

ELEVATOR CODE

STATE OF WISCONSIN

REVISED 1926

Effective Date Aug. 12, 1926

Issued by
INDUSTRIAL COMMISSION OF WISCONSIN
MADISON



COMMISSIONERS
VOYTA WRABETZ, *Chairman*
PETER A. NAPIECINSKI
HARRY R. McLOGAN

INDUSTRIAL COMMISSION OF WISCONSIN

Secretary
R. McA. KEOWN, *Engineer* *Building Engineer*

ELEVATOR CODE

INTRODUCTION

The present Wisconsin Elevator Code is a complete revision of the original elevator code which became effective February 20, 1913. The first Wisconsin Elevator Code was drafted by the then existing committee on safety and sanitation composed of the following persons:—

- Representing Wisconsin State Federation of Labor:
 - George Mutter, Machinist, Milwaukee.
 - Fred French, Patternmaker, Milwaukee.
- Representing Milwaukee Merchants and Manufacturers' Association:
 - Charles P. Bossert, Pfister and Vogel Leather Company.
 - Edward J. Kearney, Kearney and Trecker Company, Chairman.
- Representing Milwaukee Health Department:
 - Joseph Derfus, Chief Sanitary Inspector.
- Representing Wisconsin Manufacturers' Association:
 - Thomas McNeill, Sheboygan Chair Company, Sheboygan.
 - H. W. Bolens, Gilson Manufacturing Company, Port Washington.
- Representing Employers' Mutual Liability Company of Wausau:
 - W. C. Landon, Wausau.
- Representing Industrial Commission of Wisconsin:
 - John W. Mapel, Pfister and Vogel Leather Company.
 - Fred W. McKee, Fairbanks-Morse Company, Beloit.
 - C. W. Price, Assistant to the Industrial Commission and Secretary of the committee.

The following sub-committee assisted the main committee on safety and sanitation in drafting the orders:—

- C. F. Ringer, former Inspector of Buildings, Milwaukee.
- P. Jermain, Otis Elevator Company.
- George Mueller, Inspector of Elevators, Milwaukee.

Otto Fischer, Inspector of Elevators, Milwaukee.
G. N. Chapman, Inspector of Safety, Travelers' Insurance Company.
C. W. Price, Assistant to Industrial Commission.

The elevator code was amended first rather extensively in 1917, by an elevator code committee including the following persons.

C. F. Ringer, Architect, former Inspector of Buildings, Milwaukee.
P. Jermain, Otis Elevator Company.
George Mueller, Inspector of Elevators, Milwaukee.
G. N. Chapman, Inspector of Safety, Aetna Insurance Company.
Sidney J. Williams, Engineer, Industrial Commission.

The revision by the above committee became effective January 10, 1918. Minor details of the code were amended in 1920, becoming effective April 23, 1920. Order 499 of the previous edition of the elevator code was adopted March 23, 1920, and became effective April 24, 1920.

The present revision of the elevator code was drafted by the following elevator code committee:

George Mueller, Chairman, Elevator Inspector for Building Inspection Department, Milwaukee.
W. C. Muehlstein, Madison, Secretary of Committee, Industrial Commission.
C. P. Bossert, Pfister and Vogel Leather Company, Milwaukee.
Mathew Orth, Elevator Constructor, 27 Martin Street, Milwaukee.
*Harrison P. Reed, General Manager, A. Kieckhefer Elevator Company, Milwaukee.
John Rodenberg, Milwaukee Manager, Otis Elevator Company, Milwaukee.
Thomas L. Rose, Architect, Wisconsin Chapter of American Institute of Architects, Milwaukee.
Walter S. Smith, Wisconsin Mutual Liability Company, Milwaukee.
Louis G. Koster, Elevator Inspector, Industrial Commission. Now Superintendent of Construction, S. Heller Elevator Company, Milwaukee.

Advisory Members:

Leo Glueckstein, President, S. Heller Elevator Company, Milwaukee.
W. A. Rosenberg, President, F. Rosenberg Elevator Company, Milwaukee.

This edition of the elevator code is a complete revision of the requirements as applied to elevator manufacture and installation in Wisconsin, and includes the repeal of certain of the present requirements, and the addition of new orders.

*Deceased short time before revision was completed.

The changes are based on study of elevator accidents throughout the country, and are intended to parallel the Safety Code for Elevators which was prepared under the general auspices of the American Engineering Standards Committee.

The orders contained in the elevator code are adopted by the commission under authority of Sections 101.01 to 101.28, inclusive, of the statutes of Wisconsin, and apply to all places of employment and to all public buildings, as defined by the statutes. The statutes specifically authorize the charging of fees for elevator inspections as described in Order 407.

Administration

The elevator code will be enforced by the Industrial Commission in cooperation with local officials, who are required by law to enforce all orders of the commission which are germane to their respective duties (Section 101—28), and in cooperation with inspectors and insurance companies.

Appeal

Any person who considers any part of the elevator code, or any interpretation of the code to be unreasonable, may appeal to the commission to modify or suspend the same. (See Sections 101.15 to 101.17 inclusive).

Penalty for Violation of an Order

Section 101.18 of the Wisconsin statutes provides that "every day during which any person, persons, corporation, or any official, agent, or employee thereof, shall fail to observe and comply with any order of the commission, or to perform any duty enjoined by Sections 101.01 to 101.29 inclusive, shall constitute a separate and distinct violation of such order, or of said sections, as the case may be".

Section 101.28 of the statutes provides that any employer or other person who violates an order, or fails or refuses to comply with a requirement of the elevator code shall forfeit and pay into the state treasury the sum of not less than \$10, nor more than \$100 for such violation.

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Part I

DEFINITIONS

SECTION I. DEFINITIONS.

Order 400.—Definitions.

1. An elevator is an elevating and lowering device, other than a dumbwaiter, provided with a platform and cage which is located in a permanent shaftway and is designed or used to carry persons or materials.

2. A dumbwaiter is an elevating and lowering device provided with a platform which is located in a permanent shaftway, is designed and used to carry materials only, is not more than 9 square feet in area and not more than 4 feet high, and has a carrying capacity of not more than 500 pounds.

3. A passenger elevator is an elevator used chiefly for carrying persons.

4. A freight elevator is an elevator used chiefly for carrying materials.

5. A carriage type elevator is an elevator which is supported by cables attached to the platform at four or more points.

6. A sidewalk elevator is an elevator located below a sidewalk or other public thoroughfare, and which has no lifting or counterweighting mechanism above the top landing level.

7. A hand power elevator is an elevator which is operated by hand power only.

8. A power elevator is an elevator which is operated by machinery and this classification includes all elevators which are not classed as hand power elevators.

9. An automatic push button elevator is an elevator the operation of which is controlled by buttons, at the landings and in the car, in such a manner that all landing stops are automatic.

10. An escalator is a moving, inclined, continuous stairway, or runway, used for raising or lowering persons.

11. A full automatic door, or a full automatic gate, is one which is opened by the action of the elevator car approaching the landing and is closed by gravity as the car leaves the landing.

12. A semi or half automatic door, or a semi or half automatic gate, is one which must be opened by hand, but which closes by gravity when the car leaves the landing.

13. An independently operated door, or an independently operated gate, is one which is opened and closed manually, or by power, from a source in no way derived from the motion of the car.

14. The travel of an elevator is the vertical distance from the lowest to the highest landing.

15. The term speed as applied to the movement of an elevator car means the average of the maximum speeds attained, in the up and down directions with 50 per cent of the capacity load on the car, in making a complete return trip between terminal landings.

16. The depth of pit is the vertical distance from the lowest landing to the bottom of the shaftway.

17. The overhead clearance is the vertical distance between nearest points of contact between the car and the overhead construction when the car is at the highest landing.

18. A basement is a story whose floor line is below the grade at any entrance, and whose ceiling is not more than 9 feet above such grade at any entrance.

19. An incombustible material is one which will not support combustion.

20. Fireproof construction means the use of incombustible material throughout and resistant to fire action.

21. A semi-fireproof enclosure or a semi-fireproof wall consists of not less than $1\frac{5}{8}$ x $3\frac{5}{8}$ inch studding, spaced not more than 16 inches center to center, with the $3\frac{5}{8}$ inch dimension at right angles with the plane of the wall, and having the following protection on both sides of the partition:—

(1) Metal lath and at least $\frac{3}{4}$ inch of Portland cement or gypsum plaster or gauged plaster containing one-half lime, one-half part (or more) Portland cement, and not over four parts sand; or

(2) Good quality plaster board at least $\frac{1}{2}$ inch thick, covered with sheet metal; or

(3) $\frac{1}{4}$ inch asbestos board, covered with at least $\frac{1}{2}$ inch Portland cement or gypsum plaster, or with sheet metal; or two layers of $\frac{1}{4}$ inch asbestos board, breaking joints; or

(4) The spaces between studding may be filled with approved incombustible material, the partition being plastered with Portland cement or gypsum plaster on metal lath; or

(5) Other equivalent approved fire resistive construction.

22. A fire door consists of a door and frame constructed entirely of fire resistive metal, or of wood completely covered with fire resistive metal.

23. A shaftway door interlock or a shaftway gate interlock is a device, the purpose of which is:

(1) To prevent the operation of the elevator machine to move the car away from the landing,

(a) Unless all shaftway landing doors or gates are closed and latched within 4 inches of the fully closed position, or

(b) Unless the shaftway door or gate opposite which the car is standing is closed and latched within 4 inches of the fully closed position; and

(2) To prevent the opening of a shaftway door or gate from the landing side unless the car is at that landing.

Note.—Where a door is equipped with an approved door closer which will positively latch the door after being released from the hand of the operator, such door is considered latched when the 4-inch zone is reached, provided that, after the car leaves the landing, the door cannot be opened from the landing side more than 4 inches.

24. A door electric contact or gate electric contact is an electrical device, actuated by the movement of the door or gate, the function of which is to prevent the operation of the elevator machine to move the car away from the landing unless all shaftway doors or shaftway gates are closed and latched within 4 inches of the fully closed position.

25. A telescoping gate is one in which the several parts slip together without distortion.

26. A collapsing gate is one that is distorted in opening and closing.

Note.—An accordion or expansion bar gate is a collapsing gate.

27. New installations or elevators hereafter installed include:—

(1) Every elevator for which the contract was not let before the effective date of this code;

(2) The shaftway enclosure, guides and machine of an elevator installed after the effective date of this code;

(3) The shaftway enclosure, guides and machine of an elevator which is hereafter moved to a new location or materially changed;

(4) Any complete part of an existing elevator which is materially altered or renewed after the effective date of this code;

(5) Every elevator which, after the effective date of this code, is changed from freight to passenger service, or vice versa.

Note.—Ordinary repairs necessary to maintain elevators in safe condition are not considered material alterations.

28. Existing installations or elevators heretofore installed include all those elevators, or parts of elevators, which cannot be considered as elevators hereafter installed or new installations.

29. Approved means approved by the Industrial Commission.

Effective Date April 15, 1900

Part II

SCOPE OF THE ELEVATOR CODE

SECTION I. SCOPE OF THE ELEVATOR CODE.

Order 401.—General Scope.

The provisions of this code shall apply to all elevator, dumbwaiter and escalator installations in public buildings and places of employment as defined by the statutes. The requirements apply to both existing installations and those hereafter installed unless otherwise specified.

Order 402.—Renewing of Elevators, Dumbwaiters and Escalators.

Any elevator, dumbwaiter or escalator which may hereafter be damaged or deteriorated by fire or other causes, including ordinary wear, so that its condition per cent is less than 50 per cent of its original condition shall not be repaired or rebuilt except in conformity with the requirements for new installations.

Order 403.—Exemptions.

This code does not apply to belt, bucket, scoop, roller, or similar inclined or vertical freight conveyors, tiering or piling machines when not passing through a floor, skip hoists, man hoists, mine hoists, lumber lifts, wharf ramps or apparatus in kindred classes, amusement devices, stage curtain hoists or lift bridges, nor to elevators used only for handling building material during the period of building construction.

Note.—For regulations relative to the use of elevators, hoists, derricks and similar equipment during the period of construction of a building or any other structure see Orders 3520 to 3527 inclusive of the General Orders on Safety in Construction issued by the Industrial Commission and re-printed in the appendix to this code.

Part III

PLANS, INSPECTIONS AND TESTS

SECTION I. PLANS.

Order 404.—Plans. New Installations.

Before starting work on any new installation of an elevator, dumbwaiter or escalator, plans shall be submitted to the Industrial Commission for approval, with an application, properly filled out, on a blank form furnished by the commission. Plans shall be in duplicate. This order shall not apply in cities where elevator permits are issued by the city in a manner approved by the Industrial Commission. Every elevator manufacturer who furnishes an elevator, dumbwaiter or escalator to be installed by the owner, or an agent of the owner, shall submit plans and file an application in compliance with this order.

Note.—The elevator manufacturer and architect should cooperate in preparing plans to avoid discrepancy in design. See also order 464—(k).

SECTION II. INSPECTIONS.

Order 405.—Inspection by Insurance Companies.

The Industrial Commission will accept inspections of insured elevators, dumbwaiters and escalators by inspectors of insurance companies on the following conditions:

(1) Each installation shall be inspected semi-annually, as near as may be, except that in public buildings and places of employment outside the City of Milwaukee which are covered by compensation insurance policies only, an inspection shall be made at least annually.

(2) A detailed report of each inspection shall be filed with the commission within 14 days after inspection on a printed form approved by the Commission. Such report shall show all respects in which the installation fails to comply with the code requirements. If there are any special conditions which, in the inspector's opinion would re-

quire modification of any general order, the facts shall be fully stated in the report, with the inspector's recommendation.

(3) A certificate of inspection on a form approved by the commission shall be posted by the insurance company in a conspicuous place in the elevator car, dumbwaiter cage or escalator, as the case may be, and shall show the date of inspection, name of insurance company, name of inspector, safe carrying capacity (see order 452) and in the case of an elevator, whether steel cables are used. (See order 441).

(4) The insurance company shall use all reasonable diligence to secure compliance with the commission's orders. If unsuccessful, it shall so report to the commission. If it then becomes necessary for the commission to make an inspection, the statutory fee of two dollars for each elevator inspected will be charged. (See order 407).

(5) The competency of each elevator inspector shall be certified by each insurance company to the commission in writing prior to making inspections, and inspections will be approved by the commission only after receipt of acceptable evidence of competency or after a satisfactory examination has been passed.

Order 406.—Inspection by Cities.

In the City of Milwaukee, and in any other city which provides a competent elevator inspector, the Industrial Commission will accept inspections by such city, provided the conditions of paragraphs (1), (3), (4) and (5), order 405, are complied with, substituting "city" for "insurance company".

Order 407.—Inspection Fees.

A charge of two dollars (Sec. 101.10 subsection 12, Revised Statutes) will be made by the Industrial Commission for each inspection of each elevator except that no charge will be made for the inspection of any new installation made within six months following its completion, provided that notification of the completion of such new installation is given the Industrial Commission prior to the time of placing the installation into regular service. The elevator company or party putting in the installation shall give the Industrial

Commission a reasonable advance notice of the time when such installation will be ready for inspection.

Note.—The elevator constructor or representative of the elevator company should be present at the time a new installation is first inspected. A responsible and competent mechanic should accompany the elevator inspector while a periodic inspection is being made.

SECTION III. TESTS.

Order 408.—Tests. New Installations.

A full capacity test shall be made of every elevator and dumbwaiter before being put into regular service.

For test of catching device see order 464.

For test of escalators see order 492.

Part IV

GENERAL REQUIREMENTS

SECTION I. SHAFTWAY CONSTRUCTION.

Order 410.—Passenger Elevator Shaftway Enclosures. New Installations.

(a) The shaftway of every new passenger elevator installation shall be completely enclosed on all sides with a fireproof enclosure made of wired glass in metal frame, or solid incombustible plaster not less than 2 inches thick on metal lath and metal frame, all metal well covered; or of brick, concrete, approved hollow building units (clay or concrete tile or blocks) of sufficient thickness to give rigidity. Every fireproof enclosure shall be extended to the roof, or shall be covered at the top with a fireproof floor.

(b) Every shaftway entrance and other shaftway opening shall be protected by an approved fire door, except that wired glass may be used in the upper section of any such door. Every window in such a shaftway enclosure, except in outside walls, shall consist of metal frame, metal sash and wired glass.

See also orders 421, 422, 423 and 435.

Note: Doors in outside walls of elevator shaftways need not be fireproof except in cases where fire doors are required by the State Building Code.

Order 411.—Freight Elevator Shaftway Enclosures. New Installations.

(a) The shaftway of every freight elevator and dumbwaiter hereafter installed in a building more than two stories in height (excluding basement), or in a building three stories or less in height where the travel exceeds 30 feet, shall be completely enclosed on all sides with a fireproof enclosure as specified in order 410; except that no fireproof enclosure is required in a three story building without basement where the travel of the car does not exceed 30 feet, and where the building complies with one of the following:—

- (1) used as a warehouse only;
- (2) of fireproof construction and with the contents practically incombustible;
- (3) equipped with a complete automatic sprinkler system.

Note: An open balcony or mezzanine is not considered a story.

(b) In any three story building of frame construction, with or without basement, the elevator shaftway enclosure above the basement may be semi-fireproof, instead of fireproof, but if the shaftway extends to the basement the enclosure in the basement shall be fireproof.

(c) The shaftway of every new elevator installation shall be completely inclosed in the basement with a fireproof enclosure as specified in order 410, except freight elevators in shaftways not over one story in height above the basement.

Note: Where an elevator is located under a roof and such sheltered space is not enclosed on two sides or more, the elevator will be considered as located outside of the building.

(d) Doors shall be approved fire doors or shutters and shall be self-closing or equipped to close automatically in case of fire or provided with shaftway landing door interlocks. All windows in inside enclosure walls shall be of approved fire resistive construction with wired glass. Where a hand cable is operated through the shaftway enclosure a slot not more than 5 inches wide by not more than 3 feet long with the bottom 30 inches from the floor, may be cut in the enclosure. This slot or opening shall be protected with an approved self-closing fire shutter, or an approved fire shutter which will close automatically in case of fire.

Exception: Doors in outside walls of elevator shaftways need not be fire-proof except in cases where fire doors are required by the State Building Code.

Note: Experience has demonstrated the value of the elevator as a life saving device in case of fire. A simple form of fire-resistive construction (plaster on metal lath) will usually resist a fire for a greater length of time than the elevator can be used as an exit from a burning building. Fire resisting shaftway enclosures are therefore recommended for all elevators.

Order 412.—Guarding Shaftways of Elevators. New and Existing Installations.

(a) The shaftway of every freight elevator, dumbwaiter and existing passenger elevator, where a fireproof enclosure is not required and is not provided, shall be enclosed with guards not less than 6 feet in height above each floor. If the guards are made of wood they shall be solid. If the guards are made of metal they shall be the equivalent in strength, rigidity and protection of wire

screen of not less than No. 10 U. S. Standard Gauge with mesh not greater than 1 inch measured along the wire from center to center of wires at points where they cross.

Note: On an existing elevator where the openings in the grill work are larger than specified in this order, a screen may be stretched around the outside of the car.

(b) On new freight elevator installations, existing passenger elevators, and all other existing elevators where the ceiling height is more than 12 feet, the space between the top of the entrance opening and ceiling shall be enclosed. This enclosure shall be in a plane not more than 6½ inches from the edge of the landing.

(c) Where material is stored near a shaftway enclosure the enclosure shall extend from floor to ceiling.

Note: In the case of a shaftway enclosure for a hand power elevator space for operating the hand rope should be allowed.

Order 413.—Combined Stairways and Elevator Shaftway Enclosures. New and Existing Installations.

An elevator shaftway which is placed in a fireproof stair enclosure need not have an additional fireproof enclosure, but the elevator shaftway shall be guarded to a height of not less than 6 feet above each floor and every stairway in the manner described in order 412—(a), except that incombustible material shall be used throughout.

Order 414.—Guards for Outside Windows in Shaftways. New and Existing Installations.

(a) Every outside window in an elevator shaftway, up to and including the fourth story, and in every case where the window sill is not more than 15 feet above an adjoining roof, shall be completely guarded on the outside with:—

(1) Metal bars not less than ½ inch in diameter or equivalent and spaced not more than 10 inches center to center, or

(2) Wire screen of wire not less than ¼ inch in diameter with mesh not greater than 3 inches, measured along the wire from center to center of wires at points where they cross. If any such screen is hinged the fastening shall be on the inside.

Note: Flat bars not less than ¼ inch thick, with the ends securely anchored, will be considered the equivalent of ½ inch diameter rods in building window guards.

(b) Where an open side of an elevator car passes a window in a wall of a shaftway and approved car gate protection is not provided for such open side a guard consisting of vertical metal bars $\frac{1}{2}$ inch in diameter or equivalent, spaced not more than 2 inches apart, or substantial grating, removable if desired, shall be provided over the inside of the window.

Order 415.—Guards for Projections in Shaftways.

1. Existing Installations.

(a) All projections and shearing edges in elevator shaftways, such as floors, beams, sills, pipes, bolts and other stationary parts within 4 inches of the edge of the car, unless guarded against by the permanent car enclosure, shall be provided with smooth beveled guards fitted directly under such projections so as to push any projecting object back into the car. The beveled surface of each guard shall make an angle of not less than 60 degrees with the horizontal.

Recommendation: Where conditions permit the angle of inclination should be made 70 degrees with the horizontal.

2. New Installations.

(b) On elevators hereafter installed beveled guards shall be made of smooth metal not less than $\frac{1}{8}$ inch in thickness (No. 11 U. S. Standard Gauge) unless a solid backing of wood, concrete or equivalent material is provided, in which case the metal may be not less than $\frac{1}{16}$ inch in thickness.

(c) On a car where a leveling device operates the car with the door open, the platform shall be equipped on the under side with a vertical toe guard at least two inches longer than the leveling zone. Dust caps over hanger tracks and door hanger sheaves shall be fastened in place to prevent displacement or movement toward the car.

(d) In new installations contact boxes, door closers and other equipment shall be placed so that the purpose of this order will not be defeated.

Note: The requirements of this order do not apply to interlocks or other floor lock devices where the guarding of such devices would interfere with their proper operation.

For additional toe guards on sidewalk elevators see order 480—(d).

Order 416.—Clearances on Car Fronts. New Installations.

The distance between the car sill and the landing threshold sill shall be not more than $1\frac{1}{2}$ inches nor less than $\frac{3}{4}$ inch on any elevator hereafter installed. All moving parts, including ropes, cables and sheaves, shall clear passing points at least $\frac{3}{4}$ inch. On every elevator hereafter installed, a clearance of $1\frac{1}{2}$ inches or more shall be maintained between any part of the door fronts or mechanism and the car sill, except on an elevator which is equipped with a car gate and provided with a device to prevent the operation of the car unless the car gate is closed.

Order 417.—Depth of Pits and Overhead Clearances. New Installations.

(a) The depth of the pit and the overhead clearance for any power elevator hereafter installed shall each be not less than the number of inches shown for a given speed and capacity in the following table; except that in no case shall the clearance between the bottom of the car and the bottom of the pit be less than 15 inches when the car is resting on the fully compressed buffers:

TABLE SHOWING REQUIRED MINIMUM DEPTH, IN INCHES, OF PITS AND OVERHEAD CLEARANCES

Elevator car speed in feet per min.	Capacity of Elevator in Pounds								
	0 to 2500	3000	4000	5000	6000	7000	8000	9000	10000 or more
0 to 50.....	30	31	34	36	38	41	43	46	48
100.....	34	35	37	40	42	45	47	49	52
200.....	41	43	45	47	50	52	54	57	59
300.....	49	50	53	55	57	60	62	64	67
400.....	57	58	60	63	65	67	70	72	75
500.....	64	65	67	70	73	75	77	80	82
600 or more.....	72	73	76	78	80	83	85	88	90

Note: The required depth of pit and overhead clearance for intermediate car speeds and elevator capacities can be obtained by interpolation.

Recommendation: It is recommended that every pit be deeper than the minimum depth given in this table and that no power elevator pit be less than 36 inches deep.

(b) Every hand power elevator hereafter installed shall have a pit at the bottom of the shaftway equal to not less than the thickness of the elevator platform plus the required clearance for any attachment that may be placed on the bottom of the platform.

(c) All parts of a new elevator installation shall be designed and adjusted to permit safe movement to the limits of travel at the top and bottom of the shaftway, including the depth of the pit and the overtravel at the top of the shaftway.

Note: Where oil buffers are installed (see order 419) the elevator manufacturer will need to be consulted to determine the necessary increase in the pit depth.

Order 418.—Construction of Pits.

1. New Installations.

(a) The pit for every elevator hereafter installed shall be equal in area to the shaftway. The walls and floor of the pit shall be substantially constructed of incombustible material forming a tight enclosure.

2. New and Existing installations.

(b) Where water cannot be kept out of a pit with ordinary construction, a proper automatic drain shall be installed to keep the pit dry, or a pit tank shall be constructed of boiler plate not less than $\frac{1}{4}$ inch thick, properly braced.

(c) The floor of every pit shall be level, except that sufficient slope shall be allowed for drainage.

(d) The foundation of every guide rail shall be constructed so as to withstand the impact of the fully loaded car when the car safety device is applied to the guides in a free fall of 10 feet.

Order 419.—Buffers. New Installations.

(a) Every passenger elevator, every power freight elevator and every set of counterweights hereafter installed, shall be provided with buffers which shall rest on a solid foundation in the pit. The function of the buffers shall be to absorb the energy of the fully loaded car and the counterweights descending at full rated speed. For car speeds up to and including 400 feet per minute, oil or spring buffers may be used. For car speeds exceeding 400 feet per minute oil buffers shall be used.

(b) Car buffers of the spring type, or their equivalent, shall be installed in the pits of hand power invalid elevators and hand power hospital elevators.

Order 420.—Shaftways and Pits Unobstructed. New and Existing Installations.

(a) No elevator machine or other machinery shall be located in the pit, except that this requirement need not apply to machinery used in connection with sidewalk elevators. Every elevator shaftway and pit shall be kept free of any rope, wire or pipe, except such as is needed for the operation of the elevator and for the heating and lighting of the car or the shaftway, and except branch pipes with sprinkler heads.

Exception: In existing installations, pipes in a shaftway may remain unless carrying steam with pressure exceeding 15 pounds, and wires may remain if placed in conduit.

(b) No elevator shaftway or pit shall be designed or used as a passageway, or for the storage of material.

Order 421.—Penthouses—Where Required. New Installations.

Above every elevator hereafter installed there shall be a penthouse or working space with at least six feet average headroom above the screen or floor required by orders 423-424, except that such headroom may be decreased if approved in writing by the Industrial Commission. Where a new elevator is installed in an existing building, or in a new building where the elevator terminates below an occupied floor, or below a roof, provided the overhead machinery consists only of sheaves and governor and where the penthouse cannot readily be provided, the headroom may be decreased to a height which will permit access to the sheaves for oiling and inspection.

Exception: This requirement does not apply to sidewalk type elevators, without counterweights, which are located within buildings.

Order 422.—Construction of Penthouses.

(a) In new installations in fireproof buildings every penthouse shall be made of incombustible material throughout. Every penthouse in a non-fireproof building shall be made of incombustible material, or may be of frame con-

struction if covered on the outside with incombustible material.

(b) Properly weatherproofed windows shall be provided for the lighting and ventilation of penthouses.

(c) In every new installation access to the penthouse shall be made safe and easy from outside the shaftway by means of a stairway (with handrail) inclined not less than 75 degrees with the horizontal. One such stairway or ladder may serve a number of penthouses, on the same roof.

(d) In every new installation where a scuttle opening is provided in the floor over the shaftway the opening shall be equipped with a substantial cover so arranged that the opening cannot be conveniently used as an entrance to the penthouse.

Recommendation: Access to each penthouse should be under the same penthouse roof. The penthouse ceiling and wall in every installation should be so constructed or insulated as to minimize moisture from condensation which may damage the elevator equipment.

Order 423.—Overhead Floors and Machinery Supports. New and Existing Installations.

(a) There shall be a floor immediately under the machinery and sheaves at the top of the shaftway of every elevator. If the elevator machine is placed at the top of the shaftway, the floor shall cover the entire shaftway, shall be of fireproof or mill construction (see orders 5100 and 5101 of the Building Code issued by the Industrial Commission), and shall be built and supported for a safe load of not less than 300 pounds at the center in addition to the machinery load.

(b) The openings in floors through which cables, ropes, or transmission lines are passed shall be fitted with suitable guards to prevent any loose material from coming in contact with such cables, ropes, or transmission lines, and also to prevent any loose parts from dropping through the openings.

(c) Every overhead platform on which elevator machinery or equipment is placed shall be equipped on the open sides with standard handrails and toeboards.

Order 424.—Floors or Screens Under Sheaves. New and Existing Installations.

(a) If the overhead machinery consists only of sheaves and governor the floor below, if of wood, shall be solid and not less than $2\frac{1}{2}$ inches thick, or not less than $\frac{7}{8}$ inch thick if supported by joists spaced not more than 16 inches center to center. If such floor is a metal grating there shall be no opening greater than 1 inch in width. It shall be built and supported to carry a safe load of not less than 300 pounds at the center. The floor shall cover the shaftway if the area of the shaftway does not exceed 50 square feet and if the average headroom above such floor is not less than 5 feet; if the area is larger than 50 square feet or the headroom is less than 5 feet such floor need extend only two feet outside of all sheaves and machinery which must be reached for oiling and inspection. In such cases there shall be a toeboard not less than 6 inches in height at the edge of the floor, and where the space between the floor and the wall of the shaftway exceeds 12 inches, a handrail shall be provided 30 inches above the floor. This order shall also apply to the secondary sheaves of full wrap traction elevators, and to hand power elevators having no screens over the cars, excepting existing installations where there is not room for such floors.

(b) To prevent broken parts or material from falling into the shaftway a suitable guard shall be provided underneath every overhead deflecting sheave except in existing installations where there is not sufficient clearance for such guards.

Order 425.—Guards for Counterweight Runways. New and Existing Installations.

(a) Where a counterweight runway is located in the elevator shaftway the outside (the side away from the elevator), if exposed to contact shall be protected the full height with a solid guard and, if there is no other means provided for inspection of the counterweight stack, a removable panel at least twelve inches longer than the counterweight stack shall be provided at the bottom.

(b) The inside of every counterweight runway shall be entirely enclosed with a solid guard from a point not

more than 18 inches above the bottom of the pit to a height of 90 inches, except for

- (1) hand power elevators;
- (2) existing power elevators where there is not room for such guards;
- (3) elevators whose counterweights are equipped with compensating devices connected to the bottom of the counterweights.

(c) Where a counterweight runway is located outside the elevator shaftway, the runway shall be solidly enclosed on all sides but a removable panel 12 inches longer than the counterweight stack shall be provided on the outside at the bottom.

Note: Guards in shaftways should be made of metal of not less than 16 gauge.

Order 426.—Counterweight Stops.

(a) In every hand power elevator which does not have a limit stop at the top, a solid footing shall be provided on which the counterweight will rest when the car is six inches above the highest landing.

(b) In every power drum type elevator hereafter installed an I-beam or other obstruction shall be strongly secured at the upper limit of travel of the counterweights so that they cannot be drawn out of the runway. Such obstruction shall be so arranged that the counterweights will be stopped squarely, without distortion. The counterweight guide rails shall be strongly fastened together every 4 feet from the top of the guide rails of every power elevator hereafter installed to a point opposite the bottom of the counterweight stack when it is at the upper limit of normal travel. This requirement shall also apply to every existing installation in which the travel is more than 35 feet if the counterweight runway is not properly fastened together or guarded at the top.

SECTION II. CARS.

Order 427.—Construction of Cars. New Installations.

(a) Every freight car platform hereafter installed shall be constructed to support a load of not less than 50 pounds per square foot. Every elevator carrying automobiles shall have a car platform of sufficient strength to sup-

port safely 70 per cent of the total live load concentrated equally on two wheels at either end of a superimposed automobile located any distance from the entrance sill.

(b) Every power freight elevator hereafter installed shall have a steel sling designed with a factor of safety of not less than $7\frac{1}{2}$ based on the rated load uniformly distributed.

Exception: The requirements of the preceding paragraph need not apply to elevators of the plunger type which are not provided with counterweights.

(c) Every car sling for hand power elevators hereafter installed shall be made of metal or sound seasoned wood and shall be designed with a factor of safety of not less than 4 for metal and 6 for wood based on the rated load uniformly distributed.

(d) Every power passenger elevator hereafter installed shall have a steel sling designed with a factor of safety of not less than $7\frac{1}{2}$ based on the rated load uniformly distributed.

Exception: The requirements of the preceding paragraph need not apply to elevators of the plunger type which are not provided with counterweights.

(e) Cast iron in tension shall not be used for suspension members of any car sling except for cable anchorages.

(f) If there is a railroad track on an elevator car, the tops of the rails shall be flush with the car floor.

(g) The frame members of every elevator car shall be securely bolted or riveted and braced. Welding in an approved manner will be accepted.

Order 428.—Enclosures for Passenger Elevator Cars.

(a) Every existing passenger elevator car shall be enclosed on all sides, excepting the entrance opening. This enclosure shall be solid from floor to cover in front of the counterweight runway, and openings in other sections shall be not larger than $1\frac{3}{4}$ inches square; or if ~~larger~~ than $1\frac{3}{4}$ inches, not wider than 1 inch. If wire mesh is used, the wire shall be not less than No. 10 U. S. Standard Gauge, with mesh not greater than $1\frac{3}{4}$ inches, measured along the wire from center to center of wires at points where they cross.

(b) The car walls of every passenger elevator hereafter installed shall be constructed of solid panels to a height of not less than 6 feet, and the panel in front of the counterweight runway shall be solid to the cover. Wood veneer finish may be used inside of metal cars. The car enclosure shall be made of incombustible material. The floor covering may be made of wood.

(c) The roof of every passenger car shall be constructed of solid material. A portion of every such roof, measuring 20 inches by 30 inches where possible, and not less than 12 inches by 24 inches in any case, shall be so constructed that it can be readily removed by a person inside the car. } ?

(d) In new installations where two or more passenger elevators run in the same shaftway, doors, or removable panels, shall be provided to enable persons to pass from one elevator to the other. Such doors shall open into the cars, and shall be fastened with prominent thumbscrews. } ?

(e) No passenger elevator car enclosure shall deflect more than $\frac{1}{4}$ inch for every 5 feet of enclosure length when subjected to a force of 75 pounds applied at any point perpendicular to the car enclosure. The car enclosure shall be secured to the car floor and sling so that it cannot work loose and become displaced in ordinary service.

Order 429.—Furnishings for Passenger Elevator Cars. New and Existing Installations.

(a) No glass shall be used in any passenger car except to cover certificates, emergency switches, annunciators and lamps. (Mirrors will not be permitted.)

(b) A metal handrail not less than 1 inch in diameter and approximately $3\frac{1}{2}$ feet above the floor shall be placed on each side, except on the entrance side or sides of any passenger car.

(c) No seats, except one for the operator, and except for elevators designed to carry invalids, shall be placed in any elevator car.

Order 430.—Car Gates for Passenger Elevator Cars.

(a) The entrance to every passenger elevator car hereafter installed which travels faster than 150 feet per

Amper

minute shall be equipped with a car gate or car door. If the car of any new or existing passenger elevator has more than one entrance, the secondary entrance shall also be equipped with a gate, or door, completely filling the opening.

(b) In every electric passenger elevator car hereafter installed the secondary gate, or door, if any, shall be equipped with an approved device such that the elevator cannot be started unless such gate or door is closed. On every automatic push button elevator each entrance to the car shall be equipped with a gate, or door so arranged that the elevator cannot be operated unless all gates, or doors, are closed. This will not prohibit the use of a device which makes it possible to operate the elevator from the hall button with the car gate open only when the elevator is unoccupied and the shaftway doors are closed and latched.

(c) The horizontal dimension of any opening in required car gates and doors on passenger elevators shall not exceed 3 inches.

Note: If an electric contact is used on a car gate it need not prevent the motion of the car toward the landing while the car is being controlled by a car leveling device.

Order 431.—Enclosures for Freight Elevator Cars.

(a) Every freight elevator car shall be solidly enclosed on all sides, except the entrance side. The height of every such enclosure shall be at least 6 feet, except as follows:

(1) On every elevator hereafter installed the enclosure shall be at least 7 feet in height in front of the counterweight runway, and shall extend from floor to cover on every car where a cover is required or provided.

(2) On every hand power carriage type elevator traveling not more than two stories the enclosure shall be at least 3½ feet in height, except in front of the counterweight runway, where it shall be 7 feet high.

(3) On the side of the operating cable, sufficient space to operate the cable shall be allowed, but in no case shall the opening be more than 15 inches wide.

(b) Every freight elevator car shall be equipped with a metal cover the equivalent in strength, rigidity and

protection of wire screen of wire not less than No. 10 U. S. Standard Gauge with mesh not greater than one inch measured along the wire from center to center of wires at points where they cross, supported and reinforced to carry a safe-load of not less than 300 pounds at any point, except as follows:

(1) On a freight elevator traveling only one story no cover is required if the shaftway above the lowest story is enclosed to a height of 6 feet and the body of each gate at the top landing extends to the floor.

(2) On a freight elevator car 10 feet or more in length, open at one end only (except at the lowest landing), and traveling not more than two stories, but not to exceed 30 feet, a cover is required over only that half of the car next to the open end.

(3) No cover is required over a hand power elevator car where the bottom rail of every landing gate above the lowest landing rests on the floor. In every such case a floor or screen shall be provided under the overhead machinery as specified in order 424—(a).

(4) On any hand power elevator operating outside of a building, except sidewalk elevators, the cover shall be solid and form a part of the car enclosure or cab.

(c) Every car cover shall be equipped with a hinged section facing each entrance, unless such entrance occurs only at the lowest landing, or unless there is a car gate on such side. This hinged section shall be at least 12 inches wide, shall extend the full width of the entrance to within 5 inches of the landing sill, and shall be constructed so it will rise easily if it meets an obstruction as the car descends. (See order No. 482—(a) for covers on H. P. hospital elevators and H. P. invalid lifts).

Note: On an existing elevator the wire screen enclosure may remain if the mesh is not greater than 1 inch, and is properly braced and fastened. The wire must be of sufficient size to give rigidity.

Order 432.—Entrances to Freight Elevator Cars. New and Existing Installations.

There shall be not more than two entrances to any freight elevator car except when approved in writing by the Industrial Commission.

Order 433.—Car Gates for Freight Elevator Cars.

(a) If a freight elevator car has more than one entrance, and the difference in the landing floor levels at such entrances is more than 30 inches, the secondary entrance shall be equipped with a car gate. If the distance between the edge of the car and the shaftway enclosure on the side of the secondary entrance is more than 7 inches at any point the car gate shall be provided, or the shaftway enclosure on that side shall be altered so that it will come within the specified limit.

(b) Every car gate shall run in guides, shall extend to the floor and be at least 6 feet high, and in the case of a vertically sliding gate, shall contain no openings greater than 3 inches measured in a horizontal direction.

(c) Every car gate which weighs more than 35 pounds or which is more than 8 feet in width shall be counterbalanced with a secondary rope and weight.

(d) Every car gate hereafter installed shall be semi-automatic or be equipped with an approved device such that the elevator cannot be started unless the car gate is closed.

(e) Every freight elevator car operating in a shaftway outside a building and which is inclosed only at the ground landing, shall be protected on the landing side by a semi-automatic car gate, or by a gate with electric contacts and in either case complying in other respects with order 433.

Note: If an electric contact is used on a car gate it need not prevent the motion of the car toward the landing while the car is being controlled by a car leveling device.

SECTION III. SHAFTWAY LANDING DOORS AND GATES.

Order 435.—Passenger Elevator Shaftway Landing Doors.

(a) In every passenger elevator hereafter installed the shaftway shall be equipped at each landing with a horizontally sliding door, or doors, which shall entirely fill the opening to the shaftway. Every such door shall be an approved fire door and shall be solid to a height of not less than 12 inches above the floor level. Upper sections of such doors may be of wired glass, or of solid metal. Every landing door shall be of sufficient strength to resist a lateral pressure of 100 pounds applied at the center.

Exception: In cases where the doors in outside walls of elevator shaftway enclosures are not required by the Building Code to be fire-

proof the phrase in the preceding paragraph reading "every such door shall be an approved fire door" does not apply.

Note: Order 5111 of the Building Code limits the size of any pane of wired glass to 720 square inches.

(b) Existing wooden doors will be accepted, but if such doors contain grill work or screen the openings shall not be larger than described in order 428—(a). Doors shall not swing on vertical axes except on automatic push button elevators, and except where restricted spaces will not permit the use of sliding doors.

(c) On an existing installation solid metal or metal screen on substantial door framing will be accepted. The screen shall be the equivalent in strength, rigidity and protection of wire screen described in order 428—(a).

Exceptions:

(1) On an existing door where the openings in the grill work are larger than specified in order 428—(a), a screen may be stretched across the inner face of the door.

(2) On an existing installation where a regular operator is stationed on the car existing grill work will be accepted unless an especially hazardous condition exists.

(3) Other than horizontally sliding doors may be used in an existing installation if the restricted space will not permit a horizontally sliding door.

(d) Doors in every passenger elevator shaftway enclosure, except in the case of push button elevators, shall be equipped with self-locking devices which cannot be opened from the outside except by means of a key not easily duplicated, which key shall be placed in charge of a responsible person.

Order 436.—Passenger Elevator Shaftway Landing Door Interlocks.

(a) Shaftway landing door interlocks shall be provided on every passenger elevator installation. Such interlocks shall be provided on existing installations not later than June 1, 1928.

Exception: The interlock shall not prevent the movement of the car within the leveling zone when the car is being moved by a car leveling device.

(b) No shaftway landing door interlock shall be constructed or installed so that its functioning is dependent upon the action of a spring (or springs) in tension, or upon the closure of an electric circuit.

(c) On every passenger elevator installation, except push button elevators, provision shall be made for opening one landing door from the landing side.

Order 437.—Automatic Push Button Elevators; Electric Contacts.

Electric contacts shall be provided on the car gate or gates of every automatic push button controlled elevator. Such electric contacts shall be provided on every such existing installation not later than June 1, 1928.

Order 438.—Freight Elevator Shaftway Landing Doors and Gates.

(a) All openings in the shaftway enclosure of every freight elevator shall be protected at landings in one of the following ways:

(1) Doors, as described in order 435 for passenger elevators. Such doors will be accepted only where an operator is stationed on the car, except on push button controlled elevators. In new installations such doors shall be equipped with shaftway door interlocks or door electric contacts. Doors which are equipped with shaftway door interlocks or door electric contacts may swing on vertical axes.

(2) Vertically sliding gates. Where the car speed does not exceed 50 feet per minute the gates at the terminal landings shall be semi-automatic, full automatic, equipped with gate electric contacts, or provided with interlocks. At intermediate landings the gates shall be semi-automatic, equipped with gate electric contacts, or provided with interlocks. If approved in writing by the Industrial Commission full automatic gates may be installed at intermediate landings of elevators where the car speed does not exceed 50 feet per minute.

Where the car speed exceeds 50 feet per minute vertically sliding gates, whether at terminal or intermediate landings, shall be semi-automatic, equipped with gate electric contacts, or provided with interlocks.

(3) Balanced gates, or balanced doors. Such gates or doors will be permitted only when they are equipped with gate electric contacts or door electric contacts.

General Exceptions: In an existing installation where there is a vertically-rising hatch cover at the top floor, if there is not less than

three feet of headroom above the cover when the car is at such floor, and the cover is so located or guarded that it cannot be used as a passageway, then a landing gate is not required at such top floor landing.

(b) In every case where fire doors are used as gates at freight elevator shaftway landings the doors shall be equipped with shaftway landing door interlocks or shaftway door electric contacts.

(c) On every existing hand power elevator traveling not more than 30 feet, or serving not more than two floors and basement, or three floors without basement, where vertically hinged shaftway landing doors are used, the doors shall be equipped with self-locking devices designed to prevent opening the doors from the outside except by means of a key, or so arranged that the doors can be opened only when the car is at, or within three inches of, the floor level.

Note: Where possible vertically rising gates should be installed in preference to doors.

(d) Gates over 8 feet wide may be full automatic provided the car speed is not over 50 feet per minute and an operator is stationed on the car, or where there is provided means of stopping the elevator without reaching over, through, or under the gates.

(e) Every full automatic gate shall be so arranged that it will be fully closed when the car has traveled a distance of not more than 8 feet from the landing.

(f) In new installations where the car speed exceeds 50 feet per minute, and in existing installations where the car speed exceeds 75 feet per minute, shaftway landing gates shall be not less than $5\frac{1}{2}$ feet high. If the car speed does not exceed 50 feet per minute in new installations, and 75 feet per minute in existing installations, landing gates may be $3\frac{1}{2}$ feet high.

(g) Every landing gate at an opening in an outside wall shall extend to the sill when closed. The bottom bar of each landing gate above the lower terminal landing shall extend to within 12 inches of the sill when closed, except in existing installations, where conditions require more space to secure sufficient headroom for safety, a clearance of not more than 20 inches between the lower bar of a closed gate and the floor will be permitted.

(h) In a new installation a bar gate not less than 12 inches in total depth may be used at a basement landing

where conditions will not permit a standard gate, except that the distance from the floor to the bottom of such a bar gate when closed shall be not more than 30 inches. Existing installations equipped with bar gates at lower terminal landings will be accepted if the gates are self-closing.

(i) No collapsible gate shall be installed at any shaftway landing in new installations.

Order 439.—Freight Elevator Shaftway Landing Gates; Construction.

(a) The net width of an opening between the slats or bars of a landing gate shall be not more than 3 inches, except that on the side toward the operating cable, where such cable is provided, there may be an opening large enough to permit the operation of the cable, but not more than 5 inches in width. On elevators in plants where racks are used on cars center slots or openings in the landing gates will be permitted to allow passage of the racks.

(b) The main horizontal cross members of every landing gate, to which members the vertical slats or bars are fastened shall extend into the guides, or against uprights at the gate posts, so that pressure exerted on the gate from the landing side will not cause the gate to move into the shaftway in case the slat or bar fastenings become loose or disarranged.

(c) Every gate shall be well braced to secure rigidity and shall be of sufficient strength to withstand a lateral pressure of 250 pounds at the center.

Note: A gate constructed of wire screen of not less than No. 10 U. S. Standard Gauge, with mesh not greater than 3 inches, measured along the wire from center to center of wires at points where they cross, will be considered the equivalent of a wood gate.

(d) Every gate shall move in guides which shall be so constructed that the gate upright or shoe on the gate will have a lap of at least 1 inch on the guide strip or in the guide post furrow.

(e) Each gate guide post shall be installed and securely fastened so as to prevent warping and shall be set so it will not be damaged by trucks or material being passed to or from the car. Every gate guide post attached to a

brick, tile or plaster wall shall be fastened with through bolts, or their equivalent.

Note: The use of wood plugs inserted in a wall for fastening a gate guide post will not be accepted.

(f) Where a gate upright or shoe on the gate is continuous the runway furrow in the guide post shall be at least $\frac{1}{4}$ inch wider than the gate upright or shoe.

(g) Every gate shall be properly balanced, adequately counterbalanced, and hung with substantial cord or flexible cable over pulleys not less than 3 inches in diameter.

(h) Gate or door counterweights shall be boxed in, or shall run in metal guides from which they cannot be dislodged. The bottoms of the boxes, or guides, shall be of such construction that the counterweights will be retained if the ropes break.

Order 440.—Power Freight Elevator Shaftway Landing Doors and Gates; Locking Devices. New installations.

In new installations of power freight elevators every landing door and gate, except full automatic doors and gates, shall be equipped with an approved device such that the door or gate cannot be opened unless the car is at, or within 3 inches of, the landing. Such device shall be so constructed and located that it cannot be easily put out of order or reached from the floor when the door or gate is closed.

SECTION IV. CABLES.

Order 441.—Factors of Safety for Cables. New and Existing Installations.

(a) The factors of safety for hoisting and counterweight cables, based on the cable manufacturer's schedule, shall be not less than is given in the following table:

FACTORS OF SAFETY FOR HOISTING CABLES

Car speed in feet per min.	Factors of Safety		
	Passenger Elevators	Freight Elevators	Dumbwaiters
50 or less.....	7.0	6.7	5.3
100.....	7.8	7.0	5.7
200.....	8.5	7.6	6.3
300.....	9.1	8.2	6.9
400.....	9.7	8.7	7.5
500.....	10.2	9.1	8.0
600.....	10.6	9.5	-----
700.....	11.0	9.8	-----
800.....	11.25	10.0	-----
900.....	11.4	10.2	-----

(b) Unless the ultimate strength and material of a cable are known, the load shall be limited to the load allowed for an iron cable of the same diameter.

(c) No car or counterweight cable shall be repaired or lengthened by splicing.

Order 442.—Cable Data. New Installations.

(a) For permanent record there shall be posted in a conspicuous place on the car beam of every elevator hereafter installed a metal sign bearing the following original data:

CABLE SPECIFICATIONS

Kind of Cable	Number of Cables	Diameter in Inches	Rated Ultimate Strength	Date of Installation
Hoisting				
Car Counterweight				
Machine Counterweight				

(b) Where steel cables are required, or needed, this fact shall be indicated on the metal sign.

(c) On new installations and whenever cables are renewed there shall be attached to the cable fastening or car beam another metal tag bearing the following data:

CABLE INSTALLATION DATA

Diameter of Cables -----
 Material of Cables -----
 Rated Ultimate Strength -----
 Date Installed -----

Order 443.—Renewing of Cables. New and Existing Installations.

Cables are considered unsafe and shall be renewed when through broken wires, wear, rust, undue strain, or other deterioration, the strength has decreased 25 per cent. When for any reason it becomes necessary to renew one or more cables of a group supporting a common load, all cables in that group shall be renewed.

Order 444.—Number of Cables Required.

(a) Every elevator car which requires hoisting cables shall have not less than two hoisting cables, except that on existing installations a single hoisting cable will be permitted if the factor of safety is not less than 10.

(b) Every traction type elevator hereafter installed shall be equipped with not less than four cables, except where the capacity is not more than 1200 pounds, not less than three cables shall be used.

Order 445.—Turns Required on Drums.

In every new installation of a drum type elevator the hoisting and counterweight cables shall have at least one and one-half turns on the drum when the car is at either the bottom or top landing. This requirement shall also apply, where possible, in the recabbling of existing installations. The winding drum end of every car or counterweight cable shall be secured on the inside of the drum.

Order 446.—Cable Fastenings at Terminals.

(a) On every elevator hereafter installed the ends or terminals of each hoisting and each counterweight cable shall be independently fastened to the cross-head of the car frame and counterweight frame, respectively.

(b) Where an adjustable draw bar or equalizer is used, the details of construction of such draw bar or equalizer for each condition of installation and type of apparatus shall be submitted to the Industrial Commission for approval, and only approved construction shall be used.

(c) On no elevator hereafter installed shall more than one cable be fastened into the same clevis or socket, except on car counterweights.

(d) Where a cable is fastened in a socket the strands of the cable shall be separated and turned in toward the center. The length of the turned portion of a cable shall be not less than $4\frac{1}{2}$ times the diameter of the cable. The knot thus formed shall be drawn tightly into the socket which shall be filled with zinc or babbitt. Cast iron socket thimbles shall not be used. The socket shall be drop-forged steel, steel casting, or formed in a substantial block of malleable cast iron or better, such as semi-steel.

(e) The cable fastening shall be capable of sustaining a load of not less than 80 per cent of the ultimate strength of the undisturbed portion of the cable.

Note: In heat treating the materials while making a cable fastening careful workmanship is needed to avoid harmful change in the socket metal.

Order 447.—Governor Cables.

(a) A wire governor cable shall be used on every new elevator installation where a governor is required, except that in new installations where the governor cable is exposed to excessive moisture or other corrosive elements, hemp rope with wire center shall be used.

(b) In every new installation where a wire governor rope or cable is used the governor sheaves shall be not less than 12 inches in diameter.

SECTION V. COUNTERWEIGHTS.

Order 448.—Drum and Car Counterweights.

(a) Every new installation in which the hoisting cables wind around a drum, and in which the speed exceeds 100 feet per minute, shall be equipped with car counterweights supported by separate cables. Every drum type passenger or freight elevator hereafter installed, except sidewalk type elevators, shall be equipped with a drum counterweight.

(b) Drum and car counterweights shall be made of metal and shall run in substantial guides.

(c) If two sets of counterweights run in the same guides, the car counterweight shall be above the machine counterweight, and there shall be a clearance of not less than 8 inches between them.

(d) If an independent car counterweight is used, it shall not be of sufficient weight to cause undue slacking in any of the cables during acceleration or retardation of the car.

Order 449.—Counterweight Cables. New Installations.

Each set of counterweights on freight elevators hereafter installed in which the weight of the car exceeds 1000 pounds, the travel exceeds 25 feet, or the speed exceeds 60 feet per minute, shall be supported by not less than two cables. Each set of counterweights on passenger elevators hereafter installed shall be supported by not less than two cables.

Order 450.—Protection of Counterweight Cables. New and Existing Installations.

Where the cables of one set of counterweights pass through, or by, another set of counterweights, the cables shall be so protected as to prevent chafing or wearing.

Order 451.—Bolting of Counterweights.

(a) In each set of counterweights on every power elevator hereafter installed, unless the counterweights are contained in a steel frame, the separate weights shall be bolted together with not less than four bolts with lock nuts and cotter pins at each end, at least two of which bolts shall pass through all of the weights, tightly bolting them together. Each set of counterweights on hand power elevators, and on hand power elevators changed to power elevators, (see order 460—m), shall be bolted together with not less than two bolts. Each set of counterweights on existing elevators shall be bolted or strapped together to keep the individual weights in position.

(b) In every counterweight stack over 8 feet high there shall be a middle guide unless all weights are contained in a steel frame.

SECTION VI. LOADS AND STRESSES.

Order 452.—Capacities of Passenger Elevators.

(a) Every passenger elevator hereafter installed shall be designed for the maximum probable live load, but

in no case less than 75 pounds per square foot of car floor area, except that for a hospital elevator not serving an assembly hall or clinic such minimum live load may be reduced to 50 pounds per square foot, but in no case less than 1500 pounds or the maximum load to be carried.

(b). No passenger elevator used for hoisting safes or similar special freight shall be loaded over the rated capacity.

See order 460—(m) for capacity limit for a hand power elevator.

Order 453.—Capacity Plates. New and Existing Installations.

A metal plate with raised letters not less than $\frac{1}{2}$ inch in height, stating the live load for which the elevator was designed, shall be placed in a conspicuous position on the car of every elevator.

Order 454.—Stresses Allowed in Design. New Installations.

Every elevator hereafter installed and every part thereof (except cables), and all structural support of such an installation shall be designed and constructed to carry the total maximum load, plus 100 per cent for impact, using the safe working stresses specified in the State Building Code.

See tables in orders 5313, 5316, 5317, in Appendix to this code.
For cable stresses see order 441.

SECTION VII. GUIDE RAILS.

Order 455.—Guide Rails, General Requirements.

(a) Wrought iron or steel guide rails shall be provided for car and counterweights as follows:

(1) On every power freight elevator hereafter installed whose speed exceeds 100 feet per minute; and

(2) On every power freight elevator whose capacity exceeds 4,000 pounds and travel exceeds 50 feet; and

(3) On every passenger elevator hereafter installed.

Where wrought iron or steel guide rails are not required hardwood guide rails may be used.

Note: Where the use of steel guide rails presents an accident hazard, as in chemical shops or in plants where explosives are manufactured, wood guide rails may be used.

(b) Cast iron guide rails shall not be used. Guide rails shall be of sufficient strength, shall rest on a proper foundation (see order 418—d), and shall be securely supported so that they will not spread.

(c) In new installations of power elevators the guide rails shall not be used to support the overhead machinery.

(d) Guide rails shall extend to the overhead construction.

Order 456.—Sizes and Construction of Guide Rails. New Installations.

(a) Steel car guide rails when required shall be not less than as follows:

Total Weight of Car & Load; Total Weight of Counterweights or Pair of Rails		Minimum Weight per Lineal Ft. of Each Car Guide Rail (Pounds)	Minimum Weight per Lineal Ft. of Each Counterweight Guide Rail (Pounds)		
Per Pair of Rails			With Guide Rail Safeties	Without Guide Rail Safeties	
Above (Pounds)	To and Including (Pounds)			1 to 1 Roping	2 to 1 Roping
2,500	2,500	6½	6½	6½	6½
15,000	15,000	14	14	6½	6½
	40,000	30	30	6½	14

(b) The size of wood guide rails shall be not less than as follows:

Total Weight of Car and Load per Pair of Maple Guide Rails		Dimensions of Each Guide Rail in Inches
Above Pounds	To and Including Pounds	
5,000	5,000	2 x 2½
	8,000	2¾ x 3

(c) Joints in steel or wood guide rails shall be tongued and grooved, or dowelled.

Order 457.—Fastening of Guide Rails. New Installations.

(a) Guide rails installed on brick or concrete shaftway walls shall be fastened at points not more than 8 feet apart. Where anchorage is to substantial floor beam construction, anchorage points may be 12 feet apart; if the

anchorage points are necessarily farther apart than 12 feet the guide rails shall be proportionately stiffened.

(b) Connections to steel guide rails shall be by means of clips, or by through bolts of not less than the following sizes:

For 6½ to 7½ pound rails.....	½ inch bolts
For 14 pound rails.....	⅝ inch bolts
For 30 pound rails.....	¾ inch bolts

(c) Fastenings to brick walls shall be made with through bolts. Wood plugs inserted in a wall for guide rail anchorage are not permitted. In solid concrete walls where through bolts cannot be used fastenings may be secured by lead, sulphur, efficient toggle bolts, expansion bolts, or inserts. Fastenings to hollow tile walls, plaster partitions and similar construction are not permitted.

(d) Material used for aligning steel rails shall be metal so secured as not to drop from its position if the fastening becomes loose.

(e) Steel car guide rails shall be fitted with substantial foundation plates to withstand the impact of the loaded car when suddenly clamped to the rails by the car safety device.

See also order 418—(d).

SECTION VIII. MACHINES AND SAFETY DEVICES.

Order 458.—Minimum Sizes of Drums and Sheaves. New Installations.

The diameter of drums and sheaves on every power elevator hereafter installed, except sidewalk type elevators, shall be not less than the following:

Diameter in inches of cables	Diameter in inches of drums and sheaves
5/8	20
7/8	20
1	20
1 1/8	22
1 1/4	24
1 3/8	30
1 1/2	36
1 3/4	40

Note: A larger diameter than the required minimum is recommended.

Order 459.—Machinery—General Requirements.

(a) The factors of safety based on the static loads (the rated load plus the weight of the car, cable, counterweight, etc.) to be used in the design of elevator machines hereafter installed shall be:

Hand Power Elevators	
For wrought iron or steel.....	5
For cast iron, cast steel and other materials---	8
Power Elevators	
For wrought iron or steel.....	8
For cast iron, cast steel and other materials---	10

(b) Drums and leading sheaves on new installations shall be steel or cast iron with machine finished grooves, except on hand power elevators, and no traction U groove shall be more than $\frac{1}{16}$ inch larger than the cable it carries.

(c) Every drum, traction sheave, pulley, gear, or other such part of an elevator installation shall be securely keyed or pinned on its shaft.

(d) Elevator gear housings shall have a sufficient number, and correct size of openings so located as to permit proper inspection of the gears and gear spider fastenings.

(e) Overhead direct connected electric elevator machines hereafter installed shall be mounted on continuous bed plates.

(f) No cable or link chain of any description shall be used to form the operating connection between the machine and the shifting gear or wheel on any single belt elevator hereafter installed or remodeled.

(g) In new installations every shaft shall be fillet finished at every journal or shoulder cut.

Order 460.—Prohibited Installations.

1. New and Existing Installation.

(a) No belt or chain driven machine shall be used in any passenger elevator installation.

(b) No friction gearing or clutch mechanism shall be used for connecting the drums or sheaves to the main driving gear of any elevator.

(c) No passenger car shall have more than two entrances except in existing installations when approved in writing by the Industrial Commission.

(d) No passenger elevator shall be arranged to be controlled from the landing by means of a hold down push button.

Note: By hold down push button is meant a push button so arranged that the elevator car will continue in motion so long as the push button is being pressed.

2. New Installations.

(e) Chains shall not be used for hoisting except on sidewalk elevators, elevators of the sidewalk type within buildings and traveling not more than 14 feet, and on hand power elevators traveling not more than 14 feet.

(f) Belt driven freight elevators hereafter installed shall be limited to a travel of not more than 50 feet in any case and to a speed of not more than 50 feet per minute.

(g) No power elevator which consists of the platform or carriage type of car supported by cables attached at four or more points shall hereafter be installed.

(h) Cast iron worm gears shall not be used in the hoisting mechanism of any elevator hereafter installed.

(i) In any new installation of a direct air elevator, or a combination of air and water; steam, or a combination of steam and water the travel shall not exceed 25 feet.

(j) No elevator of any type hereafter installed shall have more than one compartment, nor shall elevator cars counterbalance each other.

(k) Hand rope control shall not be used for any passenger elevator hereafter installed, except on hydraulic elevators.

(l) The speed of any hand rope controlled elevator hereafter installed shall not exceed 75 feet per minute.

(m) No hand power elevator hereafter installed shall exceed 1,500 pounds capacity, nor shall any hand power elevator of more than 1,500 pounds capacity be hereafter changed to power.

(n) The travel of any hand power elevator hereafter installed shall not exceed 30 feet.

Order 161.—Power Attachments to Hand Power Elevators.

New and Existing Installations.

No power attachment, such as worm reduction units, rope clutch or rope grip devices, belts to improvised rope wheels,

or any similar device, shall be installed on any hand power elevator unless all requirements for power elevators are complied with.

Order 462.—Slack Cable Devices.

1. New and Existing Installations.

(a) A slack cable device which will automatically shut off the power and stop the machine if the cables loosen or break shall be provided on every drum type power elevator, except on existing belt driven freight elevators where the machines are in good condition and such devices cannot be provided without rebuilding the machines.

2. New Installations.

(b) Every slack cable switch on elevators hereafter installed shall be so constructed, installed and maintained that it will not automatically reset when the slack in the cable is removed.

(c) Every ceiling drum type elevator machine hereafter installed shall be so located with respect to height that the slack cable device will operate with not more than 6 feet of slack cable.

Recommendation: A ceiling type machine should be located not higher than the first story ceiling as this will permit proper lead to the cable and will result in longer service of each cable.

Order 463.—Limit Stops. New and Existing Installations.

(a) Every elevator which is provided with an electric brake shall be equipped with shaftway limit switches that will automatically interrupt the power circuit and stop the car at each terminal landing. If the motor of such an elevator is operated by alternating current the limit switches shall be so connected as to automatically stop the elevator in case of phase reversal.

(b) In every case passenger elevators and freight elevators controlled by car switches shall be equipped with two limit switches at each terminal of travel, one switch to be a direction cut-off and the other a final cut-out switch.

(c) Every drum type elevator machine shall be equipped with an approved device which will automatically stop the machine when the car reaches either of the terminal landings.

Order 464.—Car Safety Devices and Speed Governors.

(a) A car safety device capable of stopping and sustaining the car with the rated load, in case the cables break or become slack, shall be attached to every elevator except—

- (1) Freight elevators which travel not more than 10 feet.
- (2) Direct lift plunger elevators.
- (3) Carriage-type elevators which travel not more than 18 feet and in no case more than one story, provided the cables and their end fastenings shall have a factor of safety of not less than 10.

(b) A friction clamp car safety device shall be provided for every passenger elevator and every freight elevator hereafter installed in which the speed is more than 100 feet per minute.

(c) If it is desired to stop an ascending car on account of overspeed a safety device shall be attached to the counterweight.

(d) In every new installation of a car safety device, except on a hand power elevator, the dogs or clamps of the safety device shall be attached to the under side of the car platform. The gripping surfaces of a car or counterweight safety device shall not be used to guide the car or counterweights.

(e) Every drum and idler sheave which is underneath the car and which actuates the car safety device shall be so guarded that the rope or cable cannot leave the drum or sheave.

(f) A cut-out switch that will open the motor and brake control circuits shall be provided in connection with every car safety device on every electric elevator hereafter installed.

(g) A speed governor shall be installed in connection with the required car safety device of every power elevator hereafter installed and on each existing power elevator traveling more than 18 feet. The governor shall be set to operate at not more than 40% excess speed, but need not be set at a lower speed than 150 feet per minute. (See paragraph (a) of this order.

(h) Every speed governor hereafter installed shall be of a type which will securely grip the cable and thereby actuate the car safety device, and shall be located where it

cannot be struck by the car or counterweights in case of overtravel.

(i) Every type of car safety device shall be subjected to an actual drop test made at the risk and expense of the elevator manufacturer and under the direction of the Industrial Commission; and complete plans and specifications of such device shall be submitted to the Commission for approval. The test load shall be equal to two-thirds of the capacity. The car safety device shall stop and hold the elevator car within a drop of 10 feet. No car safety device shall be used which has not been so tested and approved.

Note: Tests of car safety devices and other safety appliances by the United States Bureau of Standards will be recognized by the Industrial Commission.

(j) In every new installation the speed governor and car safety device shall be put to a running test with the rated load on the car.

Note: The speed governor is the only device which will operate the safety when the car attains excessive speed due to broken machinery or other cause. A safety device without a speed governor operates only when the cable breaks.

(k) When the elevator capacity exceeds the maximum for which the car safety device was approved a new drop test shall be made and drawings, or prints, with specifications of the safety device submitted to the Industrial Commission for approval.

(l) Every car safety device and every governor shall be kept in proper working condition and shall be subjected to a running test at such intervals as is consistent with good operating practice.

Order 465.—Stop Balls for Hand Ropes. New and Existing Installations.

Every elevator equipped with hand rope control shall be provided with adjustable stop balls, or equivalent device, for the operation of the automatic stopping mechanism at the top and bottom landings.

Order 466.—Guards for Sheaves and Idlers. New and Existing Installations.

In every hand rope controlled elevator the sheaves which lead the hand rope from the shaftway to the machine shall

be guarded to prevent injury to an operator. Every sheave and every idler under which is led any hoisting or counterweight cable shall be provided with a guard that will keep the cable on the sheave or idler if the cable becomes slack. Every idler sheave around which is led an operating rope or a governor rope shall be provided with a guard that will keep the rope on the sheave.

Order 467.—Centering Ropes. New and Existing Installations.

Every hand rope controlled elevator, except hydraulic elevators, shall be equipped with a properly adjusted centering rope so arranged that it can be easily and safely used at any point in the car travel.

Order 468.—Warning Chains. New and Existing Installations.

Warning chains shall be hung from the car platform within 2 inches of the edge of the entrance side or sides of every power freight elevator, except where shaftway landing doors with electric contacts or interlocks are provided. Such chains shall extend at least 5 feet below the bottom of the platform, shall be spaced not more than 5 inches apart, and shall be made of not less than No. 10 U. S. Standard Gauge wire with long links.

Order 469.—Brakes.

(a) Every direct connected electric elevator hereafter installed shall be equipped with an electrically released brake so designed, installed and maintained that it will not be released until the power has been applied to the motor. Under normal operating conditions the action of the brake magnet shall not be retarded by any motor field discharge or counter voltage, nor by any single ground or short circuit.

(b) Every power elevator, except direct connected electric elevators, shall be equipped with a brake so designed, installed and maintained that it will be released whenever the control mechanism is shifted to the starting position, and so that the brake will be applied by means of

springs or gravity whenever the control device is moved to the stopping position.

(c) Every hand power elevator shall be equipped with a brake that will operate effectively in either direction of motion of the elevator. Whenever such a brake has been applied it shall remain locked in position until released.

(d) The brake on every hand power elevator hereafter installed shall be so arranged that it will operate automatically at the top landing.

SECTION IX. CONTROL AND PROTECTION.

Order 470.—Control Mechanism.

(a) There shall not be installed or used any control system which depends upon the completion or maintenance of an electric circuit for the interruption of the power, for the application of electro-mechanical brakes, for the operation of car safety devices, or for the closing of a contactor by an emergency stop button, except that the requirements in this paragraph do not apply to dynamic braking and speed control devices.

(b) The car switch or hand lever on every power elevator hereafter installed which requires such mechanism shall be so arranged that the movement of the lever toward the car gate (which the operator usually faces) will cause the car to descend and the movement of the lever away from the gate will cause the car to ascend. Except on hydraulic elevators and existing electric lever control elevators, the lever shall return to the neutral position when released, and the lever shall automatically latch in this neutral position.

(c) A properly fused manually operated disconnecting switch opening all lines shall be installed separately in the supply circuit of every electrically driven elevator machine hereafter installed. If possible this switch shall be located adjacent to, and visible from, the elevator machine. No provision shall be made to close the disconnecting switch from any other part of the building. This switch shall comply with order 1350—(h) of the Wisconsin State Electrical Code.

Note: It is recommended that this switch be located in the machine room at the lock-jamb side of the entrance door.

(d) On mechanically controlled elevators the operation of directional switches or operating valves shall, in no case, depend solely upon a belt or a chain. If a handrope is used the cable shall be securely anchored to the operating sheave or drum.

(e) The handrope for control of an elevator shall be accessible from the car at any point in the car travel.

Note: The handrope for the control of an elevator is sometimes made accessible from the landing side by cutting an opening in the shaftway enclosure. To avoid this it is permissible to arrange the handrope by means of auxiliary sheaves so that one run of the handrope will be on the outside of the shaftway enclosure, provided that in every such case the handrope on the outside shall be guarded in an approved manner to a point not less than four feet above each floor.

(f) The overhead tension weight for the handrope of any elevator equipped with lever control apparatus shall be secured by a chain attached to the weight and to a suitable anchorage.

(g) The car of every power freight elevator with handrope control shall be equipped with a cable lock so designed, installed and maintained that the handrope can be locked at any landing to prevent the operation of the car by persons on other floors.

Exception: The requirements contained in the preceding paragraph need not apply to sidewalk elevators, elevators equipped with emergency switches and elevators equipped with interlocks or electric contacts.

(h) The car of every electrically driven elevator equipped with an electric brake shall be provided with an emergency switch (safety or so-called baby switch) to cut off the source of power.

Order 471.—Push Button Controlled Elevators. New and Existing Installations.

Push button controlled elevators shall conform to the following requirements:

(1) Every directional button shall be arranged to return to the open position when the hand of the operator is removed.

(2) The breaking of a circuit to stop a push button controlled elevator shall not depend on the operation of a spring or springs in tension nor upon the completion of an electric circuit.

(3) In an automatic push button elevator the stop button on the car may be used as the emergency switch if it is a button marked "STOP".

Order 472.—Electrical Protection.

(a) Every elevator driven by a polyphase alternating current motor shall be protected against damage due to phase reversal by either:

(1) Limit switches as specified in order 463 arranged to cut all wires, or all except one, which shall be the ground conductor on grounded systems, and so connected that after the car overtravels, it cannot be moved until the phase reversal is corrected, or

(2) A reverse phase relay, or other protective device, which will prevent starting the motor if the phase rotation is in the wrong direction. Such reverse phase relay, or other protective device, shall be provided for existing installations not later than June 1, 1928.

Note: If the elevator is equipped with an electric brake, limit switches wired in series are required by order No. 463.

(b) The proper functioning of a reverse phase relay hereafter installed shall not be dependent upon the closure of an electric circuit to open the motor circuit in case of failure or reversal of phase.

Recommendation: The reverse phase relay should not be put on the control board, as the vibration of the control equipment may interfere with the proper operation of the relay.

(c) The functioning of a door or gate electric contact, to prevent the movement of the car, shall not be dependent upon the action of a spring or springs in tension nor upon the closing of an electric circuit.

Exception: The contact shall not prevent the movement of the car when the emergency release is in temporary use or when the car is being moved by a car leveling device.

(d) Every electrically driven elevator hereafter or heretofore installed shall be protected against damage due to electrical failure as follows:

(1) An automatic overload protective device, such as fuses, overload relays or circuit breakers. If an overload relay or a circuit breaker is provided for this purpose it shall be additional to the elevator control equipment, and shall be so arranged that it cannot be reset from the elevator car.

(2) Under or low voltage protection which will cause and maintain the interruption of power to the main circuit upon reduction or failure of voltage. This

protection may be a part of the control equipment. (See also order 1357—g of the Wisconsin State Electrical Code.)

(e) Every electrically driven elevator hereafter installed which is controlled by a handrope, lever or wheel shall be equipped with a positive no-voltage release device requiring the centering of the handrope before the circuit can be re-closed. This may be accomplished by the addition of a relay interlocked with the control apparatus.

Order 473.—Switches and Wiring.

(a) In new installations in garages the shaftway limit switches and other spark emitting devices shall be placed at least 4 feet above the line of the lowest floor level.

(b) The floor underneath every unit of unenclosed electrical apparatus shall be covered with a fire resistive and insulating material.

(c) Live parts of electrical apparatus in elevator shaftways shall be guarded by suitable enclosures. Metal coverings shall be thoroughly grounded.

(d) Conductors for car control, safety control, lights and signals shall be in separate cables.

(e) The wires to the emergency switch, if such a switch is installed, shall be run as a separate cable so grouped with relation to other wires or cables, if there are any, that the fault in these wires or cables will not prevent the emergency switch or stop button from opening the circuit.

(f) Every safety switch (so-called baby switch) or other safety stop control conductor cable shall be in a separate unit, not in the same cable with the direction wire.

(g) No conduit shall be loaded more than 40 per cent of the internal cross sectional area of the conduit. (See also order 1331—(a) of the Wisconsin State Electrical Code.)

(h) Wires in vertical conduit risers shall be supported as required by order 1342—(b) of the Wisconsin State Electrical Code. The flexible or traveling cables of the operating and lighting circuits where suspended under the

car shall be supported on insulating spools to relieve the wire connections from strain.

(i) Individual conductors of lighting cables shall not be smaller than No. 14 A. W. G. and for control cables not smaller than No. 16 A. W. G. Signal wires, other than those receiving energy from primary batteries or approved bell transformers, shall be encased in approved conduit equipped with approved terminal bushings having an individual outlet hole for each wire.

(j) If the wires of a motor circuit between the motor and the control panel are grouped together without any extra insulation on the separate wires, the complete group shall be taped or corded and painted in a manner to make it a rigid, self-supporting form, not over three feet long, and not in a position liable to mechanical damage or subject to a temperature in excess of 120 degrees Fahrenheit.

(k) Wires between the main circuit resistances and the backs of control panels shall have individual flame-proof outer coverings. Other wiring on the control panels may be of the rubber covered type, provided the wires are laid flat against the panels and held in such a manner as to be immovable and not exposed to mechanical drainage, nor to a temperature exceeding 120 degrees Fahrenheit.

(l) Every conductor cable hung from an overhead machine platform on any elevator hereafter installed shall be secured approximately at the center of the shaftway to prevent swinging. Where the penthouse floor is not of incombustible material the floor under the controller shall be protected with fire resistive, insulating material.

(m) Wiring shall be in approved rigid conduit, except where otherwise specified in this code, and shall conform to the requirements of the Wisconsin State Electrical Code.

Order 474.—Grounding.

Exposed noncurrent carrying metal parts of electrically driven elevators operating at more than 100 volts to ground including frames, conduit, hand ropes, etc., shall be permanently and effectively grounded in accordance with Section 103 of the Wisconsin State Electrical Code.

Note: The ground connection should be made to water piping systems, if available, never to gas pipes. Other large buried metal structures and grounded steel building frames may be used where water pipes are not available.

Order 475.—Signal Systems. New and Existing Installations.

(a) Every elevator and every power dumbwaiter shall be equipped with a signal system or warning bell, so arranged that it can be safely and conveniently operated from any landing, except elevators and dumbwaiters controlled by push buttons and hand power elevators traveling in no case more than 25 feet.

(b) Every automatic push button elevator shall be provided with an emergency call bell in the caretaker's office, with properly placarded push button in the car.

SECTION X. LIGHTING.

Order 476.—Lighting.

(a) Car Lighting. Elevator cars shall be adequately lighted when in use. Provision for electric light shall be made if current is available. The intensity of illumination shall be not less than 0.75 foot-candle at the edge of the car platform.

Note: This illumination is the equivalent of a 75 watt lamp at the ceiling of an ordinary elevator car. Threshold lights are also recommended for passenger elevators.

(b) Landing Light. While occupied ample light shall be provided at every elevator landing within, or in connection with, any building.

(c) Penthouse and Overhead Lighting. Every penthouse shall be provided with suitable artificial light. Every elevator machine room and area about a ceiling type machine, including overhead sheave rooms and lofts, shall be well lighted. Control of such lighting shall be in the approach to the penthouse or overhead equipment. (See Industrial Lighting Code issued by the Industrial Commission.)

SECTION XI. OPERATION, MAINTENANCE AND USE.

Order 477.—Operation of Elevators. New and Existing Installations.

(a) A competent operator shall be stationed on the car of every passenger elevator while in use, except push button elevators.

Note: Section 103.06 of the Wisconsin Statutes prohibits the employment of persons under 18 years of age in the operation of elevators.

(b) No elevator car shall be used for hoisting material which projects from the car at any point, nor shall material be hung underneath the car, except in extreme necessity when the following precautions shall be observed:

(1) No material extending above the top of any elevator car shall be hoisted unless a regular operator is on the car and an attendant is stationed at the floor level where the material is to be delivered.

(2) The car shall be operated at slow speed when it is necessary to use it for this purpose.

(3) Every car gate and car door shall be closed while the car is in motion.

Order 478.—Maintenance. New and Existing Installations.

(a) Elevators, dumbwaiter and escalator equipment shall be kept in safe operating condition, properly lubricated and clean.

(b) Hatch covers of the vertically rising type used on elevators shall not be used for storage purposes, nor as passageways.

(c) Explosives or highly inflammable substances shall not be stored within 20 feet of any elevator shaftway or penthouse.

(d) Material which is not a permanent part of the elevator equipment shall not be permitted on the top or cover of an elevator car.

Note: A sign should be used to plainly designate a freight elevator, at the same time prohibiting unauthorized persons from riding on the car.

Part V

REQUIREMENTS APPLYING TO SPECIAL TYPES OF ELEVATORS

SECTION I. DUMBWAITERS.

Order 479.—Dumbwaiters. New and Existing Installations.

(a) The shaftway openings of every electric dumbwaiter shall be provided with landing doors, so arranged that the dumbwaiter cannot be started unless all doors are closed. Where a fireproof shaftway is required all landing doors shall be fire doors. (See orders 410-411).

(b) Every dumbwaiter shaftway opening at the floor level shall be protected by a gate in compliance with orders 438 and 439. Every other dumbwaiter shaftway shall be enclosed on the loading side to a height of at least 30 inches above each floor.

(c) Every dumbwaiter shall have a solid cover over the full area of the car. For shaftway enclosure see orders 411-413 inclusive.

SECTION II. SIDEWALK ELEVATORS.

Order 480.—Sidewalk Elevators.

(a) Every sidewalk elevator shaftway shall be covered at the top with doors designed and constructed to carry a load of 250 pounds per square foot within the safe limits of stresses. The surface of the doors shall be rough and no part of them shall project above the sidewalk level when closed. The doors shall open only sufficiently for proper service, and when open shall form a suitable guard for the opening. The dimensions of the sidewalk opening shall, in no case, exceed 5 feet at right angles to the curb, and 7 feet parallel with the curb.

(b) On each side of a sidewalk opening not fully protected by a door or other guard to a height of not less than 30 inches, a full screen or solid guard panel shall be pro-

vided. This guard panel shall be so installed that it cannot be pushed into the opening.

(c) Every power sidewalk elevator shall be equipped with a device to prevent its operation until the doors over the top of the shaftway are open. The doors shall be closed when the elevator is not in actual use.

(d) Beveled toe-guards shall be provided under the edges of the sidewalk, and under other projections, if any, as required by order 415. If the elevator platform rises above the sidewalk, similar toe-guards shall be provided under the platform on all exposed sides. (See order 487—g).

(e) A power sidewalk elevator which travels only one story, or not more than 30 feet, is subject to the following orders only: 400, 401, 402, 404, 405, 406, 407, 408, 412—(a), 418—(a), 427—(a) and (g), 438 and 439, as applied to lower terminal freight elevator landings, 441—(a), 442, 443, 453, 466, 468 where the travel is more than 15 feet, 473—(c), (d), (g), (j) and (m), 474, 476—(b), 478—(a), and 480. Hydraulic sidewalk elevators shall also be subject to such paragraphs of orders 485, 486, 487, and 488 as may reasonably be applicable to sidewalk elevators.

(f) A sidewalk elevator which travels more than one story or more than 30 feet is subject to all the freight elevator orders.

Recommendation: The back wall of the shaftway should not be more than 1 inch from the car.

(g) Every hand power chain hoist sidewalk elevator shall comply with orders 438 and 439 as applied to lower terminal freight elevator landings, order 478—(a), and with 480—(a) and (b).

(h) Every sidewalk elevator car or platform hereafter installed shall be enclosed to a height of 1 foot on the sides not used for entrance.

Order 481.—Freight Elevators of the Sidewalk Type.

(a) Every power elevator of the sidewalk type, located within a building, and traveling less than one story, shall be equipped with toe-guards as specified in order 415; the side of the car, or sides of the shaftway or both shall be guarded with an enclosure constructed as specified in order

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412 and of such height as will afford reasonable safety, and shall be subject to the orders enumerated in order 480—(e).

(b) Every elevator of the sidewalk type, located within a building and traveling one story, or more than 30 feet, shall comply with all the freight elevator orders.

(c) Every elevator of the sidewalk type located below the stage of a theater and traveling one story only shall have the opening on the stage floor equipped with a flush hatchway cover, which, when the elevator is down, shall be closed forming part of the stage floor. The hatchway cover shall be lifted by the elevator in its upward travel by a device consisting of corner posts and framework attached to the car platform and of sufficient height to provide proper headroom. Each corner post shall be provided with a stud or projection engaging a socket on the under side of the hatchway cover so that it cannot readily be dislodged. The opening in the stage floor shall be protected by toeguards as required in order 415. The shaftway in the basement shall be enclosed with metal guards as described in order 412 and a swinging door equipped with a lock shall be provided at each entrance. The speed of any elevator installed in such a manner shall not exceed 50 feet per minute. The carrying capacity of the car platform shall be as required in order 427—(a).

SECTION III. HAND POWER HOSPITAL ELEVATORS AND HAND POWER INVALID LIFTS.

Order 482.—Special Requirements.

(a) The car of every hand power invalid lift and of every hand power hospital elevator shall be completely enclosed on the top and on the sides not used for entrance.

(b) The minimum carrying capacity of a hand power invalid lift and of a hand power hospital elevator shall be not less than 35 pounds per square foot of platform area inside of the car enclosure. (See order 419—(b), for car buffers.)

SECTION IV. HYDRAULIC ELEVATORS. NEW INSTALLATIONS.

Order 485.—Construction and General Requirements.

(a) Every piston rod of tension-type hydraulic elevators shall have a factor of safety of not less than 8, based

on the cross-sectional area at the root of the thread. A true bearing shall be maintained under the nut at each end of the piston rod to prevent eccentric loading on the rod.

(b) Every hydraulic elevator machine, whether of the vertical or horizontal type, shall be so constructed and so roped that the piston will be stopped before the car can be drawn into the overhead work. A stop of ample strength shall be provided to bring the piston to rest when under full pressure without causing damage to the cylinder or cylinder head.

(c) The traveling sheaves for vertical hydraulic elevators shall be guided. The guide rails and guide shoes shall be of metal. The side frames of traveling sheaves for vertical hydraulic elevators shall be made of structural steel or of forged steel.

(d) Pressure tanks shall be made and tested in accordance with the requirements of the Boiler Code issued by the Industrial Commission.

(e) Every pressure tank that may be subjected to vacuum shall be provided with one or more vacuum valves to prevent collapse of the tank.

(f) Every pressure tank shall be so located and supported that inspection may be made of the entire exterior.

(g) Every discharge tank open to the atmosphere shall be so designed that when completely filled the factor of safety shall be not less than 4 based on the ultimate strength of the material. Every discharge tank shall be covered to prevent the entrance of foreign material and shall be provided with a suitable vent to the atmosphere.

(h) The outlet of each pressure tank shall be so located as to prevent the entrance of air or other gas into the elevator cylinder.

(i) Automatic stop valves shall be packed with cup leathers, or other means shall be used to prevent sticking of the valve stems.

(j) Each pump connected to the pressure tank of a hydraulic elevator shall be equipped with a relief valve, so installed that it cannot be shut off. The relief valve shall be of sufficient size and so set as to pass the full capacity of the pump at full speed without exceeding the safe working

pressure of the pump or tank. The relief valve shall be piped to discharge into the discharge tank or into the pump suction. Two or more relief valves may be used to obtain the capacity.

(k) Every elevator pump, unless equipped with a pressure regulator which controls the motive power, shall be equipped with an automatic by-pass.

(l) Every hydraulic elevator operated from a pressure tank where the fluid pressure is obtained by directly admitting steam, air or other gas to the tank shall comply with all the rules covering hydraulic elevators. For limitations in use see order 460.

Order 486.—Safety Equipment.

(a) The handrope on every hydraulic elevator shall be equipped with a limit stop to prevent damage to the valve mechanism.

(b) Every tank for a hydraulic elevator shall be fitted with a quarter inch pipe connection for attaching a test gauge, when the tank is in service so that the accuracy of the pressure gauge can be ascertained.

(c) Every pressure tank shall be equipped with a water gauge glass to indicate the height of the water in the tank. Pet cocks may be used where pressure is obtained by steam, air, or other gas.

(d) Each pressure tank shall be equipped with a pressure gauge which correctly indicates pressure to at least one and one-half ($1\frac{1}{2}$) times the normal working pressure of the tank. This gauge shall be connected to the tank by a brass or other non-corrodible pipe in such a manner that the gauge cannot be shut off from the tank except by a cock with a "T" or lever handle. (The "T" or lever must be set in line with the direction of the flow). The cock shall be in the pipe near the gauge.

(e) The cylinders of hydraulic elevator machines, except plunger type machines, shall be provided with means for releasing air or other gas.

(f) Every hydraulic elevator shall be provided with an independent automatic means for gradually stopping the car at the terminal landings.

Order 487.—Plunger Type Elevators.

(a) The piping system of plunger type elevators shall be provided with proper air chambers to stop the water hammer on both directions of travel.

(b) The sections of the piston shall be rigidly joined, and the bottom section shall be so designed and installed that it cannot leave the cylinder.

(c) A cast iron plunger shall not be used in any case where the elevator travel is more than 50 feet.

(d) Every plunger type elevator operating on greater than 150 pounds pressure shall have extra heavy pressure fittings throughout.

(e) There shall be no lead piping in the water line between the plunger cylinder and the operating valve.

(f) The construction of the operating valve shall be such that the opening and closing of the valve will gradually stop the flow of water to and from the cylinder.

(g) No plunger elevator of the sidewalk type with sliding extended car guide rails shall rise more than 4 feet above any sidewalk.

Order 488.—Maintenance.

(a) The piston rods of hydraulic elevator machines, except plunger type machines, shall be exposed for inspection at least once every two years. The preparation for such inspections shall be made by the owners or parties using the elevators.

(b) The discharge tank and the pressure tank of every hydraulic elevator shall be cleaned at least once every two years. The water level in the pressure tank of a hydraulic elevator shall be maintained at about two-thirds of the capacity of the tank.

Order 489.—Recabing Hydraulic Elevators.

Where more than one vertical hydraulic cylinder is placed in the same shaftway, or where the horizontal cylinders are placed in duplex or triplex, the operation of all such connected elevators shall be stopped by closing the main water supply valve before recabing any one of the elevators.

SECTION V. ESCALATORS.

Order 490.—Construction of Escalators.

(a) The angle of inclination of an escalator shall not exceed 30 degrees with the horizontal.

(b) The width of an escalator shall be measured between the balustrading at a vertical height of 24 inches above the nose line of the tread, and no escalator shall be less than 22 inches nor more than 48 inches wide. Every escalator more than 29 inches in width shall have a horizontal tread formation.

(c) Every escalator shall be provided on each side with solid balustrading. On the escalator side the balustrading shall be smooth, without depressed or raised paneling or molding. There shall be no abrupt change in the width between the balustrading on the two sides of any escalator. Should any change in the width be necessary the change shall be not more than 8 per cent of the greatest width. In changing from the greater to the smaller width the change in the direction of the balustrading shall not exceed 15 degrees from the line of the escalator travel. Each balustrading shall be equipped with a handrail moving at the same speed and in the same direction as the travel of the escalator. The use of glass panels for balustrading is not permissible.

(d) Escalator treads and landings shall be of material affording a secure foothold, such as wood or material used for safety treads. If a landing is made of concrete, it shall have edge insertions of metal, wood or other anti-slip material.

(e) Every escalator truss or girder shall be so designed and installed that, in case of the failure of the track system to retain the running gear in its guides, the truss will safely retain the steps and running gear. A factor of safety of not less than 5, based on the static loads, shall be used in designing escalator trusses or girders.

(f) The track arrangement shall be designed to prevent the displacement of the treads and running gear if the tread chain breaks.

(g) The rated load on an escalator 22 to 24 inches in width shall be computed by the following formula:

$$\text{Rated load} = 110 A$$

The rated load on an escalator wider than 24 inches but not exceeding 48 inches shall be computed by the following formula:

$$\text{Rated load} = 4.6 WA$$

On these formulae, "W" is the width of the escalator in inches, and "A" is the horizontal projected length in feet of the exposed treads. The rated load is expressed in pounds.

Order 491.—Safety Requirements for Escalators.

(a) The speed of an escalator in the direction of travel shall not exceed 100 feet per minute.

(b) Every escalator shall be driven by an individual electric motor. Two or more escalators placed side by side and operated as a single unit may be driven by one motor.

(c) Every escalator chain shall have a factor of safety of not less than 10 except where the chain is made of cast steel links (which shall be thoroughly annealed), in which case the factor of safety shall not be less than 20.

(d) Every escalator drive shall be provided with an electrically released, mechanically applied brake, which shall stop the escalator automatically when the power is interrupted.

(e) There shall be an emergency stop button, or other type of switch, accessible to the public and conspicuously located at the top and bottom of each escalator. The operation of either one of these buttons, or switches, shall open the power circuit, apply the brake and stop the escalator. It shall be impossible to start the escalator by means of these buttons or switches. They shall be marked thus:

ESCALATOR

*

STOP BUTTON

(f) Where starting buttons or switches are accessible to the public they shall be of the key operated type or they shall be enclosed in boxes provided with locks and keys.

(g) Every escalator operating in the ascending direction shall be equipped with a safety mechanism so that in case of accidental reversal of the escalator the power shall be cut off, the brake applied, and the escalator stopped. On a reversible escalator this safety mechanism shall be arranged to be in-operative when the escalator is descending and operative when the escalator is ascending.

(h) Every escalator shall be provided with a safety mechanism, which will open the power circuit, apply the brake, and bring the escalator to a gradual stop, in case the speed exceeds the normal running speed by 40 per cent.

(i) Every escalator shall be provided with a safety device to open the power circuit, apply the brake, and bring the escalator to a gradual stop, in case the tread chain or chains break.

(j) Where an escalator is equipped with a tightening device, operated by means of a tension weight, provision shall be made to retain this weight in the escalator truss in case the weight should fail.

(k) Every escalator operated by a motor driven by polyphase alternating current shall be provided with a relay of the potential type or other suitable means which will prevent starting the motor while—

- (1) the phase rotation is in the wrong direction, or
- (2) there is a failure in any phase.

(l) There shall be a suitable light in every escalator machine room as a permanent fixture, which can be lighted without passing over or reaching over any part of the machinery.

(m) Reasonable access to the interior of the escalator shall be provided for inspection and maintenance.

Order 492.—Tests.

A practical test of an escalator installation shall consist of the following:

(1) Speed Test—The application of the overspeed safety device shall be obtained by causing the escalator to travel at the governor tripping speed. If an escalator is operated by a motor driven by alternating current the gov-

ernor may be tripped by hand with the escalator traveling at its normal rate of speed.

(2) Reversal Tests. The application of the reversal safety device shall be made by releasing the machine brake and operating the escalator by hand in the reversed direction.

(3) Broken Chain Test. The application of the broken chain safety device shall be obtained by operating the safety by hand.

(4) Miscellaneous Safety Devices. Tests of the machine brake and of the emergency stopping buttons or switches shall be made to determine whether they function properly.

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Appendix

Extracts from Other Industrial Commission Codes

GENERAL ORDERS ON SAFETY

The General Orders on Safety require adequate guards for such hazardous parts as gears, pulleys, belts, sprockets, protruding set-screws in revolving parts, keys and keyseats in revolving shafting, couplings with protruding parts and revolving shafting. All such parts, where exposed to contact must be guarded in accordance with these general orders.

STATE BUILDING CODE

Order 5100. Fireproof Construction.

A building is of fireproof construction if all the walls, partitions, piers, columns, floors, ceilings, roof and stairs are built of incombustible material; and if all metallic structural members are protected by an incombustible fire resisting covering of low heat conductivity, of not less than 2 inches thickness of concrete or 3 inches thickness of other approved material, for columns; not less than 2 inches thickness for girders; and not less than 1½ inches thickness for other structural parts. This thickness shall be outside of the extreme edges of structural members. Such covering shall consist of Portland cement concrete, brick, terra cotta, or tile, laid in cement mortar, or other approved material and shall be properly reinforced, bonded, wired or otherwise secured in place. Steel reinforcement shall be protected as in order 5313. The plastering shall not be applied to wood lath or wood furring strips.

Floor panels may be built of approved metal (see Order 5316), designed to resist all stresses independent of any protective covering, protected on the upper and lower sides. Steel lumber joists shall not be spaced more than 24 inches center to center well bridged with proper tension strips. Upper slab shall be reinforced concrete not less than 2 inches thick over all structural metal. Expanded metal or metal lath of proper weight and rigidity to span the joist spacing, well fastened to joists, may be used for reinforcement, but no metal less than 24 gauge shall be used. Lower side of joists shall be protected by not less than $\frac{7}{8}$ inch cement plaster on expanded metal or metal lath. The upper slab and plastered ceiling shall create air spaces between the metal floor supports completely isolated from the open atmosphere. All beams and girders supporting the floor panels shall be fully protected. Connections of metal joists to beams, girders, and other bearings shall be in a manner approved by the Industrial Commission. All steel lumber joists shall receive a protective coat of lead and oil or bituminous paint before being placed in position. Metal lumber shall not be used in floor panels having less than 3 feet of well ventilated air space below or in floor panels over damp basements.

Note. Expanded metal or metal lath weighing not less than $3\frac{3}{4}$ lbs. per square yard should be considered the minimum for joist spacing of $23\frac{1}{2}$ inches, and $2\frac{3}{4}$ lbs. per square yard for joists spacing of $15\frac{3}{4}$ inches.

The trimmings and finished floor may be of wood, provided all spaces behind or below same are filled with incombustible material. Partitions entirely contained within a private apartment may be non-fireproof provided the partitions enclosing such apartment are fireproof.

A wood roof with incombustible roof covering will be permitted on a fireproof building not more than 85 feet high, provided the ceiling of the uppermost story is of fireproof construction not suspended from the roof.

A room or a portion of a building is of fireproof construction if it complies with all of the above requirements, and is separated from the rest of the building by means of fireproof walls, floors and ceiling, in which all openings are protected by means of firedoors or fixed standard fire windows.

For outside windows and doors see order 5201.

Note (a). A "fireproof" floor, ceiling, or wall is one of "fireproof construction." A "standard fire wall," "fireproof partition," etc., are defined in orders 5108-5113. "Incombustible" includes any material which will not burn or support combustion.

Note (b). To secure the best protection against a severe fire, the finish, floors, trim, doors, windows, etc., should be made entirely of incombustible material.

The fireproof covering of exterior columns should be at least 4 inches thick to resist a severe fire.

Note (c). The fireproofing of steel roof trusses may, if approved by the Industrial Commission, be omitted in cases where no increased hazard will result.

Order 5101.

A building is of mill construction if all walls are built of incombustible material, and if all wood girders and joists are at least $5\frac{1}{2}$ inches thick. No wood girder or joist shall measure less than 63 square inches and no wood posts less than 90 square inches in sectional area, except that $7\frac{1}{2} \times 7\frac{1}{2}$ inch (or larger) posts may be used in the top story only. All structural steel or iron (not including post caps, bases, and joists hangers) shall be fireproofed with not less than one inch of incombustible material or with metal lath and cement or gypsum plaster. The lower thickness of each floor shall be not less than $2\frac{5}{8}$ inch lumber with grooves and splines at the joints; this shall be covered with felt or building paper, and with a separate finished floor not less than $\frac{3}{8}$ inch thick.

Note. Floor joists should be at least $7\frac{1}{2}$ inches thick. The roof shall be at least $2\frac{1}{2}$ inches thick and shall have an incombustible roof covering; if an airtight roof covering (such as felt or tin) is not used, then the roof planking shall be in two thicknesses, with felt or building paper between.

There shall be no openings in the floor unless protected by standard fire doors, and no concealed air spaces except such as are enclosed by incombustible material.

All stairways and elevators shall be enclosed with standard fireproof enclosures.

For outside windows and doors see order 5201.

Order 5110.—Standard Fire Door.

A standard fire door shall consist of a wooden core encased with tin, or shall be entirely of metal; and shall be of design approved by the Industrial Commission. The door frame shall be metal. The door shall close automatically in case of fire.

Order 5111.—Standard Fire Window.

A standard fire window shall have a metal frame, metal sash, and wired glass of design approved by the Industrial Commission. No pane shall be less than $\frac{1}{4}$ inch thick nor of greater area than 720 square inches. The window either shall be fixed or shall close automatically in case of fire.

CONCRETE CONSTRUCTION

Order 5313.—Unit Stresses and Reinforcement.

The following unit stresses (pounds per square inch) shall not be exceeded.

Reinforced Concrete 1:2:4 mix:—

Compression in concrete, extreme fiber, (assuming a straight line stress distribution)	700
Tension in concrete	none
Compression in steel—15 times the compression in concrete at the same point.	
Tension in steel	16,000
Bond between concrete and steel.....	80
Shear in concrete.....	40
Compression on net core area of concrete column, with longitudinal and transverse reinforcement each equal to at least 1 per cent of the core volume.....	800
Compression on net core area of a similar column but with concrete of a 1:1½:3 mix.....	900
Compression on net core area of a column with less reinforcement than the above	500

Plain Concrete:—

	Com- pression	Shear	Tension due to bending
1:2:4 mix.....	400	40	35
1:2½:5 mix.....	300	35	30
1:3:6 mix.....	250	30	25

Note. The foregoing are maximum stresses, suitable for concrete which will develop a crushing strength of at least 2,000 pounds per square inch in 28 days, with a 1:2:4 mix. Where fine sand (very common in Wisconsin) or soft stone is used, the stresses should be decreased or the proportion of cement increased. The following table indicates what strength may be expected with different aggregates, with good coarse sand and good workmanship.

Aggregate	1:1:2	1:1½:3	1:2:4	1:2½:5	1:3:6
Granite, trap rock.....	3300	2800	2200	1800	1400
Gravel, hard limestone and hard sandstone ..	3000	2500	2000	1600	1300
Soft sandstone and sandstone.....	2200	1800	1500	1200	1000
Cinders.....	800	700	600	500	400

Joint Committee on Concrete and Reinforced Concrete.

The minimum longitudinal reinforcement of a column or beam shall be four $\frac{1}{2}$ inch round rods. The minimum trans-

verse reinforcement of a column or beam shall be the equivalent of $\frac{1}{4}$ inch round rods, averaging not more than 12 inches apart. The steel shall be protected by at least $1\frac{1}{2}$ inches of concrete for columns, 1 inch for beams, and $\frac{1}{2}$ inch for slabs; but this protection shall not be less than the diameter of the rod in any case. In any column longer than 15 times its least diameter the unit stresses shall be properly decreased. The transverse reinforcement shall not be considered in calculating the strength of a column.

Every concrete structure shall be designed in accordance with this code and with the rules and principles of standard practice.

Note (a). For proper fire-resistance the protection of reinforcement is recommended to be at least $\frac{1}{2}$ inch greater than required above.
Note (b). "Standard practice" is well illustrated in the final report of the Joint Committee on Concrete and Reinforced Concrete.
 To quote from introduction to this report: "In their use concrete and reinforced concrete involve the exercise of good judgment to a greater degree than do any other building materials."

STEEL AND IRON CONSTRUCTION

Order 5316.

The following unit stresses (pounds per square inch) shall not be exceeded:

	Rolled Steel	Cast Steel	Wrought Iron	Cast Iron
Tension on, net section	16,000	16,000	12,000	
Compression on gross section (max). See formula below	12,000	12,000	10,000	8,000
Tension on extreme fiber	16,000	16,000	12,000	3,000
Compression on extreme fiber	16,000	16,000	12,000	10,000
Extreme fiber of pins	25,000			
Shear:				
Pins and power-driven rivets	10,000			
Hand-driven rivets	8,000			
Machine Bolts	7,000			
Rolled steel shapes	12,000			
Plate girder webs, net section	10,000			
Brackets				2,000
Bearing:				
Pins and power-driven rivets	20,000			
Hand-driven rivets	16,000			
Machine bolts	14,000			
Compression:				
Steel			17,100—57	L
Wrought iron			12,000—60	R
Cast iron			10,000—60	L

Where L...length in inches.
 R...radius of gyration in inches.

Every steel or iron structure shall be designed in accordance with this code and with the rules and principles of standard practice.

All steel or iron shall conform to the standard specifications of the American Society for Testing Materials in force October 1, 1914. (Furnished on request.)

WOOD CONSTRUCTION

Order 5317.—Unit Stresses.

The following unit stresses (pounds per square inch) shall not be exceeded:

	Tension		Compression		Transverse	Shear
	With grain	Across grain	With grain	Across grain	Extreme fibre	
White oak.....	1,200	125	1,100	500	1,500	150
White pine.....	700	50	900	200	1,000	80
Long leaf yellow pine.....	1,200	60	1,500	350	1,700	150
Short leaf yellow pine.....	1,000	50	1,100	300	1,400	100
Douglas fir.....	1,000	50	1,300	325	1,600	110
Norway pine.....	800	50	1,000	250	1,200	100
Eastern spruce and fir.....	800	50	800	200	1,000	80
Hemlock.....	600	-----	900	200	1,100	80

The stress in compression members shall not exceed $C \left\{ 1 - \frac{L}{60D} \right\}$ where

C = "compression with grain"
 L = length in inches
 D = least width in inches

Note. The above are maximum stresses, suitable for timber which is free from injurious defects and of sufficient density.

Defects include decay, knots, shakes, checks, etc. Decay is dangerous because it tends to spread and because it is difficult to determine the extent to which the timber is weakened. Knots and cross grain in the center half of beams near the bottom edge are especially serious. Deep checks and ring shakes are of importance when they occur in the middle half of the height of the beam or when they run diagonally across the faces; for beams containing such checks, the allowable stress in horizontal shear should be decreased.

The density of the wood is important because the strength of timber increases with the density; this in turn is in proportion to the per cent of "summerwood" (i. e. the hard, dark part of the ring). In yellow pine and Douglas fir the summerwood should form at least 25 per cent of the total if the above stresses are to be used.

These stresses should be decreased at least 20 per cent for timber exposed to moisture.

For further details on the strength and grading of timbers, see Bulletin 108 and other publications of the U. S. Forest Service.

GENERAL ORDERS ON SAFETY IN CONSTRUCTION

Order 3520.—Elevators.

Every elevator as defined in Order 400-(1) of the Elevator Code issued by the Industrial Commission shall conform to all of the requirements of the Elevator Code, except that this requirement need not apply to the final completion of doors and cabs. Where the permanent doors and cabs are not completed temporary enclosure shall be provided.

Order 3521.—Riding on Elevators and Derricks.

No contractor or employer shall permit anyone to ride on derricks or other hoisting apparatus, except elevators which conform to the Elevator Code issued by the Industrial Commission.

Order 3522.—Hoisting Signals.

Bell, whistle or electric signals shall be provided for platform elevators, concrete hoists, etc., and in all other cases wherever practicable.

Note. Electric bell (or telephone) signals are the most reliable and are cheaper to maintain. Hoisting signals should be given by competent men only. Signals should be located so that the man cannot operate the signal if he is standing on the elevator platform.

Order 3523.—Partition Between Elevators.

If two or more elevators are located in the same shaft, and one elevator is put into temporary service before the others are completed, then the elevator in use (together with its counterweights) shall be separated from the other elevators by a continuous partition. This partition shall either be solid or consist of a screen of not less than No. 10 U. S. Standard Gauge wire with not more than one inch openings.

Order 3524.—Working in Shafts.

Workmen of more than one craft or doing different classes of work shall not be permitted in a shaftway at the same time unless a temporary floor protection as described

in Order 3531 is provided between all upper and lower workmen or groups of workmen.

Note. When men are working in a shaft, all material, etc., on upper floors should be kept well away from the shaft. See Orders 3504, 3510, and 3509 which requires a railing around every floor opening.

Order 3525.—Hoisting in Shaft Prohibited.

When elevator constructors or others are working in an elevator shaft no other material, tools or any other objects whatsoever shall be hoisted or lowered in such shafts.

Order 3526.—Protection of Machine Operatives.

Every hoisting engine, air compressor, concrete mixer or other machine used in construction work, shall be properly covered over to protect the operatives stationed at the machine unless the horizontal distance from such machine to the nearest point where work is being done is at least one-half the vertical height of such point above the machine.

Order 3527.—Hoisting Machines Enclosed.

All hoisting machines, irrespective of the motive power, shall be housed in to protect the operatives from November 15th to March 15th. This order does not apply to machines used on a job for not more than three days.

Order 3550.—Inspection of Equipment.

All derricks, elevators, hoists, chains, slings, cables, ropes, shackles, blocks and all other equipment shall be maintained in safe condition while in use, and shall be competently inspected by the employer or his agent at least once each month while in use. If such equipment has not been used for 30 days or more, then careful inspection shall be made before using.

STATE ELECTRICAL CODE

Order 1310.—Guarding Live Parts.

(a) *Equipment.*

(1) All ungrounded current-carrying parts of equipment operating at voltages higher than 100 volts to ground, shall be suitably guarded, if elevated less than 8 feet above floor or platform, or if exposed to contact above that level.

(b) *Conductors.* (For wires in Elevator Shafts see Elevator Code Order 420.) (See also Order 1357—e.)

(1) All exposed conductors, not included in (2) (3) and (4) below, when brought closer to floor or platform than 8 feet, or when exposed to mechanical injury above that level, shall be guarded by inclosure in conduit, armored cable or surface metal raceways.

(2) All conductors in schools, theaters, assembly halls, hotels, hospitals and public garages shall be guarded by inclosure in rigid or flexible conduit, armored cable or surface metal raceways.

(3) Conductors operating at voltages higher than 300 volts to ground shall be guarded by inclosure in conduit, in all buildings and at all elevations.

(4) Bus-bars and other open bare ungrounded conductors operating at voltages higher than 100 volts to ground, which are elevated less than 8 feet above floor or platform, shall be inclosed by suitable guards.

Order 1313.—Grounding.

(c) *Noncurrent-Carrying Metal Parts.*

All exposed noncurrent-carrying metal parts of equipment operating at voltages above 100 volts to ground shall be bonded together and permanently and effectively grounded.

Note: The ground connection should be made to water piping systems, if available, never to gas pipes. Other large buried metal structures and grounded steel building frames may be used where water pipes are not available.

Order 1342.—Wiring in Conduit Raceways and Armored Cable.

(b) *Support of Vertical Conduit Wiring.*

(1) Wires in vertical conduit risers shall be supported within the conduit system in accordance with the following:

No. 14-A. W. G. to 0-A. W. G. inclusive, every 100 feet.

No. 00-A. W. G. to 0000-A. W. G. inclusive, every 80 feet.

Above 0000-A. W. G. to 350,000-C. M. inclusive, every 60 feet.

Above 350,000-C. M. to 500,000-C. M. inclusive, every 50 feet.

Above 500,000-C. M. to 750,000-C. M. inclusive, every 40 feet.

Above 750,000-C. M. every 35 feet.

(2) Any of the following methods of support shall be used:

I. Approved clamping devices constructed of or employing insulating wedges inserted in the ends of conduits.

II. Junction boxes with covers inserted in the conduit system at the required intervals, in which insulating supports of approved type are installed and secured in a satisfactory manner so as to withstand the weight of the wires attached thereto.

III. Junction boxes with covers in which wires are supported on two or more insulating supports so placed that the conductors will be deflected at an angle of not less than 90 degrees, and carried a distance of not less than twice the diameter of the wire from its vertical position, and where necessary wires are additionally secured to these insulators by tie wires.

Order 1350. General Requirements for Switches.

(h) *Guarding Live Parts of Switches.* All manual switches, including service entrance switches, shall have suitable casings or inclosures of such design as to permit of operation without opening the inclosure and so that the operator is at all times protected against danger. Cases shall be locked, sealed or made inaccessible, to other than qualified persons, by other suitable methods.

Order 1357.—Motors and Generators.

(e) *Wiring.* Where speed-limiting devices or remote-control switches are electrically operated, the control circuits by which such devices are actuated shall be adequately guarded by conduit or otherwise, against mechanical injury.

(f) *Under or Low-Voltage Protection.* Where the re-starting of the motor on restoration of voltage may result in injury to persons or apparatus, under or low-voltage protection, which will cause and maintain the interruption of power to the main circuit upon reduction or failure of voltage, shall be supplied. (See also Order 1350—f-2.)

Exception: When the motor and driven machinery are isolated and accessible to qualified persons only, the provision of a disconnecting switch eliminates the hazard to persons.

(g) *Reverse-Phase Relays for Motors.*

(1) Electric freight or passenger elevators, operated by polyphase alternating current motors, shall be provided with protective devices (relays) which will prevent starting the motor if phase rotation is in the wrong direction or if there is a failure in any phase.

Exception: Limit switches placed in the elevator shaftway in accordance with Order No. 463 of the elevator code will make unnecessary the installation of reverse phase relays.

Order 1384.—Special Precautions.

(a) *Location of Cut-outs, Switches, etc.* Cut-outs, switches and receptacles shall be placed at least four feet above the floor.

(b) *Hatch Limit Switches.* Hatch limit switches of elevators shall be located at least four feet above the lowest floor level.

THE INDUSTRIAL LIGHTING CODE

Order 2112.—Artificial Light.

When the natural light is less than twice the minimum permissible intensities of illumination set forth in the following table, artificial light shall be supplied and maintained in accordance with the table.

Note: The measurements of illumination at the work will be made with a properly standardized portable photometer.

**ILLUMINATION INTENSITY AT THE WORK IN
FOOT-CANDLES**

Room or Space to be Illuminated	Minimum Permissible Intensities (1)	Intensities of Good Practice (2)	Productive Intensities (3)
(a) Roadways and yard thoroughfares	0.02	0.05 — 0.25	-----
(b) Storage spaces	0.25	0.5 — 1.	-----
(c) Stairways, passageways, aisles	0.25	0.75 — 2.	-----

Note: The foot-candle is the lighting effect produced upon an object by a lamp of one candle-power at a distance of one foot; at two feet, the effect would be not one-half foot candle, but one-fourth foot-candle; at three feet, one-ninth foot candle, etc.

Order 2113. Shading of Lamps for Overhead Lighting.

Lamps suspended at elevations above eye level less than one quarter their distance from any position at which work is performed, shall be shaded in such a manner that the intensity of the brightest square inch of visible light source does not exceed seventy-five candle-power.

Exception: Lamps suspended at greater elevations than twenty feet above the floor, are not subject to this requirement.

Order 2118.—Maintenance.

Windows and artificial lighting units shall be cleaned at sufficiently frequent intervals to maintain illumination in accordance with the standards of these orders. All parts of the artificial lighting system shall be frequently inspected and when found defective, replaced or repaired.

GENERAL ORDERS ON FIRE PREVENTION

Order 6050.

No combustible waste, rubbish or refuse shall be placed, kept or stored in any air, elevator or stair shaft, in closets or dark out-of-the-way places, around electric motors or machinery, or against steam pipes, or within 10 feet from any stove, boiler or furnace, or in any place where oils are used or stored. * * *

Order 6060.—Oily Waste.

Oily waste and oily rags, when not in actual use, during the day, shall be kept in approved, standard, self-closing

metal waste cans, set firmly on three-inch legs. One such waste can shall be installed for every 2,500 square feet of floor area, on each floor, where oily waste or oily rags are used. The contents of all such waste cans shall be destroyed, burned or removed from the building at the close of each day's work.

Order 6062.—Oil Drip Pans.

Metal drip pans shall be placed under all oil barrels resting on wooden floors, platforms or supports, and under all machines using oil, to catch the oil drippings, and oily metal borings and shavings. The contents of such drip pans shall be burned or removed from the building each day.

When a printing press or other oil-bearing machine is placed on a combustible floor, such floor shall be covered with substantial sheet metal.

All combustible floors and platforms shall be kept free of oils, oil drippings and oily waste and rags.

Metal oil drip cups shall be placed under all shaft bearings, including elevator machinery, suspended from the ceilings.