

SECTION IV.—CABLES.

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

(a) The factor of safety based on static loads for car and counterweight cables for power passenger and freight elevators shall be not less than the values given in the following table corresponding to the contract speed of the car.

FACTORS OF SAFETY FOR HOISTING CABLES

Car Speed in Feet per Min.	Passenger Elevators	Freight Elevators	Dumb-waiters
50 or less	7.0	6.7	See Order 479 (h) 1
100	7.8	7.0	
200	8.5	7.6	
300	9.1	8.2	
400	9.7	8.7	
500	10.2	9.1	
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.**

(a) There shall be posted for permanent record 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				
Governor				

For governor cable see order 447.

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

(c) On elevators hereafter installed and thereafter whenever cables are renewed on elevators, there shall be attached to the cable fastening or car beam a metal tag or plate 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 and Size 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 elevator hereafter installed shall have not less than four cables, except, for 2 to 1 roping, or where the capacity is not more than 1200 pounds, not less than three cables shall be used.

(c) Hoisting cables less than  $\frac{1}{2}$  inch in diameter shall not be used for power elevators.

(d) The minimum number of hoisting cables shall be determined by using the factor of safety in Order 441(a) together with the rated ultimate strength of the cable. The computed load on the car-hoisting cables shall be the weight of the elevator car, plus the contract load, plus the weight of the car-hoisting cables and the compensation minus the weight of the independent car counterweight, if any, (See order 452).

**Note:** On traction elevator machines the number of cables required to secure adequate traction may exceed the number required in Order 441(a).

#### **Order 445.—Cable Guards for Sheaves and Idlers.**

Every sheave or idler under which is led any hoisting, counterweight, or governor cable, shall be provided with a guard that will keep the cable on the sheave or idler if the cable becomes slack.

**Note:** (1) See Order 424(b) for deflecting sheave guards.

**Note:** (2) See Order No. 1 in the "General Orders on Safety" for guarding of pinch points.

#### **Order 446.—Cable Terminal Fastenings and Turns Required on Drums.**

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

(b) Where a cable equalizer is used in any elevator installation, the details of construction of such equalizer shall be submitted to the Industrial Commission for approval, and only approved construction shall be used.

(c) Not more than one cable, on any elevator hereafter installed, shall be fastened into the same clevis or socket.

(d) The hoisting and counterweight cables of every drum type elevator hereafter installed 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 recabing of existing installations. The winding drum end of every car or counterweight cable shall be secured on the inside of the drum.

(e) 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.

Exception: Where cable fastenings are installed by the cable manufacturer, other methods of socketing giving equivalent strength may be used.

#### **Order 447.—Governor Cables.**

(a) The governor cable shall be of iron, steel, monel metal or phosphor bronze. The cable shall be not less than  $\frac{3}{8}$ " in diameter. Tiller-rope construction shall not be used for governor cables, except that tiller rope may be used for the portion of the cable wound on the safety drum, but such rope shall be of corrosion-resistant metal.

In replacing existing governor cables they shall be of the same size, material and construction as the cable originally furnished by the manufacturer, except that where a cable of either different material or construction is employed, a test of the car or counterweight safety shall be made with the new cable to demonstrate that it will successfully operate the safety.

Exception: An approved fibre governor rope may be used on a freight elevator traveling not more than 50 feet with a car speed not to exceed 75 feet per minute and designed for a capacity of not more than 3,500 pounds, provided that the rope is re-

quired to run over only two sheaves, namely, the governor sheave at the top of the shaftway and the tension weight sheave at the bottom of the shaftway, and provided further that the setting of the dogs of the car safety device does not depend upon the traction of the rope in the governor sheave and a consequent continuous pull on the rope.

(b) In every elevator hereafter installed, 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 elevator hereafter installed, in which the hoist cables wind around a drum, and a contract speed exceeding 100 feet per minute, shall be equipped with car counterweights supported by separate cables. Every drum type passenger elevator and every drum type freight elevator having a contract load exceeding 2500 pounds hereafter installed, except sidewalk type elevators, shall be equipped with drum counterweights.

(b) Drum and car counterweights shall be made of metal, shall run in substantial guides and shall be provided with not less than four guide shoes or slots.

(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 power freight elevators hereafter installed, the weight of which 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. New Installations.**

(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 elevators, and on hand elevators changed to power elevators 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. Where counterweight sections are carried in frames they shall be secured by at least two tie rods passing through holes in all sections.

(b) In every counterweight stack hereafter installed 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 and Loadings for Passenger Elevators.**

(a) Every passenger elevator hereafter installed shall be designed and constructed for the contract load, but in no case based on a loading per square foot of platform area less than given in the following table:

**PASSENGER ELEVATOR CAPACITIES CORRESPONDING TO  
EFFECTIVE PLATFORM AREAS**

Effective Platform Area Square Feet	Rated Capacity	Loading of Car Per Square Foot in Pounds
10	700	70
13.5	1000	74
19	1500	79
24	2000	83
29	2500	87
33	3000	90
37.6	3500	93
42	4000	95
50	5000	98
58	6000	103
74	8000	108
87.5	10000	114

**Note:** The "effective platform area" is the area within the car enclosure. No allowance shall be made for handrails in determining this area.

The minimum contract load for elevators having effective platform areas not shown in the table may be obtained by interpolation.

(b) No passenger elevator used for hoisting safes or similar special freight shall be loaded in excess of the contract load.

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

(a) Passenger Elevators. There shall be a metal plate which shall be fastened in a conspicuous place in each passenger elevator car, the letters and figures in each plate to be not less than  $\frac{1}{4}$  inch in height, and to be stamped in, etched or raised on the surface of the plate, and shall bear the following information:

- (1) The contract load of the elevator in pounds.
- (2) The number of persons, including the operator, allowed on the car.

**Note:** The estimated number of persons allowed on the car is based on the contract load divided by 150.

(b) Freight Elevators. A metal plate with raised letters not less than  $\frac{1}{2}$  inch in height, stating the contract load of the elevator, shall be fastened in a conspicuous place in each freight elevator car.

(c) A metal plate or plates shall be placed upon the car crosshead of each power elevator hereafter installed bearing the following information:

- (1) The total weight of the complete car, including the safeties. See Order 404.
- (2) The contract car speed in feet per minute at which the elevator is designed to travel.
- (3) The cable data as required by Order 442-(a).

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

(a) 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 contract load, using the safe working stresses specified below for car frame members and the stresses permitted by the State Building Code for structural members.

See tables in Orders 5322, 5324, 5328 of State Building Code.

For cable stresses see Order 441.

(b) The stresses of rolled steel sections or annealed cast steel in the construction of car frames and platforms, based on the static load imposed upon them, shall not exceed the values given in Table 1 for passenger cars and in Table 2 for freight cars for steels meeting Specification A-7 of the American Society for Testing Materials for steel having an ultimate strength of from 55,000 to 65,000 lbs. per square inch for rolled sections or cast steel, and 46,000 to 56,000 lbs. per square inch for rivets.



**TABLE 1. ALLOWABLE STRESSES FOR PASSENGER CAR  
FRAME MEMBERS**

Loading	Maximum Allowable Stress (Lb. per sq. in.)	Basis
Tension	10,000	Net Area
Bending	10,000	Gross Section
Shear on shop rivets	8,000	Net Area
Bearing on shop rivets	16,000	Net Area
Shear on bolts in clearance holes	7,000	Gross Section
Bearing on bolts in clearance holes	14,000	Gross Section
Bolts on threaded portions of rods in tension	6,000	Gross Section
Compression	11700—49 l/r	Gross Area

l = effective free length of member in inches.  
r = least radius of gyration in inches.

**TABLE 2. ALLOWABLE STRESSES FOR FREIGHT CAR—  
FRAME MEMBERS**

Loading	Maximum Allowable Stress (Lbs. per sq. in.)	Basis
Tension	12,000	Net Area
Bending of car frame member and platform framing at entrance	12,000	Gross Section
Bending of platform stringers	15,000	Gross Section
Shear on shop rivets	9,500	Net Area
Bearing on shop rivets	19,000	Net Area
Shear on bolts in clearance holes	8,000	Gross Section
Bearing on bolts in clearance holes	16,000	Gross Section
Bolts on threaded portions of rods in tension	8,000	Gross Section
Compression	14,000—59 l/r	Gross Area

l = effective free length of member in inches.  
r = least radius of gyration in inches.

(c) For steels of greater strength, the allowable stresses may be increased proportionally, based on ultimate strength.

(d) When material other than steel referred to in Table 1 and 2 is used in the construction of car frames or platforms, the stresses shall not exceed 13 per cent of the ultimate strength of the material for passenger cars and 15.6 per cent of the ultimate strength of the material for freight cars.

(e) Holes in webs of cross head for sheave pins shall be reinforced by means of a plate at least 50 per cent thicker than the web and riveted to it.

**Note:** Local reductions in section of a member in bending through bolt holes for the fastening of hoist-rope or compensating rope hitches, auxiliary apparatus on the crosshead or plank, sheave boxes and the fastening of platform to plank, need not be considered.

(f) The deflection of crosshead and safety plank shall not exceed  $\frac{1}{8}$  inch in each 10 feet of span under stated conditions with contract load substantially uniformly distributed over the car platform.

(g) The slenderness ratio  $l/r$  for members not normally subject to compression shall not exceed 250; for members normally subject to compression, this ratio shall not exceed 120.

**Note:** Loadings resulting from buffer or safety operations are not considered normal loadings.

**Note:** In Table 2 the limits are given to which car-frame and platform members may be stressed after the live load is in position on the elevator. Attention is called to the fact that in freight elevators, especially heavy-duty freight elevators, a different set of stresses is set up while the load, say, an auto truck, is being moved from the landing to its proper position on the car. These stresses may be dealt with as stresses which occur only occasionally in conjunction with the maximum live load, and may exceed the stresses in Table 2 so long as the deflection of car-frame or platform members is considered.

## SECTION VII. GUIDE RAILS.

### Order 455.—Guide Rails. General Requirements.

(a) Steel guide rails shall be provided for car and counterweights as follows:

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

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

(3) On every passenger elevator hereafter installed.

**Note:** Where 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) The guide rails shall be extended at the top and bottom to prevent guide shoes running off in case the over-travel is exceeded.

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

(a) Steel guide rails when required shall meet the following minimum requirements:

Maximum Permissible Total Weight of Car and Load Total Weight of Counterweights	Minimum Weight of Each Car Guide Rail (Pounds per foot)	Minimum Weight of Each Counter- weight Guide Rail Pounds per Foot	
		With Guide Rail Safeties	Without Guide Rail Safeties
Per Pair of Rails			
(Pounds)		1-to-1 Roping	2-to-1 Roping
4000	7½*	6½	6½
15000	14	7½	7½
27500	22½	7½	14
40000	30	7½	14

\* If the rails are effectively bracketed or tied at intervals of 6 feet or less to prevent spreading, this load may be doubled. This applies only to 7½ lb. rails and only when such rails are used for counterweights.  
 \*\* If car guide rails weighing 7½ lbs. per foot are effectively bracketed or tied at 10-foot intervals, the 4000 lb. load may be increased to 4500 lbs., and if bracketed or tied at 6½-foot intervals, this load may be increased to 5000 lbs.

(b) The size of wood guide rails shall be not less than the following:

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	Car	Counter-weight	Car	Counter-weight
— <u>5000</u>	2500 5000 8000	1 <sup>3</sup> / <sub>4</sub> x1 <sup>3</sup> / <sub>4</sub> 2 x2 <sup>1</sup> / <sub>4</sub> 2 <sup>1</sup> / <sub>2</sub> x2 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>8</sub> x1 <sup>1</sup> / <sub>4</sub> 1 <sup>1</sup> / <sub>4</sub> x1 <sup>1</sup> / <sub>2</sub>	1 <sup>3</sup> / <sub>4</sub> x1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>8</sub> x1 <sup>1</sup> / <sub>4</sub>

(c) Joints in steel or wood guide rails shall be tongued and grooved. Steel rails shall be fitted with fishplates, each secured with not less than 4 substantial bolts through each rail.

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

(a) Guide rails installed on brick or concrete hoistway 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) Guide rails and their fastenings shall be secured in position by clips or through bolts of not less than the following sizes:

Weight of Rails in Pounds per foot	Diameter of Bolts in Inches
6½—7½	½
14	5/8
22½	¾
30	¾

(c) The fastenings of every guide rail shall be constructed so as to withstand the impact of the car with contract load when the car safety device is applied to the guides as specified in Order 464(m) and so that the guide rails and their fastenings shall not deflect more than ¼" under normal operation.

Wood plugs inserted in a wall for guide rail anchorage are not permitted.

Fastenings to hollow tile walls, plaster partitions and similar construction are not permitted.

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

**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
$\frac{1}{2}$	20
$\frac{9}{16}$	22
$\frac{5}{8}$	24
$\frac{3}{4}$	30
$\frac{7}{8}$	36
1	40

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

See Order 481-(a) for elevators of a sidewalk type installed within a building.

**Order 459.—Machinery. General Requirements.**

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

Hand 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 sheaves on elevators hereafter installed shall be steel or cast iron with machine finished grooves, except on hand elevators, and no traction U groove shall be more than 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

on its shaft, except that no key is required under the following conditions:

(1) On geared machine where the gear and driving sheave are mounted on and bolted to a common gear and sheave spider.

(2) On gearless machines where the drive sheave is directly bolted to a flange integral with the armature spider or shaft.

(3) Idler sheaves and sheaves which turn on shafts as bearings.

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

Exception: A gear housing cover that is not integral with the bearing cap, does not require gaskets to prevent oil leakage, and is not to exceed 30 lbs. in weight, will be acceptable in lieu of the above requirement.

(e) Overhead direct connected electric elevator machines hereafter installed shall be mounted on continuous steel or cast iron 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 elevators hereafter installed, 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 installed having continuous pressure operation.

(e) A drum type freight elevator installation equipped with a mechanical brake shall not have:

- (1) Hoistway limit switches;
- (2) Car door or gate electric contacts;
- (3) Hoistway landing door or gate electric contacts;
- (4) Or any combination thereof.

Except when approved in writing by the Industrial Commission. See Order 463-(d).

(f) No emergency release shall be installed on an elevator car which can be started from a landing.

## 2. *New Installations.*

(a) 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 elevators traveling not more than 14 feet.

(b) 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.

(c) 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.

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

(e) No power elevator hereafter installed, except sidewalk elevators, shall be controlled or operated by a hand cable.

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

(g) No power freight elevator shall have a contract speed in excess of 100 feet per minute except automatic operation and elevators controlled by regular operators.

Exception: When controlled by a two speed motor, and all requirements complied with, outlined as follows:

- (1) Speed not to exceed 150 feet per minute.
  - (2) Equipped with automatic floor leveling.
  - (3) Each car entrance to be equipped with an approved car gate and electric contact.
- (h) Sheaves or idlers shall not be suspended in cast-iron stirrups from the under side of the supporting beam.
- (i) Cast iron guide rails shall not be used.
- (j) No hand elevator hereafter installed shall exceed 1,500 pounds capacity.
- (k) The travel of any hand elevator hereafter installed shall not exceed 30 feet.

**Order 461.—Power Attachments to Hand 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 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.*

(a) 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.

(b) 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 final terminal stopping devices that will automatically interrupt the power circuit and stop the car in case of over-travel at each terminal of travel, except on electric oil hydraulic elevators.

If multi-phase alternating current is used to operate the motor of any elevator hereafter installed, the terminal stopping devices shall be so arranged and connected that if phase reversal occurs and the car over-travels at either terminal the motor cannot be again started until the phase reversal is corrected, except where the requirements of Order 472(a) are met.

Final terminal stopping device for elevators hereafter installed shall consist of limit switches mounted in the hoistway and directly operated by a cam attached to the car.

(b) Every electric elevator hereafter installed shall be equipped with normal stopping device at each terminal of travel. Such device shall consist of stopping switches mounted on the car or in the hoistway and directly operated by the movement of the car.

(c) Every drum type elevator machine shall be equipped with an approved machine automatic terminal stopping device which will automatically stop the machine if the car over-travels either of the terminal landings.

(1) On alternating current drum type elevator machines hereafter installed, the terminal stopping device as outlined above shall also directly open the electric circuit to the motor and brake. This device shall be in addition to the device required by Order 463(a).

(d) Every traction type elevator machine with a mechanical brake shall, within two years of the effective date of this code, be equipped with an electric brake and limit switches.

(e) Final limit switches and the oil buffer shall be located so that the engagement of the buffer and the opening of the limit switch will occur as nearly simultaneously as possible without interfering with the normal operation of the elevator. When spring buffers are provided, the final limit switches shall be opened before the buffer is engaged.

(f) Limit switches shall be securely fastened to the steel guides or to the hoistway walls or floor beams by means of substantial steel clamps or brackets. Where the switches are mounted on hoistway walls, they shall be fastened by means of through bolts, or equivalent. The use of lag bolts, screws or nails for this purpose is prohibited.

#### **Order 464.—Car Safety Devices and Speed Governors.**

(a) A car safety device capable of stopping and sustaining the car with the contract load shall be attached to every elevator except:

(1) Freight elevators which travel not more than 10 feet.

(2) Direct lift plunger elevators.

(3) Existing 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 sliding type car safety device shall be provided for every elevator hereafter installed in which the contract speed is more than 100 feet per minute. This device shall be so arranged that it can be released inside the car, on top of the car, or by operating the machine in the up direction.

(c) A safety shall not be used to stop a car in an ascending direction.

(d) Every car safety device hereafter installed, except on hand elevators, shall have the dogs or clamps of the

safety device attached to and located in the lower part of the car frame adjacent to or below the car platform. The gripping surfaces of a car or counterweight safety device shall not be used to guide the car or counterweight. Multiple car safeties may be used subject to the approval of the Industrial Commission provided that at least one of the car safety devices meets the requirement of the first sentence of this Order.

(e) Every drum or idler sheave which is underneath the car and is used to actuate the car safety device shall be so guarded to prevent the rope or cable leaving the drum or sheave and shall be securely fastened to the car frame directly or by means of metal brackets.

(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 for every power elevator hereafter installed and every existing power elevator traveling more than 18 feet. The car speed governor shall be set to cause the application of the safety at a speed not more than 40 per cent and not less than 15 per cent above normal, provided that no governor shall be required to trip at less than 175 feet per minute. For contract speeds exceeding 500 feet per minute and not exceeding 700 feet per minute, the governor tripping speed shall not be more than  $33\frac{1}{3}$  per cent above the contract speed, and for contract speed exceeding 700 feet per minute not more than 25 per cent above contract speed.

The counterweight safety, if provided, may be operated by the same governor and governor rope that is used to operate the car safety. Provision shall be made to cause the application of the counterweight safety at a speed greater than that at which the car safety is applied, but at not more than 10 per cent above that speed. Broken-rope safeties of the instantaneous type may be used on counterweights within the limits of the following:

Contract Speed—Feet per Minute	Total Weight of Counterweight Pounds
250	2000
200	3000
160	4000
125	5000

(h) Every speed governor hereafter installed shall be of a type which will securely grip the governor cable without serious cutting, tearing or deformation thereof and thereby actuate the car safety device, and shall be located where it cannot be struck by the car or counterweight in case of overtravel and where there is sufficient space for full movement of governor parts.

(i) Every type of car safety device hereafter installed not heretofore approved and having a rated capacity less than 20,000 pounds shall be subjected to a type drop test. Such tests shall be made at the risk and expense of the elevator manufacturer under the direction of the Industrial Commission. Complete plans and specifications for every car safety device and speed governor to be tested shall be submitted to the Commission for approval, or the manufacturer may make such tests and submit to the Industrial Commission with complete plans and specifications, certified copies of the tests made on forms satisfactory to the Commission, duly witnessed and sworn to by a person or persons satisfactory to the Commission for which approval is desired.

The test load shall equal the maximum load, including the weight of the safety, for which approval is requested. The free fall shall be such that the safety under test shall have attained the maximum governor tripping speed for which approval is requested, assuming 100 per cent efficiency, before the safety actuating device starts to function, but in no case shall the required fall be greater than that needed to attain 300 feet per minute.

The drop test may be made with the governor with which the safety will be used. If so tested, the governor

shall actuate the safety. The governor shall be set for the maximum tripping speed for which approval is requested except that a tripping speed of more than 300 feet per minute shall not be required.

The distance from the starting point to the final point of rest under the above test conditions shall not be more than 12 feet.

The application of the car safety device shall not cause the car platform to become out of line in excess of  $\frac{1}{2}$  inch per foot measured in any direction.

No car safety device, or combination of car safety device and speed governor, shall be used which has not been so tested and approved.

(j) Every type of car safety device, and every combination of car safety device and speed governor, shall be maintained in proper working condition and shall be subjected to running tests at intervals as outlined as follows:

(1) Every power elevator with a car safety device and speed governor combination shall within two years from the effective date of this code, be subjected to an actual running test with the load indicated by the capacity plate on the car and, by tripping the governor by hand at contract speed, stop and hold the car with the contract load. This test shall be made with all electric apparatus operative except for the cutout switch required by Order 464(f).

On such tests car safeties of the sliding type shall stop the car within the limits specified in Order 464(m) except that the stopping distance shall be based on the car speed at which the governor is tripped.

In the event the safety device and governor combination fails to function as required, the owner or agent shall renew or replace any part or parts of equipment and make a test or tests necessary to insure satisfactory operation of the safety device and governor.

(2) When a test is made and the safety device and governor combination prove satisfactory on either

new or existing installations, a similar test shall be made at every three year period thereafter.

Reports of the above tests shall be submitted to the Industrial Commission on forms furnished by the Commission.

(k) If the approved rated capacity of safeties hereafter installed is less than the weight of the car, the contract load and the cables suspended from the car, a new drop test shall be made and complete plans and specifications shall be submitted to the Industrial Commission for approval.

(l) A drop test made on a car safety device that is designed and constructed to trip by inertia, when set within the drop test requirements, shall be considered satisfactory. The governor in connection with the above safety device as a combination shall be tested separately by means of a weight test, and also to determine tripping speed.

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

(m) An overspeed test with contract load in the car shall be made of the safeties of each new power elevator before the elevator is placed in regular service, except that governor-controlled instantaneous-type safeties shall be tested at contract speed, the governor being tripped by hand. For wedge-clamp, gradual-wedge-clamp and flexible-guide-clamp safeties, this test shall be made with contract load on the car to determine whether the safety will operate within the allowable limits of the maximum and minimum stopping distances hereafter specified. The test shall be made with cables attached and all electric apparatus operative, except for the cutout switch required by Order 464(f).

For elevators, where the contract load is unable to bring about overspeed and for elevators without sufficient travel to permit overspeed, the governor shall be tripped by hand at maximum obtainable speed.

No test of the safeties with safe-lifting load in the car shall be made.

No person shall be permitted to ride on the elevator car during an overspeed test or drop test.



The governor tripping speed shall be checked for compliance with Order 464(g).

The pull-out of the governor cable from its normal running position until the safety jaws begin to apply pressure to the guide rails shall not exceed 30 inches.

Stopping distance is the actual slide as indicated by the marks on the rails.

The maximum stopping distance of car and counterweight for safeties of Type W. C. (Wedge Clamp) with constant retarding force shall be not greater than shown by Table I, for cars with contract load and for the counterweight, and the minimum stopping distance shall not be less than shown by Table I for car with contract load and for the counterweight.

**TABLE I**  
**WEDGE CLAMP SAFETY (Constant Retarding Force)**

Governor Tripping Speed  Fpm	Maximum Stopping Distance Car plus Contract Load or for Counterweight Ft.-In.	Minimum Stopping Distance Car plus Contract Load or for Counterweight Ft.-In.
175	1- 4	0-10
200	1- 6	1- 0
300	2- 0	1- 2
400	2-10	1- 7
500	3-11	2- 0
600	5- 2	2- 5
700	6- 8	3- 0
800	8- 6	3- 7
900	10- 8	4- 4
1000	12-11	5- 1
1100	15- 6	6- 0
1200	18- 5	7- 1
1300	21- 8	8- 2
1400	25- 0	9- 4
1500	28- 3	10- 5

The maximum stopping distance of car and counterweight for safeties of Type G. W. C. (Gradual Wedge Clamp) with increasing retarding force shall be not greater than shown by Table II, for cars with contract load and for the counterweight, and the minimum stopping distance shall be not less than shown by Table II for car with contract load and for counterweight.

TABLE II  
GRADUAL-WEDGE-CLAMP SAFETY

Governor Tripping Speed Fpm	Maximum Stopping Distance Car plus Contract Load or for Counterweight Ft.-In.	Minimum Stopping Distance Car plus Contract Load or for Counterweight Ft.-In.
175	6- 2	1-11
200	6- 3	2- 0
300	6-11	2- 4
400	7-10	2- 7
500	8-10	2-11
600	9-11	3- 4
700	11- 1	3-10
800	12- 4	4- 6
900	13- 6	5- 4
1000	14- 8	6- 1
1100	16- 0	7- 0
1200	17- 4	8- 0
1300	18- 6	9- 0
1400	19- 8	10- 1
1500	21- 1	11- 1

The maximum stopping distance of the car and counterweight for safeties of Type F. G. C. (Flexible-Guide Clamp) shall be not greater than shown by Table III, for the car with contract load and for the counterweight, and the minimum stopping distance shall be not less than shown by Table III for the car with contract load and for the counterweight.

**TABLE III**  
**FLEXIBLE-GUIDE-CLAMP SAFETY**

Governor Tripping Speed  Fpm	Maximum Stopping Distance Car plus Contract Load or for Counterweight Ft.-In.	Minimum Stopping Distance Car plus Contract Load or for Counterweight Ft.-In.
175	0-10	0- 6
200	0-11	0- 7
300	1- 7	0- 8
400	2- 5	1- 1
500	3- 5	1- 6
600	4-10	1-11
700	6- 5	2- 5
800	8- 2	3- 2
900	10- 4	3-11
1000	12- 7	4- 8
1100	15- 2	5- 8
1200	18- 0	6- 8
1300	21- 1	7-10
1400	24- 7	8-11
1500	28- 0	10- 0

(n) Each safety shall be marked for identification by the manufacturer by a plate that may be placed in a conspicuous location on the plank. This plate shall show the range of weight and speed for which the safety is approved; said weight to include the complete car structure, the safety, the contract load in the car, and all moving equipment, the weight of which is borne by the safety and the name of the manufacturer.

Type -----

Load Range -----

Speed -----

Manufacturer -----

(o) The governor shall be marked for identification by a plate, which marking shall give the type, tripping speed, size and material of cable and the name of the manufacturer.

Type -----

Tripping Speed -----

Cable Size -----

Cable Material -----

Manufacturer -----

**Order 465.—Brakes.**

(a) Every direct connected electric elevator hereafter installed shall be equipped with an electrically released spring applied 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 in allowing the brake to set shall not be retarded by any motor field discharge or counter voltage, nor by any single ground or short circuit.

(b) Every power elevator 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 whenever the control device is moved to the stopping position.

(c) Every hand 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 elevator hereafter installed shall be so arranged that it will operate automatically at the top landing.

**Order 466.—Stop Balls For Hand Ropes.**

Every elevator equipped with hand cable control shall be provided with adjustable stop balls, to center the control mechanism and stop the car at each terminal landing.

**Order 467.—Guards For Hand Cable Sheaves and Idlers.**

In every hand cable controlled elevator, the sheaves which lead the hand cable from the hoistway to the machine shall be guarded to prevent injury to an operator and so that the cable cannot run off. Every idler sheave under which is led an operating cable shall be provided with a guard that will keep the cable on the sheave.

**Order 468.—Centering Ropes.**

Every hand cable 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 469.—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 hoistway 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.

**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 and for the application of electro-mechanical brakes at the terminals, for the operation of car safety devices, or for the closing of a contractor by an emergency switch or 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 switch handle

or lever toward the opening (which operator usually faces) will cause the car to descend and the movement of the switch handle or lever away from the opening will cause the car to ascend. Except on hydraulic elevators and existing electric lever control elevators, the switch handle or lever shall return to the neutral position when released, and shall automatically latch in this neutral position.

(c) A manually operated circuit-breaker or disconnecting switch of the enclosed type opening all lines shall be installed separately in the supply circuit of every elevator or dumbwaiter motor or motor generator set hereafter installed. This switch shall be provided with proper over current protection. No provision shall be made to close the disconnecting switch from any other part of the building. This switch shall be a horsepower rated motor circuit switch where the motor is rated at 2 horsepower to and including 50 horsepower.

**Note:** The intent of this Order is to require an externally-operable switch or circuit-breaker, located adjacent to and visible from the elevator machine. (See Wisconsin State Electrical Code).

(1) On existing elevators where a proper type of disconnect switch has not been installed in the machine room or visible from the elevator machine, and in the opinion of the Industrial Commission is not reasonably safe, the switch shall be relocated or a new switch of the proper type and design shall be installed.

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

(d) In mechanically controlled elevators hereafter installed, the operation of directional switches or operating valves shall in no case depend solely upon a belt or a chain.

(e) The handrope for operating 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 hoistway 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 hoistway 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 3 feet above each floor.

When necessary to renew a section of the hand cable, each splice shall be made with standard shackles.

(f) The overhead tension weight for the hand cable 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 hand cable control shall be equipped with a cable lock so designed, installed and maintained that the hand cable can be locked at any landing to prevent the operation of the car by persons on other floors.

Exception 1. Sidewalk Elevators.

Exception 2. Elevators equipped with safety switches or electric contacted gates, provided requirement of Order 466 is complied with.

Note: See Order 472-(e).

(h) The car of every electrically driven elevator equipped with an electric brake shall be provided with an emergency stop switch which will cut off the source of power. This switch shall be adjacent to the operating device.

Exception: This requirement need not apply to existing elevators controlled by hand cable, installed prior to August 12, 1926.

If the stop button of an automatic operated elevator is marked "STOP" it may be used as the emergency stop switch and shall be suitably identified and of a distinctive color.

Contacts of emergency stop switches or buttons shall be directly opened mechanically and shall not be solely dependent upon springs for opening the contacts. A self-restoring type of switch or button may be used only on elevators having single-automatic operation and manually operated or self-closing hoistway doors.

Exception: This requirement need not apply to existing elevators controlled by hand cables.

**Order 471.—Automatic and Continuous Pressure Operation Elevators. New and Existing Installations.**

Automatic and continuous pressure operation elevators shall conform to the following requirements:

*1. Existing Installations.*

(a) The breaking of a circuit to stop an automatic or continuous pressure operated elevator at the terminal shall not depend on the operation of a spring or springs in tension nor upon the completion of an electric circuit.

(b) Where hoistway landing door locking system is renewed or replaced, the equipment used shall comply with the requirements of new elevator installations as outlined in Order 432 and 437.

*2. New Installations.*

(a) Neither the operation of a spring or springs in tension nor the completion of another electric circuit shall be depended upon to break the circuit to stop an automatic operation elevator at the terminals. If springs are used they shall be in compression. The interruption of the electric circuit shall prevent the movement of the car.

(b) Automatic operation elevators shall conform to the following requirements:

(1) If the car has started for a given landing, no impulse can be given from any landing to send the car in the reverse direction until the car has reached the destination corresponding to the first impulse. It is permissible, however, to stop the car at any intermediate landing to take on or discharge passengers going in the original direction.

(2) If the car has been stopped to take on or discharge passengers and is to continue in the direction determined by the first impulse, it is permissible to start the car by the closing of the car gate.

(3) The car cannot be started under normal operation unless every hoistway door is closed and locked in the closed position (Hoistway Unit System). See Order 432-2.

**Note:** Attention is called to the fact that devices employing locks and contacts of a type in which the interlocking contact is made when



the door is closed and the locking of the door takes place subsequently, are not interlocks and are not permitted under this Code where interlocks are required.

(c) All automatic and continuous pressure operation elevators hereafter installed with a travel 35 feet or over shall be provided with 2 switches mounted on top of the car: (1) An operating switch to render all hall and car buttons inoperative, and (2) an "UP" and "DOWN" switch or button which will enable the car to be operated at the lowest possible speed in either direction as long as the switch or button is held in contact.

#### **Order 472.—Electrical Protection.**

(a) Every elevator hereafter installed 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. This requirement shall also apply to existing elevators installed since August 12, 1926.

**Note:** This does not apply to alternating current motors used in motor generator sets.

(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.

(c) If an overload circuit breaker is used for a direct-current electric elevator, the wiring shall be arranged so that the circuit of the brake-magnet coil is opened at the same time that the line circuit is opened.

(d) Every electrically driven elevator except electro-hydraulic, hereafter installed shall be provided with an elevator potential switch which will cause and maintain interruption of power to the main circuit during excessive

reduction or failure of supply voltage. This protection may be a part of the control equipment.

(e) Every electrically driven elevator with an emergency stop switch or electric contacted gates, which is controlled by a hand cable, lever or wheel, shall be equipped with a sequence device requiring the centering of the operating device after the power has been cut off the motor before the car can again be started. This may be accomplished by the addition of a relay interlocked with the control apparatus.

(f) Every elevator which is hereafter changed from hand cable control to car switch or automatic or continuous pressure operated shall comply with new installation requirements outlined as follows:

- (1) Enclosed type circuit breaker or disconnect switch. See Order 470 (c).
- (2) Electric brake. See Order 465 (a).
- (3) Hoistway limit switches. See Order 463 (a) and (b).
- (4) Electric contacted hoistway landing doors or gates. See Order 437.
- (5) Electric contacted car door or gate. See Order 436.
- (6) Emergency switch on the car. See Order 470 (h).
- (7) A cutout switch in connection with the car safety device. See Order 464 (f).
- (8) All wiring to comply with Order 473.

(g) When any material change in electrical equipment is hereafter made on any power elevator or dumbwaiter, the wiring and equipment which is an integral part of that which is being replaced or renewed must comply with the requirements of new installations.

#### **Order 473.—Switches and Wiring.**

(a) In every elevator hereafter installed in garages, the hoistway limit switches and other spark-emitting devices shall be placed at least 4 feet above the line of the

lowest floor levels unless they are of the explosion proof type or of the enclosed type with contacts immersed in oil.

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

(c) Elevators installed in hazardous locations shall also comply with the Wisconsin State Electrical Code.

(d) (1) No part of any electric circuit having a voltage in excess of 750 shall be used on any car control system. Circuits of higher voltage may be used in machine rooms or penthouses for operation of motors and brakes, provided that all control and signal wiring is thoroughly insulated from such power circuits, and all machine frames and metal, hand operated cable, etc., be permanently grounded.

(2) The maximum voltage permitted on elevators hereafter installed shall not exceed 300 volts to ground on any elevator operating devices in the car, or at the landings, including push buttons of elevator signalling circuits.

(e) All live parts of electrical apparatus in or on elevator cars or in elevator hoistways shall be enclosed to protect against accidental contact.

(f) (1) Conductors in auxiliary gutters used in machine rooms, under controllers, starters and similar apparatus for elevator machines, shall be of rubber covered type.

(2) Conductors between main circuit resistors and the back of control panels shall be of the slow-burning type (Type SB), or of the asbestos-covered type (Type A). All other wiring on control panels, unless subjected to a temperature exceeding 120 degrees F (49C), shall be of the rubber-covered type having a flame retardant, moisture-resistant outer cover or shall be of other type especially approved for the purpose.

(3) Elevator Control Circuits and Conductors or groups of conductors having flame retardant outer cover shall not be used as connections for the operating circuits of elevator controllers unless such outer covering is also moisture resistant.

(4) Traveling cables used as flexible connections between the car and the hoistway, shall be of Type E, ele-

vator cable, and shall have a flame retardant and moisture resistant outer cover.

(g) The minimum size of conductors for elevator wiring shall be as follows:

(1) For lighting circuits, No. 14, except that for flexibility 2 No. 16 may be used in parallel in traveling cables.

(2) For elevator operating and control circuits, No. 16.

(3) For signal circuits and for fixtures, No. 18.

(h) The following wiring methods shall be employed:

(1) In hoistways. Conductors located in the hoistway, except traveling cables and conductors used in signal systems, shall be installed in rigid conduit or electrical metallic tubing, except that flexible conduit or armored cable may be used between riser and limit switches, interlocks, push buttons or similar devices. (See Order 473-(p).)

(2) On the car. Conductors and traveling cables on the car shall be run in rigid conduit, electrical metallic tubing or wireways; except that short runs of:

a. Flexible conduit or armored cable may be used if so located as to be kept free from oil, and securely fastened in place.

b. Type S cord may be used as the flexible connection between the fixed wiring on the car and the switch on the car door or gate if securely fastened in position not liable to mechanical injury.

(3) The conductors of motor circuits between motors and control panels may be grouped without any additional insulation of the separate conductors, provided that the complete group is either taped or corded, and painted in manner to make same as a rigid, self-supporting form, not over 3 feet long, and not in a position liable to mechanical damage or subject to a temperature in excess of 120°F. (49°C.).

**Note:** See Wisconsin Electrical Code. Section 13-620 Order 13-6206(c) or 1940 National Electrical Code, Article 620, Section 6206(c) for interim amendments which are to remain in effect only during the war emergency unless otherwise amended or repealed.

(4) A bushing may be used in lieu of a box or terminal fitting at ends of conduit or electrical metallic tubing where conductors leave the conduit or tubing behind a switchboard, or where more than 4 conductors leave the conduit or tubing at control apparatus or in similar locations, in which case the conductors shall be bunched, taped and painted with insulating paint. Such a bushing shall be of the insulating type except for lead covered conductors.

(i) Conductors of car-lighting circuits, and signal systems when not an integral part of the elevator wiring system, shall be separated and run in separate traveling cables and raceways.

(j) Conductors for elevator circuits, including operating, control and power conductors, and signal conductors when an integral part of the wiring system, may be run in the same traveling cable or raceway system when the power supply is from the same source, even though the characteristics of the voltage and/or current may be changed within the system by rectifying, transforming or other converting devices supplied from the elevator feeder circuit; provided that all conductors are insulated for the maximum voltage found in the cable or raceway system, and the live parts of the equipment are insulated from ground for this maximum voltage. Such a traveling cable or raceway may also include a pair of telephone conductors to serve a telephone in the car, provided such conductors are insulated for the maximum voltage found in the cable or raceway system.

(k) Traveling cables for all signal circuits, and for all other circuits not over 100 feet in length, may be suspended by suitable clamps if the cables are so constructed that the weight of the cable is not carried by the individual conductors.

(l) Wherever the traveling cables in swinging may come in contact with projections or corners of the building construction in the hoistway, such as I-beams, ledges and the like, such irregular surfaces shall be made smooth by covering with heavy gauge sheet metal or other suitable means.

(m) If No. 18 conductor is used for signal circuits, it shall be protected by fuses rated at not to exceed 3 amperes.

(n) Clearances around control panels in a single machine room shall have a clear space around the live parts as follows:

CLEARANCES

	Rear	Front	Side
Single Panel Not over 42 inches wide	24"	36"	18" (one side)
Double Panel Or single panel over 42 inches wide	24"	36"	18" (each side)
3 or More Panels	36"	36"	18" (one side)

Reduction of clearances for short intervals by building columns behind the switchboard, or by equipment on a single panel in the switchboard, is permitted provided the clearances are not reduced below those required for a single panel board.

**Note:** This rule is not intended to forbid mounting controllers on the machine, nor enclosing the rear of control panels in removable cabinets. If such cabinets are installed, the prescribed dimensions of clear space apply when the back of the cabinet is removed.

(o) Terminal Housings. If the wiring to fixed motors is in armored cable or metal raceways, junction boxes to house motor terminals shall be provided. These housings shall be of ample size to properly make connections and they shall be of substantial metal construction.

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

Where electrical metallic tubing is used it shall comply with the following requirements:

(1) Straps, hanger or other supports shall be provided for each length of electrical metallic tubing re-

ardless of length to insure continuous and substantial grounded system.

(2) Electrical metallic tubing shall not be run or laid on the penthouse floor, pit floor or in any other location subject to mechanical damage.

(3) Electrical metallic tubing shall not be used in grain elevators or in hazardous locations where vapor or gas and air, dust and air, or other highly flammable substances are present.

**Order 474.—Grounding.**

For electric elevators, dumbwaiters and escalators, the frames of all motors, elevator machines, controllers, operating cable and the metal enclosures for all electrical devices in or on the car or in the hoistway shall be grounded.

**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 (1) elevators and dumbwaiters controlled by automatic or continuous pressure operation and provided with operating buttons at the landings; (2) hand elevators traveling not more than 30 feet.

(b) Every automatic push button elevator shall be provided with an emergency call bell with a properly placarded push button in the car.

(c) All elevators in such locations as acid towers, grain elevators and similar places, shall, when required by the Industrial Commission, be provided with an emergency signal system or telephone to call the boiler room or other place where assistance can be obtained in case of an emergency.

**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. Every elevator hoistway landing within or in connection with an occupied building shall be provided with sufficient light to clearly see small objects at the threshold.

(c) Penthouse and Overhead Lighting. Every penthouse shall be provided with suitable artificial light of an intensity of not less than 2 foot-candles at the floor. Every elevator machine room and the area about a ceiling type machine, including overhead sheave rooms and lofts shall be amply lighted. Control of such lighting shall be in the approach to the penthouse or overhead equipment.

(d) Work Lights. Every power elevator hereafter installed shall be equipped with work light and convenience outlets as follows:

(1) Work light receptacle and convenience outlet on top of car.

(2) Work light receptacle on underside of platform.

(3) Work light receptacle and convenience outlet at lowest hoistway level if hoistway landing doors are used.

## SECTION XI. OPERATION, MAINTENANCE AND USE.

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

A competent operator shall be stationed on the car of every passenger elevator while in use, except automatic and continuous pressure operation elevators.

**Note:** Section 103.05 of the Wisconsin Statutes prohibits the employment of persons under 18 years of age in the operation of elevators.

### **Order 478.—Maintenance. New and Existing Installations.**

(a) Elevators, dumbwaiters and escalator equipment shall be kept in safe operating condition, properly lubricated and clean, including pits and penthouses.



(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 flammable substances shall not be stored within 20 feet of any elevator hoistway 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.

(e) No material shall be stored in the penthouse or machine room of any elevator except that which is necessary for the maintenance and operation of the elevator unless the elevator equipment is entirely isolated by a rigid enclosure, 3 feet away from it and extending from the floor to a point not less than 6 feet above the floor.