	Felted Asbestos	14-8 .....40 Mils 6-2 .....60 Mils 1-4/0 .....90 Mils 250-1000 .....120 Mils	With or Without Asbestos Braid Braid .....45 Mils	Dry Locations Only. Not for General Conduit Installation. In Raceways, only as Leads to or within apparatus. If without Braid or Moisture-resistant Treatment, Limited to 300 Volts.
Impregnated Asbestos	AI	125C (257F)	Impregnated Felted Asbestos	Same as Type A	With or Without Impregnated Asbestos Braid Braid .....45 Mils	As Permitted by 2304-B, or by Special Permission
Paper		85C (185F)	Paper		Lead Sheath	For Use Only in Dry Locations Where the Room Temperature Exceeds 85C (185F)
Slow Burning	SB	90C (194F)	3 Braids Impregnated Fire-Retardant Thread	Same as Type V	Outer Cover Finished Smooth and Hard	For Use Only in Dry Locations Where the Room Temperature Exceeds 85C (185F)
Slow Burning Weatherproof	SBW	90C (194F)	2 Layers Impregnated Cotton Thread	Same as Type V	Outer Fire-Retardant Coating	
Weatherproof	WP	80C (176F)	At Least Three Cotton Braids or Equivalent Impregnated			May be used for Interior Wiring Only by Special Permission.

Rubber-covered conductors of the lead-sheathed or multiple-conductor type do not require a flame-retardant, moisture-resistant outer covering over the individual conductors, but all such conductors shall have a fibrous covering. For armored cables see order 13-93341. For non-metallic sheathed cable, see order 13-93361.
Finished conductors of Type RPT and Type RU shall be equivalent mechanically and electrically to Type R conductor.
Synthetic insulation may stiffen at temperatures below freezing and care should be used in its installation at these temperatures.

E. *Insulation Thickness—Over 600 Volts.* The thickness of insulation for conductors for use at over 600 volts shall conform to the following:

Thicknesses of Rubber Insulation for Rubber-Covered Wires and Cables, In 64ths of an Inch.

Conductor Size AWG or MCM	Classification R10	R20	R30	R40	R50
14-9	4	5	7	9	10
8	4	5	7	9	10
7-2	5	6	8	9	10
1-4/0	6	7	8	9	10
213-500	7	8	9	10	11
501-1000	8	9	9	10	11
Over 1000	9	9	10	11	12

Thicknesses of Varnished-Cambric and Filler, Single-Conductor Cable, in 64ths of an Inch.

Conductor Size AWG or MCM	For Voltages Not Exceeding 1000	2000	3000	4000	5000
14	4	..	..	..	..
12	4	5	..	..	..
10	4	5	6	..	..
8	4	5	6	7	9
7-2	4	5	6	7	9
1-4/0	5	6	6	7	9
213-500	6	6	7	8	10
501-1000	7	7	7	8	10
Over 1000	8	8	8	9	10

Thicknesses of Varnished-Cambric and Filler, Multiple-Conductor Cable, in 64ths of an Inch.

Conductor Size AWG or MCM	For Voltages Not Exceeding 1000 C	B	2000 C	B	3000 C	B	4000 C	B	5000 C	B
14	4	0	..	..	..	..	..	..	..	..
12	4	0	5	0	..	..	..	..	..	..
10	4	0	5	0	5	2	..	..	..	..
8	4	0	5	0	5	2	6	3	6	4
7-2	4	0	5	0	5	2	6	3	6	4
1-4/0	5	0	6	0	6	2	6	3	6	4
213-500	6	0	6	0	6	2	6	3	7	4
501-1000	6	2	6	2	6	3	6	4	7	4
Over 1000	7	2	7	2	7	3	7	4	7	5

The thicknesses given in columns headed "C" are for the insulation on the individual conductors. Those given in the columns headed "B" are for the thickness of the overall belt of insulation.

ARMORED CABLE, TYPES AC AND ACL

Order 13-93341. General.

Armored cable for 600 volts or less shall conform to the following:

A. *Conductors.* The conductors shall comply with the requirements for rubber-covered conductors. The individual conductors, except those of lead-covered cable, shall have a fibrous covering for their entire length so treated as to be flame-retardant and moisture-resistant.

B. *Marking.* The cable shall carry distinctive markers throughout its entire length, both in the conductors and the armor, so that their makers may be readily identified.

NON-METALLIC SHEATHED CABLE

Order 13-93361. General.

Non-metallic sheathed cable shall conform to the following:

A. *Conductors.* The conductors shall comply with the requirements for rubber-covered conductors, except that no braid need be provided directly over the rubber covering.

B. *Number and Type of Conductors.* Cable shall be approved type, in sizes Nos. 14 to 4, inclusive, and in addition to the insulated conductors may have an approved size of uninsulated copper conductor for grounding purposes only.

C. *Marking.* The cable shall have a continuous distinctive marking so that the maker may be readily identified.

RIGID METAL CONDUIT

Order 13-93461. General.

Rigid conduit as shipped shall be in standard lengths of 10 feet including coupling, one coupling to be furnished with each length. Each length shall be reamed and threaded on each end. Steel conduit shall have an interior coating of a character and appearance, and non-ferrous conduit of corrosion-resistant material shall have suitable markings, so as to readily distinguish them from ordinary pipe commonly used for other than electrical purposes.

Conduit Sizes and Weights

Stand. Pipe Size Inches	Nominal Diameter, Inches Inside	Outside	Threads Per Inch	Minimum Wt. Lbs. of Ten 10-foot Lengths of Finished Conduit with Couplings Attached
½	.622	.840	14	79.0
¾	.824	1.050	14	105.0
1	1.049	1.315	11½	153.0
1¼	1.380	1.660	11½	201.0
1½	1.610	1.900	11½	249.0
2	2.067	2.375	11½	334.0
2½	2.469	2.875	8	527.0
3	3.068	3.500	8	690.0
3½	3.548	4.000	8	831.0
4	4.026	4.500	8	982.0
4½	4.506	5.000	8	1150.0
5	5.047	5.563	8	1344.0
6	6.065	6.625	8	1770.0

ELECTRICAL METALLIC TUBING

Order 13-93481. General.

The tubing, and elbows and bends for use with the tubing, shall have a circular cross-section and shall have such a finish or treatment of outer surfaces as will provide an approved permanent means of readily distinguishing it, when installed, from rigid conduit.

SURFACE METAL RACEWAY

Order 13-93521. General.

Surface metal raceways shall be of such construction as will distinguish them from other raceways. Metal raceways and their elbows, couplings and similar fittings shall be so designed that the sections can be electrically and mechanically coupled together, while protecting the wires from abrasion. Holes for screws or bolts inside the raceway shall be so designed that when screws or bolts are in place their heads will be flush with the metal surface.

CELLULAR METAL FLOOR RACEWAYS

Order 13-93561. General.

Cellular metal floor raceways shall be so constructed that adequate electrical and mechanical continuity of the complete system will be secured. They shall provide a complete enclosure for the conductors. The interior surfaces shall be free from burrs and sharp edges, and surfaces over which conductors are drawn shall be smooth. Suitable bushings or fittings having smooth rounded edges shall be provided where conductors pass.

BOXES AND FITTINGS

Order 13-93701. Outlet, Switch and Junction Boxes and Fittings.

Outlet, switch and junction boxes and fittings, if of metal, shall conform to the following:

A. *Corrosion-Resistant.* Boxes and fittings, if of metal, unless of corrosion-resistant metal shall be well-galvanized, enameled, or otherwise properly coated, inside and out, to prevent corrosion.

See Order 13-3717 for limitation in the use of boxes and fittings protected from corrosion solely by enamel.

It is recommended that the protective coating be of conductive material, such as cadmium, tin or zinc, in order to secure better electrical contact.

B. *Thickness of Metal.* For boxes and fittings not over 100 cubic inches in size, if constructed of sheet steel, the metal shall not be less than No. 14 USS gauge (.0747 in.) in thickness, or if of cast metal shall have a wall thickness of not less than ⅛ inch, except that if of malleable iron, they shall have a wall thickness of not less than 3/32 inch.

C. *Boxes Over 100 Cubic Inches.* Boxes of over 100 cubic inches in size shall be composed of metal and shall conform to the requirements for cabinets and cutout boxes, except that the covers may consist of single flat sheets secured to the box proper by screws, or bolts instead of hinges. Boxes having covers of this form are for use only for enclosing joints in conductors or to facilitate the drawing in of wires and cables. They are not intended to enclose switches, cutouts or other control devices.

Order 13-93702. Covers.

Covers of boxes and fittings shall be of a thickness at least that specified for the walls of boxes of the same material as that used for the cover and of the size under consideration, or shall be lined with firmly attached insulating material not less than 1/32 inch in thickness. Covers of porcelain or other approved insulating material may be used if of such form and thickness as to afford the requisite protection and strength.

Order 13-93703. Bushings.

Covers of outlet boxes and outlet fittings having holes through which flexible cord pendants may pass, shall be provided with approved bushings or shall have smooth, well-rounded surfaces, upon which the cord may bear. If conductors other than flexible cord may pass through a metal cover, there shall be provided a separate hole for each wire, said hole being equipped with a bushing of suitable insulating material.

Order 13-93704. Non-Metallic Boxes.

Provisions for supports, or other mounting means, for non-metallic boxes, shall be outside of the box, or the box shall be so constructed as to prevent contact between the conductors in the box and the supporting screws.

CABINETS AND CUTOUT BOXES

Order 13-93705. Material.

Cabinets and cutout boxes shall conform to the following:

A. *Metal Cabinets and Boxes.* Metal cabinets and cutout boxes shall be well galvanized, plated with cadmium or other approved metallic finish, enameled, or otherwise properly coated, inside and out, to prevent corrosion.

It is recommended that the protective coating be of conductive material, such as cadmium, tin or zinc, in order to secure better electrical contact.

B. *Strength.* The design and construction of cabinets and cutout boxes shall be such as to secure ample strength and rigidity. If constructed of sheet steel, the metal shall be of not less than No. 16 USS gauge (0.598 inch) in thickness.

C. *Composition Cabinets.* Composition cabinets shall be submitted for approval prior to installation.

Order 13-93706. Spacing.

The spacing within cabinets and cutout boxes shall conform to the following:

A. *General.* The spacing within cabinets and cutout boxes shall be sufficient to provide ample room for the distribution of wires and cables placed in them, and for a separation between metal parts of devices and apparatus mounted within them as follows:

1. Base. There shall be an air space of at least 1/16 inch, except at points of support, between the base of the device and the wall of any metal cabinet or cutout box, on which the device is mounted.

2. Doors—General. There shall be an air space of at least 1 inch between any live metal part (including live metal parts of enclosed fuses) and the door, unless the door is lined with an approved insulating material or is of a thickness of metal not less than No. 12 USS gauge (.1046 inch), when the air space shall be not less than ½ inch.

3. Doors—Link Fuses. There shall be a space of at least 2 inches between open link fuses and metal-lined walls or metal, metal-lined or glass-paneled doors.

4. Live Parts. Except as noted above, there shall be an air space of at least ½ inch between the walls, back, gutter partition, if of metal, or door of any cabinet or cutout box and the nearest exposed current-carrying part of devices mounted within the cabinet if the potentials do not exceed 250 volts. This spacing shall be increased to at least one inch if the potentials exceed 250 volts.

B. *Switch Clearance.* Cabinets and cutout boxes shall be deep enough to allow the closing of the doors when 30-ampere branch-circuit panelboard switches are in any position, or when combination cutout switches are in any position, or when other single-throw switches are opened as far as their construction will permit.

C. *Wiring Space—When Required.* Cabinets and cutout boxes which contain devices or apparatus connected within the cabinet or box to more than 8 conductors, including those of branch circuits, meter loops, sub-feeder circuits, power circuits and similar circuits, but not including the supply circuit or a continuation thereof, shall have back wiring spaces or one or more side wiring spaces, side gutters or wiring compartments.

D. *Wiring Space—Enclosure.* Side wiring spaces, side gutters or side wiring compartments of cabinets and cutout boxes shall be rendered tight enclosures by means of covers, barriers or partitions extending from the bases of the devices, contained in the cabinet, to the door, frame, or sides of the cabinet; provided, however, that where the enclosure contains only those conductors which are led from the cabinet at points directly opposite their terminal connections to devices within the cabinet, such covers, barriers or partitions may be omitted. Partially enclosed back wiring spaces shall be provided with covers to complete enclosure. Wiring spaces that are required by paragraph (C) of this order and which are exposed when doors are open, shall be provided with covers to complete the enclosure.

SWITCHES

Order 13-93801. Marking.

Switches shall be marked with the current and voltage for which they are designed.

Order 13-93803. 600-Volt Knife Switches.

Auxiliary contacts of a renewable or quick-break type or the equivalent, shall be provided on all 600-volt knife switches designed for use in breaking currents over 200 amperes.

It is recommended that such auxiliary contacts be provided on all direct-current switches rated at over 250 volts.

Order 13-93804. Multiple Fuses.

Switches rated above 600 amperes, and therefore exceeding the rating of standard cartridge enclosed fuses, may be arranged for fuses in multiple provided as few fuses as possible are used and the fuses are of the same type and rating and are so mounted as to eliminate a potential difference between the terminals of the fuses.

SWITCHBOARDS AND PANELBOARDS

Order 13-93841. Panels.

The panels of switchboards shall be made of moisture-resistant, noncombustible material.

Order 13-93842. Bus-bars.

Bus-bars, if rigidly mounted, may be of bare metal.

Order 13-93843. Protection of Instrument Circuits.

Instruments, pilot lights, potential transformers, and other switchboard devices with potential coils, except where the operation of the overcurrent device might introduce a hazard in the operation of devices, shall be supplied by a circuit that is protected by standard overcurrent devices of a rating not greater than 15 amperes, except that for ratings of 2 amperes or less special types of enclosed fuses may be used.

Order 13-93844. Component Parts.

Switches, fuses, and fuseholders used on panelboards shall conform to the requirements of Sections 13-240 and 13-380 so far as they apply.

Order 13-93845. Branch-Circuit Switches.

Branch-circuit switches shall be so arranged that the blades, if exposed during operation, will be dead when the switches are open.

Order 13-93846. Color-Coding.

If switchboards or panelboards are provided with color markings to indicate the main bus-bars to which branch circuit bus-bars are connected, the colors shall conform to the color coding of order 13-2104.

Order 13-93847. Spacings.

Except at switches and circuit-breakers, at least the following distance between bare metal parts, bus-bars, etc., shall be maintained.

	Opposite Polarity When Mounted on the Same Surface	Opposite Polarity When Held Free in Air	*Live Parts to Ground
Not over 125 volts	¾ inch	½ inch	½ inch
Not over 250 volts	1¼ inch	¾ inch	½ inch
Not over 600 volts	2 inches	1 inch	1 inch

At switches, enclosed fuses, etc., parts of the same polarity may be placed as close together as convenience in handling will allow, unless close proximity causes excessive heating.

*For spacing between live parts and doors of cabinets, see sub-paragraph A of order 13-93706.

It should be noted that the above distances are the minimum allowable, and it is recommended that greater distances be adopted wherever the conditions will permit.

FLEXIBLE CORDS

Order 13-94001. General.

Flexible cords shall conform to the following:

A. *Rubber Covering—Required.* The individual conductors of all cords except those for heat-resistant cord (Types AFC, AFPO, AFPD, AFS, AFSJ, AVPO, AVPD, CFC, CFPO and CFPD) shall have a rubber covering, except that in Type S cord one conductor intended for use as a grounding conductor may be without individual insulation. The rubber compound shall be vulcanized except for asbestos-covered tinsel cord (Types AT and ATJ) and heater cord (Types HC, HSJ and HPD).

B. *Rubber Covering—Thickness.* The thickness of the rubber covering shall be not less than 1/64 inch for Types AT, ATJ, CT, CTJ, P-64, PO-64, POSJ-64, PWP-64, HC, HSJ and HPD. For other types the nominal thickness of the rubber covering shall be as given in the following table:

Wire size Awg.	Thickness Inch
18 and 16	1/32
14 to 10	3/64
8	1/16

FIXTURES, LAMPHOLDERS, RECEPTACLES AND ROSETTES

Order 13-94100. Design and Material.

Fixtures shall be constructed of metal, wood, or other approved material and shall be so designed and assembled as to secure requisite mechanical strength and rigidity. Wireways, including the entrances thereto, shall be such that conductors may be drawn in and withdrawn without injury.

Order 13-94101. Fixtures.

Fixtures shall conform to the following:

A. *Material Other Than Metal.* In all fixtures not made entirely of metal, wireways shall be lined with metal unless approved armored or lead-covered conductors with suitable fittings are used. (This requirement shall not apply to portable table or floor lamps, nor to wireways in glass, marble, or similar non-absorptive insulating materials.)

B. *Mechanical Strength.* Tubing used for arms and stems where provided with cut threads shall be not less than 0.040 inch in thickness and when provided with rolled (pressed) threads shall be not less than 0.025 in thickness. Arms and other parts shall be fastened to prevent turning. Metal canopies supporting lampholders, shades, etc., exceeding 8 lbs., or incorporating attachment plug receptacles, shall be not less than 0.020 inch in thickness. Other canopies shall be not less than 0.016 inch when made of steel and not less than 0.020 inch when of other metals. Pull type canopy switches shall not be inserted in the rims of metal canopies which are less than 0.025 inch in thickness unless the rims are reinforced by the turning of a bead or the equivalent. Pull type canopy switches, whether mounted in the rims or elsewhere in sheet metal canopies, shall be located not more than 3½ inches from the center of the canopy. Double set screws, double canopy rings, a screw ring, or equal method shall be used where the canopy supports a pull type switch or pendent receptacle.

The above thickness requirements apply to measurements made on finished (formed) canopies.

C. *Wiring Space.* Bodies of fixtures, including portable lamps, shall provide ample space for splices and taps and for the installation of devices, if any.

D. *Fixture Studs.* Fixture studs which are not parts of outlet boxes, hickeys, tripods, and crowfeet shall be made of steel, malleable iron, or other approved material.

E. *Insulating Joints.* Insulating joints shall be composed of materials especially approved for the purpose. Those which are not designed to be mounted with screws or bolts shall have a substantial exterior metal casing, insulated from both screw connections.

F. *Portables.* Portable table and floor lamps and fan motors on ceiling fixtures may be wired with approved rubber-covered conductors, provided the wiring is not located so as to be subject to undue heating from lamps.

G. *Cord Bushings.* Bushing or the equivalent shall be provided where flexible cord enters the base or stem of a portable lamp. The bushing shall be of insulating material unless a jacketed type of cord is used.

H. *Tests.* All wiring shall be free from short-circuits and grounds, and shall be tested for these defects prior to being connected to the circuit.

Order 13-94102. Flush and Recessed Fixtures.

Flush and recessed fixtures shall conform to the following:

A. *Temperature.* Fixtures shall be so constructed that adjacent combustible material will not be subject to temperatures in excess of 90C (194F).

B. *Enclosure.* Enclosures of sheet steel shall be not less than No. 22 USS gauge (.0299 inch) and shall be protected against corrosion by galvanizing, plating, or an equivalent heat-resisting coating.

C. *Lamp Stops.* Where enclosures are of a size which permits the use of lamps which will permit the temperature limits specified in sub-paragraph A to be exceeded, lamp stops shall be provided to prevent the use of excess size lamps.

D. *Use of Solder Prohibited.* No solder shall be used in the construction of the fixture box.

E. *Lampholders.* Lampholders shall be of porcelain. Cements, where used, shall be of the high-heat type.

F. *Conductor Insulation.* Conductor insulation shall be of a type conforming to the temperature limitations of order 13-3005.

LAMPHOLDERS

Order 13-94104. General.

Lampholders shall conform to the following:

A. *Insulation.* The outer metal shell and the cap shall be lined with insulating material which shall prevent the shell and cap from becoming a part of the circuit. The lining shall not extend beyond the metal shell more than ⅛ inch, but shall prevent any current-carrying part of the lamp base from being exposed when a lamp is in the lamp-holding device.

B. *Lead Wires.* Lead wires, furnished as a part of weatherproof lampholders and intended to be exposed after installation, shall be of approved, stranded, rubber-covered conductors, not less than No. 14 gauge (No. 18 gauge for candelabra sockets), and shall be sealed in place or otherwise made raintight.

C. *Switched Lampholders.* Switched lampholders shall be of such construction that the switching mechanism interrupts the electrical connection to the center contact. The switching mechanism may also interrupt the electrical connection to the screw shell if connection to the center contact is simultaneously interrupted.

ROSETTES

Order 13-94108. Rosettes.

Rosettes shall conform to the following:

A. *Rating.* Rosettes shall be rated at 660 watts, 250 volts, with a maximum current rating of 6 amperes.

B. *For Exposed Wiring.* If designed for use with exposed wiring, rosettes shall be provided with bases which shall have at least two holes for supporting screws, shall be high enough to keep the wires and

terminals at least ½ inch from the surface wired over, and shall have a porcelain lug under each terminal to prevent the rosette being placed over projections which would reduce the separation to less than ½ inch.

C. *For Use With Boxes or Raceways.* If designed for use with conduit boxes or wire raceways, rosette bases shall be high enough to keep wires and terminals at least ⅜ inch from the surface wired over.

INCANDESCENT LAMPS

Order 13-94201. Bases.

Incandescent lamps shall not be equipped with medium bases if above 300 watts rating, nor with mogul bases if above 1500 watts. Above 1500 watts special approved bases or other devices shall be used.

MERCURY-VAPOR LAMPS

Order 13-94205. Enclosure of Resistors and Regulators.

Resistors or regulators for mercury-vapor lamps shall be enclosed in non-combustible cases and treated as sources of heat.

MOTORS AND CONTROLLERS

Order 13-94301. Bushings.

Soft-rubber bushings may be used to protect lead wires where they pass through the frame of a motor, but only where they will not be exposed to oils, grease, oily vapors, or other substances having a deleterious effect on rubber.

Order 13-94302. Auto-Transformer—Design.

An auto-transformer starter shall provide an off position, a running position, and at least one starting position. It shall be so designed that it cannot rest in the starting position, or in any position, which will render inoperative the overcurrent protective device in the circuit.

Order 13-94303. Rheostats.

Rheostats shall conform to the following:

A. *Internal Connections.* Motor-starting rheostats shall be so designed that the contact arm cannot be left on intermediate segments. The point or plate on which the arm rests when in the starting position shall have no electrical connection with the resistor.

B. *Under-voltage Release.* Motor-starting rheostats for direct-current motors shall be equipped with automatic devices which will interrupt the supply before the speed of the motor has fallen to less than one-third its normal value.

Order 13-94304. Identifying Code Letters.

Code letters marked on motor name-plates to show motor input with locked rotor shall be in accordance with the following table:

Code Letter	Kilovolt-Amperes per Horsepower, with Locked Rotor	Code Letter	Kilovolt-Amperes per Horsepower, with Locked Rotor
A	0— 3.14	J	7.1 — 7.99
B	3.15— 3.54	K	8.0 — 8.99
C	3.55— 3.99	L	9.0 — 9.99
D	4.0 — 4.49	M	10.0 —11.19
E	4.5 — 4.99	N	11.2 —12.49
F	5.0 — 5.59	P	12.5 —13.99
G	5.6 — 6.29	R	14.0 —and up
H	6.3 — 7.09		

The above table is an adopted standard of the National Electrical Manufacturers Association.

GENERATORS

Order 13-94451. Bushings.

Soft-rubber bushings may be used to protect lead wires where they pass through the frame of generators, but only where they will not be exposed to oils, grease, oily vapors, or other substances having a deleterious effect on rubber.

CAPACITORS

Order 13-94601. Cases and Supports.

Capacitors shall be provided with non-combustible cases and supports.

RESISTORS AND REACTORS

Order 13-94701. Contacts.

Fixed and movable contacts shall be so designed that arcing will be kept at a minimum.

Order 13-94702. Materials.

Reactors shall be composed of non-combustible materials, and shall be mounted on non-combustible bases.

Chapter 10—Tables, Diagrams, Examples

TABLE 1

Allowable Current-Carrying Capacities of Conductors in Amperes

NOT MORE THAN THREE CONDUCTORS IN RACEWAY OR CABLE

(Based on Room Temperature of 30° C. 86° F.)

Size AWG MCM	Rubber Type RW Type R	Synthetic Type SN / Type RU / Rubber Type RPT Type RP	Rubber Type RHT Type RH	Paper / Synthetic Type SNA / Asbestos Var-Cam Type AVB / Var-Cam Type V	Asbestos Var-Cam Type AVA Type AVL	Impregnated Asbestos Type AI	Asbestos Type A
14	15	18	22	23	28	29	32
12	20	23	27	29	36	38	42
10	25	31	37	38	47	49	54
8	35	41	49	50	60	63	71
6	45	54	65	68	80	85	95
5	52	63	75	78	94	99	110
4	60	72	86	88	107	114	122
3	69	83	99	104	121	131	145
2	80	96	115	118	137	147	163
1	91	110	131	138	161	172	188
0	105	127	151	157	190	202	223
00	120	145	173	184	217	230	249
000	138	166	199	209	243	265	284
0000	160	193	230	237	275	308	340
250	177	213	255	272	315	334	372
300	198	238	285	299	347	380	415
350	216	260	311	325	392	419	462
400	233	281	336	361	418	450	488
500	265	319	382	404	468	498	554
600	293	353	422	453	525	543	612
700	320	385	461	488	562	598	668
750	330	398	475	502	582	621	690
800	340	410	490	514	600	641	720
900	360	434	519	556	----	----	----
1,000	377	455	543	583	681	730	811
1,250	409	493	589	643	----	----	----
1,500	434	522	625	698	784	----	----
1,750	451	544	650	733	----	----	----
2,000	463	558	666	774	839	----	----

CORRECTION FACTOR FOR ROOM TEMPERATURES OVER 30° C.

C. F.							
40 104	.71	.82	.88	.90	.94	.95	----
45 113	.50	.71	.82	----	----	----	----
50 122	.00	.58	.75	.80	.87	.89	----
55 131	----	.41	.67	----	----	----	----
60 140	----	.00	.58	.67	.79	.83	.97
70 158	----	----	.35	.52	.71	.76	.93
75 167	----	----	.00	----	----	----	----
80 176	----	----	----	.30	.61	.69	.89
90 194	----	----	----	----	.50	.61	.86
100 212	----	----	----	----	----	.51	.82
120 248	----	----	----	----	----	----	.72
140 284	----	----	----	----	----	----	.63

See Notes following Tables 1 and 2.

1. During the war emergency and for a period of 6 months thereafter, unless otherwise amended or repealed, the current carrying capacities of rubber covered wire shall be the same as the allowable carrying capacities specified in Column A, Table 1, Order 1306.12 of the 1934 (Fourth Edition) Wisconsin State Electrical Code; and for asbestos, varnished cambric, types AVA, AVB, and AVL, varnished cambric type V, the allowable current carrying capacities for sizes above 300,000 c.m. shall be increased in accordance with column B, Table 1, Order 1306.12 of the 1934 Wisconsin State Electrical Code.

TABLE 2

Allowable Current-Carrying Capacities of Conductors in Amperes

SINGLE CONDUCTOR IN FREE AIR

(Based on Room Temperature of 30° C. 86° F.)

Size AWG or MCM	Rubber Type R	Rubber Type RP	Rubber Type RHT Type RH	Synthetic Type SNA / Asbestos Var-Cam Type AVB / Var-Cam Type V	Asbestos Var-Cam Type AVA	Impregnated Asbestos Type AI	Asbestos Type A	Slow-burning Type SB / Weather-proof Type W Type SBW
14	20	24	29	30	39	40	43	30
12	26	31	37	40	51	52	57	39
10	35	42	50	54	65	69	75	54
8	48	58	69	71	85	91	100	71
6	65	78	94	99	119	126	134	98
5	76	92	110	115	136	145	158	----
4	87	105	125	133	158	169	180	130
3	101	122	146	155	182	194	211	152
2	118	142	170	179	211	226	241	176
1	136	164	196	211	247	264	280	203
0	160	193	230	245	287	306	325	237
00	185	223	267	284	331	354	372	274
000	215	259	310	330	384	410	429	318
0000	248	298	358	383	446	476	510	368
250	280	338	403	427	495	528	562	410
300	310	373	446	480	555	592	632	460
350	350	421	504	529	612	653	698	508
400	380	457	547	575	665	710	755	554
500	430	517	620	660	765	814	870	629
600	480	577	691	738	857	912	970	709
700	525	632	756	813	942	1003	1065	779
750	545	655	785	846	981	1044	1118	811
800	565	680	815	879	1020	1085	1150	845
900	605	728	872	941	----	----	----	920
1,000	650	782	936	1001	1163	1238	1332	1000
1,250	740	890	1066	1131	----	----	----	----
1,500	815	980	1174	1261	1452	----	----	1360
1,750	890	1070	1282	1370	----	----	----	----
2,000	960	1155	1383	1472	1713	----	----	1670

CORRECTION FACTOR FOR ROOM TEMPERATURES OVER 30° C.

C. F.								
40 104	.71	.82	.88	.90	.94	.95	----	----
45 113	.50	.71	.82	----	----	----	----	----
50 122	.00	.58	.75	.80	.87	.89	----	----
55 131	----	.41	.67	----	----	----	----	----
60 140	----	.00	.58	.67	.79	.83	.97	----
70 158	----	----	.35	.52	.71	.76	.93	----
75 167	----	----	.00	----	----	----	----	----
80 176	----	----	----	.30	.61	.69	.89	----
90 194	----	----	----	----	.50	.61	.86	----
100 212	----	----	----	----	----	.51	.82	----
120 248	----	----	----	----	----	----	.72	----
140 284	----	----	----	----	----	----	.63	----

See Notes Following Tables 1 and 2.

For explanation of Type Letters, and for recognized size of conductors for the various conductor insulations, see orders 13–3005 and 13–93001. For installation requirements, see order 13–3005, and the various articles of this code.

1. **Nos. 18 and 16.** The allowable current-carrying capacity of No. 18 is 5 amperes, except in heater cords of Types AFS, AFSJ, HC, HPD, and HSJ it is 10 amperes. The allowable current-carrying capacity of No. 16 is 7 amperes, except in heater cords of Types AFS, AFSJ, HC, HPD, and HSJ it is 15 amperes.

2. **Aluminum Conductors.** For aluminum conductors, the allowable current-carrying capacity shall be taken as 84 per cent of those given in the table for the respective sizes of copper conductor with the same kind of insulation.

3. **Bare Conductors.** If bare conductors are used with insulated conductors, their allowable current-carrying capacity shall be limited to that permitted for the insulated conductor with which they are used.

4. **Application of Table.** For open wiring on insulators and for concealed knob-and-tube work, the allowable current-carrying capacities of Table 2 shall be used. For all other recognized wiring methods, the allowable current-carrying capacities of Table 1 shall be used, unless otherwise provided in this code.

5. **More Than Three Conductors in a Raceway.** Table 1 gives the allowable current-carrying capacity for not more than three conductors in a raceway or cable. If the number of conductors in a raceway or cable is from 4 to 6, the allowable current-carrying capacity of each conductor shall be reduced to 80 per cent of the values in Table 1. If the number of conductors in a raceway or cable is from 7 to 9, the allowable current-carrying capacity of each conductor shall be reduced to 70 per cent of the values in Table 1.

6. **Neutral Conductor.** A neutral conductor which carries only the unbalanced current from other conductors, as in the case of normally balanced circuits of three or more conductors, shall not be counted in determining the current-carrying capacities of Table 1.

In a 3-wire circuit consisting of two phase wires and the neutral of a 4-wire, 3-phase system, a common conductor carries approximately the same current as the other conductors and is not therefore considered as a neutral conductor.

7. **Ultimate Insulation Temperature.** In no case shall conductors be associated together in such a way with respect to the kind of circuit, the wiring method employed, or the number of conductors, that the limiting temperature of the conductors will be exceeded.

8. **Use of Conductors With Higher Operating Temperatures.** If the room temperature is within 10 degrees C of the maximum allowable operating temperature of the insulation, it is desirable to use an insulation with a higher maximum allowable operating temperature; although insulation can be used in a room temperature approaching its maximum allowable operating temperature limit if the current is reduced in accordance with the table of correction factors for different room temperatures.

9. **Voltage Drop.** The allowable current-carrying capacities in Tables 1 and 2 are based on temperature alone and do not take voltage drop into consideration.

10. **Overcurrent Protection.** If the allowable current-carrying capacity of conductors, as provided in Tables 1 and 2, does not correspond to the standard sizes or ratings of overcurrent devices, the next larger size or rating may be used, provided it does not exceed 150 per cent of the allowable current-carrying capacity of the conductor.

11. **Deterioration of Insulation.** It should be noted that even the best grades of rubber insulation will deteriorate in time, so eventually will need to be replaced.

TABLE 4

Number of Conductors in Conduit or Tubing

ONE TO NINE CONDUCTORS RUBBER-COVERED—TYPES R, RW, RP, RH, and **RHT—600 V.

For more than nine conductors see Table 9
(See orders 13–3032, 13–3466 and 13–3487)

Size of Conductor	Number of Conductors in One Conduit or Tubing								
	1	2	3	4	5	6	7	8	9
No. 18	½	½	½	½	½	½	½	½	¾
16	½	½	½	½	½	½	¾	¾	¾
14	½	½	½	½	¾	¾	¾	¾	¾
12	½	½	½	¾	¾	1	1	1	1
10	½	¾	¾	¾	1	1	1¼	1¼	1¼
8	½	¾	*1	1	1¼	1¼	1¼	1¼	1½
6	½	1	*1¼	1¼	1½	1½	2	2	2
5	¾	1¼	1¼	1¼	1½	2	2	2	2
4	¾	1¼	*1¼	1½	2	2	2	2	2½
3	¾	1¼	1¼	1½	2	2	2	2½	2½
2	¾	1¼	*1½	1½	2	2	2½	2½	2½
1	¾	1½	1½	2	2	2½	2½	3	3
0	1	1½	2	2	2½	2½	3	3	3
00	1	2	2	2½	2½	3	3	3	3½
000	1	2	2	2½	3	3	3	3½	3½
0000	1¼	2	2½	2½	3	3	3½	3½	4
250000	1¼	2½	2½	3	3	3½	4	4	4½
300000	1½	2½	3	3	3½	3½	4	4½	4½
350000	1½	2½	3	3½	3½	4	4½	4½	5
400000	1¼	3	3	3½	4	4	4½	5	5
450000	1½	3	3	3½	4	4½	4½	5	6
500000	1½	3	3	3½	4	4½	5	5	6
550000	1½	3	3½	4	4½	5	5	6	6
600000	2	3	3½	4	4½	5	6	6	6
650000	2	3½	3½	4	5	5	6	6	6
700000	2	3½	3½	4½	5	5	6	6	6
750000	2	3½	3½	4½	5	5	6	6	6
800000	2	3½	4	4½	5	6	6	6	
850000	2	3½	4	4½	5	6	6		
900000	2	3½	4	4½	5	6	6		
950000	2	4	4	5	6	6			
1000000	2	4	4	5	6	6			
1250000	2½	4½	4½	6	6				
1500000	2½	4½	5	6					
1750000	3	5	5	6					
2000000	3	5	6						

See Note 5 to Tables 1 and 2.

* Where a run of conduit or electrical metallic tubing does not exceed 50 feet in length and does not contain more than the equivalent of two quarter-bends from end to end: three No. 6 stranded conductors may be installed in a 1-inch conduit or tubing. For services only, three No. 8 insulated conductors may be installed in a ¾-inch conduit or tubing; two No. 6 insulated and one No. 6, bare conductors or two No. 4 insulated and one No. 4 bare conductors may be installed in 1-inch conduit or tubing; and two No. 2, insulated and one No. 2, bare conductors in 1¼-inch conduit or tubing.

** Table 4 shall be used for the installation of Type RHT, small diameter building wire, except for rewiring in existing raceways as provided in sub-paragraph E of order 13–3005.

Tables 4 to 11. Tables 4 to 11 apply only to complete conduit systems, and do not apply to short sections of conduit used for the protection of exposed wiring from mechanical injury.

TABLE 5

Number of Conductors in Conduit or Tubing

LEAD-COVERED TYPES RL, RPL AND RHL—600 V.

(See orders 13–3466 and 13–3487)

Size of Conductor	Number of Conductors in One Conduit or Tubing											
	Single Conductor Cable				2-Conductor Cable				3-Conductor Cable			
	1	2	3	4	1	2	3	4	1	2	3	4
14	½	¾	¾	1	½	1	1	1¼	¾	1¼	1¼	1½
12	½	¾	¾	1	¾	1	1¼	1¼	1	1¼	1½	2
10	½	¾	1	1	¾	1¼	1¼	1½	1	1½	2	2
8	½	1	1¼	1½	1	1¼	1½	2	1	2	2	2½
6	¾	1¼	1½	1½	1¼	1½	2	2½	1¼	2½	3	3
4	¾	1¼	1½	1½	1¼	2	2½	2½	1½	3	3	3½
3	¾	1¼	1½	2	1¼	2	2½	3	1½	3	3	3½
2	1	1¼	1½	2	1¼	2	2½	3	1½	3	3½	4
1	1	1½	2	2	1½	2½	3	3½	2	3½	4	4½
0	1	2	2	2½	2	2½	3	3½	2	4	4½	5
00	1	2	2	2½	2	3	3½	4	2½	4	4½	5
000	1¼	2	2½	2½	2	3	3½	4	2½	4½	4½	6
0000	1¼	2½	2½	3	2½	3	3½	4½	3	5	6	6
250,000	1¼	2½	3	3	----	----	----	----	3	6	6	----
300,000	1½	3	3	3½	----	----	----	----	3½	6	6	----
350,000	1½	3	3	3½	----	----	----	----	3½	6	6	----
400,000	1½	3	3	3½	----	----	----	----	3½	6	6	----
450,000	1½	3	3	4	----	----	----	----	4	6	6	----
500,000	1½	3	3½	4	----	----	----	----	4	6	----	----
600,000	2	3½	4	4½	----	----	----	----	----	----	----	----
700,000	2	4	4	5	----	----	----	----	----	----	----	----
750,000	2	4	4	5	----	----	----	----	----	----	----	----
800,000	2	4	4½	5	----	----	----	----	----	----	----	----
900,000	2½	4	4½	5	----	----	----	----	----	----	----	----
1,000,000	2½	4½	4½	6	----	----	----	----	----	----	----	----
1,250,000	3	5	5	6	----	----	----	----	----	----	----	----
1,500,000	3	5	6	6	----	----	----	----	----	----	----	----
1,750,000	3	6	6	----	----	----	----	----	----	----	----	----
2,000,000	3½	6	6	----	----	----	----	----	----	----	----	----

The above sizes apply to straight runs or with nominal offsets equivalent to not more than two quarter-bends.

It is recommended that bends have a minimum radius of curvature at the inner edge of the bend of not less than 10 times the internal diameter of the conduit or tubing.

TABLE 6

Number of Conductors in Conduit or Tubing

SMALL DIAMETER BUILDING WIRE, TYPES RHT AND RPT—600 VOLTS ONE TO NINE CONDUCTORS

For rewiring in existing raceways as provided in sub-paragraph E of order 13–3005

Size of Conductor	Number of Conductors in One Conduit or Tubing								
	1	2	3	4	5	6	7	8	9
14	½	½	½	½	½	½	½	¾	¾
12	½	½	½	½	½	¾	¾	¾	¾
10	½	½	½	½	½	¾	¾	¾	¾
8	½	½	¾	¾	¾	¾	¾	1	1¼

Note.—Type RHT conductor recognized in sizes No. 14 to No. 8; Type RPT conductor recognized in sizes No. 14 to No. 10.

See Note 5 to Tables 1 and 2.

TABLE 7

Number of Conductors in Conduit or Tubing

SYNTHETIC, TYPE SN AND TYPE RU—600 VOLTS ONE TO NINE CONDUCTORS

For rewiring in existing raceways as provided in sub-paragraph E of order 13–3005

Size of Conductor	Number of Conductors in One Conduit or Tubing								
	1	2	3	4	5	6	7	8	9
14	½	½	½	½	½	½	½	½	½
12	½	½	½	½	½	½	½	½	¾
10	½	½	½	½	½	½	¾	¾	¾
8	½	½	½	¾	¾	¾	1	1	1
6	½	¾	¾	1	1	1¼	1¼	1¼	1¼
5	½	¾	¾	1	1	1¼	1¼	1¼	1½
4	½	¾	1	1	1¼	1¼	1¼	1½	1½
3	½	1	1	1¼	1¼	1¼	1½	1½	2
2	½	1	1	1¼	1¼	1½	1½	2	2
1	¾	1¼	1¼	1½	1½	2	2	2	2½
0	¾	1¼	1¼	1½	2	2	2	2½	2½
00	¾	1¼	1½	2	2	2	2½	2½	2½
000	¾	1½	1½	2	2	2½	2½	3	3
0000	1	1½	2	2	2½	2½	3	3	3

Note.—Type SN conductors recognized in sizes No. 14 to No. 0000; Type RU conductors recognized in sizes No. 14 to No. 10.

See Note 5 to Tables 1 and 2.

Type SN conductors without an outer covering and Type RU conductors with an outer covering have the same overall diameter. See Table 15.

TABLE 9

Number of Conductors in Conduit or Tubing

MORE THAN NINE CONDUCTORS
RUBBER-COVERED TYPES R, RW, RP, AND RH—600 V.
*WHEN SPECIFICALLY PERMITTED BY THIS CODE

(See orders 13–3466 and 13–3487)

Size of Conductor	Maximum Number of Conductors in Conduit or Tubing						
	Inch ¾	Inch 1	Inch 1¼	Inch 1½	Inch 2	Inch 2½	Inch 3
18	13	22	38	53	87	124	191
16	11	19	33	45	74	106	163
14		11	19	26	43	61	95
12			15	21	34	50	77
10			12	16	27	38	60
8				13	22	31	49
6						14	22

* More than nine conductors are permitted in a single conduit for conductors between a motor and its controller; stage pocket and border circuits, order 13–5211; sign flashers, order 13–6021-D; elevator control conductors, order 13–6214; signal and control circuits, orders 13–8006-A-1 and 13–8012-B-2.

TABLE 10

Number of Conductors in Conduit or Tubing

THREE-CONDUCTOR CONVERTIBLE SYSTEM
RUBBER-COVERED TYPES R, RW, RP, AND RH—600 V.

Size of Conductors				Size Conduit or Tubing
two	14	and one	10	¾ inch
"	12	"	8	¾ "
"	10	"	6	1 "
"	8	"	4	1 "
"	6	"	2	1¼ "
"	5	"	1	1¼ "
"	4	"	0	1½ "
"	3	"	00	1½ "
"	2	"	000	1½ "
"	1	"	0000	2 "
"	0	"	250000	2 "
"	00	"	350000	2½ "
"	000	"	400000	2½ "
"	0000	"	550000	3 "
"	250000	"	600000	3 "
"	300000	"	800000	3 "
"	400000	"	1000000	3½ "
"	500000	"	1250000	4 "
"	600000	"	1500000	4 "
"	700000	"	1750000	4½ "
"	800000	"	2000000	4½ "

TABLE 11

Combination of Conductors

(See orders 13–3466 and 13–3487)

For groups or combinations of conductors not included in the Tables 4 to 10, it is recommended that the conduit or tubing be of such size that the sum of the cross-sectional areas of the individual conductors will not be more than the percentage of the interior cross-sectional area of the conduit or tubing than as shown in the following table.

Per Cent Area of Conduit or Tubing

	Number of Conductors				
	1	2	3	4	Over 4
*Conductors (not lead covered)	53	31	43	40	40
Lead-covered conductors	55	30	40	38	35
For rewiring existing raceways with thinner insulated conductors as provided in order 13-3005-D and E	60	40	50	50	50

For carrying capacity of more than three conductors in a conduit or tubing, see Tables 1 and 2, Note 5.

See Tables 13 to 19 for dimensions of conductors, conduit and tubing.

* For Type RHT conductors used for other than rewiring in existing raceways, the areas shown in Table 13 shall be used in place of the areas shown in Table 14.

Tables 13 to 19. Tables 13 to 19 give the nominal size of conductors and conduit or tubing recommended for use in computing size of conduit or tubing for various combinations of conductors. The dimensions represent average conditions only, and while variations will be found in dimensions of conductors and conduits of different manufacture, these variations will not affect the computation.

TABLE 13

Dimensions of Rubber-Covered Conductors

TYPES R, RW, RP, AND RH

Size AWG–CM	Approx. Diam. Inches	Approx. Area Sq. Ins.	Size CM	Approx. Diam. Inches	Approx. Area Sq. Ins.
18	.14	.0154	450, 000	1.08	.91
16	.15	.018	500, 000	1.12	.99
14	.20	.031	550, 000	1.17	1.08
12	.22	.038	600, 000	1.22	1.16
10	.24	.045	650, 000	1.25	1.23
8	.30	.071	700, 000	1.29	1.30
6	.41	.13	750, 000	1.33	1.38
4	.45	.16	800, 000	1.36	1.45
2	.52	.21	850, 000	1.39	1.52
1	.59	.27	900, 000	1.43	1.60
0	.63	.31	950, 000	1.46	1.68
00	.67	.35	1, 000, 000	1.49	1.75
000	.72	.41	1, 250, 000	1.68	2.22
0000	.78	.48	1, 500, 000	1.79	2.52
250, 000	.86	.58	1, 750, 000	1.90	2.85
300, 000	.92	.67	2, 000, 000	2.00	3.14
350, 000	.98	.75			
400, 000	1.03	.83			

No. 18 to No. 8, solid conductor, No. 6 and larger, stranded.

TABLE 14

Dimensions of Conductors

SMALL DIAMETER BUILDING WIRES, TYPES RHT AND RPT

Size AWG	Approx. Diam. Inches	Approx. Area Sq. Ins.	Size AWG	Approx. Diam. Inches	Approx. Area Sq. Ins.
14	.162	.0206	10	.200	.0314
12	.179	.0252	8	.261	.0535

Note.—Small diameter building wire, Type RPT, recognized in sizes Nos. 14, 12 and 10. No. 14 to No 8, solid conductors.

TABLE 15

Dimensions of Conductors

SYNTHETIC INSULATION, TYPE SN
TYPE RU INSULATION

Size AWG	Approx. Diam. Inches	Approx. Area Sq. Ins.	Size AWG	Approx. Diam. Inches	Approx. Area Sq. Ins.
14	.130	.0133	2	.423	.1405
12	.147	.0170	1	.496	.1935
10	.168	.0220	0	.537	.226
8	.227	.0405	00	.583	.267
6	.314	.0775	000	.634	.316
4	.363	.1035	0000	.692	.376

Note.—Type SN conductors recognized in sizes Nos. 14 to No. 0000; Type RU conductors recognized in sizes No. 14 to No. 10.

No. 14 to No. 8, solid conductors, No. 6 and larger, stranded.

Type SN conductors without an outer covering and Type RU conductors with an outer covering have the same overall diameters.

TABLE 16

Dimensions of Lead-Covered Conductors

TYPES RL, RPL AND RHL

Size of Conductor AWG–MCM	Single Conductor		Two Conductor		Three Conductor	
	Diam. Inches	Area Sq. Ins.	Diam. Inches	Area Sq. Ins.	Diam. Inches	Area Sq. Ins.
14	.28	.062	.28 x .47	.115	.59	.273
12	.29	.066	.31 x .54	.146	.62	.301
10	.35	.096	.35 x .59	.180	.68	.363
8	.41	.132	.41 x .71	.255	.82	.528
6	.49	.188	.49 x .86	.369	.97	.738
4	.55	.237	.54 x .96	.457	1.08	.916
2	.60	.283	.61 x 1.08	.578	1.21	1.146
1	.67	.352	.70 x 1.23	.756	1.38	1.49
0	.71	.396	.74 x 1.32	.859	1.47	1.70
00	.76	.454	.79 x 1.41	.980	1.57	1.94
000	.81	.515	.84 x 1.52	1.123	1.69	2.24
0000	.87	.593	.90 x 1.64	1.302	1.85	2.68
250	.98	.754	----------	----------	2.02	3.20
300	1.04	.85	----------	----------	2.15	3.62
350	1.10	.95	----------	----------	2.26	4.02
400	1.14	1.02	----------	----------	2.40	4.52
500	1.23	1.18	----------	----------	2.59	5.28

Note.—No. 14 to No. 8, solid conductors; No. 6 and larger, stranded conductors.

TABLE 17

Dimensions of Asbestos-Varnished-Cambric Insulated Conductors

TYPES AVA, AVB, AND AVL

Size AWG–C. M.	Type AVA		Type AVB		Type AVL	
	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.
14	.245	.047	.205	.033	.320	.080
12	.265	.055	.225	.040	.340	.091
10	.285	.064	.245	.047	.360	.102
8	.310	.075	.270	.057	.390	.119
6	.395	.122	.345	.094	.430	.145
4	.445	.155	.395	.123	.480	.181
2	.505	.200	.460	.166	.570	.255
1	.585	.268	.540	.229	.620	.300
0	.625	.307	.580	.264	.660	.341
00	.670	.353	.625	.307	.705	.390
000	.720	.406	.675	.358	.755	.447
0000	.780	.478	.735	.425	.815	.521
250, 000	.885	.616	.855	.572	.955	.715
300, 000	.940	.692	.910	.649	1.010	.800
350, 000	.995	.778	.965	.731	1.060	.885
400, 000	1.040	.850	1.010	.800	1.105	.960
450, 000	1.085	.925	1.055	.872	1.150	1.040
500, 000	1.125	.995	1.095	.945	1.190	1.118
550, 000	1.165	1.065	1.135	1.01	1.265	1.26
600, 000	1.205	1.140	1.175	1.09	1.305	1.34
650, 000	1.240	1.21	1.210	1.15	1.340	1.41
700, 000	1.275	1.28	1.245	1.22	1.375	1.49
750, 000	1.310	1.35	1.280	1.29	1.410	1.57
800, 000	1.345	1.42	1.315	1.36	1.440	1.63
850, 000	1.375	1.49	1.345	1.43	1.470	1.70
900, 000	1.405	1.55	1.375	1.49	1.505	1.78
950, 000	1.435	1.62	1.405	1.55	1.535	1.85
1, 000, 000	1.465	1.69	1.435	1.62	1.565	1.93

Note.—No. 14 to No. 8, solid, No. 6 and larger, stranded; except AVL where all sizes are stranded.

Varnished-Cambric Insulated Conductors

TYPE V

The insulation thickness for varnished-cambric conductors, Type V, is the same as for rubber-covered conductors, Type R, except for No. 8 which has a 3/64-inch insulation for varnished-cambric, and 4/64-inch insulation for rubber-covered conductors. See table in order 13–93001. Tables 4 and 5 may, therefore, be used for the number of varnished-cambric insulated conductors in a conduit or tubing.

TABLE 18

Properties of Conductors

AWG	CM	Ohms Per 1000 Feet 15°C.-59°F.	Bare Conductor		Concentric Lay Stranded Conductors. Rubber, Paper, Asbestos, Varnished Cambric, Asbestos Varnished Cambric	
			Diam. Inches	Area Sq. Ins.	No. of Wires	Diam. Each Wire Inches
14	4, 107	2.475	.064	.003	7	.024
12	6, 530	1.557	.081	.005	7	.030
10	10, 380	.9792	.102	.008	7	.038
8	16, 510	.6158	.128	.013	7	.048
6	26, 250	.3872	.184	.026	7	.061
5	33, 100	.3071	.213	.035	7	.068
4	41, 740	.2436	.232	.042	7	.077
3	52, 630	.1931	.261	.053	7	.086
2	66, 370	.1532	.292	.067	7	.097
1	83, 690	.1215	.332	.087	19	.066
0	105, 500	.09633	.375	.110	19	.074
00	133, 100	.07639	.419	.138	19	.083
000	167, 800	.06058	.470	.173	19	.094
0000	211, 600	.04804	.528	.219	19	.105
	250, 000	.04147	.594	.276	37	.082
	300, 000	.03457	.641	.323	37	.090
	350, 000	.02963	.688	.370	37	.097
	400, 000	.02592	.734	.423	37	.104
	500, 000	.02074	.828	.540	37	.116
	600, 000	.01729	.892	.628	61	.099
	700, 000	.01481	.968	.735	61	.107
	750, 000	.01382	1.000	.785	61	.110
	800, 000	.01296	1.031	.835	61	.114
	900, 000	.01153	1.094	.938	61	.121
	1, 000, 000	.01036	1.172	1.039	61	.128
	1, 250, 000	.00829	1.290	1.320	91	.117
	1, 500, 000	.00692	1.422	1.580	91	.128
	1, 750, 000	.00593	1.546	1.872	127	.117
	2, 000, 000	.00518	1.630	2.084	127	.125

Note.—Nos. 14 to 8, solid; Nos. 6 and larger, stranded. No. 18, diam. .040; 1624 CM. No. 16, diam. .051; 2583 CM.

TABLE 19

Dimensions of Conduit or Tubing

Size	Internal diameter Inches	Area Square Inches	Size	Internal Diameter Inches	Area Square Inches
½	.622	.30	3	3.068	7.38
¾	.824	.53	3½	3.548	9.90
1	1.049	.86	4	4.026	12.72
1¼	1.380	1.50	4½	4.506	15.95
1½	1.610	2.04	5	5.047	20.00
2	2.067	3.36	6	6.065	28.89
2½	2.469	4.79			

TABLE 20

Conductor Sizes and Overcurrent Protection For Motors See Tables 26 and 27, Chapter 10.

See orders 13–4312, 13–4322 and 13–4342.

For certain exceptions to values in columns 6, 7, 8, 9 and 10, see orders 13–4324 and 13–4342. See Tables 21 to 24 for full-load current of motors. See Example No 5, Chapter 10.

Full load current rating of motor amperes	Minimum size conductor in raceways For conductors in air or for other insulations (see tables 1 and 2) AWG and MCM			For Running Protection of Motors		Maximum Allowable Rating of Branch Circuit Fuses			
				Maximum rating of N. E. C. fuses	Maximum setting of time-limit protective device	**With Code Letters** Single-phase and squirrel cage and synchronous. Full voltage, resistor and reactor starting. Code letters F to R inc. **Without Code Letters** Same as above.	**With Code Letters** Single-phase and squirrel cage and synchronous. Full voltage, resistor or reactor starting. Code letters B to E inc. Auto-transformer starting, Code letters F to R inc. **Without Code Letters** Squirrel cage and synchronous, auto-transformer starting. High reactance squirrel cage.*** Both not more than 30 amperes	**With Code Letters** Squirrel cage and synchronous Auto-transformer starting, Code letters B to E inc. **Without Code Letters** Squirrel cage and synchronous, auto-transformer starting. High reactance squirrel cage.*** Both more than 30 amperes	**With Code Letters** All motors. Code Letter A. **Without Code Letters** DC and wound-rotor motors.
	Type R	Type RP	Type RH	Amperes	Amperes				
Col. No. 1	2	3	4	5	6	7	8	9	10
1**	14	14	14	2*	1.25*	15	15	15	15
2**	14	14	14	3*	2.50*	15	15	15	15
3**	14	14	14	4*	3.75*	15	15	15	15
4**	14	14	14	6*	5.0*	15	15	15	15
5**	14	14	14	8*	6.25*	15	15	15	15
6**	14	14	14	8*	7.50*	20	15	15	15
7	14	14	14	10*	8.75*	25	20	15	15
8	14	14	14	10*	10.0 *	25	20	20	15
9	14	14	14	12*	11.25*	30	25	20	15
10	14	14	14	15*	12.50*	30	25	20	15
11	14	14	14	15*	13.75*	35	30	25	20
12	14	14	14	15	15.00	40	30	25	20
13	12	14	14	20	16.25	40	35	30	20
14	12	14	14	20	17.50	45	35	30	25
15	12	12	14	20	18.75	45	40	30	25
16	12	12	14	20	20.00	50	40	35	25
17	10	12	14	25	21.25	60	45	35	30
18	10	12	12	25	22.50	60	45	40	30
19	10	10	12	25	23.75	60	50	40	30
20	10	10	12	25	25.0	60	50	40	30
22	8	10	10	30	27.50	70	60	45	35
24	8	10	10	30	30.00	80	60	50	40
26	8	8	10	35	32.50	80	70	60	40
28	8	8	10	35	35.00	90	70	60	45
30	6	8	8	40	37.50	90	70	60	45
32	6	8	8	40	40.00	100	80	70	50
34	6	6	8	45	42.50	110	90	70	60
36	6	6	8	45	45.00	110	90	80	60
38	5	6	8	50	47.50	125	100	80	60
40	5	6	6	50	50.00	125	100	80	60
42	5	6	6	50	52.50	125	110	90	70
44	4	5	6	60	55.0	125	110	90	70
46	4	5	6	60	57.50	150	125	100	70
48	4	5	6	60	60.0	150	125	100	80
50	3	5	6	60	62.50	150	125	100	80
52	3	4	6	70	65.0	175	150	110	80
54	3	4	5	70	67.50	175	150	110	90
56	2	4	5	70	70.00	175	150	120	90
58	2	3	5	70	72.50	175	150	120	90
60	2	3	5	80	75.00	200	150	120	90
62	2	3	4	80	77.50	200	175	125	100
64	2	3	4	80	80.00	200	175	150	100
66	1	3	4	80	82.50	200	175	150	100
68	1	2	4	90	85.00	225	175	150	110
70	1	2	3	90	87.50	225	175	150	110
72	1	2	3	90	90.00	225	200	150	110
74	0	2	3	90	92.50	225	200	150	125
76	0	2	3	100	95.00	250	200	175	125
78	0	1	3	100	97.50	250	200	175	125

TABLE 20—Continued

Conductor Sizes and Overcurrent Protection For Motors See Tables 26 and 27, Chapter 10.

Full load current rating of motor amperes	Minimum size conductor in raceways For conductors in air or for other insulations (see tables 1 and 2) AWG and MCM			For Running Protection of Motors		Maximum Allowable Rating of Branch Circuit Fuses			
						With Code Letters Single-phase and squirrel cage and synchronous. Full voltage, resistor and reactor starting, Code letters F to R inc. **Without Code Letters** Same as above.	**With Code Letters** Single-phase and squirrel cage and synchronous. Full voltage, resistor or reactor starting, Code letters B to E inc. Auto-transformer starting, Code letters F to R inc. **Without Code Letters** Squirrel cage and synchronous, auto-transformer starting. High reactance squirrel cage.*** Both not more than 30 amperes	**With Code Letters** Squirrel cage and synchronous Auto-transformer starting, Code letters B to E inc. **Without Code Letters** Squirrel cage and synchronous, auto-transformer starting. High reactance squirrel cage.*** Both more than 30 amperes	**With Code Letters** All motors. Code Letter A. **Without Code Letters** DC and wound-rotor motors.
	Type R	Type RP	Type RH	Maximum rating of N. E. C. fuses	Maximum setting of time-limit protective device				
Col. No. 1	2	3	4	Amperes 5	Amperes 6	7	8	9	10
80	0	1	2	100	100.00	250	200	175	125
82	0	1	2	110	102.50	250	225	175	125
84	0	1	2	110	105.00	250	225	175	150
86	00	1	2	110	107.50	300	225	175	150
88	00	1	2	110	110.00	300	225	200	150
90	00	0	2	110	112.50	300	225	200	150
92	00	0	2	125	115.00	300	250	200	150
94	00	0	1	125	117.50	300	250	200	150
96	00	0	1	125	120.00	300	250	200	150
98	000	0	1	125	122.50	300	250	200	150
100	000	0	1	125	125.00	300	250	200	150
105	000	00	1	150	131.5	350	300	225	175
110	000	00	0	150	137.5	350	300	225	175
115	0000	00	0	150	144.0	350	300	250	175
120	0000	000	0	150	150.0	400	300	250	200
125	0000	000	00	175	156.5	400	350	250	200
130	250	000	00	175	162.5	400	350	300	200
135	250	0000	00	175	169.0	450	350	300	225
140	250	0000	000	175	175.0	450	350	300	225
145	300	0000	000	200	181.5	450	400	300	225
150	300	0000	000	200	187.5	450	400	300	225
155	300	0000	000	200	194.0	500	400	350	250
160	350	250	000	200	200.0	500	400	350	250
165	350	250	0000	225	206.	500	450	350	250
170	350	250	0000	225	213.	500	450	350	300
175	400	300	0000	225	219.	600	450	350	300
180	400	300	0000	225	225.	600	450	400	300
185	400	300	0000	250	231.	600	500	400	300
190	500	300	250	250	238.	600	500	400	300
195	500	350	250	250	244.	600	500	400	300
200	500	350	250	250	250.	600	500	400	300
210	500	400	300	250	263.	------	600	450	350
220	600	400	300	300	275.	------	600	450	350
230	600	500	300	300	288.	------	600	500	350
240	700	500	350	300	300.	------	600	500	400
250	700	500	350	300	313.	------	----	500	400
260	750	600	400	350	325.	------	----	600	400
270	800	600	400	350	338.	------	----	600	450
280	900	600	500	350	350.	------	----	600	450
290	900	700	500	350	363.	------	----	600	450
300	1000	700	500	400	375.	------	----	600	450
320	1250	750	600	400	400.	------	----	------	500
340	1500	900	600	450	425.	------	----	------	600
360	1750	1000	700	450	450.	------	----	------	600
380	----	1250	750	500	475.	------	----	------	600
400	----	1500	900	500	500.	------	----	------	600
420	----	1500	1000	600	525.	------	----	------	------
440	----	1750	1250	600	550.	------	----	------	------
460	----	----	1250	600	575.	------	----	------	------
480	----	----	1500	600	600.	------	----	------	------
500	----	----	1500	----	625.	------	----	------	------

* For running protection of motors of 1 horsepower or less, see order 13-4322.
** For the grouping of small motors under the protection of a single set of fuses, see order 13-4343.
*** High-reactance squirrel-cage motors are those designed to limit the starting current by means of deep-slot secondaries or double-wound secondaries and are generally started on full voltage.

TABLE 21

Full-Load Current†

DIRECT-CURRENT MOTORS

HP	115 V.	230 V.	550 V.
½*	4.5	2.3	----
¾*	6.5	3.3	1.4
1*	8.4	4.2	1.7
1½	12.5	6.3	2.6
2	16.1	8.3	3.4
3	28.0	12.3	5.0
5	40	19.8	8.2
7½	58	28.7	12.0
10	75	38	16.0
15	112	56	23.0
20	140	74	30
25	185	92	38
30	220	110	45
40	294	146	61
50	364	180	75
60	436	215	90
75	540	268	111
100	----	357	146
125	----	443	184
150	----	----	220
200	----	----	295

* For running protection of motors of 1 horsepower or less see order 13–4322.

† These values for full-load current are average for all speeds.

TABLE 22

Full-Load Current†

SINGLE-PHASE A.C. MOTORS

HP	110V	220V	440V
1/6*	3.34	1.67	----
¼*	4.8	2.4	----
½*	7	3.5	----
¾*	9.4	4.7	----
1*	11	5.5	----
1½	15.2	7.6	----
2	20	10	----
3	28	14	----
5	46	23	----
7½	68	34	17
10	86	43	21.5

For full-load currents of 208 and 200-volt motors, increase corresponding 220-volt motor full-load current by 6 and 10 per cent, respectively.

* For running protection of motors of 1 horsepower or less see order 13–4322.

† These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, in which case the nameplate current rating should be used.

TABLE 23

Full-Load Current†

TWO-PHASE A.C. MOTORS (4-WIRE)

	Induction Type Squirrel-Cage and Wound Rotor Amperes				Synchronous Type ‡Unity Power Factor Amperes				
H.P.	110V	220V	440V	550V	2200V	220V	440V	550V	2200V
½*	4.3	2.2	1.1	.9	-----	-----	-----	-----	-----
¾*	4.7	2.4	1.2	1.0	-----	-----	-----	-----	-----
1*	5.7	2.9	1.4	1.2	-----	-----	-----	-----	-----
1½	7.7	4.0	2	1.6	-----	-----	-----	-----	-----
2	10.4	5	3	2.0	-----	-----	-----	-----	-----
3	-----	8	4	3.0	-----	-----	-----	-----	-----
5	-----	13	7	6	-----	-----	-----	-----	-----
7½	-----	19	9	7	-----	-----	-----	-----	-----
10	-----	24	12	10	-----	-----	-----	-----	-----
15	-----	33	16	13	-----	-----	-----	-----	-----
20	-----	45	23	19	-----	-----	-----	-----	-----
25	-----	55	28	22	6	47	24	19	4.7
30	-----	67	34	27	7	56	29	23	5.7
40	-----	88	44	35	9	75	37	31	7.5
50	-----	108	54	43	11	94	47	38	9.4
60	-----	129	65	52	13	111	56	44	11.3
75	-----	156	78	62	16	140	70	57	14
100	-----	212	106	85	22	182	93	74	18
125	-----	268	134	108	27	228	114	93	23
150	-----	311	155	124	31	-----	137	110	28
200	-----	415	208	166	43	-----	182	145	37

* For running protection of motor of 1 horsepower or less see Order 13-4322.

† These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, in which case the nameplate current rating should be used. Current in common conductor of 2-phase, 3-wire system will be 1.41 times value given.

‡ For 90 and 80 per cent P. F. the above figures should be multiplied by 1.1 and 1.25 respectively.

TABLE 24

Full-Load Current†

THREE-PHASE A.C. MOTORS

	Induction Type Squirrel-Cage and Wound Rotor Amperes					Synchronous Type ‡Unity Power Factor Amperes			
HP	110V	220V	440V	550V	2200V	220V	440V	550V	2200V
½* ¾* 1*	5 5.4 6.6	2.5 2.8 3.3	1.3 1.4 1.7	1 1.1 1.3	-----	-----	-----	-----	-----
1½ 2 3	9.4 12 -----	4.7 6 9	2.4 3 4.5	2.0 2.4 4	-----	-----	-----	-----	-----
5 7½ 10	-----	15 22 27	7.5 11 14	6 9 11	-----	-----	-----	-----	-----
15 20 25	-----	38 52 64	19 26 32	15 21 26	-----	-----	-----	-----	-----
30 40 50	-----	77 101 125	39 51 63	31 40 50	7 8 10 13	54 65 86 108	27 33 43 54	22 26 35 44	5.4 6.5 8.6 10.8
60 75 100	-----	149 180 246	75 90 123	60 72 98	15 19 25	123 161 211	64 81 106	51 65 85	13 16 21
125 150 200	-----	310 360 480	155 180 240	124 144 195	32 36 49	264 -----	132 158 210	106 127 168	26 32 42

For full-load currents of 208 and 200 volt motors, increase the corresponding 220-volt motor full-load current by 6 and 10 per cent, respectively.

* For running protection of motors of 1 horsepower or less see order 13-4322.

† These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, in which case the nameplate current rating should be used.

‡ F or 90 and 80 per cent P. F. the above figures should be multiplied by 1.1 and 1.25 respectively.

TABLE 26

Maximum Rating or Setting of Motor-Branch-Circuit Protective Devices For Motors Marked With a Code Letter Indicating Locked Rotor KVA

Type of Motor	Per Cent of Full-Load Current		
	Fuse Rating (See also Table 20, Columns 7, 8, 9, 10)	Circuit-Breaker Setting	
		Instantaneous Type	Time Limit Type
All AC single-phase and polyphase squirrel cage and synchronous motors with full-voltage, resistor or reactor starting:			
Code Letter A	150	----	150
Code Letter B to E	250	----	200
Code Letter F to R	300	----	250
All AC squirrel cage and synchronous motors with auto-transformer starting:			
Code Letter A	150	----	150
Code Letter B to E	200	----	200
Code Letter F to R	250	----	200

For certain exceptions to the values specified see orders 13-4324 and 13-4342. The values given in the last column also cover the ratings of non-adjustable, time-limit types of circuit-breakers which may also be modified as in order 13-4342.

Synchronous motors of the low-torque, low-speed type (usually 450 RPM or lower), such as are used to drive reciprocating compressors, pumps, etc., which start up unloaded, do not require a fuse rating or circuit breaker setting in excess of 200 per cent of full-load current.

For motors not marked with a Code Letter, see Table 27

TABLE 27

Maximum Rating or Setting of Motor-Branch-Circuit Protective Devices For Motors Not Marked With a Code Letter Indicating Locked Rotor KVA

Type of Motor	Per Cent of Full-Load Current		
	Fuse Rating (See also Table 20, Columns 7, 8, 9, 10)	Circuit-Breaker Setting	
		Instantaneous Type	Time Limit Type
Single-phase, all types	300	----	250
Squirrel-cage and synchronous (full-voltage, resistor and reactor starting)	300	----	250
Squirrel-cage and synchronous (auto-transformer starting)			
Not more than 30 amperes	250	----	200
More than 30 amperes	200	----	200
High-reactance squirrel-cage			
Not more than 30 amperes	250	----	250
More than 30 amperes	200	----	200
Wound-rotor	150	----	150
Direct-current			
Not more than 50 H. P.	150	250	150
More than 50 H. P	150	175	150

For certain exceptions to the values specified see orders 13-4324 and 13-4342. The values given in the last column also cover the ratings of non-adjustable, time-limit types of circuit-breakers which may also be modified as in order 13-4342.

Synchronous motors of the low-torque, low-speed type (usually 450 RPM or lower), such as are used to drive reciprocating compressors, pumps, etc., which start up unloaded, do not require a fuse rating or circuit breaker setting in excess of 200 per cent of full-load current.

For motors marked with a Code Letter, see Table 26

TABLE 28—NUMBER OF OVERCURRENT UNITS, SUCH AS TRIP COILS OR RELAYS, FOR PROTECTION OF CIRCUITS

(See Diagrams 1 to 14)

(Order 13-2405 provides that when fuses are used, a fuse shall be placed in each ungrounded conductor. Where circuit-breakers are used for overcurrent protection, the number and position of the overcurrent units, such as trip coils and relays, shall be as shown in the table. For Services, see order 13-2371. For table of overcurrent units for motor protection, see table in order 13-4327.)

SYSTEM	*Number and location of Overcurrent Units, such as Trip Coils, or Relays.
2-Wire, Single-phase, A.C. or D.C., Ungrounded.	One (in either conductor. Place always in conductors connected to same side of the circuit. Fig. 1.)
2-Wire, Single-phase, A.C. or D.C., One Wire Grounded.	One (in ungrounded conductor. Fig 2).
2-Wire, Single-phase A.C. or D.C., Mid-point Grounded.	Two (one in each conductor. Fig. 3).
2-Wire, Single-phase A.C. Derived from 3-Phase, with Ungrounded Neutral.	Where a group of feeders is fed from the three phases of a common three-phase bus, each conductor served by either of two conductors of the three-phase bus must be equipped with one over-current unit. This will result in some circuits being equipped with one unit and others with two units. Fig. 4.
2-Wire, Single-phase Derived from 3-Phase, Grounded Neutral System by Using outside Wires of 3-Phase Circuit.	Two (one in each conductor. Fig. 5).
3-Wire, Single-phase A.C. or D.C., Neutral Grounded or Ungrounded.	Two (one in each conductor except neutral conductor. Fig. 6).
3-Wire, 2-Phase, A.C., Common Wire Grounded or Ungrounded.	Two (one in each conductor except common conductor. Fig. 7).
4-Wire, 2 Phase, Ungrounded, Phases Separate.	Two (one in each phase. Place always in conductors connected to same side of the circuit in each phase. Fig. 8).
4-Wire, 2-Phase, Grounded Neutral, or 5-Wire, 2-Phase, Grounded or Ungrounded.	Four (one in each conductor except neutral conductor. Fig. 9).
3-Wire, 3-Phase, Ungrounded.	a. Three (one in each conductor if the circuit is served by a Y △ or △ Y transformer having the neutral in either case ungrounded or not connected to the circuit. Fig. 10). b. Two, under all other conditions. Place always in the same phases.
3-Wire, 3-Phase, 1 Wire Grounded.	Two (one in each ungrounded conductor. Fig. 11)
3-Wire, 3-Phase, Grounded Neutral.	Three (one in each conductor. Fig. 12).
3-Wire, 3-Phase, Mid-point of one phase grounded.	Three (one in each conductor. Fig. 13).
4-Wire, 3-Phase, Neutral Grounded or Ungrounded.	Three (one in each conductor except neutral conductor. Fig. 14).

*1. Where the above table calls for one over-current unit, this may consist of one series over-current tripping device, or the combination of one current transformer and one secondary over-current tripping device.

2. Where it calls for two over-current units, these may consist of two series over-current tripping devices or the combination of two current transformers and two secondary over-current tripping devices.

3. Where it calls for three over-current units, these may consist of three series over-current tripping devices or the combination of two or three secondary over-current tripping devices with three current transformers.

4. Where it calls for four over-current units, these may consist of four series over-current tripping devices or four current transformers with four secondary over-current tripping devices.

5. Where standard devices are not available with three or four over-current units as required in the table, it is permissible to substitute two over-current units and one fuse where three over-current units are called for, two over-current units and two fuses where four units are called for. The fuse or fuses are to be placed in the conductors not containing an over-current unit. This practice, however, of substituting fuses for over-current units is to be discouraged for obvious reasons.

TABLE 29

Demand-Factor For Household Electric Ranges

The values in the table below apply to one or more cooking and baking appliances but are not applicable to other appliances.

Number of Ranges	Demand Factor (Per Cent)	
	Column I (Ranges over 1650 watts and under 3500 watts)	Column II (Ranges 3500 watts and over)
1	80	80
2	75	65
3	70	55
4	66	50
5	62	45
6	59	43
7	56	40
8	53	36
9	51	35
10	49	34
11	47	32
12	45	32
13	43	32
14	41	32
15	40	32
16	39	28
17	38	28
18	37	28
19	36	28
20	35	28
21	34	26
22	33	26
23	32	26
24	31	26
25	30	26
26–30	30	24
31–40	30	22
41–50	30	20
51–60	30	18
61 and over	30	16

The demand factor for one range may also be applied to the conductors of a range branch circuit.

TABLE 31

Flexible Cords

(See order 13–4002)

Use			Trade Name	Type	Braid on Each Conductor	Filler	Outer Covering	
							Kind	Number
Attached to a Device	Dry Places	Not Subject to Hard Usage	Asbestos Covered Tinsel Cord	AT [3]	Cotton	None	None	None
					None	None	Cotton or Rayon	1
			Cotton Covered Tinsel Cord	CT [3]	Cotton	None	Cotton or Rayon	1 or None
	Damp Places		Rubber Jacketed Tinsel Cord	ATJ [3]	None	None	Rubber	1
				CTJ [3]	Cotton			
Pendant	Dry Places		Asbestos Covered Heat-Resistant Cord	AFC	Cotton or Rayon	None	None	None
				AFPO	None	None	Cotton, Rayon or Saturated Asbestos	1
				AFPD				
			Cotton Covered Heat-Resistant Cord	CFC	Cotton or Rayon	None	None	None
				CFPO	None	None	Cotton or Rayon	1
				CFPD				
See Note 2			Parallel Cord	PO-64	Cotton	None	Cotton or Rayon	1
				PO-32				
				PO				
	Damp Places		All Rubber Parallel Cord	POSJ-64	None	None	Rubber	1
				POSJ-32				

Pendant or Portable	Dry Places		Lamp Cord	C	Cotton	None	None	None
		Hard Usage	Armored Cord	CA	Cotton	None	Metal Armor	1
		Not Subject to Hard Usage	Twisted Portable Cord	PD	Cotton	None	Cotton or Rayon	1
		Hard Usage	Reinforced Cord	P-64	Cotton	Rubber	Cotton	1
				P-32				
				P				
	Damp Places	Not Subject to Hard Usage	Moisture-Proof Reinforced Cord	PWP64	Cotton	Rubber	Cotton Moisture Resistant Finish	1
				PWP32				
				PWP				
			Braided Heavy Duty Cord	K [4]	Cotton	Jute, Cotton, Sisal, Hemp, Twisted Paper	Cotton-Moisture-Resistant Finish	2 [5]
Pendant or Portable		Hard Usage	Vacuum Cleaner Cord	SV	None	None	Rubber	1
			Jun'r Hard Service Cord	SJ				
				SJO				
		Extra Hard Usage	Hard Service Cord	S [6]			Oil-Res't Compound	
				SO			Rubber	
							Oil-Res't Compound	
Portable		Portable Heaters	Rubber Jacketed Heat-Resistant Cord	AFS AFSJ	None	None	Rubber	1
	Dry Places		Heater Cord	HC	Cotton	None	None	None
				HPD	None	None	Cotton or Rayon	1

TABLE 31—Continued

Flexible Cords

(See order 13-4002)

Use			Trade Name	Type	Braid on Each Conductor	Filler	Outer Covering	
							Kind	Number
Portable	Portable Heaters		Rubber Jacketed Heater Cord	HSJ	None	None	Cotton and Rubber	1
Pendant or Portable	Damp Places	Not Subject to Hard Usage	Heat and Moisture Resistant Cord	AVPD AVPO	None	None	Saturated Asbestos	1
						Rubber	Cotton-Flame Retardant Moisture-Resistant Finish	1
Elevator Lighting and Control			Elevator Cable	E [7]	Cotton	None	Cotton-Outer One Flame-Retardant Moisture Resistant	3 [5]

See notes following.

NOTES TO TABLE 31

1. Except for types AFPO, AVPO, CFPO, PO-64, PO-32, PO, POSJ-64 and POSJ-32 individual conductors are twisted together.
2. Type PO-64 is for use only with portable lamps, portable radio receiving appliances, portable clocks and similar appliances which are not liable to be moved frequently and where appearance is a consideration.
3. Types AT, CT, ATJ and CTJ are suitable for use in lengths not exceeding eight feet when attached directly, or by means of a special type of plug, to a portable appliance rated at 50 watts or less and of such a nature that extreme flexibility of the cord is essential. Types AT and ATJ are for use only with heating appliances.
4. Type K is suitable for use on theatre stages.
5. Rubber-filled or varnished cambric tapes may be substituted for the inner braids.
6. Type S is suitable for use on theatre stages, in garages and elsewhere, where flexible cords having rubber insulation are permitted by this code.
7. Type E may have a composite assembly of steel and copper strands in the make-up of the conductors.

TABLE 32

Isolation by Elevation

(See order 13-7162)

Distance of Live Parts Above the Floor or Other Working Surface

Voltage Between Phases	Minimum Vertical Clearance of Unguarded Parts	
	Feet	Inches
600	8	0
2300	8	0
6600	8	0
11000	9	0
22000	9	3
33000	9	6
44000	9	10
66000	10	5
88000	11	0
110000	11	7
132000	12	2

TABLE 33

Working Space

(See order 13-7163. For voltages below 600, see order 13-1111.)

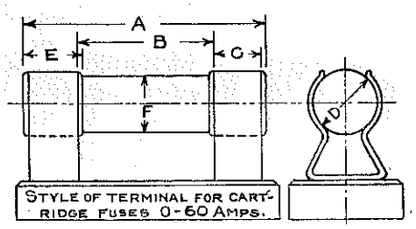
Minimum Clear Space Adjacent to Live Parts

Voltage Between Phases	Minimum Horizontal Clearance of Unguarded Parts	
	Feet	Inches
600	3	2
2300	3	3
6600	3	4
11000	3	6
22000	3	9
33000	4	0
44000	4	4
66000	4	11
88000	5	6
110000	6	1
132000	6	8

TABLE 34

Table of Dimensions of the National Electrical Code Standard Cartridge Enclosed Fuses

(See order 13–92401)

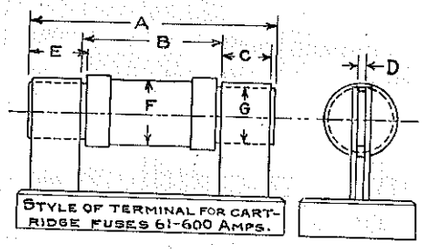


Form 1. CARTRIDGE FUSE—Ferrule Contact

Voltage	Rated Capacity Amperes	A Length Over Terminals Inches		B Distance between Contact Clips Inches	C Width of Contact Clips Inches
Not over 250	0–30	Form 1	2	1	½
	31–60		3	1¾	⅝
	61–100	Form 2	5 7/8	4	⅞
	101–200		7 1/8	4½	1¼
	201–400		8 5/8	5	1¾
	401–600		10 5/8	6	2⅛
Not over 600	0–30	Form 1	5	4	½
	31–60		5½	4¼	⅝
	61–100	Form 2	7 7/8	6	⅞
	101–200		9 5/8	7	1¼
	201–400		11 5/8	8	1¾
	401–600		13 3/8	9	2⅛

Table of Dimensions of the National Electrical Code Standard Cartridge Enclosed Fuses

(See order 13–92401)



Form 2. CARTRIDGE FUSE—Knife Blade Contact

D Diameter of Ferrules or Thickness of Terminal Blades Inches	E Min. Length of Ferrules or of Terminal Blades outside of Tube Inches	F Diam. of Tube Inches	G Width of Terminal Blades Inches		Rated Capacity Amperes
9/16	½	½		Form 1	0–30
25/64	⅝	¾			31–60
1/8	1	1	¾	Form 2	61–100
5/32	1 3/8	1½	1 1/8		101–200
¼	1 7/8	2	1 5/8		201–400
¼	2¼	2½	2		401–600
25/64	½	¾		Form 1	0–30
1 1/16	⅝	1			31–60
1/8	1	1¼	¾	Form 2	61–100
5/32	1 3/8	1¾	1 1/8		101–200
¼	1 7/8	2½	1 5/8		201–400
¼	2¼	3	2		401–600

NUMBER AND POSITION OF TRIP COILS AND RELAYS REQUIRED BY TABLE 28

SINGLE PHASE

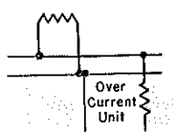


FIG. 1

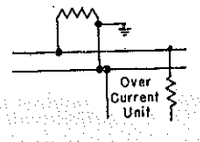


FIG. 2

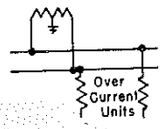


FIG. 3

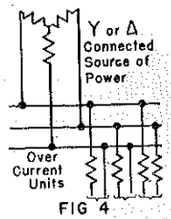


FIG 4

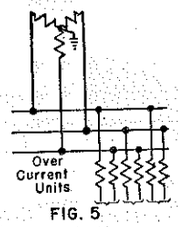


FIG. 5

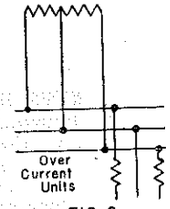


FIG. 6

TWO PHASE

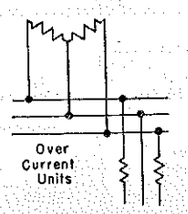


FIG. 7

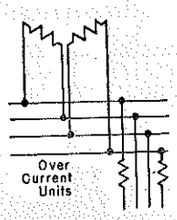


FIG. 8

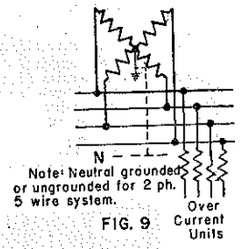


FIG. 9

THREE PHASE

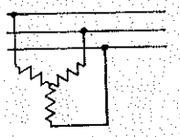


FIG. 10

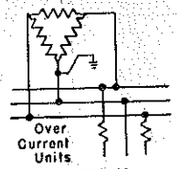


FIG. 11

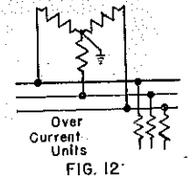


FIG. 12

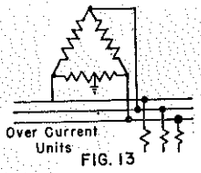


FIG. 13

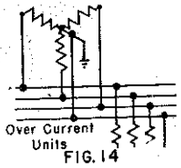


FIG. 14

MOTOR FEEDER AND BRANCH CIRCUITS

Section 13-430

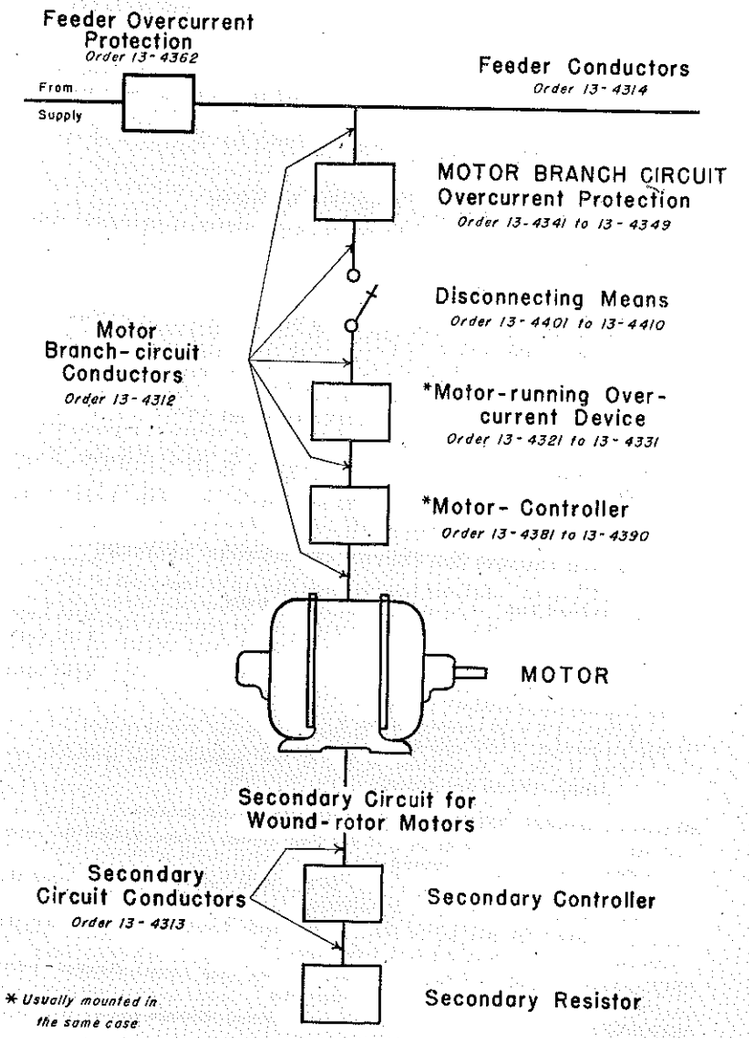


Fig. 15

EXAMPLES

Selection of Conductors. In the following examples the size of conductor has been selected on the basis of the allowable current carrying capacities of Type R rubber-covered conductors as given in Table 1. If other types of insulated conductors are used, or if the conductors are run open, or with more than three conductors in a raceway, the size of conductor may vary from those shown. Tables 1 and 2 should be consulted in selecting the size of conductor for a particular installation.

Voltage. For uniform application of the provisions of Sections 13-210 and 13-220, a nominal voltage of 115 and 230 volts shall be used in computing the ampere load on the conductor.

Fractions of an Ampere. Where the calculations result in a fraction of an ampere, such fractions may be dropped.

Example No. 1. Single-Family Dwelling

Dwelling having a floor area of 2,500 square feet, exclusive of unoccupied cellar, unfinished attic and open porches.

COMPUTED LOAD (Order 13-2108):

General lighting load:
2,500 square feet at 2 watts per square foot.....5,000 watts
Small appliance load .....1,500 watts

Total computed load .....6,500 watts

MINIMUM NUMBER OF BRANCH CIRCUITS REQUIRED (Order 13-2107):

General lighting load: 5,000 ÷ 115 = 43 amperes, or three 15-ampere, 2-wire circuits.
Small appliance load: 1,500 ÷ 115 = 13 amperes, or one 2-wire circuit of No 12 wire. (See order 13-2109)

MINIMUM SIZE FEEDERS (OR SERVICE CONDUCTORS) REQUIRED (Order 13-2203):

Total computed load .....6.500 watts
2,500 watts at 100% ..... 2,500 watts
4,000 watts at 30% ..... 1,200 watts

Net computed load ..... 3,700 watts

For 115-volt 2-wire system:
3,700 ÷ 115 = 32 amperes, or No. 8.
For 115-230-volt, 3-wire system:
3,700 ÷ 230 = 16 amperes, or No. 8. For minimum size conductor, see orders 13-2201 and 13-2305.

MINIMUM NUMBER RECEPTACLES REQUIRED (Order 13-2110):

LIVING ROOM: 16 feet by 22 feet; 76 feet total (gross) distance around the room. 76 feet ÷ 20 = 3.8 or 4 receptacles.

EACH BED ROOM: 14 feet by 15 feet; 58 feet total (gross) distance around the room. 58 feet ÷ 20 = 2.9 or 3 receptacles.

*DINING ROOM: 16 feet by 16 feet; 64 feet total (gross) distance around the room. 64 feet ÷ 20 = 3.2 or 3 receptacles.

*BREAKFAST ROOM: 10 feet by 12 feet; 44 feet total (gross) distance around the room. 44 feet ÷ 20 = 2.2 or 2 receptacles.

*KITCHEN: 14 feet by 14 feet; 56 feet total (gross) distance around the room. 56 feet ÷ 20 = 2.8 or 3 receptacles.

Note 1. Receptacles to be placed equal distances apart insofar as practicable.

*Note 2. Receptacles in these locations, also laundry, to be supplied by circuit or circuits of not less than No. 12 wire. (Order 13-2109).

Example No. 2. Store Building

A store 50 feet by 60 feet, or 3,000 square feet, has 30 feet of show window.

COMPUTED LOAD:

General lighting load:
3,000 square feet at 3 watts per square foot .....9,000 watts
Show window lighting load:
30 feet at 200 watts per foot .....6,000 watts

**MINIMUM NUMBER OF BRANCH CIRCUITS REQUIRED (Order 13-2107):

General lighting load: 9,000 ÷ 230 = 39 amperes, for 3-wire, 115-230 volts; or 78 amperes for 2-wire, 115 volts:
Two 25-ampere, 2-wire, and two 15-ampere, 2-wire circuits; or
One 25-ampere, 3-wire, and one 15-ampere, 3-wire circuits; or
Six 15-ampere, 2-wire circuits; or
Three 15-ampere, 3-wire circuits.
Special lighting load (show window): 6,000 ÷ 230 = 26 amperes for 3-wire, 115-230 volts; or 52 amperes for 2-wire, 115 volts:
Four 15-ampere, 2-wire circuits; or
Two 15-ampere, 3-wire circuits.

MINIMUM SIZE FEEDERS (OR SERVICE CONDUCTORS) REQUIRED (Order 13-2203):

For 115-230-volt, 3-wire system:
Ampere load: 39 + 26 = 65 amperes.
Size of each feeder, No. 3.
For 115-volt system:
Ampere load: 78 + 52 = 130 amperes.
Size of each feeder, No. 3/0.

**In stores and similar occupancies where practically the entire load is likely to be used for long periods of time, the loading of the circuit shall not exceed 80 per cent of the branch circuit rating. Order 13-2107. Therefore, in such installations the number of branch circuits shall be increased accordingly.

Example No. 3. Multi-Family Dwelling

Multi-family dwelling having a total floor area of 32,000 square feet with 40 apartments.
Meters in two banks of 20 each and individual sub-feeders to each apartment.
One-half of the apartments are equipped with electric ranges of 8 k.w. each.
Area of each apartment is 800 square feet.

COMPUTED LOAD (per apartment):

General lighting load: 800 square feet at 2 watts per square foot.... 1,600 watts
Small appliance load ..... 1,500 watts

Total computed load each apartment (without range)..... 3,100 watts
Special appliance load, electric range 8,000 × 80%..... 6,400 watts

MINIMUM NUMBER OF BRANCH CIRCUITS REQUIRED FOR EACH APARTMENT (Order 13-2107):

General lighting load: 1,600 ÷ 115 = 13 amperes, or one 15-ampere, 2-wire circuit.
Small appliance load: 1,500 ÷ 115 = 13 amperes, or one 2-wire circuit of No. 12 wire (See order 13-2109).
Range Circuit, 6,400 ÷ 230 = 27 amperes; or one 35-ampere, 3-wire circuit.

MINIMUM SIZE SUB-FEEDER REQUIRED FOR EACH APARTMENT (Order 13-2203):

Total Computed Load:
Lighting and appliance load .....
3,000 watts at 100% ..... 3,100 watts
100 watts at 35% ..... 3,000 watts
..... 35 watts

Net Computed Load (without Range) ..... 3,035 watts
Range Load 8,000 × 80% ..... 6,400 watts

Net Computed Load (with Range) ..... 9,435 watts

For 115-230-volt, 3-wire system (without range):

3,035 ÷ 230 = 13 amperes
Size of each sub-feeder, No. 12 (See order 13-2109)

For 115-230-volt, 3-wire system (with range):

9,435 ÷ 230 = 41 amperes
Size of each sub-feeder, No. 6.

MINIMUM SIZE FEEDERS REQUIRED FROM SERVICE EQUIPMENT TO METER BANK (FOR 20 APARTMENTS—10 WITH RANGES):

Total Computed Load:

Lighting and small appliance load, 20 × 3,100 watts.....	62,000 watts
3,000 watts at 100%	3,000 watts
59,000 watts at 35%	20,650 watts
	23,650 watts
Special Appliance Load:	
Ranges: 8,000 watts × 10 × 34%	= 27,200 watts
Net Computed Load	50,850 watts

For 115-230-volt, 3-wire system:

50,850 ÷ 230 = 221 amperes
Net Computed Load 221 amperes
Neutral Feeder (maximum unbalance of load—221 amperes)
200 amperes at 100% = 200 amperes
21 amperes at 70% = 14 amperes
Net Computed Load (neutral) 214 amperes
Size of each ungrounded feeder to each meter bank, 400,000 C.M.
*Size of neutral feeder to each meter bank, 350,000 C.M.
*See Note 6 to Tables 1 and 2.

MINIMUM SIZE MAIN FEEDER (OR SERVICE CONDUCTORS) REQUIRED (FOR 40 APARTMENTS—20 WITH RANGES):

Total Computed Load:

Lighting and small appliance load, 40 × 3,100 watts	124,000 watts
3,000 watts at 100%	3,000 watts
117,000 watts at 35%	40,950 watts
4,000 watts at 25%	1,000 watts
	44,950 watts
Special Appliance Load:	
Range: 8,000 × 20 × 28%	= 44,800 watts
Net Computed Load	89,750 watts

For 115-230-volt, 3-wire system:

89,750 ÷ 230 = 390 amperes
Net Computed Load 390 amperes
Neutral feeder (maximum unbalance of load—390 amperes)
200 amperes at 100% = 200 amperes
190 amperes at 70% = 133 amperes
Net Computed Load (neutral) 333 amperes
Size of each ungrounded main feeder .....1,250,000 cir. mils
*Size of neutral main feeder ..... 800,000 cir. mils
*See Notes 3 and 6 to Tables 1 and 2.

Example No. 4. Calculation of Neutral Feeder

(See order 13-2204)

The following example illustrates the method of calculating size of neutral feeder for computed load of a 5-wire, 2-phase system, where it is desired to modify the load in accordance with provisions of order 13-2204.

An installation consisting of a computed load of 250 amperes connected between neutral feeder and each ungrounded feeder.

Neutral feeder (maximum unbalance of load 250 amp. × 140% = 350 amperes):
200 amperes (first) at 100% = 200 amperes
150 amperes (excess) at 70% = 105 amperes
Computed load 305 amperes
Size of neutral feeder: 700,000 C.M.

Example No. 5. Motors, Conductors, and Overcurrent Protection

(See orders 13-4312, 13-4314, 13-4322 and 13-4342)

Determine the size of conductors, the motor-running overcurrent protection, the branch circuit protection, and the feeder protection, for one 25-h.p. squirrel-cage induction motor (full-voltage starting), and two 30-h.p. wound-rotor induction motors, on a 440-volt, 3-phase, 60-cycle supply.

Conductor Sizes

The full-load current of the 25-h.p. motor is 32 amperes (Table 24). A full-load current of 32 amperes requires a No. 6, Type R, rubber-covered conductor (Column 2, Table 20). The full-load current of the 30-h.p. motor is 39 amperes (Table 24) A full-load current of 39 amperes requires a No. 5, Type R, rubber-covered conductor (Column 2, Table 20).

The feeder conductor capacity will be 125 per cent of 39, plus 39, plus 32, or 120 amperes (order 13-4314). In accordance with Table 1, this would require a No. 00, Type R, rubber-covered feeder.

Note. For Type R conductors run open in air, or for conductors with insulations other than Type R, see Tables 1 and 2.

Overcurrent Protection

Running. The 25-h.p. motor, with full-load current of 32 amperes, must have running overcurrent protection of not over 40 amperes (Columns 5 and 6, Table 20). The 30-h.p. motor with full-load current of 39 amperes must have running overcurrent protection of not over 50 amperes (Columns 5 and 6, Table 20).

Branch Circuit. The branch circuit of the 25-h.p. motor must have branch-circuit overcurrent protection of not over 100 amperes (Column 7, Table 20). The branch circuit of the 30-h.p. motor must have branch-circuit overcurrent protection of not over 60 amperes (Column 10, Table 20).

Feeder Circuit. The rating of the branch-circuit fuse for a 25-h.p. squirrel cage motor is 300 per cent of 32 amperes, or 96 amperes (Table 27); and for a 30-h.p. wound-rotor motor is 150 per cent of 39 amperes or 59 amperes (Table 27). The rating of a feeder fuse is, therefore, 96 + 39 + 39 = 174 amperes, and a 175-ampere fuse is the maximum size which may be used. (See order 13-4362.)

The setting of a motor-branch-circuit circuit-breaker for a 25-h.p. squirrel cage motor is 250 per cent of 32 amperes or 80 amperes (Table 27); for a 30-h.p. wound-rotor motor is 150 per cent of 39 amperes or 59 amperes (Table 27). The maximum setting of a feeder circuit-breaker is 80 + 39 + 39 = 158 amperes. (See order 13-4362).

PART 5

RADIO INSTALLATIONS

Orders formerly contained in this part of the code will be found in Section 13-810.

PART 6

PROTECTION OF BUILDINGS AND STRUCTURES AGAINST LIGHTNING

For complete codes on lightning protection see the following:

1. Code for Protection Against Lightning, National Bureau of Standards, Handbook H-21.

2. Code for Protection Against Lightning published by the National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts.

SECTION 160. SCOPE, DEFINITIONS, ETC.

Order 1600. Scope and Purpose.

The rules of this part of the code apply to the protection against lightning of buildings and other property, with the exception of property devoted to the production, storage, and transportation of flammable liquids and gases, and electric lines and equipment.

The purpose is the prevention of fire loss and other damages from lightning by directing attention to the available means of protection which are believed to be effective.

Order 1601. Interpretation and Exceptions.

This code shall be liberally construed. In cases of practical difficulty or unnecessary hardships exceptions from its literal requirements may be made if equivalent protection is otherwise secured.

It is not intended that this code shall be interpreted as recommending the protection of every class of property to which it applies, but shall constitute the standard where economic or other considerations make it appear that protection is necessary or desirable.

Order 1602. Mandatory and Advisory Requirements.

The word "shall" where used is to be understood as mandatory and the word "should" as advisory. "May" is used in the permissive sense.

Order 1603. Terms and Definitions.

Air Terminal: The combination of elevation rod, and brace, or footing placed on upper portions of structures, together with tip or point if used.

Conductor: The portion of a protective system designed to carry the current of a lightning discharge from air terminal to ground.

Branch Conductor: A conductor which branches off at an angle from a continuous run of conductor.

Cable: A number of wires twisted or braided to form a conductor.

Copper-Clad Steel: Steel with a coating of copper welded to it as distinguished from copper-plated or copper-sheathed material.

Down Conductor: The vertical portion of a run of conductor which ends at the ground.

Elevation Rod: The vertical portion of conductor in an air terminal by means of which it is elevated above the object to be protected.

Fastener: A device used to secure the conductor to the building.

Ground Connections: A buried body of metal with its surrounding soil and a connecting conductor which together serve to bring an object into electrical continuity with the earth.

Metal-Clad Building: A building with sides made of or covered with metal.

Metal-Roofed Building: A building with a roof made of or covered with metal.

Point: The pointed piece of metal used at the upper end of the elevation rod to receive a lightning discharge.

Roof Conductor: The portion of the conductor above the eaves running along the ridge, parapet, or other portion of the roof.

SECTION 161. LIGHTNING RODS FOR ORDINARY BUILDINGS

Orders 1610 to 1613, inclusive, hereunder apply more particularly to buildings of the ordinary types which have roofs of slate, tile or other non-conducting material. Order 1614 sets forth modifications to the orders preceding it which may be made for the case of buildings which are roofed, or roofed and clad with metal. Grounding and interconnection of metals are included in orders 1615 to 1617 while Section 162 is to be referred to when buildings are equipped with spires, steeples, flag poles or towers.

Order 1610. Conductors.

A. *Materials.* The materials of which protective systems are made shall be relatively resistant to corrosion or shall be acceptably protected against corrosion. No combination of materials shall be used that forms an electrolytic couple of such nature that in the presence of moisture corrosion is accelerated, but where moisture is permanently excluded from the junction of such metals contact between them is not objectionable.

The following list of materials comprises those commonly used for protective systems, or parts of protective systems, and with their

accompanying specifications constitute materials to be regarded as standard for the purposes of this section.

1. Copper. Where copper is used it shall be of the grade ordinarily required for commercial electrical work, generally designated as being of 98 per cent conductivity when annealed.

2. Alloys. Where alloys of metals are used they shall be substantially as resistant to corrosion as copper under similar conditions.

3. Copper-clad steel. Where copper-clad steel is used, the copper covering shall be permanently and effectively welded to the steel core, and the proportion of copper shall be such that the conductance is not less than 30 per cent of the conductance of an equivalent cross-section of solid copper.

4. Galvanized steel. Where steel is used it shall be thoroughly protected against corrosion by a zinc coating which will satisfactorily withstand the standard test of the American Society for Testing Materials for galvanized coatings.

B. *Form and Size.* Branch and main conductors may be in the form of cable, tube, strip or rod having round, square, star or other cross-section. The following subsections give minimum sizes and weights.

1. Copper cable. Copper cable conductors shall weigh not less than 187.5 pounds per thousand feet. The size of any wire of a cable shall be not less than No. 17 A. W. G. (0.045 inch).

2. Copper tube, copper solid section and copper-clad steel. Tube, or solid section conductors of copper or copper-clad steel shall weigh not less than 187.5 pounds per thousand feet. The thickness of any tube wall shall be not less than No. 20 A. W. G. The thickness of any copper ribbon or strip shall be not less than No. 16 A. W. G. (0.051 inch).

3. Galvanized steel. Galvanized steel conductors shall have a net weight of steel of not less than 320 pounds per thousand feet and a zinc coating of not less than 2 ounces per square foot of galvanized surface. The thickness of any tube wall, web or ribbon before galvanizing shall be not less than No. 17 U. S. Standard Sheet Gauge (0.056 inch) and the diameter of any wire of a cable before galvanizing shall be not less than No. 14 Steel Wire Gauge (0.080 inch).

C. *Joints.* 1. General. Joints in conductors shall be as few in number as practicable and where they are necessary they shall be mechanically strong and well made and provide ample electrical contact. The latter requirement is to be regarded as met by a contact area not less than double the conducting cross-sectional area of the conductor.

2. Mechanical strength. On structures exceeding 60 feet in height, joints shall be so constructed that their mechanical strength in tension as shown by laboratory tests is not less than 50 per cent of that of the smallest of the several sections of conductor which are joined together.

3. Electrical resistance. Joints shall be so made that they have an electrical resistance not in excess of that of two feet of conductor.

D. *Fasteners.* Conductors shall be securely attached to the building or other object upon which they are placed. Fasteners in general shall be substantial in construction, not subject to breakage and shall be, with the nails, screws, or other means by which they are fixed, of the same material as the conductor, or, of such nature that there will be no serious tendency towards electrolytic corrosion in the presence of moisture because of contact between the different parts.

Fasteners shall be so spaced as to give adequate support to the conductor, generally not over four feet apart.

Order 1611. Points and Elevation Rods.

A. *Attachment of Points.* Separate points are not required, but if used shall be of substantial construction and be securely attached to the elevation rods by screw or slip joints. The conducting cross-sectional area of the base shall be at least equivalent to the conducting cross-sectional area of the elevation rod.

B. *Elevation Rods.* 1. Size. Elevation rods shall be at least equivalent in weight and stiffness of a copper tube having an outside diameter of ⅝ inch and a wall thickness of No. 20 A. W. G. (0.032 inch).

2. Form. Elevation rods may be of any form of solid or tubular cross-section.

3. Height. The height of an elevation rod shall be such as to bring the tip not less than ten inches above the object to be protected. On flat or gently sloping surfaces a greater height than ten inches should be provided but the height need not exceed five feet.

C. *Braces for Elevation Rods.* 1. Use. Elevation rods shall be amply secured against overturning either by attachment to the object to be protected or by means of substantial tripod or other braces which shall be permanently and rigidly attached to the building.

2. Materials. The material from which braces are constructed shall be at least the equivalent in strength and stiffness of one-fourth inch round iron, and with the nails or screws used in erecting must comply with the requirements of "Order 1610 A Materials" as to resistance to corrosion or protection against corrosion.

3. Form and construction. Braces shall be assembled by means of riveted joints or other joints of equivalent strength. Preference should be given to tripod or fourlegged braces and when in place the feet should be spread until the distance between them approximates one-third the height of the brace.

4. Guides. Where elevation rods are more than 24 inches high, braces shall have guides for holding the elevation rod at two points located approximately as follows: The lower at a distance above the foot of the rod equal to one-third of its height, the upper at a distance above the lower equal to one-fourth the height of the rod.

Where elevation rods are 24 inches high or less, braces with a single guide may be used, holding the rod approximately midway of its height. Ten-inch elevation rods may be braced by means of substantial footings.

Order 1612. Prevention of Deterioration.

A. *General.* Precaution shall be taken in every instance to provide against any undue tendency toward deterioration due to local conditions.

B. *Corrosion.* Where any part of a protective system is exposed to the direct action of chimney gases or other corrosive gases, it shall be protected by a continuous covering of lead one-sixteenth inch or more in thickness.

C. *Mechanical Injury.* Where any part of a protective system is exposed to mechanical injury it shall be protected by covering it with molding or tubing preferably made of wood or non-magnetic material. If metal tubing is used the conductor shall be electrically connected to it at its upper end.

D. *Use of Ornaments.* The use of small ornaments such as glass balls attached to elevation rods is not objectionable but elevation rods shall not be made to support vanes or ornaments having in any plane a wind resistance area in excess of 20 square inches.

Order 1613. Air Terminal and Conductors.

A. *General.* Air terminals shall be provided for all structural parts that are likely to receive, and be damaged by, a stroke of lightning.

B. *Projections.* In the case of projections such as gables, chimneys, and ventilators, the air terminal shall be placed on, or attached to, the object to be protected where practicable, otherwise within two feet of it.

C. *Ridges, Parapets, and Edges of Flat Roofs.* Along ridges, parapets, and edges of flat roofs, air terminals shall be spaced at intervals not exceeding 25 feet.

D. *Metal Projections and Parts of Buildings.* Metal projections and parts of buildings such as chimneys, ventilators, flagpoles, towers, water tanks, spires, smoke stacks, steeples, deck railings, shaft houses, gables, skylights, dormers, ridges, and parapets which are made of or covered with metal that are likely to receive, but not be appreciably damaged by, a stroke of lightning, need not be provided with air terminals, but shall be securely bonded to the lightning conductor with metal of the same weight per unit length as the main conductor.

E. *Coursing of Conductors.* Conductors shall in general be coursed over the roofs and down the corners and sides of buildings in such a way as to constitute as nearly as local conditions will permit, an enclosing network.

F. *Roof Conductors.* Roof conductors shall be coursed along contours, such as ridges, parapets, and edges of flat roofs, and where necessary over flat surfaces, in such a way as to join each air terminal to all the rest.

Roof conductors surrounding decks, flat surfaces, and flat roofs, shall be connected to form a closed loop.

G. *Down Conductors.* Down conductors shall preferably be coursed over the extreme outer portions of buildings, such as corners, due consideration being given to the best places for making ground connections, and to the location of air terminals.

H. *Obstructions.* Conductors shall be coursed around chimneys, ventilators, and similar obstructions in a horizontal direction.

I. *Bends.* No bend in a conductor which embraces a portion of a building such as an eave, shall have a radius of less than eight inches. The angle of any turn shall not exceed 90° and conductors shall everywhere preserve a downward or approximately horizontal course.

Order 1614. Metal-Roofed and Metal-Clad Buildings.

The materials and equipment required by this rule for the protection of metal-roofed or metal-roofed and clad buildings, shall comply with the requirements of orders 1610 to 1613, inclusive.

A. *Metal in Overlapping Sections.* Buildings which are roofed, or roofed and clad, with metal in the form of sections insulated from one another, or so applied that they are not in electric contact, shall be treated in the same manner as are buildings composed of non-conducting materials.

B. *Metal Continuous.* When buildings are roofed or roofed-and-clad, with all metal sheets made electrically continuous by means of an interlocking or other contact, or by bonding, the following modifications may be made to the requirements of orders 1611 to 1617, inclusive.

Air terminals need be provided only on chimneys, ventilators, gables, and other projections, such as are likely to receive and be damaged by a stroke of lightning. Projections that are likely to receive, but not be damaged by a stroke of lightning need not be provided with air terminals, but shall be securely bonded to the roof.

Roof conductors may be dispensed with, and elevation rods if used connected to the roof by soldered joints, or securely bolted joints, having an area of contact of not less than three square inches. If the roof metal is in small sections connection shall be made to at least four of the sections.

Down conductors shall be connected to the edges of roofs, or to the lower edges of metal siding, by soldered or bolted joints having an area of contact of at least three square inches. If the metal is in small sections, connection shall be made to at least four of the sections.

Order 1615. Number of Down Conductors.

A. *Minimum.* There shall be not less than two down conductors on any type of buildings, and these shall be run so as to be as widely separated as practicable. The following rules shall apply as to additional down conductors.

B. *Rectangular Structures.* On rectangular structures having gable, hip, or gambrel roofs, and exceeding 110 feet in length, there shall be at least one additional down conductor for each additional 50 feet of length, or fraction thereof.

On rectangular structures having French, flat, or sawtooth roofs, and exceeding three hundred feet in perimeter, there shall be at least one additional down conductor for each additional 100 feet of perimeter or fraction thereof.

C. *Irregular-shaped Structures.* On an ell or T-shaped structure there shall be at least one additional down conductor; on an H-shaped structure at least two additional down conductors; and on a wing-built structure at least one additional down conductor for each wing.

On irregular-shaped structures the total number of down conductors shall in every case be sufficient to make the average distance between them along the perimeter not greater than 100 feet.

D. *Structures Exceeding 60 Feet in Height.* On structures exceeding 60 feet in height there shall be at least one additional down conductor for each additional 60 feet of height, or fraction thereof, except that the application of this rule shall not cause down conductors to be placed about the perimeter of a structure at intervals of less than 50 feet.

E. *Metal-Roofed and Metal-Clad Buildings.* The number of down conductors and ground connections for metal-roofed and metal-clad buildings shall be determined in the same manner as for buildings composed of non-conducting materials, i. e. according to the requirements of A, B, C, and D above.

F. *Dead Ends.* Additional down conductors shall be installed where necessary to avoid "dead ends," or branch conductors ending at air terminals, which exceed 16 feet in length, except that single down conductors descending flagpoles, spires, and similar structures which are adjuncts of buildings shall not be regarded as "dead ends" but shall be treated as air terminals.

Order 1616. Interconnection of Metallic Masses.

A. *Exterior Bodies of Metal.* Metal situated wholly on the exterior of buildings such as ornamental ridges, ventilators, roofs, valleys, gutters, down spouts, structural iron, etc., shall be connected to the conductor at its upper or nearest end, and if of considerable length, shall be grounded or electrically connected to the conductor at its lower or farthest end.

B. *Interior Bodies of Metal.* Metal situated wholly in the interior of buildings such as radiators, piping systems, electric conduit, tanks, stationary machinery and stanchions, which are often in contact with persons or animals shall not be connected to the lightning conductor. Lightning conductors shall be kept more than six feet from the above mentioned objects.

C. *Metal Bodies Projecting Through Sides and Roofs.* Metal which projects through roofs, or through sides of buildings above the second floor, shall be bonded to the nearest conductor at the point where it emerges from the building and be grounded at its lower or extreme end within the building.

D. *Interconnection of Metals on or within Metal-Roofed and Metal-Clad Buildings.* All parts of metal roofs, or roofs and sides, shall be securely bonded together.

E. *Metallic Bodies to be Independently Grounded.* Metallic bodies having any dimension exceeding five feet, and situated wholly within buildings, and which do not at any point come within six feet of a lightning conductor or metal connected thereto shall be independently grounded.

F. *Substitution for Regular Conductors.* Extended metal parts of buildings shall not be substituted for regular conductors, except where they are permanently electrically continuous, and have a conducting cross-sectional area at least double that of the lightning conductor that would otherwise be used.

G. *Size of Interconnecting and Bonding Wires.* For bonding, interconnecting and independent grounding of metallic masses the conductor used shall be at least the equivalent in strength and conducting cross-sectional area of a No. 6 A. W. G. copper wire, except where full size lightning conductor is required by order 1613 D.

Order 1617. Ground Connections.

A. *Number.* A ground connection shall be provided for each down conductor, preference being given to metal water pipes connected to an extensive water system and other large underground metallic structures.

B. *Distribution.* Ground connections (and down conductors) shall be placed at as uniform intervals about a building as practicable, and grouping of ground connections on one side of the building shall be avoided.

C. *Moisture.* In making ground connections advantage should be taken of all permanently moist places where practicable, although such places should be avoided if wet with waste water which contains chemical substances especially corrosive to the metal with which the ground connection is made.

D. *Permanency.* Ground connections shall in every case be thoroughly and permanently made, with due regard to the character of the surrounding soil.

E. *Ground Connection to Pipe Systems.* No grounding electrode shall be located within 6 feet of any water system of limited extent, gas pipe, electrical conduit or other metal object which enters the building except where the grounding electrode encircles the building as provided in "G" following. Where an extensive waterpipe system is available and where it enters the building, at least one down conductor shall be attached to it at a point immediately outside the basement wall by means of a substantial clamp to which the conductor can be attached by bolts or solder.

F. *Grounding Electrodes in Deep Soil.* Where the soil is moist clay, or other soil of similar character as to electrical resistivity, artificial grounding electrodes may be made by extending the rod itself into the ground a distance of not less than 10 feet. Where the soil is largely sand, gravel, or stones, more extensive artificial grounding electrodes

shall be made by adding metal in the form of driven rods or pipes, or strips, plates, or lengths of conductor buried in trenches as in "G" following.

G. *Grounding Electrodes in Shallow Soil.* Where bed rock is near the surface, ground connections may be made by digging trenches radially from the building and burying in them the lowest ends of the down conductors or their equivalent in the form of metal strips or wires. Where the soil is very dry or will not permit digging to a depth of more than one foot in addition to the conductors laid radially, a similar conductor shall be buried which encircles the structure to be protected and connects all of the down conductors together.

H. *Trenches.* Trenches shall be long enough to accommodate 12 feet of conductor when laid straight, but need not be more than three feet in depth.

Order 1618. Radio Installations and Wires Entering Buildings.

A. *Grounding Conduit.* Metal conduits projecting through the exterior walls of rural buildings shall be permanently grounded outside of the building by an independent grounding conductor run from it to an independent grounding electrode as directly as possible.

B. *Metal Radio Masts on Buildings.* Metal radio masts on buildings shall be bonded to the nearest lightning conductor.

C. *Wooden Radio Masts.* Wooden radio masts which extend more than six feet above the ridge or highest parts of the building on which they are placed shall be treated in the same manner as flagpoles.

SECTION 162. MISCELLANEOUS STRUCTURES

Order 1620. Spires, Steeples, and Flag Poles.

A. *General.* The materials, equipment and ground connections required by the rules of this section for the protection of spires, steeples, and flag poles, shall comply with the requirements of Section 161.

B. *Air terminals.* A single air terminal may be used, which elevates the tip a distance of not less than ten inches above the uppermost point of the structure.

C. *Down Conductors.* A single down conductor may be used, which, if the structure is isolated, shall be extended directly to a ground connection. If the structure is an adjunct of a building and near or touching the perimeter, the down conductor shall be extended directly to a ground connection, but shall also be connected to the lightning conductor system on the building. If it is set well within the perimeter the descending conductor shall be connected to the nearest roof conductor.

D. *Interconnection of Metals.* Bells, clocks, structural iron, and other metallic masses shall be connected to the down conductor. If the length of a metallic body is comparable to the height of the structure, connection shall be made at the upper and lower extremities; otherwise connection may be made at the nearest point.

E. *Grounding of Metallic Spires and Flagpoles.* Spires and flag poles composed entirely of or covered entirely with metal and resting on foundations of non-conducting material with the top so constructed as to receive a stroke of lightning without appreciable damage, need not be provided with air terminals or down conductors, but shall be grounded or connected to the nearest lightning conductor, or both, according as the structure is isolated, set within the perimeter of a building or near it, respectively.

Order 1621. Water Towers, Silos, and Similar Structures.

A. *General.* The materials, equipment and ground connections required by the rules of this section for the protection of water towers, silos, and similar structures, shall comply with the requirements of Section 161.

B. *Air Terminals.* The number and location of air terminals shall in general comply with the requirements of order 1613, except that on silos and other towers having roofs ending in a peak a single air terminal may be regarded as sufficient.

C. *Conductors.* Where more than one air terminal is used they shall be connected together by a conductor which forms a closed loop about the structure near the top, or passes over it, as the contour of the roof may require. From this, or from the single air terminal if but one is used, at least two down conductors shall be extended directly to ground connections on opposite sides, if the structure is isolated. If it is an adjunct of a building, near or touching the perimeter, one down conductor shall be extended directly to a ground connection while the other may be connected to the lightning conductor system on the building. If it is set well within the perimeter both down conductors may be connected to the lightning conductor system on the building. If the height of the structure exceeds 100 feet the down conductors should be cross-connected midway between top and bottom.

D. *Interconnection of Metals.* All metallic bodies of considerable size or extent, whether exterior or interior, shall be connected to the down conductors. If their length is comparable to the height of the structure, they shall be connected to the down conductors at both ends; otherwise connection may be made at the nearest point.

E. *Grounding of Metal Towers and Water Tanks.* Towers and tanks composed entirely of or covered entirely with metal and resting on foundations of non-conducting material, with the uppermost portion so constructed as to receive a stroke of lightning without appreciable damage, shall be grounded by means of two earth terminals on opposite sides of the structure.

SECTION 163. BUILDINGS CONTAINING BALED FLAMMABLE MATERIALS

Order 1630. Methods and Materials.

The materials, equipment and ground connections required by the rules of this section shall comply with the requirements of Sections 161 and 162.

Order 1631. Metal-Roofed and Metal-Clad Buildings.

Metal-roofed and metal-clad buildings shall be treated in the same manner as required in Section 161, order 1614.

Order 1632. Buildings of Non-Conducting Materials.

The effect of an electrostatic shield may be obtained by constructing on or above the roof a network of wires or cables and grounding it about the perimeter at the same intervals as required for metal-roofed buildings.

SECTION 164. SMOKESTACKS AND CHIMNEYS

Order 1640. Metal Smokestacks.

Metal smokestacks shall be properly grounded. If the construction of the foundation is not such as to provide ample electrical connection with the earth, ground connections shall be provided similar to those required for stacks made of materials other than metal as provided in order 1641 G.

Metal guy wires and cables shall be grounded at their lower ends.

Order 1641. Brick, Hollow Tile, and Concrete Stacks.

Where stacks of brick, hollow tile, concrete, or other material liable to damage by lightning are to be protected the following rules shall apply.

A. *Conductors.* Conductors shall be of copper of the grade required for commercial electrical work, generally designated as having 98 per cent conductivity when annealed.

The weight of the conductor shall be not less than 375 pounds per thousand feet.

The size of any wire in a cable shall be not less than No. 15 A. W. G. (0.057 inch).

The thickness of any tube wall shall be not less than No. 15 A. W. G. (0.057 inch).

The thickness of any web or ribbon shall be not less than No. 12 A. W. G. (0.080 inch).

B. *Fasteners.* Fasteners shall be of copper or copper alloy substantially as resistant to corrosion as the conductor itself, and must be strongly constructed. Each fastener must have a sufficiently tight grip to support its corresponding length of conductor.

Fasteners shall be spaced close enough to give ample support to the conductor, generally not over four feet apart.

C. *Air Terminals.* Air terminals shall be strongly constructed of the same grade of material as the conductor and shall be uniformly distributed about the rim of the stack at intervals not exceeding eight feet.

The height above the rim shall be not less than 30 inches.

They shall be secured to the top of the stack by means of expansion bolts or fan shank fasteners of substantial construction. The air terminals shall be electrically connected together by means of a metal ring or band which forms a closed loop about two feet below the top of the chimney. If there is a metal crown the air terminals should be connected thereto.

D. *Down Conductors.* At least two down conductors shall be provided on opposite sides of the stack, leading from the ring or crown at the top to the ground.

On stacks exceeding 160 feet in height the down conductors shall be cross-connected approximately midway between top and bottom. Where a metal ladder is continuous from the rim to the ground, and the vertical members have a combined cross-section not less than twice that specified in Order 1610 B, 3, such members may be utilized as down conductors.

E. *Lead Covering.* In order to prevent corrosion by gases, air terminals, conductors, and fasteners within 25 feet of the top of the stack should have a continuous covering of lead at least one sixteenth inch thick.

F. *Joints.* Joints in conductors must be as few as practicable and of such construction as to show by laboratory tests a strength in tension of at least 50 per cent of that of the conductor.

G. *Ground Connections.* Ground connections may be made in the manner prescribed for buildings in order 1617.

H. *Protection Against Mechanical Injury.* Down conductors near the ground shall be protected against mechanical injury by means of wood molding or other non-magnetic material.

If metal tubing is used for protective purposes the down conductor shall be electrically connected to it at its upper end.

I. *Metal Linings.* Where stacks have a metal lining extending part way up the lining shall be connected to the rod at its upper end and grounded at the bottom.

SECTION 165. LIVESTOCK IN FIELDS

The information on this subject is limited, but the best obtainable has been made use of in formulating the following rules. On account of the nature of the exposure it is not possible, of course, to eliminate the hazard entirely, but it is believed that if these rules are applied it can be much reduced.

The loss of livestock by lightning is caused in large measure by herds drifting against ungrounded wire fences during thunderstorms and receiving a sufficient discharge to kill them, either from accumulated static electricity or from a stroke on the fence itself. The fences

that give rise to the most trouble of this kind are those constructed with posts of poorly conducting material, such as wood or concrete. Fences built with metal posts set in earth are as safe from lightning as it is possible to make them, especially if the electrical continuity is broken as provided hereafter. Breaking the electrical continuity is very useful in that it prevents a lightning stroke from affecting the entire length of a fence, as it may if the stroke is direct and the fence continuous, even though grounded.

Isolated trees in pastures where stock congregate seeking shade are also a source of loss. In pastures where shade is available from wooded areas of considerable size, isolated trees should be removed, but otherwise should be protected by suitable rodding as described in Order 1652 below.

Order 1650. Grounding of Wire Fences.

Where it appears desirable or necessary to mitigate the danger from wire fences constructed with posts of nonconducting material the following rules shall apply.

A. *Iron Posts.* Ground connections may be made by inserting at intervals galvanized-iron posts, such as are ordinarily used for farm fencing, and attaching in electrical contact all of the wires of the fence. If the ground is normally dry the intervals between metal posts shall not exceed 150 feet. If the ground is normally damp they may be placed 300 feet apart.

B. *Iron Pipe.* A less expensive ground connection than A, may be made by driving a length of one-half or three-quarter inch internal diameter galvanized iron pipe beside the fence and attaching the wires by ties of galvanized iron wire. The spacing shall be the same as for the posts under A above.

C. *Depth of Grounds.* Pipes or posts shall be extended into the ground at least three feet.

Order 1651. Breaking Continuity of Fence.

In addition to grounding the fence its electrical continuity shall be broken by inserting insulating material in breaks in the wires at intervals of about 1000 feet. These insertions may be in the form of fence panels of wood or lengths of insulating material to the ends of which the wires can be attached. Such lengths of insulating material may consist of strips of wood 2x2x24 inches, or their equivalent as far as insulating properties and mechanical strength are concerned.

Order 1652. Trees.

Where a tree is isolated and the vicinity is much frequented by livestock, the danger from lightning can be reduced by installing a single conductor extending from the top of the tree, to a distance of at least six feet into the ground.

Note: For protection of hangars, balloons, airships, ships, trees, and structures containing flammable liquids and gases, reference should be made to "Code for Protection Against Lightning," National Bureau of Standards Handbook H-21.

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