# Part 2
# Electric Elevators

(ED)

## SCOPE

Part 2 applies to electric elevators installed at an angle greater than 70 deg from the horizontal. It applies to other equipment only as referenced in the applicable Part.

NOTE. See also Part 8 for additional requirements that apply to *electric elevators*.

## SECTION 2.1
## CONSTRUCTION OF HOISTWAYS AND HOISTWAY ENCLOSURES

### 2.1.1 Hoistway Enclosures

Hoistway enclosures shall conform to 2.1.1.1, 2.1.1.2, or 2.1.1.3.

#### 2.1.1.1 Fire-Resistive Construction

**2.1.1.1.1** Where fire-resistive construction is required, hoistways shall be enclosed in conformance with the requirements of the building code (see 1.3).

**2.1.1.1.2** Partitions between hoistways and machine rooms having fire-resistive enclosures shall be of noncombustible solid or openwork construction that meets the requirements of 2.1.1.2.2(c)(1), (2), and (3). Openwork construction shall reject a ball 25 mm (1 in.) in diameter, except where there are openings essential for ropes, drums, sheaves, and other elevator equipment.

**2.1.1.1.3** Hoistway enclosure openings shall be protected with entrances or access doors having a fire-protection rating conforming to the requirements of the building code.

#### 2.1.1.2 Non-Fire-Resistive Construction

**2.1.1.2.1** Where fire-resistive construction is not required by the building code, hoistway construction shall conform to 2.1.1.2.2 or 2.1.1.3.

**2.1.1.2.2** The hoistway shall be fully enclosed conforming to 2.1.1.2.2(a), (b), and (c), or 2.1.1.2.2(a) and (d).

*(a)* Enclosures and doors shall be unperforated to a height of 2 000 mm (79 in.) above each floor or landing and above the treads of adjacent stairways. The enclosure shall be unperforated, adjacent to, and for 150 mm (6 in.) on either side of any moving equipment that is within 100 mm (4 in.) of the enclosure.

*(b)* Openwork enclosures, where used above the 2 000 mm (79 in.) level, shall reject a ball 25 mm (1 in.) in diameter.

*(c)* Openwork enclosures shall be

*(1)* at least 2.2 mm (0.087 in.) thick wire, if of steel wire grille

*(2)* at least 2.2 mm (0.087 in.) thick, if of expanded metal

*(3)* so supported and braced as to deflect not over 15 mm (0.6 in.) when subjected to a force of 450 N (100 lbf) applied horizontally at any point

*(d)* Enclosures shall be permitted to be glass, provided it is laminated glass conforming to ANSI Z97.1, 16 CFR Part 1201, or CAN/CGSB-12.1, whichever is applicable (see Part 9). Markings as specified in the applicable standard shall be on each separate piece of glass and shall remain visible after installation.

**2.1.1.2.3** Entrances shall be in conformance with 2.11, except 2.11.14, 2.11.15, 2.11.16, and 2.11.18.

**2.1.1.3 Partially Enclosed Hoistways.** For elevators that are not fully enclosed, protection at least 2 400 mm (94.5 in.) high shall be provided on the hoistway sides that are located 1 500 mm (59 in.) or less from elevator equipment to areas accessible to other than elevator personnel. Such protection shall comply with 2.1.1.2.

**2.1.1.4 Multiple Hoistways.** The number of elevators permissible in a hoistway shall be in conformance with the building code.

**2.1.1.5 Strength of Enclosure.** The hoistway enclosure adjacent to a landing opening shall be of sufficient strength to maintain, in true lateral alignment, the hoistway entrances. Operating mechanisms and locking devices shall be supported by the building wall, if load-bearing, or by other building structure. Adequate consideration shall be given to pressure exerted on hoistway enclosures as a result of windage and elevator operation.

### 2.1.2 Construction at Top and Bottom of the Hoistway

**2.1.2.1 Construction at Top of the Hoistway.** The top of the hoistway shall be enclosed as required by the building code.

**2.1.2.2 Construction at Bottom of Hoistway.** Pits extending to the ground shall have noncombustible floors, and shall be designed to prevent entry of ground

water into the pit. The pit floor of any hoistway not extending to the ground shall be of construction having a fire-resistance rating at least equal to that required for the hoistway enclosure. (See also 2.2 and 2.6.)

**2.1.2.3 Strength of Pit Floor.** The pit equipment, beams, floor, and their supports shall be designed and constructed to meet the applicable building code requirements and to withstand the following loads, without permanent deformation, in the manner in which they occur:

*(a)* the impact load due to car or counterweight buffer engagement at 125% of the rated speed or 125% of the striking speed where reduced stroke buffers are used (see 8.2.3)

*(b)* the part of the load transmitted due to the application of the car safety, or where applicable, the counterweight safety

*(c)* compensation up-pull load where compensation tie-down is applied (see 2.17.17)

### 2.1.3 Floor Over Hoistways

#### 2.1.3.1 General Requirements

**2.1.3.1.1** A metal or concrete floor shall be provided at the top of the hoistway.

**2.1.3.1.2** Floors are not required below

*(a)* secondary and deflecting sheaves of traction-type machines located over the hoistway

*(b)* overhead sheaves, governors, and other equipment where the elevator machine is located below or at the side of the hoistway, provided that

*(1)* means of access for inspection and servicing of governors conforming to 2.7.3.3 is provided from outside the hoistway

(ED) *(2)* sheaves and other equipment (except governors) can be inspected and serviced from the top of the car or means of access from outside the hoistway conforming to 2.7.3.3 is provided

**2.1.3.2 Location of Floor.** The floor shall be located

*(a)* above or level with the top of the machine beams where the machine is located over the hoistway; or

*(b)* below the overhead sheaves where the machine is not located over the hoistway.

**2.1.3.3 Strength of Floor.** The strength of the overhead floor shall be capable of sustaining a concentrated load of 1 000 N (225 lb) on any 2 000 $mm^2$ (3 $in.^2$) area, and in addition, where it constitutes the floor of the main or secondary level machinery space, it shall be designed for a live load of not less than 6 kPa (125 $lb/ft^2$) in all open areas.

Where the elevator machine is to be supported solely by the machine room floor slab, the floor slab shall be designed in accordance with 2.9.4 and 2.9.5.

**2.1.3.4 Construction of Floors.** Floors shall be of concrete or metal construction with or without perforations. Metal floors shall conform to the following:

*(a)* If of bar-type grating, the openings between bars shall reject a ball 20 mm (0.8 in.) in diameter.

*(b)* If of perforated sheet metal or of fabricated openwork construction, the openings shall reject a ball 25 mm (1 in.) in diameter.

#### 2.1.3.5 Area to Be Covered by Floor

**2.1.3.5.1** Where a floor over a hoistway is required by 2.1.3.1, the floor shall extend over the entire area of the hoistway where the cross-sectional area is 10 $m^2$ (108 $ft^2$) or less. Where the cross-sectional area is greater, the floor shall extend not less than 600 mm (24 in.) beyond the general contour of the machine or sheaves or other equipment, and to the entrance to the machinery space at or above the level of that floor. Where the floor does not cover the entire horizontal area of the hoistway, the open or exposed sides shall be provided with a standard railing conforming to 2.10.2.

**2.1.3.5.2** Where a floor over the hoistway is not required by 2.1.3.1 and the access door is not located so that the overhead sheaves and governor can be serviced from outside the hoistway, a catwalk or platform shall be provided in the hoistway from the access door to the machinery. The construction of the platform shall comply with 2.1.3.4 and it shall be equipped on the exposed sides with a standard railing conforming to 2.10.2.

**2.1.3.6 Difference in Floor Levels.** Differences in levels of machine room and machinery-space floors shall be avoided where practicable. Where there is a difference in level in such floors exceeding 400 mm (16 in.), a standard railing conforming to 2.10.2 shall be provided.

### 2.1.4 Control of Smoke and Hot Gases

When required by the building code, hoistways shall be provided with means to prevent the accumulation of smoke and hot gases.

Where air pressurization of the hoistway is utilized as a means of smoke and hot gas control, the air shall not be introduced into the hoistway in such a manner as to cause erratic operation by impingement of traveling cables, selector tapes, governor ropes, compensating ropes, and other components sensitive to excessive movement or deflection.

### 2.1.5 Windows and Skylights

In jurisdictions not enforcing the NBCC, windows in the walls of hoistway enclosures are prohibited.

Windows and skylights and their frames and sashes in machine rooms shall conform to the requirements of the building code (see 1.3).

### 2.1.6 Projections, Recesses, and Setbacks in Hoistway Enclosures

Hoistway enclosures shall have flush surfaces on the hoistway side, subject to the requirements of 2.1.6.1 and 2.1.6.2.

**2.1.6.1** On sides for loading and unloading, landing sills, hoistway doors, door tracks, and hangers shall be permitted to project inside the hoistway enclosure. Sills shall be guarded as required by 2.11.10.1.

**2.1.6.2** On sides not used for loading and unloading

(*a*) recesses, except those necessary for installation of elevator equipment, shall not be permitted

(*b*) beams, floor slabs, or other building construction making an angle less than 75 deg with the horizontal shall not project more than 100 mm (4 in.) inside the hoistway enclosure unless the top surface of the projection is beveled at an angle not less than 75 deg with the horizontal

(*c*) separator beams between adjacent elevators are not required to have bevels

(*d*) where setbacks exceeding 100 mm (4 in.) occur in the enclosure wall, the top of the setback shall be beveled at an angle of not less than 75 deg with the horizontal

(*e*) bevels are not required if the projections and setbacks are covered with material conforming to the following:

(*1*) it shall be equal to or stronger than 1.110 mm (0.0437 in.) wire

(*2*) it shall have openings not exceeding 25 mm (1 in.)

(*3*) it shall be supported and braced such that it will not deflect more than 25 mm (1 in.) when subjected to a force of 4.79 kPa (100 lbf/ft$^2$) applied horizontally at any point

## SECTION 2.2
## PITS

### 2.2.1 General

A pit shall be provided for every elevator.

### 2.2.2 Design and Construction of Pits

**2.2.2.1** The construction of the pit walls, the pit floor, and any pit access doors (see 2.2.4) shall conform to 2.1.1 and 2.1.2.

(ED) **2.2.2.2** The floor of the pit shall be approximately level, except that

(*a*) trenches or depressions shall be permitted for the installation of buffers, compensating sheaves and frames, and vertically sliding biparting hoistway doors, where structural conditions make such trenches or depressions necessary

(*b*) in existing buildings, where new elevators are installed or existing elevators are altered, existing foundation footings extending above the general level of the pit floor shall be permitted to remain in place, provided that the maximum encroachment of such footings does not exceed 15% of the cubic content of the pit, and further provided that it is impracticable to remove the footing

**2.2.2.3** Permanent provisions shall be made to prevent accumulation of ground water in the pit (see 2.1.2.2).

**2.2.2.4** Drains and sump pumps, where provided, shall comply with the applicable plumbing code, and they shall be provided with a positive means to prevent water, gases, and odors from entering the hoistway.

**2.2.2.5** In elevators provided with Firefighters' Emergency Operation, a drain or sump pump shall be provided.

**2.2.2.6** Sumps and sump pumps in pits, where provided, shall be covered. The cover shall be secured and level with the pit floor.

**2.2.2.7** In jurisdictions enforcing the NBCC sump pumps and their control equipment shall not be installed in any elevator pit.

### 2.2.3 Guards Between Adjacent Pits

**2.2.3.1** Where there is a difference in level between the floors of adjacent pits, a metal guard, unperforated, or perforated with openings that will reject a ball 50 mm (2 in.) in diameter, shall be installed for separating such pits. Guards shall extend not less than 2 000 mm (79 in.) above the level of the higher pit floor and a self-closing access door shall be permitted. (ED)

**2.2.3.2** Where the difference in level is 600 mm (24 in.) or less, a standard railing conforming to 2.10.2 shall be permitted to be installed in lieu of the guard.

### 2.2.4 Access to Pits

Safe and convenient access shall be provided to all pits, and shall conform to 2.2.4.1 through 2.2.4.4.

**2.2.4.1** Access shall be by means of the lowest hoistway door or by means of a separate pit access door.

**2.2.4.2** There shall be installed in the pit of each elevator, where the pit extends more than 900 mm (35 in.) below the sill of the pit access door, a fixed vertical ladder of noncombustible material, located within reach of the access door. The ladder shall extend not less than 1 200 mm (48 in.) above the sill of the access door. The rungs, cleats, or steps shall be a minimum of 400 mm (16 in.) wide. When unavoidable obstructions are encountered, the width shall be permitted to be decreased to less than 400 mm (16 in.). The reduced width shall be as wide as the available space permits, but not less than 225 mm (9 in.). The rungs, cleats, or steps shall be spaced 300 mm (12 in.) on center. A clear distance of not less than 180 mm (7 in.) from the centerline of the rungs, cleats, or steps to the nearest permanent

object in back of the ladder shall be provided. When unavoidable obstructions are encountered, the distance shall be permitted to be reduced to 115 mm (4.5 in.). Siderails, if provided, shall have a clear distance of not less than 115 mm (4.5 in.) from their centerline to the nearest permanent object. The nearest point of the ladder shall be within 1 000 mm (39 in.), measured horizontally from the means to unlock the egress door from the pit.

Pit access by a ladder shall not be permitted when the pit floor is more than 3 000 mm (120 in.) below the sill of the access door, except where there is no building floor below the bottom terminal landing, this height shall be permitted to be greater but not more than 4 200 mm (165 in.).

**2.2.4.3** Pits shall be accessible only to elevator personnel.

**2.2.4.4** Separate pit door, when provided, shall be subject to the following requirements:

*(a)* If the door swings into the pit, it shall be located so that it does not interfere with moving equipment.

*(b)* If the door swings out, and the lowest structural or mechanical part, equipment, or device installed beneath the car platform, except guide shoes or rollers or safety jaw assemblies, projects below the top of the separate pit access door opening when the car is level with the bottom terminal landing

*(1)* an electric contact conforming to 2.26.2.26 shall be provided to prevent operation of the elevator when the door is open

*(2)* the door shall be provided with a vision panel(s) that is glazed with clear wired glass not less than 6 mm (0.25 in.) thick, will reject a ball 150 mm (6 in.) in diameter, and have an area of not more than 0.03 $m^2$ (47 $in.^2$)

*(c)* The door shall provide a minimum opening of 750 mm (29.5 in.) in width and 1 825 mm (72 in.) in height.

*(d)* The door shall be equipped with a barrier conforming to 2.11.1.2(i), where the door sill is located more than 300 mm (12 in.) above the pit floor.

*(e)* The door shall be self-closing and provided with a spring-type lock arranged to permit the door to be opened from inside of the pit without a key. Such doors shall be kept closed and locked. The key shall be of Group 1 Security (see 8.1).

### 2.2.5 Illumination of Pits

A permanent lighting fixture shall be provided and shall conform to 2.2.5.1 through 2.2.5.3.

**2.2.5.1** The lighting shall provide an illumination of not less than 100 lx (10 fc) at the pit floor and at a pit platform, when provided.

**2.2.5.2** The light bulb(s) shall be externally guarded to prevent contact and accidental breakage.

**2.2.5.3** The light switch shall be so located as to be accessible from the pit access door.

### 2.2.6 Stop Switch in Pits (ED)

An enclosed stop switch(es), meeting the requirements of 2.26.2.7 and 2.2.6.1 through 2.2.6.3, shall be installed in the pit of each elevator.

**2.2.6.1** The stop switch shall be so located as to be accessible from the pit access door. Where access to the pits of elevators in a multiple hoistway is by means of a single access door, the stop switch for each elevator shall be located adjacent to the nearest point of access to its pit from the access door. (ED)

**2.2.6.2** In elevators where access to the pit is through the lowest landing hoistway door, a stop switch shall be located approximately 450 mm (18 in.) above the floor level of the landing, within reach from this access floor and adjacent to the pit ladder, if provided. When the pit exceeds 1 700 mm (67 in.) in depth, an additional stop switch is required adjacent to the pit ladder and approximately 1 200 mm (47 in.) above the pit floor.

**2.2.6.3** Where more than one switch is provided, they shall be wired in series.

### 2.2.7 Minimum Pit Depths Required

The pit depth shall be not less than is required for the installation of the buffers, compensating sheaves, if any, and all other elevator equipment located therein and to provide the minimum bottom car clearance and runby required by 2.4.1.

### 2.2.8 Access to Underside of Car

Where the distance from the pit floor to the underside of the plank channels or slings exceeds 2 100 mm (83 in.), with the car at the lowest landing, a means shall be permanently installed or permanently stored in the pit to provide access to the equipment on the underside of the car.

## SECTION 2.3
## LOCATION AND GUARDING OF COUNTERWEIGHTS

### 2.3.1 Location of Counterweights

Counterweights shall be located in the hoistway of the elevator that they serve, or in a remote hoistway subject to the limitations and requirements of 2.3.3.

### 2.3.2 Counterweight Guards

**2.3.2.1** Metal guards shall be installed in the pit and/or machine room located underneath the hoistway on all open sides of the counterweight runway, except that

*(a)* the guard, or portion thereof, is not required on the side facing the car where there is no space greater

than 500 mm (20 in.) between compensating ropes (chains), or between compensating ropes (chains) and counterweight rails, or between compensating ropes (chains) and guards

*(b)* where pit-mounted buffers are used, the guard is not required where the bottom of the counterweight resting on its compressed buffer is 2 130 mm (84 in.) or more above the pit floor, or above the machine or control room floor if located underneath the hoistway

**2.3.2.2** Guards shall

*(a)* extend from the lowest part of the counterweight assembly when the counterweight is resting on the fully compressed buffer to a point not less than 2 100 mm (83 in.) and not more than 2 450 mm (96 in.) above the pit floor

*(b)* be the full width of the area being guarded

*(c)* not prevent determination of the counterweight runby

*(d)* be fastened to a metal frame reinforced and braced to be at least equal in strength and stiffness to 2 mm (0.074 in.) thick sheet steel

*(e)* if perforated, reject a ball 25 mm (1 in.) in diameter

### 2.3.3 Remote Counterweight Hoistways

Where elevators are not provided with either compensating means or counterweight safeties, the counterweights shall be permitted to be located in a remote hoistway conforming to 2.3.3.1 through 2.3.3.6.

**2.3.3.1** The hoistway shall be fully enclosed and shall be fire resistive, conforming to 2.1.1.1 if it penetrates separate fire-resistive areas of the structure.

**2.3.3.2** Construction at the top and bottom of the hoistway shall conform to 2.1.2.

**2.3.3.3** Permanent means shall be provided for inspection, repair, and maintenance of the counterweight, deflecting and secondary sheaves, hoistway, ropes, counterweight guide rails, and counterweight buffers or bumpers. Entry doors into the separate counterweight hoistway shall be provided at top, bottom, and center of counterweight hoistway, but in no case shall the entry doors be more than 11 m (36 ft) from sill to sill. Doors shall be located and of such width to provide unobstructed access to the space between the counterweight guides. The height of the door shall be at least 1 975 mm (78 in.). Doors shall conform to 2.11.1.2(b) through (e), inclusive. An enclosed stop switch, meeting the requirements of 2.26.2.5(a), (b), and (c), a permanent electric light switch, outlet, and light shall be provided in the hoistway immediately inside the entry door.

**2.3.3.4** Ropes and sheaves leading to the separate counterweight hoistways shall be protected against unauthorized access.

**2.3.3.5** Not more than four counterweights shall be located in a single separate counterweight hoistway. Multiple counterweights located in a single hoistway shall be separated by means of an unperforated metal guard at the top, bottom, and center of the hoistway. Guards shall extend a minimum of 2 450 mm (96 in.) in length opposite the entry door. Doors and all other means described in 2.3.3.3 shall be provided for each counterweight.

**2.3.3.6** There shall be a clearance of not less than 600 mm (24 in.) between the weight in the counterweight frame and the wall containing the entry door.

### 2.3.4 Counterweight Runway Enclosures

Where a counterweight is located in the same hoistway as the car, the runway for the counterweight shall be permitted to be separated from the runway for the car, provided it conforms to 2.3.4.1 and 2.3.4.2.

**2.3.4.1** The partition shall be noncombustible. Unperforated metal partitions shall be equal to or stronger than 1.2 mm (0.047 in.) thick sheet steel. Openwork partitions shall be either wire grille at least 2.2 mm (0.087 in.) in diameter or expanded metal at least 2.2 mm (0.087 in.) in thickness.

**2.3.4.2** The counterweight runway shall be permitted to be fully enclosed for the full height, provided that the partitions are removable in sections weighing not more than 25 kg (55 lb), which permit inspection and maintenance of the entire counterweight assembly and the inspection of the counterweight guide rails and guide-rail brackets. (ED)

## SECTION 2.4
## VERTICAL CLEARANCES AND RUNBYS FOR CARS AND COUNTERWEIGHTS

### 2.4.1 Bottom Car Clearances

**2.4.1.1** When the car rests on its fully compressed buffers or bumpers, there shall be a vertical clearance of not less than 600 mm (24 in.) between the pit floor and the lowest structural or mechanical part, equipment, or device installed beneath the car platform, except as specified in 2.4.1.2.

**2.4.1.2** The 600 mm (24 in.) clearance does not apply to

*(a)* any equipment on the car within 300 mm (12 in.) horizontally from any side of the car platform

*(b)* any equipment located on or traveling with the car located within 300 mm (12 in.) horizontally from either side of the car frame centerline parallel to the plane of the guide rails

*(c)* any equipment mounted in or on the pit floor located within 300 mm (12 in.) horizontally from either side of the car frame centerline parallel to the guide rail

**2.4.1.3** In no case shall the available refuge space be less than either of the following:

(*a*) a horizontal area of 600 mm × 1 200 mm (24 in. × 48 in.) with a height of 600 mm (24 in)

(*b*) a horizontal area of 450 mm × 900 mm (18 in. × 35 in.) with a height of 1 070 mm (42 in.)

**2.4.1.4** Trenches and depressions or foundation encroachments permitted by 2.2.2.2 shall not be considered in determining these clearances.

**2.4.1.5** When the car is resting on its fully compressed buffers or bumpers, no part of the car, or any equipment attached thereto or equipment traveling with the car, shall strike any part of the pit or any equipment mounted therein.

**2.4.1.6** In any area in the pit, outside the refuge space, where the vertical clearance is less than 600 mm (24 in.), that area shall be clearly marked on the pit floor. Markings shall not be required in the area under the platform guard and guiding means if that is the only area in the pit where the vertical clearance is less than 600 mm (24 in.). The marking shall consist of alternating 100 mm (4 in.) diagonal red and white stripes. In addition, a sign with the words "DANGER LOW CLEARANCE" shall be prominently posted on the hoistway enclosure and be visible from within the pit and the entrance to the pit. The sign shall conform to ANSI Z535.2 or CAN/CSA-Z321, whichever is applicable (see Part 9). The sign shall be of such material and construction that the letters and figures stamped, etched, cast, or otherwise applied to the face shall remain permanently and readily legible.

### 2.4.2 Minimum Bottom Runby for Counterweighted Elevators

The bottom runby of cars and counterweights shall be not less than the requirements stated in 2.4.2.1 and 2.4.2.2.

**2.4.2.1** Where oil buffers are used, the bottom runby shall be not less than 150 mm (6 in.), except that

(*a*) where practical difficulties prevent a sufficient pit depth or where a top clearance cannot be provided to obtain the runby specified, it shall be permitted to be reduced

(*b*) where spring-return-type oil buffers are used, the runby shall be permitted to be eliminated so that the buffers are compressed by amounts not exceeding those permitted by 2.22.4.8, when the car floor is level with the terminal landings

**2.4.2.2** Where spring buffers or solid bumpers are used, the bottom runby shall be not less than 150 mm (6 in.), except for rheostatic and single-speed AC control, not less than shown in Table 2.4.2.2.

### 2.4.3 Minimum Bottom Runby for Uncounterweighted Elevators

The bottom runby of uncounterweighted elevators shall be not less than

**Table 2.4.2.2 Minimum Bottom Runby for Counterweight Elevators With Spring Buffers or Solid Bumpers and Rheostatic Control or Single-Speed AC Control**

| Rated Speed, m/s (ft/min) | Runby, mm (in.) |
|---|---|
| Not over 0.13 (not over 25) | 75 (3) |
| Over 0.13 to 0.25 (over 25 to 50) | 150 (6) |
| Over 0.25 to 0.50 (over 50 to 100) | 225 (9) |
| Over 0.50 to 1.0 (over 100 to 200) | 300 (12) |

(*a*) 75 mm (3 in.) where the rated speed does not exceed 0.15 m/s (30 ft/min)

(*b*) 150 mm (6 in.) where the rated speed exceeds 0.15 m/s (30 ft/min)

### 2.4.4 Maximum Bottom Runby

In no case shall the maximum bottom runby exceed

(*a*) 600 mm (24 in.) for cars

(*b*) 900 mm (35 in.) for counterweights

### 2.4.5 Counterweight Runby Data Plate

A data plate permanently and securely attached shall be provided in the pit, in the vicinity of the counterweight buffer, indicating the maximum designed counterweight runby. The data plate shall conform to 2.16.3.3, except that the letters shall be not less than 25 mm (1 in.) in height.

### 2.4.6 Top Car Clearances for Counterweighted Elevators

**2.4.6.1 General Requirements.** The top car clearance shall be not less than the sum of either of the following:

(*a*) the dimensions specified in 2.4.6.2(a) through (d)

(*b*) the dimensions specified in 2.4.6.2(a), (b), (c), and (e)

**2.4.6.2 Components of the Top Car Clearances.** The following shall be considered when calculating the minimum top car clearances:

(*a*) the designed maximum bottom counterweight runby [see 2.4.4(b)]

(*b*) the stroke of the counterweight buffer, determined as follows:

(*1*) for full-stroke buffers, the stroke of the buffer used, or the remaining stroke when the buffer is compressed with the car at the top terminal landing (see 2.4.2 and 2.22.4.8); or

(*2*) for reduced-stroke oil buffers (see 2.22.4.1.2), the full stroke required by 2.22.4.1.1.

(*c*) 600 mm (24 in.) or the distance that any sheave or any other equipment mounted in or on the car crosshead projects above the top of the car crosshead, whichever is greater, but in no case shall there be less than 150 mm

(6 in.) clearance above the equipment, exclusive of guide-shoe assemblies or gate posts for vertically sliding gates, mounted on the car top or in or on the car crosshead when the car has reached its maximum upward movement.

NOTE: See also 2.4.12, requirements for refuge space on top of car enclosure.

*(d)* ½ the gravity stopping distance, based on:

*(1)* 115% of the rated speed where oil buffers are used, or 115% of the reduced striking speed when emergency terminal speed-limiting devices meeting the requirements of 2.25.4 are used and no compensating rope tie-down device in conformance with 2.17.17 is provided (see 8.2.5 for gravity stopping distances); or

*(2)* the governor tripping speed where spring buffers are used.

*(e)* the distance to which the compensating rope tie-down device, if provided (see 2.17.17) limits the jump of the car when the counterweight strikes the buffers at speeds specified in 2.4.6.2(d).

### 2.4.7 Top Car Clearance for Uncounterweighted Elevators

The top car clearance shall be not less than the greater of the following:

*(a)* 750 mm (29.5 in.); or

*(b)* 150 mm (6 in.), plus the amount that any equipment mounted on the car crosshead, or above the car top when no crosshead is provided, projects vertically above the crosshead or top.

NOTE (2.4.7): See also 2.4.12, requirements for refuge space on top of car enclosure.

### 2.4.8 Vertical Clearances With Underslung Car Frames

Where an underslung car frame is used, the clearances between the overhead car rope dead-end hitch or overhead car sheave and the portions of the car structure vertically below them, when the car floor is level with the top terminal landing, shall be not less than the following:

*(a)* where no counterweight is used, 230 mm (9 in.)

*(b)* where a counterweight is used, the sum of the following items:

*(1)* the bottom counterweight runby (see 2.4.2)

*(2)* the stroke of the counterweight buffer used, or the remaining stroke when the buffer is compressed with the car at the top terminal landing (see 2.4.2 and 2.22.4.8)

*(3)* 150 mm (6 in.)

*(4)* ½ the gravity stopping distance based on 115% of the rated speed where oil buffers are used, or 115% of the reduced striking speed when emergency terminal speed-limiting devices meeting the requirements of 2.25.4 are used and no provision is made to prevent the jump of the car at counterweight buffer engagement, or on governor tripping speed where spring buffers are used (see 8.2.5 for gravity stopping distances)

NOTE [2.4.8(b)(4)]: See also 2.4.12, requirements for refuge space on top of car enclosure.

### 2.4.9 Top Counterweight Clearances

The top counterweight clearance shall be not less than the sum of the following items:

*(a)* the bottom car runby (see 2.4.2)

*(b)* the stroke of the car buffer used, or the remaining stroke when the buffer is compressed with the car at the bottom terminal landing (see 2.4.2 and 2.22.4.8)

*(c)* 150 mm (6 in.)

*(d)* ½ the gravity stopping distance based on

*(1)* 115% of the rated speed where oil buffers are used, or 115% of the reduced striking speed when emergency terminal speed-limiting devices meeting the requirements of 2.25.4 are used and no provision is made to prevent the jump of the counterweight at car buffer engagement; or (04)

*(2)* the governor tripping speed where spring buffers are used (see 8.2.5 for gravity stopping distances).

### 2.4.10 Overhead Clearances Where Overhead Beams Are Not Over Car Crosshead

Where overhead beams or other overhead hoistway construction, except sheaves, are located vertically over the car, but not over the crosshead, the requirements of 2.4.10.1 and 2.4.10.2 shall be met.

**2.4.10.1** The clearance from the car top to such beams or construction, when the car is level with the top landing, shall be not less than the amount specified in 2.4.6 and 2.4.7.

**2.4.10.2** Such beams or construction shall be located not less than 600 mm (24 in.) horizontally from the crosshead.

### 2.4.11 Equipment on Top of Car Not Permitted to Strike Overhead Structure

When the car crosshead, or car top where no crosshead is provided, is at a distance equal to that specified in 2.4.6.2(c) from the nearest obstruction above it, no equipment on top of the car shall strike any part of the overhead structure or the equipment located in the hoistway.

### 2.4.12 Refuge Space on Top of Car Enclosure

**2.4.12.1** An unobstructed horizontal area of not less than 0.5 $m^2$ (5.4 $ft^2$) shall be provided on top of the car enclosure for refuge space. It shall measure not less than 600 mm (24 in.) on any side. This area shall be permitted to include the space utilized for the top emergency exit [see 2.14.1.5.1(f)]. The minimum vertical distance in the refuge area between the top of the car enclosure and the overhead structure or other obstruction shall be not less than 1 100 mm (43 in.) when the car has reached its maximum upward movement.

**2.4.12.2** In any area outside the refuge space where the vertical clearance between the top of the car enclosure and the overhead structure or other obstructions is less than specified in 2.4.12.1, the top of the car enclosure shall be clearly marked. The marking shall consist of alternating 100 mm (4 in.) diagonal red and white stripes. In addition, a sign with the words "DANGER LOW CLEARANCE" shall be prominently posted on the crosshead and be visible from the entrance. The sign shall conform to ANSI Z535.2 or CAN/CSA-Z321, whichever is applicable (see Part 9). The sign shall be of such material and construction that the letters and figures stamped, etched, cast, or otherwise applied to the face shall remain permanently and readily legible.

## SECTION 2.5
## HORIZONTAL CAR AND COUNTERWEIGHT CLEARANCES

### 2.5.1 Clearances Between Cars, Counterweights, and Hoistway Enclosures

**2.5.1.1 Between Car and Hoistway Enclosures.** The clearance between the car and the hoistway enclosure shall be not less than 20 mm (0.8 in.), except on the sides used for loading and unloading.

**2.5.1.2 Between Car and Counterweight and Counterweight Guard.** The clearance between the car and the counterweight shall be not less than 25 mm (1 in.). The clearance between the car and the counterweight guard, counterweight and the counterweight guard, and between the counterweight and the hoistway enclosure shall be not less than 20 mm (0.8 in.).

**2.5.1.3 Between Cars in Multiple Hoistways.** The running clearance between the cars and any equipment attached thereto, of elevators operating in a multiple hoistway, shall be not less than 50 mm (2 in.).

**2.5.1.4 Between Car and Landing Sills.** The clearance between the car platform sill and the hoistway edge of any landing sill, or the hoistway side of any vertically sliding counterweighted or counterbalanced hoistway door, or of any vertically sliding counterbalanced biparting hoistway door, shall be not less than 13 mm (0.5 in.) where side guides are used, and not less than 20 mm (0.8 in.) where corner guides are used. The maximum clearance shall be not more than 32 mm (1.25 in.).

**2.5.1.5 Clearance Between Loading Side of Car Platforms and Hoistway Enclosures**

**2.5.1.5.1** The clearance between the edge of the car platform sill and the hoistway enclosure or fascia plate for the full width of the clear hoistway door opening shall be not more than

*(a)* 190 mm (7.5 in.) for vertically sliding doors

*(b)* 125 mm (5 in.) for other doors

**2.5.1.5.2** This clearance shall be maintained to the location of the car sill when the car is resting on fully compressed buffer.

**2.5.1.5.3** The clearance is not limited on passenger elevators, provided that

*(a)* a car door interlock conforming to 2.14.4.2 is provided to prevent a door from being opened unless the car is within the unlocking zone

*(b)* the strength of the door complies with 2.11.11.2, 2.11.11.4, 2.11.11.6, 2.11.11.7, and 2.11.11.8

**2.5.1.6 Clearance Between Car Platform Apron and Pit Enclosure.** Where the lowest landing sill projects into the hoistway, the clearance between the car platform apron and the pit enclosure or fascia plate shall be not more than 32 mm (1.25 in.). This clearance shall be maintained to the location of the car platform apron when the car is resting on its fully compressed buffer.

**2.5.1.7 Measurement of Clearances.** The clearances specified in 2.5.1 shall be measured with no load on the car platform.

## SECTION 2.6
## PROTECTION OF SPACE BELOW HOISTWAYS

Where a hoistway does not extend to the lowest floor of the building and there is space below the hoistway that is accessible, requirements of 2.6.1 and 2.6.2 shall be complied with.

### 2.6.1 Where the Space Is Underneath the Counterweight and/or Its Guides

Where the space is underneath the counterweight and/or its guides

*(a)* the counterweight shall be provided with a counterweight safety conforming to 2.17.4

*(b)* spring buffers, if used, shall conform to 2.22, except that they shall not be fully compressed when struck by the counterweight at the following speeds (see 2.1.2.3):

*(1)* at governor tripping speed where the counterweight safety is governor operated, or

*(2)* 125% of the rated speed where the counterweight safety is not governor operated

### 2.6.2 Where the Space Is Underneath the Car and/or Its Guides

Where the space is underneath the car and/or its guides and if spring buffers are used, they shall be so designed and installed that they will not be fully compressed solid or to a fixed stop when struck by the car with its rated load at the governor tripping speed (see 2.1.2.3).

# SECTION 2.7
# MACHINE ROOMS AND MACHINERY SPACES

## 2.7.1 Enclosure of Machine Rooms and Machinery Spaces

Machines, control equipment, sheaves, and other machinery shall not be exposed to the weather. Machine room and machinery space enclosures shall conform to 2.7.1.1 or 2.7.1.2.

**2.7.1.1 Fire-Resistive Construction.** Where fire-resistive construction is required by the building code, the requirements of 2.7.1.1.1 and 2.7.1.1.2 shall be conformed to.

**2.7.1.1.1** Spaces containing machines, control equipment, sheaves, and other machinery shall be separated from the remainder of the building by a fire-resistive enclosure conforming to the requirements of the building code.

**2.7.1.1.2** Openings in the machine room enclosure shall be protected with access doors having a fire protection rating conforming to the requirements of the building code.

NOTES (2.7.1.1):
(1) See 2.1.3 for floors of machine rooms and machinery spaces over the hoistways.
(2) See 2.7.2.1 for separating elevator machinery from building machinery.
(3) See 2.1.1.1.2 for partitions between machine rooms and hoistways.

**2.7.1.2 Non-Fire-Resistive Construction.** Where fire-resistive construction is not required by the building code, the requirements of 2.7.1.2.1 and 2.7.1.2.2 shall be conformed to.

**2.7.1.2.1** Machine rooms and machinery spaces shall be enclosed with noncombustible material extending to a height of not less than 2 000 mm (79 in.).

**2.7.1.2.2** The enclosure, if of openwork material, shall reject a ball 50 mm (2 in.) in diameter.

## 2.7.2 Equipment in Machine Rooms

**2.7.2.1 Equipment Permitted.** Only machinery and equipment used in conjunction with the function or use of the elevator shall be permitted in the elevator machine room.

### 2.7.2.2 Maintenance Clearance

**2.7.2.2.1** A clear path of not less than 450 mm (18 in.) shall be provided to all components that require maintenance.

**2.7.2.2.2** A clearance of not less than 450 mm (18 in.) shall be provided in the direction(s) required for maintenance access.

## 2.7.3 Access to Machine Rooms and Machinery Spaces

**2.7.3.1 General Requirements.** A permanent and unobstructed means of access to elevator machine rooms and overhead machinery spaces shall be provided.

**2.7.3.2 Access Across Roofs.** Where passage over roofs is necessary to reach the means of access to machine rooms or machinery spaces, the requirements of 2.7.3.2.1 and 2.7.3.2.2 shall be conformed to.

**2.7.3.2.1** A stairway with a swinging door and platform at the top level, conforming to 2.7.3.3, shall be provided from the top floor of the building to the roof level. Hatch covers, as a means of access to roofs, shall not be permitted.

**2.7.3.2.2** Where the passage is over a roof having a slope exceeding 15 deg from the horizontal, or over a roof where there is no parapet or guard rail at least 1 070 mm (42 in.) high around the roof or passageway, a permanent, unobstructed and substantial walkway not less than 600 mm (24 in.) wide, equipped on the side sloping away from the walk with a railing conforming to 2.10.2.1, 2.10.2.2, and 2.10.2.3, shall be provided from the building exit door at the roof level to the means of access to the machine room or machinery spaces.

**2.7.3.3 Means of Access.** The means of access to machine rooms, machinery spaces, and different floor levels in machine rooms shall conform to 2.7.3.3.1 through 2.7.3.3.5.

**2.7.3.3.1** A permanent, fixed, noncombustible ladder or stair shall be provided where the floor of the machine room or the machinery space above or below the floor or roof from which the means of access leads, or where the distance between the machine room floor levels, is more than 200 mm (8 in.).

**2.7.3.3.2** A permanent, noncombustible stair shall be provided where the floor of the machine room or the machinery space above or below the floor or roof from which the means of access leads, or where the distance between the machine room floor levels, is 900 mm (35 in.) or more. Vertical ladders with handgrips shall be permitted to be used in lieu of stairs for access from building floors or machine rooms to machinery spaces containing overhead sheaves, secondary and deflecting sheaves, governors, and auxiliary equipment, not including controllers and motor generators. (ED)

**2.7.3.3.3** Permanent, fixed, noncombustible ladders shall conform to ANSI A14.3.

**2.7.3.3.4** Permanent, noncombustible stairs shall have a maximum angle of 60 deg from the horizontal, and shall be equipped with a noncombustible railing conforming to 2.10.2.1, 2.10.2.2, and 2.10.2.3.

**2.7.3.3.5** A permanent, noncombustible platform or floor shall be provided at the top of the stairs with noncombustible railings conforming to 2.10.2.1, 2.10.2.2, and 2.10.2.3 on each open side. In jurisdictions not enforcing the NBCC, the size of the platform shall be sufficient to permit the full swing of the door plus 600 mm (24 in.) from the top of the riser to the swing line of the door. The floor of the platform shall be at the level of not more than 200 mm (8 in.) below the level of the access-door sill. Where the door swings inward, the width of the platform shall be not less than 750 mm (29.5 in.), and the length not less than the width of the door.

### 2.7.3.4 Access Doors and Openings

**2.7.3.4.1** Access doors to machine rooms and overhead machinery spaces shall

*(a)* for machine rooms, be of a minimum width of 750 mm (29.5 in.) and a minimum height of 2 030 mm (80 in.); for other spaces as specified in 2.7.4.2 and 2.7.4.3, be of a minimum width and height of 750 mm (29.5 in.).

*(b)* be self-closing and self-locking.

*(c)* be provided with a spring-type lock arranged to permit the doors to be opened from the inside without a key.

*(d)* be kept closed and locked. Keys to unlock the access doors shall be of Group 2 Security (see 8.1).

**2.7.3.4.2** Doors are not required at openings in machine room floors for access to deflecting and secondary-sheave spaces, provided the access opening is provided on all four sides with a standard railing conforming to 2.10.2, one side of which is arranged to slide or swing to provide access to the ladder or stairs leading to the secondary sheave space. Trap doors, where provided, shall have a standard railing conforming to 2.10.2 or guard wings on all open nonaccess sides.

**2.7.3.4.3** Access openings in elevator hoistway enclosures where complete bodily entry is not necessary for maintenance and inspection of components shall be

*(a)* of adequate size and located to permit the required maintenance and inspection

*(b)* of maximum width of 600 mm (24 in.) and a maximum height of 600 mm (24 in.)

*(c)* provided with doors that shall be kept closed and locked. Keys to unlock the access doors to the elevator hoistways shall be of Group 1 Security (see 8.1)

**2.7.3.5 Stop Switch in Overhead Machinery Space in the Hoistway.** A stop switch, conforming to 2.26.2.24, shall be provided for each elevator in the overhead machinery space in the hoistway, adjacent to the lock jamb side of the door or adjacent to the nearest point of access to its overhead machinery space from the access door.

### 2.7.4 Headroom in Machine Rooms and Overhead Machinery Spaces

**2.7.4.1** Elevator machine rooms and machinery spaces not located over the hoistway shall have a clear headroom of not less than 2 130 mm (84 in.).

**2.7.4.2** Where a floor is provided at the top of the hoistway (see 2.1.3), elevator machine rooms and overhead machinery spaces above such floor shall have a clear headroom of not less than the following:

*(a)* machine, control, and motor-generator rooms, 2 130 mm (84 in.)

*(b)* spaces containing only overhead, secondary, or deflecting sheaves, 1 070 mm (42 in.)

*(c)* spaces containing overhead, secondary, or deflecting sheaves, and governors, signal machines, or other equipment, 1 350 mm (53 in.)

**2.7.4.3** Where floors are provided under overhead, secondary, or deflecting sheaves [see 2.7.4.2(b) and (c)] the machine and supporting beams shall be permitted to encroach on the required headroom, provided there is a clearance of not less than 900 mm (35 in.) high and minimum width of 750 mm (29.5 in.) in the path of access to sheaves, governors, signal machines, or other equipment. (ED)

### 2.7.5 Lighting, Temperature, and Humidity in Machine Rooms and Machinery Spaces

**2.7.5.1 Lighting.** Permanent electric lighting shall be provided in all machine rooms and machinery spaces. The illumination shall be not less than 200 lx (19 fc) at the floor level. The lighting control switch shall be located within easy reach of the access to such rooms or spaces. Where practicable, the light control switch shall be located on the lock-jamb side of the access door.

**2.7.5.2 Temperature and Humidity.** Machine rooms shall be provided with natural or mechanical means to keep the ambient air temperature and humidity in the range specified by the elevator equipment manufacturer to ensure safe and normal operation of the elevator. The temperature and humidity range shall be permanently posted in the machine room.

### 2.7.6 Location of Machine Rooms and Control Rooms

Elevator machine and control rooms shall not be located in the hoistway. Drive and deflector sheaves and machine parts and supports are permitted to project into the hoistway (see 2.1.3.1).

### 2.7.7 Machine and Control Rooms Underneath the Hoistway

When a machine or control room is located underneath the hoistway, it shall conform to 2.7.7.1 through 2.7.7.5.

**2.7.7.1** The machine or control room shall have a solid ceiling (pit floor, at the normal pit depth) of concrete or steel above the machine or control room, with a minimum 2 130 mm (84 in.) clearance above the machine or control room floor.

**2.7.7.2** The ceiling of the machine or control room shall be capable of sustaining a concentrated load of 1 000 N (225 lbf) on any 2 000 $mm^2$ (3 $in.^2$) area, and it shall be designed for a live load of 6 kPa (125 $lbf/ft^2$) and loads imposed by rails and/or buffers, if applicable.

**2.7.7.3** The car and counterweight guide rails and buffer supports shall be permitted to extend into the machine room and be supported by the machine room floor. If the counterweight buffer or buffer support extends to the machine room or control room floor, a counterweight safety is not required unless the space below the machine room is not permanently secured against access. If a counterweight buffer is supported at the machine room ceiling (pit floor), a counterweight safety is required. (See 2.6.1 for additional requirements.)

(04) **2.7.7.4** The solid ceiling (pit floor at normal pit depth) shall be permitted to be slotted for the penetration of equipment (suspension ropes, selector drives, electrical conduit, rails, buffers, etc.). Passage and guards shall be provided in conformance with 2.3.2 and 2.10.1 for both the machine or control room and pit. A counterweight guard shall be installed at the pit floor as well as the machine or control room floor if the counterweight extends into the machine or control room and 2.3.2.1(a) does not apply. The guard in the machine or control room shall extend to the ceiling.

**2.7.7.5** Compensating ropes or chains and traveling cables shall not extend into the machine room located underneath the hoistway.

### 2.7.8 Remote Machine and Control Rooms

Elevators that are provided with remote machine and/or control rooms shall conform to 2.7.8.1 through 2.7.8.4.

**2.7.8.1** Ropes and sheaves leading to the remote machine room that penetrate separate fire-resistive areas of the structure shall be fully enclosed, and the enclosures shall conform to 2.1.1.1.

**2.7.8.2** Rope and sheave enclosures leading to the remote machine room shall be protected against unauthorized access.

**2.7.8.3** Permanent means of access shall be provided to the enclosures for inspection, repair, and maintenance of hoist ropes passing over sheaves that are not located in the hoistway or remote machine rooms. Access doors to these enclosures shall be provided at each sheave location, conforming to 2.7.3.4. Access openings shall be provided for inspection and maintenance of hoist ropes passing over sheaves and shall conform to 2.7.3.4. A stop switch meeting the requirements of 2.26.2.23, a permanent electric outlet, a light switch, and light shall be provided in the enclosures immediately inside the access doors and openings.

**2.7.8.4** A permanent means of communication between the elevator car and remote machine room and or control room shall be provided.

## SECTION 2.8
## EQUIPMENT IN HOISTWAYS AND MACHINE ROOMS

### 2.8.1 Electrical Equipment and Wiring

**2.8.1.1** Installation of electrical equipment and wiring shall conform to NFPA 70 or CSA-C22.1, whichever is applicable (see Part 9).

**2.8.1.2** Only such electrical wiring, raceways, and cables used directly in connection with the elevator, including wiring for signals, for communication with the car, for lighting, heating, air conditioning, and ventilating the car, for fire detecting systems, for pit sump pumps, and for heating and lighting the hoistway and/or machine room shall be permitted to be installed inside the hoistway.

**2.8.1.3** Bonding conductors from the lightning protection system grounding down conductor to long vertical metal bodies in the hoistway such as elevator rails and vertical wireways shall be permitted to be installed in the hoistway as required by NFPA 780, or CAN/CSA-B72, whichever is applicable (see Part 9). The lightning protection system grounding down conductor shall not be permitted in the hoistway, and the elevator rails shall not be used as the lightning protection system grounding down conductor. Bonding conductors installed in the hoistway shall not interfere with the operation of the elevator.

### 2.8.2 Pipes, Ducts, Tanks, and Sprinklers

**2.8.2.1** Steam and hot-water pipes shall be permitted to be installed in hoistways, machine rooms, and machinery spaces for the purpose of heating these areas only, subject to the requirements of 2.8.2.1.1 through 2.8.2.1.3.

**2.8.2.1.1** Heating pipes shall convey only low-pressure steam [100 kPa (15 psi) or less] or hot water [100°C (212°F) or less].

**2.8.2.1.2** All risers and return pipes shall be located outside the hoistway. When the machine room is located above the roof of the building, heating pipes for the machine room shall be permitted to be located in the hoistway between the top floor and the machine room.

**2.8.2.1.3** Traps and shutoff valves shall be provided in accessible locations outside the hoistway.

**2.8.2.2** Ducts shall be permitted to be installed in the hoistway, machine room, and machinery space for the purpose of heating, cooling, ventilating, and venting these areas only and shall not encroach upon the required clearances.

**2.8.2.3** Sprinkler systems conforming to NFPA 13 or the NBCC, whichever is applicable (see Part 9), shall be permitted to be installed in the hoistway, machine room, and machinery spaces, subject to the requirements of 2.8.2.3.1 through 2.8.2.3.4.

**2.8.2.3.1** All risers and returns shall be located outside these spaces. Branch lines in the hoistway shall supply sprinklers at not more than one floor level. When the machine room is located above the roof of the building, risers, return pipes, and branch lines for the machine room sprinkler(s) shall be permitted to be located in the hoistway between the top floor and the machine room.

**2.8.2.3.2** In jurisdictions not enforcing the NBCC, means shall be provided to automatically disconnect the main line power supply to the affected elevator upon or prior to the application of water from sprinklers located in the machine room or in the hoistway more than 600 mm (24 in.) above the pit floor. This means shall be independent of the elevator control and shall not be self-resetting. The activation of sprinklers outside of the hoistway or machine room shall not disconnect the main line power supply.

**2.8.2.3.3** Smoke detectors shall not be used to activate sprinklers in these spaces or to disconnect the main line power supply.

**2.8.2.3.4** In jurisdictions not enforcing the NBCC, when sprinklers are installed in the hoistway, all electrical equipment, except earthquake protective devices conforming to 8.4.10.1.2(d), located less than 1 225 mm (48 in.) above the pit floor, shall be

*(a)* weatherproof (NEMA4)

*(b)* wiring shall be identified for use in wet locations in accordance with the requirements in NFPA 70

**2.8.2.4** Other pipes or ducts conveying gases, vapors, or liquid and not used in connection with the operation of the elevator shall not be installed in any hoistway, machine room, or machinery space. Where a machine room or hoistway, or both, extend above the roof of a building, pipes shall be permitted from roof drains to the closest point where they can be diverted out of this space. Pipes shall be covered to prevent leakage or condensate from entering the machine room or hoistway.

**2.8.2.5** Where permitted and provided, pipes, drains, and tanks, or similar equipment that contains liquids, shall not be located directly above the elevator equipment and shall not encroach upon the required clearances in the hoistway, machine room, or machinery spaces.

### 2.8.3 Electrical Heaters

Listed/certified electrical heaters shall be permitted.

### 2.8.4 Air Conditioning

Air conditioning equipment is permitted to be installed in machine rooms or machinery spaces for the purpose of cooling these areas only, subject to the requirements of 2.8.4.1 through 2.8.4.5.

**2.8.4.1** Air conditioning equipment shall not be located directly above elevator equipment.

**2.8.4.2** The clear headroom below suspended air conditioning equipment shall conform to 2.7.4.

**2.8.4.3** Means shall be provided to collect and drain condensation water from these spaces. Condensation drains shall not be located directly above elevator equipment. Drains connected directly to sewers shall not be installed.

**2.8.4.4** Safe and convenient access within the elevator machine room shall be provided to the air-conditioning equipment for servicing and maintaining.

**2.8.4.5** There shall be no exposed gears, sprockets, belts, pulleys, or chains.

NOTES (2.8.4):

(1) See 2.8.2.2 for requirements for duct work.

(2) These requirements do not pertain to air-conditioning equipment used to cool selective elevator equipment.

## SECTION 2.9
## MACHINERY AND SHEAVE BEAMS, SUPPORTS, AND FOUNDATIONS

### 2.9.1 Beams and Supports Required

**2.9.1.1** Machines, machinery, and sheaves shall be so supported and maintained in place as to prevent any part from becoming loose or displaced under the conditions imposed in service.

**2.9.1.2** Supporting beams, if used, shall be of steel or reinforced concrete.

**2.9.1.3** Beams are not required under machine(s), sheave(s), and machinery or control equipment that is supported on floors, provided such floors are designed and installed to support the load imposed thereon.

### 2.9.2 Loads on Machinery and Sheave Beams, Floors, or Foundations and Their Supports

**2.9.2.1 Overhead Beams, Floors, and Their Supports.** Overhead beams, floors, and their supports shall be designed for not less than the sum of the following loads:

*(a)* the load resting on the beams and supports, which shall include the complete weight of the machine, sheaves, controller, governor, and any other equipment,

together with that portion, if any, of the machine room floor supported thereon

*(b)* two times the sum of the tensions in all wire ropes supported by the beams with rated load in the car

NOTE [2.9.2.1(b)]: These tensions are doubled to take care of accelerations and decelerations.

**2.9.2.2 Foundations, Beams, and Floors for Machinery and Sheaves Not Located Directly Over the Hoistway.** The supports for machines and sheaves located below or at the sides of the hoistway shall meet the requirements of 2.9.2.2.1 through 2.9.2.2.4.

**2.9.2.2.1** The foundation shall support the total weight of the machine, sheaves, and other equipment, and the floor, if any.

**2.9.2.2.2** The sheave beams and the foundation bolts shall withstand two times the vertical force component acting thereon as a result of the tension in all the suspension ropes, less the weight of the machine or sheaves.

**2.9.2.2.3** The sheave beams and the foundation bolts shall withstand two times the horizontal force component, if any, acting thereon as a result of the tension in all the suspension ropes.

**2.9.2.2.4** The foundation shall withstand two times the overturning moment, if any, acting thereon as a result of the tension in all the suspension ropes.

### 2.9.3 Securing of Machinery and Equipment to Beams, Foundations, or Floors

#### 2.9.3.1 Overhead Beams and Floors

**2.9.3.1.1** Machinery or equipment shall be secured to and supported on or from the top of overhead beams or floors, except for the following equipment:

*(a)* secondary or deflecting sheaves of traction elevators

*(b)* devices and their accessories for limiting or retarding car speed

**2.9.3.1.2** Securing bolts or fastenings are not required where sound isolation is used between bases of machinery or equipment and supporting beams or floors.

#### 2.9.3.2 Beams or Foundations Supporting Machinery and Sheaves Not Located Directly Over the Hoistway

**2.9.3.2.1** Machines and sheaves located below or at one side of a hoistway shall be anchored to beams, foundations, or floors with bolts, conforming to ASTM A 307, of sufficient size and number to withstand the applicable load conditions specified in 2.9.2.2. Based on these initial loads, total tension in anchor bolts shall not exceed 85 MPa (12,000 psi) of net section, and the total shear shall not exceed 60 MPa (9,000 psi) of actual area in the shear plane.

**2.9.3.2.2** Bolts made of steel having a greater strength than specified by ASTM A 307 shall be permitted to be used, and the maximum allowable stresses increased proportionally based on the ratio of the ultimate strengths. Elongation shall conform to the requirements of the corresponding ASTM specification. (ED)

**2.9.3.2.3** Where bolts are used through greater than 5 deg sloping flanges of structural shapes, the bolt heads shall be of the tipped or beveled head type or shall be fitted with beveled steel washers, and nuts on greater than 5 deg sloping flanges shall seat on beveled steel washers. (ED)

#### 2.9.3.3 Overhead Hoisting Rope Hitches

**2.9.3.3.1** Where hoisting ropes are secured to the structure above a hoistway, the hitch plates and hitch-plate blocking beams, where used, shall be secured to and mounted on top of overhead beams, machine beams, or on top of auxiliary beams connected to the webs of overhead beams.

**2.9.3.3.2** Hitch plates, blocking, or auxiliary beams shall be secured by bolts conforming to ASTM A 307, rivets conforming to ASTM A 502, or welding conforming to 8.8, and shall be so located that the tension in the hoisting ropes will not develop direct tensions in the bolts or rivets. Where bolts and rivets are subjected to shearing stresses due to tension in the hoisting ropes, the total shear shall not exceed 60 MPa (9,000 psi) of actual area in the shear plane. The stresses in welds due to tensions in the hoisting ropes shall not exceed 55 MPa (8,000 psi) on the throat area of the welds.

**2.9.3.3.3** Bolts made of steel having greater strength than specified by ASTM A 307 shall be permitted to be used, and the maximum allowable stresses increased proportionally based on the ratio of the ultimate strengths. (ED)

**2.9.3.3.4** Elongation shall conform to the requirements of the corresponding ASTM specification.

**2.9.3.3.5** The hitch plate supporting beams shall be designed to withstand two times the sum of the tensions in all hoisting ropes attached to the hitch plates. (See also 2.15.13.)

**2.9.3.3.6** Total stresses in hitch plates and hitch-plate shapes shall not exceed 85 MPa (12,000 psi).

**2.9.3.4 Cast Metals in Tension or Bending.** Cast metals having an elongation of less than 20% in a length of 50 mm (2 in.), when measured in accordance with ASTM E 8, which are subject to tension or bending, shall not be used to support machinery or equipment from the underside of overhead beams or floors.

### 2.9.4 Allowable Stresses for Machinery and Sheave Beams or Floors and Their Supports

**2.9.4.1** The unit stresses for all machinery and sheave beams and floors and their supports, based on the loads computed as specified in 2.9.2 or 2.9.6, whichever is greater, shall not exceed 80% of those permitted for static loads by the following standards:

*(a) Structural Steel.* AISC Book No. S326 or CAN/CSA-S16.1, whichever is applicable (see Part 9).

*(b) Reinforced Concrete.* ANSI/ACI 318 or CAN3-A23.3, whichever is applicable (see Part 9).

**2.9.4.2** Where stresses due to loads, other than elevator loads supported on the beams or floor, exceed those due to the elevator loads, 100% of the permitted stresses are permitted.

### 2.9.5 Allowable Deflections of Machinery and Sheave Beams and Their Supports

The allowable deflections of machinery and sheave beams and their immediate supports under static load shall not exceed $1/1666$ of the span.

### 2.9.6 Allowable Stresses Due to Emergency Braking

Machinery and sheave beams, supports, and their fastenings subject to forces due to the application of the emergency brake (see 2.19.4) shall be designed to withstand the maximum forces developed during the retardation phase of the emergency braking so that the resulting stresses due to the emergency braking and all other loading acting simultaneously, if applicable, shall not exceed those specified in 2.9.4.

## SECTION 2.10
## GUARDING OF EQUIPMENT AND STANDARD RAILING

### 2.10.1 Guarding of Equipment

In machine rooms and secondary machinery spaces, the following shall be guarded to protect against accidental contact:

*(a)* driving machine sheaves and ropes whose vertical projection upon a horizontal plane extends beyond the base of the machine

*(b)* sheaves

*(c)* exposed gears, sprockets, tape or rope sheaves, or drums of selectors, floor controllers, or signal machines, and their driving ropes, chains, or tapes

*(d)* keys, keyways, and screws in projecting shafts

Handwinding wheels and flywheels that are not guarded shall have yellow markings.

### 2.10.2 Standard Railing

A standard railing shall be substantially constructed of metal and shall consist of a top rail, intermediate rail, posts, and toe-board.

**2.10.2.1 Top Rail.** The top rail shall have a smooth surface, and the upper surface shall be located at a vertical height of 1 070 mm (42 in.) from the surface on which the railing is installed.

**2.10.2.2 Intermediate Rail.** The intermediate rail shall be located approximately halfway between the top rail and the surface on which the railing is installed.

**2.10.2.3 Post.** Posts shall be located not more than 2 400 mm (94.5 in.) apart.

**2.10.2.4 Toe-Board.** The toe-board shall be securely fastened to the posts and extend from the surface on which the railing is installed to a height not less than 100 mm (4 in.).

## SECTION 2.11
## PROTECTION OF HOISTWAY OPENINGS

### 2.11.1 Entrances and Emergency Doors Required

**2.11.1.1 Hoistway Landing Entrances.** All elevator hoistway landing openings shall be provided with entrances that shall guard the full height and width of the openings. Entrances shall be at least 2 030 mm (80 in.) in height and 800 mm (31.5 in.) in width.

**2.11.1.2 Emergency Doors in Blind Hoistways.** Where an elevator is installed in a single blind hoistway, there shall be installed in the blind portion of the hoistway an emergency door at every third floor, but not more than 11 m (36 ft) from sill to sill, conforming to the following:

*(a)* The clear opening shall be at least 700 mm (28 in.) wide and 2 030 mm (80 in.) high.

*(b)* It shall be easily accessible and free from fixed obstructions.

*(c)* It shall be either of the horizontally sliding or swinging single-section type, irrespective of the type of door installed at other landings.

*(d)* It shall be self-closing and self-locking and shall be marked, in letters not less than 50 mm (2 in.) high, "DANGER, ELEVATOR HOISTWAY."

*(e)* It shall be provided with an electromechanical device that will prevent the operation of the driving machine unless the door is closed and locked (see 2.26.2.25).

*(f)* It shall be unlocked from the landing side only through the use of a cylinder-type lock, having not less than five pins or five discs. The cylinder lock shall

*(1)* not be unlocked by any key that will open any other lock or device used for any purpose in the building

*(2)* be so designed that the key shall be removable only in the locked position

*(g)* It shall be openable from the hoistway side without the use of a key.

*(h)* The key shall be of Group 1 Security (see 8.1). This key shall also be made available to emergency personnel during an emergency.

*(i)* A hinged self-closing barrier independent of the door shall be installed horizontally across the entrance on the hoistway side at a height of 1 070 mm (42 in.). The barrier shall not open into the hoistway.

**2.11.1.3 Telephone as Alternative to Emergency Doors.** Where an elevator is installed in a single blind hoistway, and there are no landings from which to gain access through an emergency door, a means of two-way conversation conforming to 2.27.1.2 shall be provided.

NOTE: Examples are pulp mills, grain elevators, dams, or similar locations.

**2.11.1.4 Access Openings for Cleaning of Car and Hoistway Enclosures.** Nonremovable sliding or swing panels or doors in the hoistway conforming to 2.11.1.2(d), (f), (g), and (i) shall be permitted for access to car or hoistway transparent enclosures for cleaning purposes. An electromechanical device shall be provided that will prevent the operation of the driving machine unless the access panels or doors are closed and locked (see 2.26.2.32). Key shall be Group 2 Security (see 8.1).

### 2.11.2 Types of Entrances

**2.11.2.1 Passenger Elevators.** For passenger elevators, entrances shall be one of the following types:

*(a)* horizontally sliding;

*(b)* horizontally swinging, single-section;

*(c)* combination horizontally sliding and swinging; or

*(d)* hand- or power-operated vertically sliding that slide up to open.

**2.11.2.2 Freight Elevators.** For freight elevators, entrances shall be one of the following types:

*(a)* horizontally sliding

*(b)* swinging, single-section

*(c)* combination horizontally sliding and swinging

*(d)* center-opening, two-section horizontally swinging, subject to restrictions of 2.11.2.3

*(e)* vertically sliding biparting counterbalanced (see 2.16.4)

*(f)* vertically sliding counterweighted, single or multisection

**2.11.2.3 Limitations of Use of Center-Opening Swinging Entrances.** Center-opening swinging entrances shall be permitted only

*(a)* for freight elevators which can be operated only from the car; or

*(b)* for freight elevators not accessible to the general public that can be operated from outside the hoistway, and that are located in factories, warehouses, garages, and similar industrial buildings.

### 2.11.3 Closing of Hoistway Doors

**2.11.3.1** Horizontally sliding or single-section swinging doors of automatic-operation elevators shall be provided with door closers arranged to close and open door automatically if the car, for any reason, leaves the landing zone.

**2.11.3.2** Horizontally sliding doors shall be closed when the car is at a landing, except when

*(a)* the car is operated by a designated attendant in the car;

*(b)* loading or unloading;

*(c)* the elevator conforms to 2.27.3.2.1 and 2.27.3.2.3 through 2.27.3.2.6, Phase I Emergency Recall Operation by fire alarm initiating device; or

*(d)* the car is at the recall level when Phase I is in effect [see 2.27.3.1.6(a)].

**2.11.3.3** On center-opening doors, if there is an interlock on only one panel, the door closer required by 2.11.3.1 shall be provided on the leading panel that operates in the opposite direction (see 2.11.11.7).

### 2.11.4 Location of Horizontally Sliding or Swinging Hoistway Doors

Horizontally sliding or swinging doors shall be so located that the distance from the hoistway face of the doors to the edge of the hoistway landing sill, measured from the face of the door section nearest to the car, shall be not more than the requirements specified in 2.11.4.1 and 2.11.4.2.

**2.11.4.1** For elevators that can be operated only from the car, 100 mm (4 in.), except that where new elevators are installed in existing multiple hoistways or where alterations involving replacement of the doors are made to existing elevators in multiple hoistways, and the location of the door openings is such that the 100 mm (4 in.) dimension specified cannot be maintained, the distance specified is permitted to be increased to not more than 125 mm (5 in.) where horizontally sliding doors are used.

**2.11.4.2** For elevators with automatic or continuous-pressure operation, 19 mm (0.75 in.) for swinging doors and 57 mm (2.25 in.) for sliding doors, except that

*(a)* freight elevators not accessible to the general public, and which are located in factories, warehouses, garages, and similar industrial buildings are permitted to have single-section or center-opening two-section horizontally swinging doors conforming to 2.11.4.1; or

*(b)* for swinging doors used on elevators with automatic and continuous-pressure operation, the distance shall be permitted to be increased from 19 mm to 57 mm (0.75 in. to 2.25 in.) if such doors are emergency doors conforming to 2.11.1. (See also 2.14.4.5.)

### 2.11.5 Projection of Entrances and Other Equipment Beyond the Landing Sills

Entrances and equipment shall not project into an elevator hoistway beyond the line of the landing sill, except for

*(a)* equipment required for interlocking, indicator and signal devices, and door operating devices

*(b)* vertical slide entrances

### 2.11.6 Opening of Hoistway Doors

**2.11.6.1** When the car is within the unlocking zone, the hoistway doors shall be openable by hand from within the car without the use of tools.

**2.11.6.2** Means shall not be provided for locking out of service the doors at

*(a)* the top terminal landing

*(b)* the bottom terminal landing

*(c)* the designated and alternate landings for elevators equipped with Phase I Emergency Recall Operation, when Phase I is effective

*(d)* no landing for elevators equipped with Phase II Emergency In-Car Operation when Phase II is effective

**2.11.6.3** Automatic fire doors, the functioning of which is dependent on the action of heat, shall not lock any elevator hoistway door so that it cannot be opened manually from inside the hoistway.

**2.11.6.4** Handles or other means provided for operation of manually operated doors shall be so located that it is not necessary to reach the back of any panel, jamb, or sash to operate them.

### 2.11.7 Glass in Hoistway Doors

Glass in hoistway doors shall conform to 2.11.7.1 and 2.11.7.2.

**2.11.7.1 Vision Panels.** Manually operated or self-closing hoistway doors of the vertically or horizontally sliding type, for elevators with automatic or continuous-pressure operation, shall be provided with a vision panel. Vision panels shall not be required at landings of automatic operation elevators where a hall position indicator is provided. In multisection doors, the vision panel is required in one section only, but is permitted to be placed in all sections. All horizontally swinging elevator doors shall be provided with vision panels. Vision panels are permitted for any type of hoistway door.

Where required or used, vision panels shall conform to 2.11.7.1.1 through 2.11.7.1.7.

**2.11.7.1.1** The area of any single vision panel shall be not less than 0.015 $m^2$ (24 $in.^2$), and the total area of one or more vision panels in any hoistway door shall be not more than 0.055 $m^2$ (85 $in.^2$).

**2.11.7.1.2** Each clear panel opening shall reject a ball 150 mm (6 in.) in diameter.

**2.11.7.1.3** Muntins used between panel sections shall be of noncombustible material and of substantial construction.

**2.11.7.1.4** Panel opening shall be glazed with either of the following:

*(a)* clear wire glass not less than 6 mm (0.25 in.)

*(b)* other transparent glazing material not less than 6 mm (0.25 in.) thick that meets the impact safety standard 16 CFR Part 1201 or CAN/CGSB-12.1, CAN/CGSB-12.11, or CAN/CGSB-12.12, whichever is applicable (see Part 9)

**2.11.7.1.5** The center of the panel shall be located not less than 1 300 mm (51 in.) and not more than 1 700 mm (67 in.) above the landing, except that for vertically sliding biparting counterbalanced doors, it shall be located to conform to the dimensions specified insofar as the door design will permit.

**2.11.7.1.6** Vision panels in power-operated doors shall be substantially flush with the surface of the landing side of the door.

**2.11.7.1.7** Vision panels shall be protected by protective grilles made of steel not less than 1.4 mm (0.055 in.) thick, in accordance with the following specifications:

*(a)* Grilles shall be sized to fit within or over the vision panel frame and completely cover the vision panel opening in the hoistway door.

*(b)* Grilles shall be secured by means that deter removal by common tools.

*(c)* Grilles shall contain openings that shall be not larger than 19 mm × 19 mm (0.75 in. × 0.75 in.) in diameter. Such openings shall be spaced at 25 mm (1 in.) center-to-center.

*(d)* Grille edges shall be free of burrs and beveled.

*(e)* Grilles shall be installed on the hoistway side of the door.

**2.11.7.2 Glass Doors.** Where provided, glass hoistway doors shall conform to 2.11.7.2.1 through 2.11.7.2.5.

**2.11.7.2.1** The glass shall be laminated glass conforming to 16 CFR Part 1201 or CAN/CGSB-12.1. Markings as specified in the applicable standard shall be on each separate piece of glass and shall remain visible after installation.

**2.11.7.2.2** The glass shall be not less than 60% of the total visible door panel surface area as seen from the landing side of the doors. Door lap shall not be used in calculating glass size.

**2.11.7.2.3** In power-operated doors, the glass panel shall be substantially flush with the surface of the landing side of the door.

**2.11.7.2.4** A nonglass edge shall be provided on the leading edge of the door panel.

**2.11.7.2.5** The glass door shall conform to 2.11.11.5.7 for horizontally sliding type entrances, 2.11.12.4 for vertically sliding type entrances, or 2.11.13.3 for swinging entrances.

### 2.11.8 Weights for Closing or Balancing Doors

Hoistway door weights, where used for closing or balancing doors, shall be guided or restrained to prevent them from coming out of their runway. The bottom of the guides or other restraining means shall be so constructed as to retain the weights if the weight suspension means breaks.

### 2.11.9 Hoistway Door Locking Devices and Power Operation

**2.11.9.1 Locking Devices.** Doors shall be provided with door locking devices conforming to 2.12.

**2.11.9.2 Power Operation.** Where hoistway doors are power operated or are opened or closed by power, their operation shall conform to 2.13.

### 2.11.10 Landing-Sill Guards, Landing-Sill Illumination, Hinged Landing Sills, and Tracks on Landings

#### 2.11.10.1 Landing-Sill Guards

**2.11.10.1.1** Landing sills shall be guarded on the underside with guard plates of smooth metal not less than 1.4 mm (0.055 in.) thick, extending the full width of the car sill exposed to the landing entrance, and securely fastened in place. Landing sill guards are not required for

*(a)* vertically sliding biparting counterbalanced doors

*(b)* vertically sliding counterweighted doors that slide down to open

*(c)* elevators where the landing sills do not project into the hoistway

**2.11.10.1.2** Where a car leveling device is provided and the hoistway edge of the sill is either flush with or projects into the hoistway, the guard shall have a straight vertical face extending below the sill not less than the depth of the leveling zone plus 75 mm (3 in.). Where the sill projects inward from the hoistway enclosure, the bottom of the guard shall also be beveled at an angle of not less than 60 deg and not more than 75 deg from the horizontal, or the guard shall be extended from the hoistway edge of the landing sill to the top of door hanger pocket of the entrance next below.

**2.11.10.1.3** Where no car leveling device is provided and the sill projects inward from the general line of the hoistway, the guard shall be either beveled at an angle of not less than 60 deg and not more than 75 deg from the horizontal, or have a straight vertical face extending from the hoistway edge of the landing sill to the top of door hanger pocket of the entrance below.

**2.11.10.2 Illumination at Landing Sills.** The building corridors shall be so lighted that the illumination at the landing sills, when an elevator is in service, shall be not less than 100 lx (10 fc).

**2.11.10.3 Hinged Hoistway Landing Sills.** Hinged hoistway landing sills provided in connection with vertically sliding, biparting, counterbalanced doors of freight elevators shall be hinged on the landing side so that they can be lowered only when the landing doors are in the fully opened position.

### 2.11.11 Entrances, Horizontal Slide Type

**2.11.11.1 Landing Sills.** Landing sills shall

*(a)* be of metal and of sufficient strength to support the loads to be carried by the sills when loading and unloading the car, and be secured in place

*(b)* be substantially flush with the floor surface of the elevator landings

*(c)* be so designed and maintained as to provide a secure foothold over the entire width of the door opening

**2.11.11.2 Hangers, Tracks, and Track Supports.** Hangers, tracks, and their supports and fastenings for doors shall be constructed to withstand, without damage or appreciable deflection, an imposed static load equal to four times the weight of each panel as applied successively downward and upward at the vertical centerline of the panel. (See 2.11.11.5.7 and 2.11.11.5.8.)

#### 2.11.11.3 Entrance Frames

**2.11.11.3.1** Where used, entrance frames shall be anchored to the sills and to the building structure or the track supports. The head of the entrance frame shall not be used to support the weight of the wall over the frame.

**2.11.11.3.2** Where decorative material is applied to listed/certified frames, it shall conform to the requirements of the certifying organization.

**2.11.11.4 Hangers.** Hangers shall conform to 2.11.11.4.1 and 2.11.11.4.2.

**2.11.11.4.1** Means shall be provided to prevent the hangers from jumping the track.

**2.11.11.4.2** Stops shall be provided in the entrance assembly to prevent hangers from overrunning the end of the track.

**2.11.11.5 Panels.** Panels shall conform to 2.11.11.5.1 through 2.11.11.5.8.

**2.11.11.5.1** The panels shall overlap the top and sides of the opening, and each other, in the case of multispeed entrances, by not less than 13 mm (0.5 in.).

Where entrances without frames are used, the overlap shall extend the thickness of the facing used to finish

the opening plus 13 mm (0.5 in.) or more.

**2.11.11.5.2** The clearance shall not exceed 10 mm (0.375 in.) between

*(a)* the panel and the frame

*(b)* the panel and the wall, where entrances without frames are used in masonry or concrete

*(c)* related panels of multispeed entrances

*(d)* the panel and the sill measured vertically

**2.11.11.5.3** The leading panel edge of side-opening entrances shall not close into pockets in the strike jamb and shall be smooth and free of sharp projections.

**2.11.11.5.4** The meeting panel edges of center-opening entrances shall be smooth and free of sharp projection.

The meeting panel edges of center-opening entrances shall be protected with not less than one resilient male member extending the full height of the panel. The resilient members shall be permitted to interlock by not more than 10 mm (0.375 in.).

When in the closed position, the distance between the metal parts of the meeting panels shall not exceed 13 mm (0.5 in.).

**2.11.11.5.5** No areas shall be depressed or raised more than 3 mm (0.125 in.) from the adjacent area and edges shall be beveled at not more than 30 deg to the panel surface.

**2.11.11.5.6** Where decorative material is applied to listed/certified panels, it shall conform to the requirements of the certifying organization.

**2.11.11.5.7** The entrance assembly shall be capable of withstanding a force of 2 500 N (560 lbf) applied on the landing side at right angles to and approximately at the center of a panel. This force shall be distributed over an area of approximately 100 mm × 100 mm (4 in. × 4 in.). There shall be no appreciable permanent displacement or deformation of any parts of the entrance assembly resulting from this test.

**2.11.11.5.8** Means shall be provided to prevent opening of locked doors more than 20 mm (0.8 in.) per panel at the farthest point from the interlock when a force of 135 N (30 lbf) is applied in the opening direction at the leading edge of the door at the farthest point from the interlock.

**2.11.11.6 Bottom Guides.** Bottom guides shall conform to the following:

*(a)* The bottom of each panel shall be guided by one or more members.

*(b)* Guide members shall be securely fastened.

*(c)* The guide members and any reinforcements or guards shall engage the corresponding member by not less than 6 mm (0.25 in.). (See 2.11.11.5.7.)

**2.11.11.7 Multipanel Entrances.** Panels of multipanel doors shall conform to either 2.11.11.7.1 or 2.11.11.7.2. Multiple-speed and center-opening multiple-speed doors shall also conform to 2.11.11.7.3.

**2.11.11.7.1** Panels shall be interconnected directly or through their hangers so as to assure simultaneous movement of all panels. The factor of safety of the interconnecting means shall not be less than 10 for cast iron or 5 for other materials.

**2.11.11.7.2** Panels shall be equipped with hoistway door interlocks on each driven panel and provided with a door closer(s) installed to comply with 2.11.3.1. All panels shall move simultaneously when the car is at the landing.

**2.11.11.7.3** Multiple speed and center-opening multiple-speed panels shall be provided with secondary mechanical interconnecting means to ensure that individual panels of multiple panel doors moving in the same direction cannot become separated from the panel that is locked by the interlock in the event that the normal interconnecting means fails.

**2.11.11.7.4** Where cable and pulleys are used to connect panels of multisection sliding doors, each pulley shall be equipped with a guard to prevent the cable from leaving the pulley.

**2.11.11.8 Hoistway Door Safety Retainers.** The top and bottom of horizontally sliding doors shall be provided with a means of retaining the closed door panel in position if the primary guiding means fail, and preventing displacement of the door panel top and bottom by more than 20 mm (0.8 in.) when the door panel is subjected to a force of 5 000 N (1,125 lbf) in the direction of the hoistway applied at right angles to the panel over an area of 300 mm × 300 mm (12 in. × 12 in.) at the approximate center of the panel.

The retaining means shall also withstand, without detachment or permanent deformation, a force of 1 000 N (225 lbf) applied upward at any point along the width of the door panel and, while this force is maintained, an additional force of 1 100 N (250 lbf) applied at right angles to the door at the center of the panel. This force shall be distributed over an area of 300 mm × 300 mm (12 in. × 12 in.).

The retaining means shall not be subjected to wear or stress during normal door operation or maintenance.

**2.11.11.9 Beams, Walls, Floors, and Supports.** The building structural supports of the entrance, such as building beams, walls, and floors, shall be designed to withstand the horizontal forces stipulated in 2.11.11.8.

**2.11.11.10 Hoistway Door to Sill Clearance.** The horizontal distance from the hoistway side of the leading edge of the hoistway door, or sight guard, if provided, to the edge of the landing sill, shall not exceed 13 mm

(0.5 in.). The vertical clearance between the sight guard, if provided, and the landing sill shall not exceed 13 mm (0.5 in.).

### 2.11.12 Entrances, Vertical Slide Type

#### 2.11.12.1 Landing Sills

**2.11.12.1.1** Landing sills shall be of metal and of sufficient strength to support the loads to be carried by the sills when loading and unloading the car, and be secured in place (see 2.16.2.2 for classes of loading); the load on the sill during loading and unloading shall be considered to be the same as that on the platform members specified in 8.2.2.6.

**2.11.12.1.2** Landing sills shall be secured to the building structure in substantially the same plane as the elevator landing floor.

#### 2.11.12.2 Entrance Frames

**2.11.12.2.1** Where used, entrance frames shall be anchored to the sills and to the building structure or the track supports. The head of the entrance frame shall not be used to support the weight of the wall over the frame.

**2.11.12.2.2** Where decorative material is applied to listed/certified frames, it shall conform to the requirements of the certifying organization.

(ED) **2.11.12.3 Rails.** The panel guide rails shall be securely fastened to the building structure and the entrance frame, at intervals, throughout their entire length.

Rails and their supports shall withstand the forces specified in 2.11.12.4.6. Where truckable sills are provided as specified in 2.11.12.4.2, the rails shall withstand any reactions that could be transmitted to the rails as a result of loading and unloading operations.

**2.11.12.4 Panels.** Panels shall conform to 2.11.12.4.1 through 2.11.12.4.8.

**2.11.12.4.1** The panels shall be constructed of noncombustible material, or of a structural core made of combustible material if covered with not less than 0.45 mm (0.0175 in.) sheet metal.

**2.11.12.4.2** The lower panel of biparting entrances and the top of the panel of vertical slide entrances that slide down to open shall be provided with a truckable sill designed for the loads specified in 2.11.12.1.1. Provisions shall be made to transmit the panel sill load to the building structure.

**2.11.12.4.3** Panels of biparting counterbalanced entrances shall conform to the following:

*(a)* They shall be provided with means to stop the closing panels when the distance between the closing rigid members of the panel is not less than 20 mm (0.8 in.) and not more than 50 mm (2 in.).

*(b)* A fire-resistive, nonshearing, and noncrushing member of either the meeting or overlapping type shall be provided on the upper panel to close the distance between the rigid door sections when in contact with the stops. This member shall allow a minimum compressible clearance of 20 mm (0.8 in.).

*(c)* Rigid members that overlap the meeting edge, and center-latching devices, are prohibited.

**2.11.12.4.4** The panels, with their attachments for doors that slide up to open, shall overlap the sides and top of the entrance opening by at least 50 mm (2 in.) when in the closed position. Other vertically sliding panels and their attachments shall overlap their entrance openings and sills by at least 50 mm (2 in.) when in the closed position. The overlap shall extend at least 50 mm (2 in.) beyond the thickness of any facing used to finish the opening.

**2.11.12.4.5** The clearance between a panel and the frame lintel, between a panel and the sill, and between related panels of multispeed entrances, shall not exceed 25 mm (1 in.).

**2.11.12.4.6** Panels, rails, and door guides shall conform to the strength requirements of 2.11.11.5.7. Hangers, guides, and guide shoes shall not be permanently displaced or deformed by more than 20 mm (0.8 in.) when their panel is subjected to a force of 5 000 N (1,125 lbf) in the direction of the hoistway applied at right angles to the panel over an area of 300 mm × 300 mm (12 in. × 12 in.) at the approximate center of the panel.

**2.11.12.4.7** Means shall be provided to close the opening between the upper panel of pass-type entrances and the entrance frame lintel. The sum of the clearance between the panel, the device used to close the opening, and the entrance lintel shall not exceed 25 mm (1 in.).

**2.11.12.4.8** Means shall be provided to prevent the opening of locked doors more than 25 mm (1 in.) per panel at the farthest point from the interlock when a force of 135 N (30 lbf) is applied in the opening direction at the leading edge of the door at the farthest point from the interlock.

**2.11.12.5 Guides.** Panel guides shall conform to 2.11.12.5.1 through 2.11.12.5.3.

**2.11.12.5.1** Each panel shall be equipped with not less than four guide members or with continuous guides.

**2.11.12.5.2** Guide members shall be securely fastened to the panels.

**2.11.12.5.3** Guide members shall be designed to withstand the forces specified in 2.11.12.4.6.

**2.11.12.6 Counterweighting or Counterbalancing.** Single or multisection vertically sliding panels shall be so counterweighted, and vertically sliding biparting

panels shall be so counterbalanced, that they will not open or close by gravity.

Fastenings shall be provided to prevent the fall of a counterweight, and the detachment or dislodgment of counterweight parts or of balancing weights. Suspension means and their connections, for vertically sliding biparting counterbalanced doors and for the counterweights of vertically sliding counterweighted doors, shall have a factor of safety of not less than 5.

**2.11.12.7 Sill Guards.** Where the panel sill or other structural member projects more than 13 mm (0.5 in.) into the hoistway or beyond the panel surface below it, the projection shall be provided with a metal guard not less than 1.4 mm (0.055 in.) thick and beveled at an angle of not less than 50 deg and not more than 75 deg from the horizontal.

**2.11.12.8 Pull Straps.** Manually operated vertically sliding biparting entrances shall be provided with pull straps on the inside and outside of the door.

The length of the pull straps shall conform to 2.11.12.8.1 and 2.11.12.8.2.

**2.11.12.8.1** The bottom of the strap shall be not more than 2 000 mm (79 in.) above the landing when the panel is in the fully opened position.

**2.11.12.8.2** The length of the strap shall not be extended by means of ropes or other materials.

### 2.11.13 Entrances, Swinging Type

**2.11.13.1 Landing Sills.** Landing sills shall

*(a)* be of metal and of sufficient strength to support the loads to be carried by the sills when loading and unloading the car, and be secured in place

*(b)* be substantially flush with the floor surface of the elevator landings

*(c)* be so designed and maintained as to provide a secure foothold over the entire width of the door opening

**2.11.13.2 Entrance Frames.** Frames shall conform to 2.11.13.2.1 and 2.11.13.2.2.

**2.11.13.2.1** They shall be designed to support in place the panels with their hinges or pivots, closer if attached to the frame and interlock. They shall withstand the forces referred to in 2.11.13.3.5, and the forces resulting from the normal opening of the door or normal attempts to open it when locked in the closed position.

**2.11.13.2.2** Where decorative material is applied to listed/certified panels, it shall conform to the requirements of the certifying organization.

**2.11.13.3 Panels.** Panels shall conform to 2.11.13.3.1 through 2.11.13.3.7.

**2.11.13.3.1** The panels shall overlap the part of the frame against which they close by not less than 13 mm (0.5 in.).

**2.11.13.3.2** The clearance between a panel and its sill shall not exceed 10 mm (0.375 in.).

**2.11.13.3.3** The panels of entrances used with automatic-operation passenger elevators shall have no hand latches or other hand-operated door-fastening devices, nor shall such panels have any handles or knobs on the hoistway side.

**2.11.13.3.4** Where decorative material is applied to listed/certified panels, it shall conform to the requirements of the certifying organization.

**2.11.13.3.5** Panels and their assembled accessories shall

*(a)* be capable of withstanding a force on the handle of not less than 450 N (100 lbf) in the opening direction of a closed and locked door. There shall be no permanent displacement or deformation of the handle or the door panel resulting from this force.

*(b)* conform to 2.11.11.5.7.

*(c)* not be permanently displaced or deformed by more than 20 mm (0.75 in.) when the panel is subjected to a force of 5 000 N (1,125 lbf) in the direction of the hoistway, applied at right angles to the panel over an area of 300 mm × 300 mm (12 in. × 12 in.) at the approximate center of the panel.

**2.11.13.3.6** Center-opening horizontally swinging doors shall have one door section provided with an overlapping astragal on its vertical edge, except where each door section is provided with a landing door interlock [see 2.12.2.4.4(c)].

**2.11.13.3.7** Center-opening horizontally swinging doors shall have door stops provided at the top entrances that will stop each door panel when closed and that will meet the requirements specified in 2.11.13.3.5.

**2.11.13.4 Hinges.** Hinges of the mortise and surface type shall conform to the requirements of NFPA 80, Table 2-4.3.1. (04)

**2.11.13.5 Entrances With Combination Horizontally Sliding and Swinging Panels.** Where both the sliding and swinging panels are not equipped with hoistway door interlocks or locks and contacts conforming to 2.12, the horizontally sliding and swinging panels forming a part of the entrance shall be so interconnected that

*(a)* the swinging panel can be opened only when the sliding panel is in the open position

*(b)* both panels swing as a unit

### 2.11.14 Fire Tests

**2.11.14.1** In jurisdictions enforcing the NBCC

*(a)* the fire protection rating of entrances and doors shall be determined in accordance with the requirements specified in the NBCC (CAN4-S104)

*(b)* where required, the hoistway door interlock mechanism and associated wiring shall remain operational

for a period of 1 h when subjected to the standard fire exposure test described in CAN4-S104

NOTE (2.11.14.1): Requirements 2.11.14.2 through 2.11.18 do not apply in jurisdictions enforcing the NBCC.

(04) **2.11.14.2** In jurisdictions not enforcing the NBCC, 2.11.15 through 2.11.18, and 2.11.14.2.1 through 2.11.14.2.3 apply where fire-resistive construction is required by 2.1.1.1.3.

**2.11.14.2.1** Entrances shall be subjected to the type tests specified in 8.3.4.

**2.11.14.2.2** The following basic types of entrances shall be tested:

*(a) Horizontally Sliding Type.* Test a side-sliding and a center-opening assembly.

*(b) Swinging Type.* Test a single swinging assembly.

*(c) Vertically Sliding Type.* Test a biparting assembly.

**2.11.14.2.3** When an entrance assembly has been tested for one type of wall construction, i.e., masonry or drywall, only the frame-to-wall interface shall be acceptable to the certifying organization for other types of construction.

### 2.11.15 Marking

(04) **2.11.15.1 Labeling of Tested Assembly.** In jurisdictions not enforcing the NBCC, 2.11.15.1.1 and 2.11.15.1.2 apply where fire-resistive construction is required by 2.1.1.1.3.

**2.11.15.1.1** Each entrance shall be labeled. Each label shall be permanently attached to the equipment and shall be readily visible after installation. The following data shall be on the label:

*(a)* certifying organization's name or identifying symbol

*(b)* the name, trademark, or file number by which the organization that manufactured the product can be identified

*(c)* statement of compliance with 8.3.4

(ED) **2.11.15.1.2** Labels shall be provided for each entrance as follows:

*(a)* One label shall be provided for the door panels.

*(b)* One label shall be provided for the frame, except that no label is required where frames are installed in masonry or concrete and the panel overlaps the wall in conformance with 2.11.11.5.1 and 2.11.11.5.2, or 2.11.12.4.4.

*(c)* One label shall be provided for the transom panel. One label shall be permitted to be provided for the frame and transom, provided that the label states that it includes both the frame and the transom.

*(d)* Where entrance hardware components have not all been tested in complete assembly, individually labeled hardware components that are designed to be compatible with the entrance assembly shall be provided. A single label shall be permitted to be provided for the entrance hardware where the entrance hardware components are equivalent to those tested in a complete assembly.

*(e)* A single label shall be permitted to be provided for the entire entrance assembly where components are equivalent to those tested as a complete assembly.

**2.11.15.2 Other Assemblies.** In jurisdictions not enforcing the NBCC, the following shall apply. Other assemblies of the three basic types (see 2.11.14) shall qualify for labeling or listing/certification:

*(a)* when composed of panel(s), frame, and hardware of the same type as tested and not exceeding the overall height and width of any panel and frame of the largest size tested; or

*(b)* when such panel(s), frame, and hardware are modified, and test or technical data demonstrates that the modifications will meet the performance requirements of the test procedure in 8.3.3.

All other elements of the assembly shall conform to all other applicable requirements of this Code.

**2.11.15.3 Entrances Larger Than Tested Assemblies.** In jurisdictions not enforcing the NBCC, the following shall apply. When the entrance is too large for the regularly available test facilities, the certifying organization shall be permitted to issue oversize certificates or oversize labels, or such entrances shall be permitted to be used subject to approval by the authority having jurisdiction.

### 2.11.16 Factory Inspections

In jurisdictions not enforcing the NBCC, the following shall apply. The manufacturing facilities for the production of entrances or components thereof shall be inspected by the certifying organization at random at least quarterly, or if they are not manufactured on a continuous basis, at the time they are being produced, to assure that production methods are such that entrances or components thereof similar to those tested are being produced.

### 2.11.17 Transoms and Fixed Side Panels

In jurisdictions not enforcing the NBCC, the following shall apply. Transoms and fixed side panels shall be permitted to close openings above and beside the horizontally sliding or horizontally swinging type entrances, provided that

*(a)* the opening closed by the transom and fixed side panel does not exceed in width or height the dimensions of the entrance in which it is installed

*(b)* the transom panels and fixed side panels are

*(1)* constructed in a manner equivalent to the construction of the entrance panels

*(2)* secured

(04) **2.11.18 Installation Instructions**

In jurisdictions not enforcing the NBCC, the following shall apply:

*(a)* Instructions detailing the application and installation of door listed/certified panels and entrance hardware shall be provided.

*(b)* Where frames are used, instructions detailing the listed/certified frame-to-wall interface shall be provided.

**2.11.19 Gasketing of Hoistway Entrances**

Where gasketing material is applied to fire-resistive entrances, it shall conform to 2.11.19.1 through 2.11.19.4.

**2.11.19.1** The gasketing material shall be subjected to the tests specified in UL 10B, NFPA 252, or CAN4-S104, whichever is applicable (see Part 9).

**2.11.19.2** The gasketing material shall withstand the maximum elevated temperature tests as defined by UL 1784 standard without deterioration.

**2.11.19.3** Each section of the gasketing material shall be labeled. Each label shall bear the name of the manufacturer and a statement indicating conformance with 2.11.19.1 and 2.11.19.2. The label shall be visible after installation

**2.11.19.4** Labeled gasketing material shall conform to 2.11.16 or the NBCC, whichever is applicable.

NOTES (2.11.19):

(1) See also 2.1.1.5, 2.11.3, and 2.13.4 for additional requirements to be considered when gasketing material is applied to a hoistway entrance.

(2) These requirements do not evaluate the air and/or smoke leakage performance of the gasketing material.

## SECTION 2.12
## HOISTWAY DOOR LOCKING DEVICES AND ELECTRIC CONTACTS, AND HOISTWAY ACCESS SWITCHES

**2.12.1 General**

**2.12.1.1** When the car is stopped within the unlocking zone, the hoistway doors shall be unlocked, or locked but openable from the landing side either manually or by power.

**2.12.1.2** When the car is outside the unlocking zone, the hoistway doors shall be openable from the landing side only by a hoistway door unlocking device (see 2.12.6, 2.12.7, and Nonmandatory Appendix B).

**2.12.1.3** For security purposes, hoistway doors shall be permitted to be locked out of service, subject to the requirements of 2.11.6.

**2.12.1.4** Passenger elevator hoistway doors shall be equipped with interlocks conforming to 2.12.2.

**2.12.1.5** Freight elevator hoistway doors shall be equipped with interlocks conforming to 2.12.2 or combination mechanical locks and electric contacts conforming to, and where permitted by, 2.12.3.

**2.12.2 Interlocks**

**2.12.2.1 General.** Each entrance at a landing to an elevator used for passengers or freight and not conforming to 2.12.3.1 shall be equipped with one or more interlocks meeting the design requirements of 2.12.2.4.

**2.12.2.2 Closed Position of Hoistway Doors.** Hoistway doors shall be considered to be in the closed position under the following conditions. These dimensions apply to the doors in their normal operating condition (see 2.14.4.11):

*(a)* for horizontally sliding or swinging doors, when the leading edge of the door is within 10 mm (0.375 in.) of the nearest face of the jamb or when the panels of center-opening doors are within 10 mm (0.375 in.) of contact with each other

*(b)* for vertically sliding counterweighted doors, when the leading edge of the door is within 10 mm (0.375 in.) of the sill for doors which slide up to open, or 10 mm (0.375 in.) of the lintel for doors that slide down to open

*(c)* for vertically sliding biparting counterbalanced doors, when the astragal on the upper panel is within 19 mm (0.75 in.) of the lower panel

**2.12.2.3 Operation of the Driving Machine With a Hoistway Door Unlocked or Not in the Closed Position.** Operation of the driving machine when a hoistway door is unlocked or not in the closed position (see 2.12.2.2) shall be permitted under one of the following conditions:

*(a)* by a car leveling or truck zoning device (see 2.26.1.6)

*(b)* when a hoistway access switch is operated (see 2.12.7)

*(c)* when a bypass switch is activated (see 2.26.1.5)

**2.12.2.4 General Design Requirements.** Interlocks shall conform to 2.12.2.4.1 through 2.12.2.4.7.

**2.12.2.4.1** Interlock contacts shall be positively opened by the locking member or by a member connected to and mechanically operated by the locking member, and the contacts shall be maintained in the open position by the action of gravity, or by a restrained compression spring, or by both, or by means of the opening member (see 2.26.2.14). If the contacts are maintained in the open position by other than the locking member, the interlock shall be located such that the contacts cannot be closed by hand from the car or landing when the doors are open.

The electrical contact bridging means shall withstand a separating force of 200 N (45 lbf) in any direction from the locking member.

**2.12.2.4.2** The locking member of the interlock shall hold the door in the locked position by means of gravity, or by a restrained compression spring, or by both, or by means of a positive linkage.

**2.12.2.4.3** The interlock shall lock the door in the closed position with a minimum engagement of 7 mm (0.28 in.) of the locking members before the interlock contacts are closed and before the driving machine can be operated, except as permitted in 2.12.2.3.

Devices that permit operation of the driving machine by the normal operating device when the door is closed but before it is locked are not interlocks and are not permitted where interlocks are required by this Code.

(ED) **2.12.2.4.4** Interlocks, used with multisection doors, shall conform to the following requirements:

*(a)* They shall lock all sections of the door, but shall be permitted to be applied to only one section of the door, provided the device used to interconnect the door sections is so arranged that locking one section will prevent the opening of all sections.

*(b)* Where used with vertically sliding biparting counterbalanced doors, they shall be so arranged that the interlock contacts are mechanically held in the open position by the door or devices attached thereto, unless the door is in the closed position.

*(c)* Where used with center-opening horizontally swinging doors, either

*(1)* both door panels shall be equipped with interlocks; or

*(2)* where the door panels are so arranged that one panel can be opened only after the other panel has been opened, the interlock is not required on the section that opens last, if that door panel is provided with a door electric contact conforming to 2.14.4.2.3, 2.14.4.2.5, and 2.26.2.15, except that terms "door or gate" and "car door or gate" shall be replaced with the "hoistway door" or "hoistway door section" and the term "accessible from inside the car panel" with the term "accessible from the landing side when the hoistway doors are closed."

*(d)* Where used with combination horizontally sliding and swinging doors, either

*(1)* the sliding and swinging panels shall both be equipped with interlocks; or

*(2)* where the sliding and swinging panels are interconnected in conformity with the requirements of 2.11.13.5, the interlock is not required on the swinging panel, provided that the interlock on the sliding panel is so designed and installed that the car cannot be operated unless the sliding and swinging panels are both locked in the closed position, as defined in 2.12.2.2.

*(e)* Where a door closer, used with a combination sliding and swinging door, is arranged to be disconnected to allow the sliding panel to swing, it shall be so designed and installed that it shall not make the interlock contact when disconnected and released.

**2.12.2.4.5** Interlock systems employing a single master switch for more than one door are prohibited.

**2.12.2.4.6** The locking member shall not disengage when the door is subjected to a repetitive force of 450 N (100 lbf) in the direction of opening and at a right angle.

**2.12.2.4.7** Mercury tube switches shall not be used.

**2.12.2.5 Interlock Retiring Cam Device.** Retiring cams used to actuate an interlock shall exert a force at least double the average force required to operate the interlock and shall have a movement at least 13 mm (0.5 in.) more than the average movement required to operate the interlock. (ED)

An interlock retiring cam device shall be permanently marked by the manufacturer with its rated horizontal force and rated horizontal movement.

The rated horizontal force shall be the static force exerted by a retiring cam device in the horizontal direction when extended a distance equal to 75% of its rated horizontal movement. The rated horizontal movement shall be the horizontal distance traveled by the retiring cam device from the fully retired position to the fully extended position.

**2.12.2.6 Location.** Interlocks shall be so located that they are not accessible from the landing side when the hoistway doors are closed.

### 2.12.3 Hoistway Door Combination Mechanical Locks and Electric Contacts

**2.12.3.1 Where Permitted.** Hoistway door combination mechanical locks and electric contacts shall be permitted only on freight elevators equipped with manually operated vertically sliding doors and only at the following landings:

*(a)* the top terminal landing and the landing located not more than 1 225 mm (48 in.) below the top terminal landing, provided that the elevator travel does not exceed 4 570 mm (15 ft)

*(b)* any landing whose sill is within 1 525 mm (60 in.) of the pit floor, regardless of the elevator travel

**2.12.3.2 Closed Position of Hoistway Doors.** Hoistway doors shall be considered to be in the closed position under the following conditions. These dimensions apply to the doors in their normal operating condition (see also 2.14.4.11):

*(a)* for vertically sliding counterweighted doors, when the leading edge of the door is within 10 mm (0.375 in.) of the sill for doors that slide up to open, or 10 mm (0.375 in.) of the lintel for doors that slide down to open

*(b)* for vertically sliding biparting counterbalanced doors, when the astragal on the upper panel is within 19 mm (0.75 in.) of the lower panel

**2.12.3.3 Operation of the Driving Machine With a Hoistway Door Not in the Closed Position.** Operation of the driving machine when a hoistway door is not in the closed position shall be permitted under one of the following conditions:

*(a)* by a car leveling or truck zoning device (see 2.12.2.2 and 2.26.1.6)

*(b)* when a hoistway access switch is operated (see 2.12.7)

*(c)* when bypass switch is activated (see 2.26.1.5)

**2.12.3.4 General Design Requirements.** Combination mechanical locks and electric contacts shall conform to 2.12.3.4.1 through 2.12.3.4.6.

**2.12.3.4.1** They shall be so designed that the locking member and the electric contact are mounted on and attached to a common base, in such a manner that there is a fixed relation between the location of the contact and the location of the locking member.

They shall be so installed and adjusted that the electric contact cannot close until the door is in the closed position as specified in 2.12.3.2, and so that the locking member is in a position to lock the door when or before the contact closes. In order to prevent motion of the door from opening the electric contact while the door is locked in the closed position, multiple-locking points shall, where necessary, be provided on the locking mechanism.

**2.12.3.4.2** The electric contact shall be positively opened by the locking bar of the mechanical lock or by a lever or other device attached to and operated by the door, and the electric contact shall be maintained in the open position by the action of gravity or by a restrained compression spring, or by both, or by positive mechanical means. (See 2.26.2.14.)

**2.12.3.4.3** The mechanical lock shall hold the door in the locked position by means of gravity or by a restrained compression spring, or by both.

**2.12.3.4.4** Combination mechanical locks and electric contacts used with vertical-slide multiple-panel doors shall conform to the following requirements:

(ED) *(a)* They shall lock all panels of the door, but shall be permitted to be applied to only one section of the door, provided the device used to interconnect the door sections is so arranged that locking one panel will prevent the opening of all panels.

*(b)* Where used with vertically sliding biparting counterbalanced doors, the electric contact shall be so arranged that it is mechanically held in the open position by the door or a device attached thereto, unless the door is in the closed position.

**2.12.3.4.5** The locking member shall not disengage when the door is subjected to a repetitive force of 450 N (100 lbf) in the direction of opening and at a right angle.

**2.12.3.4.6** Mercury tube switches shall not be used.

**2.12.3.5 Location.** Combination mechanical locks and electric contacts shall be so located that they are not accessible from the landing side when the hoistway doors are closed.

### 2.12.4 Listing/Certification Door Locking Devices and Door or Gate Electric Contacts

**2.12.4.1 Type Tests.** Each type and make of hoistway door interlock, hoistway door combination mechanical lock and electric contact, and door or gate electric contact, shall conform to the type tests specified in 8.3.3, unless tested prior to

*(a)* August 1, 1996, and shall have been subjected to the tests specified in A17.1a–1994, Section 1101; or

*(b)* _____ (insert effective date of ASME A17.1 or CSA B44 Code) in jurisdictions enforcing CSA B44 and shall have been subjected to the tests specified in CSA B44S1-1997, Clause 11.4.

The tests shall be done by or under the supervision of a certifying organization.

**2.12.4.2 Listing/Certification.** Each type and make of hoistway door interlock, hoistway door combination mechanical lock and electric contact, and door or gate electric contact shall conform to the general requirements for tests and certification specified in 8.3.1.

**2.12.4.3 Identification Marking.** Each listed/certified device shall be labeled. It shall be permanently attached to the device, and shall be so located as to be readily visible when the device is installed in its operating position.

The labels shall include the following data:

*(a)* the name, trademark, or certifying organization file number by which the organization that manufactured the product can be identified

*(b)* the certifying organization name or identifying symbol

*(c)* statement of compliance with ASME A17.1 or CSA B44

*(d)* a distinctive type, model, or style letter or number

*(e)* rated voltage and current, and whether AC or DC

*(f)* rated test force and rated test movement when the device is of a type released by an interlock retiring cam (see 8.3.3.4.7)

*(g)* date (month and year) devices subjected to type test specified in 2.12.4.1

*(h)* if the device has only been type tested and listed/certified for use on a private residence elevator, the label shall indicate the restricted use

### 2.12.5 Restricted Opening of Hoistway or Car Doors

Hoistway and car doors of passenger elevators shall conform to 2.12.5.1 through 2.12.5.3.

**2.12.5.1** When a car is outside the unlocking zone, the hoistway doors or car doors shall be so arranged that the hoistway doors or car doors cannot be opened more than 100 mm (4 in.) from inside the car.

**2.12.5.2** When the car doors are so arranged that they cannot be opened when the car is outside the unlocking zone, the car doors shall be openable from outside the car without the use of a special tool(s).

**2.12.5.3** The doors shall be openable from within the car (see 2.14.5.7) when the car is within the unlocking zone.

NOTE (2.12.5): See also 2.12.1 and Nonmandatory Appendix B, Unlocking Zone.

### 2.12.6 Hoistway Door Unlocking Devices

**2.12.6.1 General.** Except in jurisdictions that limit the use of hoistway door unlocking devices, they shall be provided for use by elevator and emergency personnel for each elevator at every landing where there is an entrance.

**2.12.6.2 Location and Design.** Hoistway door unlocking devices shall conform to 2.12.6.2.1 through 2.12.6.2.5.

**2.12.6.2.1** The device shall unlock and permit the opening of a hoistway door from a landing irrespective of the position of the car.

**2.12.6.2.2** The device shall be designed to prevent unlocking the door with common tools.

**2.12.6.2.3** Where a hoistway unlocking device consists of an arrangement whereby a releasing chain, permanently attached to a door locking mechanism, is kept under a locked panel adjacent to the landing door, such a panel shall be self-closing and self-locking and shall not have identifying markings on its face.

**2.12.6.2.4** The operating means for unlocking the door shall be Group 1 Security (see 8.1). The operating means shall also be made available to emergency personnel during an emergency.

**2.12.6.2.5** The unlocking device keyway and locked panel (see 2.12.6.2.3), if provided, shall be located at a height not greater than 2 100 mm (83 in.) above the landing.

### 2.12.7 Hoistway Access Switches

#### 2.12.7.1 General

**2.12.7.1.1** Hoistway access switches shall be provided when the rated speed is greater than 0.75 m/s (150 ft/min) at

*(a)* the lowest landing for access to the pit, when a separate pit access door is not provided

*(b)* the top landing for access to the top of the car

**2.12.7.1.2** For elevators with a speed of 0.75 m/s (150 ft/min) or less, hoistway access switches shall be provided at the top landing when the distance from the top of the car to the landing sill exceeds 900 mm (35 in.) when the car platform is level with the landing immediately below the top landing.

**2.12.7.2 Location and Design.** Hoistway access switches shall conform to 2.12.7.2.1 through 2.12.7.2.3.

**2.12.7.2.1** The switch shall be installed adjacent to the hoistway entrance at the landing with which it is identified.

**2.12.7.2.2** The switch shall be of the continuous-pressure spring-return type, and shall be operated by a cylinder-type lock having not less than a five-pin or five-disk combination, with the key removable only when the switch is in the "OFF" position. The key shall be Group 1 Security (see 8.1).

**2.12.7.2.3** The electric contacts in the switch shall be positively opened mechanically; their openings shall not be solely dependent on springs.

**2.12.7.3 Operating Requirements.** The operation of the switch shall permit movement of the car with the hoistway door at this landing unlocked or not in the closed position, and with the car door or gate not in the closed position, subject to the requirements of 2.12.7.3.1 through 2.12.7.3.8.

**2.12.7.3.1** The operation of the switch shall not render ineffective the hoistway-door interlock or electric contact at any other landing, nor shall the car move if any other hoistway door is unlocked.

**2.12.7.3.2** The car cannot be operated at a speed greater than 0.75 m/s (150 ft/min).

**2.12.7.3.3** For automatic and continuous-pressure operation elevators, provided that (ED)

*(a)* car and landing operating devices are first made inoperative by means within the car. This means shall enable the hoistway access switches and shall be key operated or behind a locked cover. The key shall be Group 1 Security (see 8.1).

*(b)* power operation of the hoistway door and/or car door or gate is inoperative.

**2.12.7.3.4** Automatic operation by a car-leveling device is inoperative.

**2.12.7.3.5** Both top-of-car inspection operation (see 2.26.1.4.2) and in-car inspection operation (see 2.26.1.4.3) are not in effect.

**2.12.7.3.6** The movement of the car initiated and maintained by the access switch at the lowest landing, if this landing is the normal means of access to the pit, shall be limited in the up direction to the point where

the bottom of the platform guard is even with hoistway entrance header.

**2.12.7.3.7** The movement of the car initiated and maintained by the upper access switch shall be limited in the down direction to a travel not greater than the height of the car crosshead above the car platform, and limited in the up direction to the distance the platform guard extends below the car platform.

**2.12.7.3.8** The access switch shall only control the movement of the car within the zone specified in 2.12.7.3.6 or 2.12.7.3.7. Control circuits related to, or operated by, the hoistway access switches shall comply with 2.26.9.3(c), (d), and (e) and 2.26.9.4.

## SECTION 2.13
## POWER OPERATION OF HOISTWAY DOORS AND CAR DOORS

### (ED) 2.13.1 Types of Doors and Gates Permitted

Where both a hoistway door and a car door or gate are opened and/or closed by power, the hoistway door and the car door or gate shall both be either of the horizontally sliding type or vertically sliding type.

### 2.13.2 Power Opening

**2.13.2.1 Power Opening of Car Doors or Gates.** Power opening of a car door or gate shall be subject to the requirements of 2.13.2.1.1 and 2.13.2.1.2.

**2.13.2.1.1** Power opening shall occur only at the landing where the car is stopping, or is leveling, or at rest, and shall start only when the car is within the landing zone where an automatic car-leveling device is provided, except that on elevators with static control, power shall not be applied to open car doors until the car is within 300 mm (12 in.) of the landing.

**2.13.2.1.2** Collapsible car gates shall not be power opened to a distance exceeding one-third of the clear gate opening, and in no case more than 250 mm (10 in.).

**2.13.2.2 Power Opening of Hoistway Doors.** Power opening of a hoistway door shall conform to 2.13.2.2.1 through 2.13.2.2.3.

**2.13.2.2.1** Power opening shall occur only at the landing where the car is stopping, leveling, or at rest, and shall start only when the car is within the landing zone where an automatic car leveling device is provided, except that on elevators with static control, opening shall not start until the car is within 300 mm (12 in.) of the landing.

(ED) **2.13.2.2.2** Power opening shall be permitted to be initiated automatically through control circuits, provided that the car is being automatically stopped or leveled, and that, when stopping under normal operating conditions, the car shall be at rest or substantially level with the landing before the hoistway door is fully opened.

**2.13.2.2.3** Sequence opening of vertically sliding hoistway doors and adjacent car doors or gates shall comply with 2.13.6.

### 2.13.3 Power Closing

**2.13.3.1 Power Closing or Automatic Self-Closing of Car Doors or Gates Where Used With Manually Operated or Self-Closing Hoistway Doors**

**2.13.3.1.1** Where a car door or gate of an automatic or continuous-pressure operation passenger elevator is closed by power, or is of the automatically released self-closing type, and faces a manually operated or self-closing hoistway door, the closing of the car door or gate shall not be initiated unless the hoistway door is in the closed position, and the closing mechanism shall be so designed that the force necessary to prevent closing of a horizontally sliding car door or gate from rest is not more than 135 N (30 lbf). (ED)

**2.13.3.1.2** Requirement 2.13.3.1.1 does not apply where a car door or gate is closed by power through continuous pressure of a door closing switch, or of the car operating device, and where the release of the closing switch or operating device will cause the car door or gate to stop or to stop and reopen.

**2.13.3.2 Power Closing of Hoistway Doors and Car Doors or Gates by Continuous-Pressure Means.** Horizontally or vertically sliding hoistway doors with manually closed, or power-operated, or power-closed car doors or gates shall be permitted to be closed by continuous-pressure means, subject to the requirements of 2.13.3.2.1 through 2.13.3.2.5.

**2.13.3.2.1** The release of the closing means shall cause the hoistway door, and a power-operated or power-closed car door or gate, to stop or to stop and reopen.

**2.13.3.2.2** The operation of the closing means at any landing shall not close the hoistway door at any other landing, nor the car door or gate when the elevator car is at any other landing.

**2.13.3.2.3** Any closing means at a landing shall close only that hoistway door and the car door or gate at the side where such means is located.

**2.13.3.2.4** For elevators having more than one hoistway opening at any landing level, a separate closing means shall be provided in the car for each car door or gate and its adjacent hoistway door, except that a separate closing means need not be furnished for a horizontally sliding hoistway door and adjacent car door or gate that conform to 2.13.4.

**2.13.3.2.5** For sequence closing of vertically sliding hoistway doors and adjacent car doors or gates, see 2.13.6.

**2.13.3.3 Power Closing of Horizontally Sliding Hoistway Doors and Horizontally Sliding Car Doors or Gates by Momentary Pressure or by Automatic Means.** Power closing by momentary pressure or by automatic means shall be permitted only for automatic or continuous-pressure operation elevators. The closing of the doors shall be subject to the requirements of 2.13.3.3.1 and 2.13.3.3.2.

**2.13.3.3.1** The closing of the doors shall conform to 2.13.4.

**2.13.3.3.2** A momentary pressure switch or button shall be provided in the car, the operation of which shall cause the doors to stop or to stop and reopen. The switch or button shall be identified as required by 2.26.12.

(ED) **2.13.3.4 Power Closing of Vertically Sliding Hoistway Doors and Vertically Sliding Car Doors or Gates by Momentary Pressure or by Automatic Means.** Power closing by momentary pressure or by automatic means shall be permitted only for automatic or continuous-pressure operation elevators.

Vertically sliding hoistway doors used with vertically sliding power-operated car doors or gates closed by momentary pressure or automatic means, shall conform to the requirements of 2.13.3.4.1 through 2.13.3.4.5.

**2.13.3.4.1** A warning bell or other audible signal shall be provided on the car, which shall start to sound at least 5 s prior to the time the car door or gate starts to close and shall continue to sound until the hoistway door is substantially closed. When the doors are closed by a closing switch in the car, the 5 s time interval shall be permitted to be omitted.

**2.13.3.4.2** Sequence closing of the hoistway door and adjacent car door or gate shall be provided and shall conform to 2.13.6. Sequence closing is not required when a biparting vertically sliding hoistway door faces a biparting vertically sliding car door or gate.

**2.13.3.4.3** The car door or gate shall be equipped with a reopening device conforming to 2.13.5.

**2.13.3.4.4** A momentary pressure switch or button shall be provided in the car and at each landing, which, when operated, shall cause the car door or gate and the hoistway door at the landing to stop or to stop and reopen.

**2.13.3.4.5** The average closing speed shall not exceed 0.3 m/s (1 ft/s) for a vertically sliding counterweighted hoistway door or for each panel of a biparting counterbalanced hoistway door or car gate, and shall not exceed 0.6 m/s (2 ft/s) for a vertically sliding counterweighted car door or gate.

## 2.13.4 Closing Limitations for Power-Operated Horizontally Sliding Hoistway Doors and Horizontally Sliding Car Doors or Gates

**2.13.4.1 Where Required.** Where a power-operated horizontally sliding hoistway door or car door/gate or both is closed by momentary pressure or by automatic means (see 2.13.3.3), or is closed simultaneously with another door or car door/gate or both from one continuous-pressure means (see 2.13.3.2.3 and 2.13.3.2.4), the closing mechanism shall be designed and installed to conform to 2.13.4.2 and the reopening device shall be designed and installed to conform to 2.13.5.

### 2.13.4.2 Closing Mechanism

#### 2.13.4.2.1 Kinetic Energy

*(a)* Where the hoistway door and the car door/gate are closed in such a manner that stopping either one manually will stop both, the kinetic energy of the closing door system shall be based upon the sum of the hoistway and the car door weights, as well as all parts rigidly connected thereto, including the rotational inertia effects of the door operator and the connecting transmission to the door panels.

*(b)* Where a reopening device conforming to 2.13.5 is used, the closing door system shall conform to the following requirements:

*(1)* The kinetic energy computed for the actual closing speed at any point in the Code zone distance defined by 2.13.4.2.2 shall not exceed 23 J (17 ft-lbf).

*(2)* The kinetic energy computed for the average closing speed as determined in accordance with 2.13.4.2.2 shall not exceed 10 J (7.37 ft-lbf).

*(c)* Where a reopening device is not used, or has been rendered inoperative (see 2.13.5), the closing door system shall conform to the following requirements:

*(1)* The kinetic energy computed for the actual closing speed at any point in the Code zone distance defined by 2.13.4.2.2 shall not exceed 8 J (6 ft-lbf).

*(2)* The kinetic energy computed for the average closing speed within the Code zone distance (see 2.13.4.2.2), or in any exposed opening width, including the last increment of door travel, shall not exceed 3.5 J (2.5 ft-lbf).

#### 2.13.4.2.2 Door Travel in the Code Zone Distance

*(a)* For all side sliding doors using single or multiple speed panels, the Code zone distance shall be taken as the horizontal distance from a point 50 mm (2 in.) away from the open jamb to a point 50 mm (2 in.) away from the opposite jamb.

*(b)* For all center-opening sliding doors using single or multiple speed panels, the Code zone distance shall be taken as the horizontal distance from a point 25 mm (1 in.) away from the open jamb to a point 25 mm (1 in.) from the center meeting point of the doors.

(c) The average closing speed shall be determined by measuring the time required for the leading edge of the door to travel the Code zone distance.

**2.13.4.2.3 Door Force.** The force necessary to prevent closing of the hoistway door (or the car door or gate if power operated) from rest shall not exceed 135 N (30 lbf) (see 2.13.3.1). This force shall be measured on the leading edge of the door with the door at any point between one third and two thirds of its travel.

**2.13.4.2.4 Data Plate.** A data plate conforming to 2.16.3.3 shall be attached to the power door operator or to the car crosshead and shall contain the following information:

(a) minimum door closing time in seconds for the doors to travel the Code zone distance as specified in 2.13.4.2.2 corresponding to the kinetic energy limits specified in 2.13.4.2.1(b)(2)

(b) minimum door closing time in seconds for the doors to travel the Code zone distance as specified in 2.13.4.2.2 corresponding to the kinetic energy limits specified in 2.13.4.2.1(c)(2), if applicable [see 2.27.3.1.6(e)]

(c) where heavier hoistway doors are used at certain floors, the minimum door closing time in seconds corresponding to the kinetic energy limits specified in 2.13.4.2.1(b)(2) and 2.13.4.2.1(c)(2), if applicable, for the corresponding floors shall be included on the data plate

### 2.13.5 Reopening Device for Power-Operated Car Doors or Gates

**2.13.5.1** Where required by 2.13.3.4 or 2.13.4, a power-operated car door shall be provided with a reopening device that will function to stop and reopen a car door and the adjacent landing door sufficiently to permit passenger transfer in the event that the car door or gate is obstructed while closing. If the closing kinetic energy is reduced to 3.5 J (2.5 ft-lb) or less, the reopening device shall be permitted to be rendered inoperative. The reopening device used shall be effective for substantially the full vertical opening of the door (see 2.13.4.2).

**2.13.5.2** For center-opening doors, the reopening device shall be so designed and installed that the obstruction of either door panel when closing will cause the reopening device to function.

**2.13.5.3** For vertically sliding doors or gates, reopening devices shall respond to any obstruction within the width of the opening to a point 125 mm (5 in.) maximum from each side of the opening.

**2.13.5.4** Where Phase I Emergency Recall Operation by a fire alarm initiating device (see 2.27.3.2.3) is not provided, door reopening devices that can be affected by smoke or flame shall be rendered inoperative after the doors have been held open for 20 s. Door closing for power-operated doors shall conform to 2.13.5.

### 2.13.6 Sequence Operation for Power-Operated Hoistway Doors With Car Doors or Gates

#### 2.13.6.1 Where Required

**2.13.6.1.1** Sequence opening and closing shall be provided between hoistway doors and car doors or gates on passenger elevators and freight elevators permitted to carry passengers (see 2.16.4) when the elevator is equipped with power-operated vertically sliding slide-up-to-open type car doors or gates and

(a) power-operated vertically sliding biparting counterbalanced hoistway doors; or

(b) power-operated vertically sliding counterweighted hoistway doors that slide down to open.

**2.13.6.1.2** Sequence opening and/or closing shall be permitted for vertically sliding power-operated hoistway doors and car doors or gates that are closed by continuous pressure means.

**2.13.6.2 Operating Requirements.** The sequence operation of a hoistway door and adjacent power-operated vertically sliding car door or gate shall conform to 2.13.6.2.1 and 2.13.6.2.2.

**2.13.6.2.1** In opening, the hoistway door shall be opened at least two-thirds of its travel before the car door or gate can start to open.

**2.13.6.2.2** In closing, the car door or gate shall be closed at least two-thirds of its travel before the hoistway door can start to close.

## SECTION 2.14
## CAR ENCLOSURES, CAR DOORS AND GATES, AND CAR ILLUMINATION

### 2.14.1 Passenger and Freight Enclosures, General

**2.14.1.1 Enclosure Required.** Elevators shall be equipped with a car enclosure.

#### 2.14.1.2 Securing of Enclosures

**2.14.1.2.1** The enclosure shall be securely fastened to the car platform and so supported that it cannot loosen or become displaced in ordinary service, on the application of the car safety, on buffer engagement, or the application of the emergency brake (see 2.19).

**2.14.1.2.2** The car enclosure shall be so constructed that removable portions cannot be dismantled from within the car.

**2.14.1.2.3** Enclosure linings, decorative panels, light fixtures, suspended ceilings, and other apparatus or equipment attached within the car enclosure shall be securely fastened and so supported that they will not loosen or become displaced in ordinary service, on car safety application, or on buffer engagement.

**2.14.1.2.4** Panels attached to the car enclosure for decorative or other purposes shall either

*(a)* not be unfastened from inside the car by the use of common tools; or

*(b)* be permitted to be removed from inside the car when perforations, exceeding that which would reject a ball 13 mm (0.5 in.) in diameter, in the enclosure used for panel hanging or support have permanent means to prevent straight through passage beyond the running clearance.

**2.14.1.3 Strength and Deflection of Enclosure Walls.** The enclosure walls shall be designed and installed to withstand a force of 330 N (75 lbf) applied horizontally at any point on the walls of the enclosure without permanent deformation and so that the deflection will not reduce the running clearance below the minimum specified in 2.5.1, nor cause the deflection to exceed 25 mm (1 in.).

**2.14.1.4 Number of Compartments in Passenger and Freight Elevator Cars.** Cars shall not have more than two compartments. Where elevators have two compartments, one shall be located above the other, and the elevator shall conform to 2.14.1.4.1 through 2.14.1.4.6.

**2.14.1.4.1** The elevator shall be used exclusively for passengers or exclusively for freight at any one time. If freight is to be carried in only one compartment, means shall be provided to lock the other compartment out of service.

**2.14.1.4.2** Each compartment shall conform to the requirements of this Section, except that a trap door in the floor of the upper compartment shall provide access to the top emergency exit for the lower compartment.

**2.14.1.4.3** Where either or both compartments are intended for passenger service, the minimum rated load for each compartment shall conform to 2.16.1.

Where one compartment is intended for freight use, its minimum rated load shall conform to 2.16.1 or shall be based on the freight loads to be handled, if greater than the minimum rated load required by 2.16.1.

Where both compartments are used exclusively for freight, the minimum rated load of each compartment shall conform to 2.16.2.

The rated load of the elevator shall be the sum of the rated loads of the individual compartments.

**2.14.1.4.4** An emergency stop switch, where required by 2.26.2.5, shall be provided in each compartment, and these emergency stop switches shall be so connected that the car cannot run unless both are in the run position.

**2.14.1.4.5** An in-car stop switch, where required by 2.26.2.21, shall be provided in each compartment, and these switches shall be so connected that the car cannot run unless both are in the run position.

**2.14.1.4.6** All hoistway doors shall be closed and locked and the car doors for each compartment closed before the car can be operated.

**2.14.1.5 Top Emergency Exits.** An emergency exit with a cover shall be provided in the top of all elevator cars, except cars in partially enclosed hoistways (see 2.14.1.5.2).

**2.14.1.5.1** Top emergency exits shall conform to the following requirements:

*(a)* The top emergency exit opening shall have an area of not less than 0.26 $m^2$ (400 $in.^2$) and shall measure not less than 400 mm (16 in.) on any side.

*(b)* The top emergency exit and suspended ceiling opening, if any, shall be so located as to provide a clear passageway, unobstructed by fixed equipment located in or on top of the car. Equipment is permitted directly above the exit opening, provided that

*(1)* it is not less than 1 070 mm (42 in.) above the top of the car; or

*(2)* the exit is located to allow unobstructed passage of a parallel piped volume measuring 300 mm × 500 mm by 1 500 mm (12 in. × 20 in. × 59 in.) at an angle not less than 60 deg from the horizontal (see Nonmandatory Appendix C).

*(c)* The top emergency exit cover shall open outward. It shall be hinged or securely attached with a chain when in both the open and closed positions. If a chain is used, it shall be not more than 300 mm (12 in.) in length and have a factor of safety of not less than 5. The exit cover shall only be openable from the top of the car, where it shall be openable without the use of special tools. The exit cover of the lower compartment of a multideck elevator shall be openable from both compartments. On elevators with two compartments, if the emergency exit of the lower compartment does not open directly into the upper compartment, a guarded passageway shall be provided between the lower compartment roof and the upper compartment floor.

*(d)* The movable portion (exit panel) of the suspended ceiling that is below the top exit opening shall be restrained from falling. It shall be permitted to be hinged upward or downward, provided that the exit permits a clear opening with the top exit opening. (ED)

*(1)* A minimum clear headroom of 2 030 mm (80 in.) above the car floor shall be maintained when downward-swinging suspended ceiling exit panels are used.

*(2)* Upward-opening suspended ceiling exit panels shall be restrained from closing when in use and shall not diminish the clear opening area of the corresponding top exit opening.

*(3)* The movable portion and the fixed portion of a suspended ceiling shall not contain lamps that could be shattered by the rescue operation using the top emergency exit. The movable portion of the suspended ceiling shall be permitted to contain light fixtures connected to

the stationary portion of the suspended ceiling wiring by means of a plug and socket or by flexible armored wiring. Flexible wiring shall not be used to support or restrain the exit opening in the suspended ceiling in the open position.

*(e)* Where elevators installed in enclosed hoistways are provided with special car top treatments such as domed or shrouded canopies, the exit shall be made accessible, including the car top refuge space as specified in 2.4.12.

*(f)* Immediately adjacent to the top emergency exit there shall be a space available for standing when the emergency exit cover is open. This space shall be permitted to include a portion of the refuge area (see 2.4.12). All exit covers shall be provided with a car top emergency exit electrical device (see 2.26.2.18) that will prevent operation of the elevator car if the exit cover is open more than 50 mm (2 in.), and the device shall be so designed that it

*(1)* is positively opened

*(2)* cannot be closed accidentally when the cover is removed

*(3)* must be manually reset from the top of the car and only after the cover is within 50 mm (2 in.) of the fully closed position

*(4)* shall be protected against mechanical damage

**2.14.1.5.2** On elevators in partially enclosed hoistways, means shall be provided to facilitate emergency evacuation of passengers. Such means shall not require a top emergency exit. A top emergency exit shall be permitted.

**2.14.1.6 Car Enclosure Tops.** Tops of car enclosures shall be so designed and installed as to be capable of sustaining a load of 135 kg (300 lb) on any area 600 mm × 600 mm (24 in. × 24 in.), or 45 kg (100 lb) applied to any point, without permanent deformation. The resulting deflection under these loads shall be limited to prevent damage to any equipment, devices, or lighting assemblies fastened to or adjacent to the car enclosure top.

### 2.14.1.7 Railing and Equipment on Top of Cars

**2.14.1.7.1** A standard railing conforming to 2.10.2 shall be provided on the outside perimeter of the car top on all sides where the perpendicular distance between the edges of the car top and the adjacent hoistway enclosure exceeds 300 mm (12 in.) horizontal clearance.

**2.14.1.7.2** A working platform or equipment that is not required for the operation of the elevator or its appliances, except where specifically provided herein, shall not be located above the top of an elevator car.

**2.14.1.7.3** Devices that detect unauthorized access to the top of the car shall be permitted. These devices shall only be permitted to initiate an alarm. Audible alarms shall not exceed 90 dBA measured 1 m from the source.

### 2.14.1.8 Glass in Elevator Cars

**2.14.1.8.1** Where enclosures include panels of glass, or transparent or translucent plastic, the panels shall

*(a)* be constructed of laminated glass that complies with the requirements of 16 CFR Part 1201, Sections 1201.1 and 1201.2; or be constructed of laminated glass, safety glass, or safety plastic that comply with CAN/CGSB-12.1, CAN/CGSB-12.11, or CAN/CGSB-12.12; whichever is applicable (see Part 9)

*(b)* be provided with a handrail or framing designed to guard the opening should the panel become detached, where wall panels are wider than 300 mm (12 in.)

*(c)* be mounted in the structure so that the assembly shall withstand the required elevator tests without damage (see 2.14.1.2)

**2.14.1.8.2** Glass used for lining walls or ceilings shall conform to 2.14.1.8.1(a) and (c), except that tempered glass shall be permitted, provided that

*(a)* it conforms to ANSI Z97.1, 16 CFR Part 1201, Sections 1201.1 and 1201.2, or CAN/CGSB-12.1; whichever is applicable (see Part 9)

*(b)* the glass is not subjected to further treatment such as sandblasting, etching, heat treatment, painting, etc., that could alter the original properties of the glass

*(c)* the glass is bonded to a nonpolymeric coating, sheeting, or film backing having a physical integrity to hold the fragments when the glass breaks

*(d)* the glass is tested and conforms to the acceptance criteria for laminated glass as specified in ANSI Z97.1, or 16 CFR Part 1201, Section 1201.4, or CAN/CGSB-12.11, whichever is applicable (see Part 9)

**2.14.1.8.3** In jurisdictions enforcing the NBCC, type 3C film reinforced silvered mirror glass that conforms to CAN/CGSB-12.5 shall be permitted for lining walls or ceilings.

**2.14.1.8.4** Markings as specified in the applicable glazing standard shall be on each separate piece, and shall remain visible after installation.

### 2.14.1.9 Equipment Inside Cars

**2.14.1.9.1** Apparatus or equipment not used in connection with the function or use of the elevator shall not be installed inside of any elevator car, except as follows:

*(a)* Support rails (handrails) are permitted.

*(b)* Fastening devices for padded protective linings are permitted.

*(c)* Lift hooks, conveyor tracks, and support beams for freight handling, mounted in the ceiling of passenger elevator, shall clear the car floor to a height of 2 450 mm (96 in.) (see 2.16.9).

*(d)* Picture frames, graphic display boards, plaques, and other similar visual displays shall be mounted to withstand the required elevator tests without damage. All edges shall be beveled or rounded. The material shall conform to 2.14.1.2 and 2.14.2.1. When attached to the car wall less than 2 130 mm (84 in.) above the floor, projections from the car wall, excluding support rails, shall not be greater than 38 mm (1.5 in.).

*(e)* Conveyor tracks shall be permitted in freight elevators cars.

*(f)* Heating equipment, ventilating fans, and air-conditioning equipment, if used, shall be securely fastened in place and located above the car ceiling or outside the enclosure.

**2.14.1.9.2** Passenger car floors shall have no projections or depressions greater than 6 mm (0.25 in.).

**2.14.1.10 Side Emergency Exits.** Side emergency exits are prohibited.

### 2.14.2 Passenger-Car Enclosures

**2.14.2.1 Material for Car Enclosures, Enclosure Linings, and Floor Coverings.** All materials exposed to the car interior and the hoistway shall be metal, glass, or shall conform to 2.14.2.1.1 through 2.14.2.1.6.

**2.14.2.1.1** Materials in their end-use configuration, other than those covered by 2.14.2.1.2 through 2.14.2.1.6 shall conform to the following requirements, based on the tests conducted in accordance with the requirements of ASTM E 84, UL 723, NFPA 252 or CAN/ULC-S102.2, whichever is applicable:

*(a)* flame spread rating of 0 to 75

*(b)* smoke development of 0 to 450

**2.14.2.1.2** In jursidictions enforcing the NBCC materials in their end-use configuration, where the elevator is designed as a firefighters' elevator, shall have

(ED) *(a)* a flame spread rating for walls and ceiling of 0 to 25 with smoke development of 0 to 100 based on the test conducted in accordance with the requirements of CAN/ULC-S102

*(b)* a flame spread rating for floor surfaces of 0 to 300 with smoke development of 0 to 300, based on the test conducted in accordance with the requirements of CAN/ULC-S102.2

**2.14.2.1.3** Napped, tufted, woven, looped, and similar materials in their end-use configuration on car enclosure walls shall conform to 8.3.7 or the NBCC and National Fire Code of Canada, whichever is applicable. The enclosure walls to which this material is attached shall conform to 2.14.2.1.1.

**2.14.2.1.4** Padded protective linings, for temporary use in passenger cars during the handling of freight, shall be of materials conforming to either 2.14.2.1.1 or 2.14.2.1.3, whichever is applicable. The protective lining shall clear the floor by not less than 100 mm (4 in.).

**2.14.2.1.5** Floor covering, underlayment, and its adhesive shall have a critical radiant flux of not less than 0.45 W/cm$^2$, as measured by ASTM E 648 or conform to the requirements of the NBCC and ULC standard CAN/ULC-S102.2, whichever is applicable.

**2.14.2.1.6** Handrails, operating devices, ventilating devices, signal fixtures, audio and visual communication devices, and their housings are not required to conform to 2.14.2.1.1 through 2.14.2.1.4.

**2.14.2.2 Openings Prohibited.** Openings or hinged or removable panels in an enclosure are prohibited, other than as required for the following:

*(a)* signal, operating, and communication equipment

*(b)* entrances

*(c)* vision panels

*(d)* top emergency exit

*(e)* ventilation

*(f)* access panels for maintenance of equipment or cleaning glass on observation elevators (see 2.14.2.6)

Such panels, where provided, shall conform to 2.14.1.10.2(b), (c), (f), (g), and (h), except that they are not required to be openable from the outside.

#### 2.14.2.3 Ventilation

**2.14.2.3.1** Natural ventilation openings conforming to the following shall be provided in car enclosures:

*(a)* Openings exposed to the inside of the car shall be located in the portion of the enclosure walls extending from a point 300 mm (12 in.) above the floor to a point 1 825 mm (72 in.) above the floor.

*(b)* Openings less than 300 mm (12 in.) above the floor shall reject a ball 25 mm (1 in.) in diameter and be guarded to prevent straight-through passage.

*(c)* Openings above the 1 825 mm (72 in.) level shall reject a ball 50 mm (2 in.) in diameter and be guarded to prevent straight-through passage.

*(d)* Openings in the car ceiling shall be protected and shall conform to 2.14.1.6.

*(e)* The total area of natural ventilation openings shall be not less than 3.5% of the inside car floor area divided equally between the bottom and top of the car enclosure.

*(f)* The total unrestricted opening in or around the car doors or gates shall be permitted to be included as part of the total natural ventilation required.

*(g)* The unrestricted opening provided by forced ventilation systems shall be permitted to be part of the natural ventilation area on the part of the car in which it is located. (ED)

**2.14.2.3.2** Ventilating fans or blowers, if used, shall be located above the car ceiling or outside the enclosure and shall be securely fastened in place.

**2.14.2.3.3** Forced ventilation conforming to the following shall be provided on observation elevators

with glass walls exposed to direct sunlight:

*(a)* There shall be a minimum air handling capacity to provide one air change per minute based on net inside car volume.

*(b)* An auxiliary power source capable of providing the minimum air handling capacity for a continuous period of at least 1 h shall be provided on each elevator car.

NOTE (2.14.2.3.3): Special consideration should be given to elevators such as observation and parking garage elevators, when they are exposed to the elements. In extreme cases, emergency power may be required for this purpose.

**2.14.2.4 Headroom in Elevator Cars.** A minimum clear headroom of 2 025 mm (80 in.) above the car floor shall be provided.

**2.14.2.5 Vision Panels.** Vision panels are not required, but where used, shall

*(a)* be of a total area of not more than 0.1 $m^2$ (155 $in.^2$) and contain no single glass panel having a width exceeding 150 mm (6 in.).

*(b)* be provided with wire-glass panels or laminated-glass panels conforming to 16 CFR Part 1201 or CAN/CGSB-12.11, whichever is applicable (see Part 9). Markings as specified in the applicable standard shall be on each separate piece of laminated glass, and shall remain visible after installation.

*(c)* be located in the car door or in the front return panel of the car enclosure.

*(d)* have the inside face of a car door vision panel, grille, or cover located substantially flush with the inside surface of the car door.

*(e)* have fasteners that are located on the hoistway side. It shall not be possible to remove the fasteners with common tools.

**2.14.2.6 Access Panels.** Nonremovable sliding or swing panels shall be permitted for access to the car or hoistway transparent enclosures for cleaning purposes. Such panels or doors shall

*(a)* if hinged, open only into the car

*(b)* be provided with cylinder-type locks, having not less than a five-pin or a five-disc combination, or a lock that provides equivalent security, arranged so that they can be unlocked with a key from the car side, and the key shall be Group 2 Security (see 8.1)

*(c)* be openable by hand from the hoistway side

*(d)* be self-locking

*(e)* be provided with a device arranged so that the panel must be in the closed and locked position (see 2.26.2.31) before the elevator can operate

*(f)* have a bottom edge a minimum of 1 070 mm (42 in.) from the floor in cases where the adjacent hoistway wall is more than 140 mm (5.5 in.) from the car enclosure or where there is no adjacent hoistway wall

### 2.14.3 Freight-Car Enclosure

**2.14.3.1 Enclosure Material.** Enclosures shall be of metal without perforations to a height of not less than 1 825 mm (72 in.) above the floor.

Above the 1 825 mm (72 in.) level, the walls and top of the enclosure shall be metal with or without perforations, except that portion of the enclosure wall in front of and extending 150 mm (6 in.) on each side of the counterweight, which shall be without perforations.

Perforated portions of enclosures shall reject a ball 25 mm (1 in.) in diameter.

Freight elevators that are permitted to carry passengers (see 2.16.4) shall conform to 2.14.2.2.

**2.14.3.2 Openings in Car Tops.** Hinged or removable panels shall not be provided in car tops, except for emergency exits.

**2.14.3.3 Ventilation.** If ventilating grilles or louvers are provided in the enclosure below the 1 825 mm (72 in.) level, they shall be located not more than 300 mm (12 in.) above the floor and shall reject a ball 50 mm (2 in.) in diameter.

### 2.14.4 Passenger and Freight Car Doors and Gates, General Requirements

**2.14.4.1 Where Required.** A door shall be provided at each entrance to a passenger car and a door or gate shall be provided at each entrance to a freight car.

### 2.14.4.2 Door and Gate Electric Contacts and Door Interlocks

**2.14.4.2.1** Each car door or gate shall be provided with a door or gate electric contact conforming to 2.26.2.15, 2.14.4.2.3, and 2.14.4.2.5, or a car-door interlock conforming to 2.26.2.28, 2.14.4.2.4, and 2.14.4.2.5.

**2.14.4.2.2** A car door interlock shall be required for

*(a)* car doors of elevators where the clearance between the loading side of the car platform and hoistway enclosure exceeds the maximum specified in 2.5.1.5

*(b)* car doors of elevators that face an unenclosed portion of the hoistway during the travel of the car

**2.14.4.2.3** Car door and gate electric contacts shall

*(a)* prevent operation of the driving machine when the car door or gate is not in the closed position, except under one of the following conditions:

*(1)* when a hoistway access switch is operated (see 2.12.7)

*(2)* when a car-leveling or truck-zoning device is operated (see 2.26.1.6)

*(3)* when a bypass switch is activated (see 2.26.1.5)

*(b)* be positively opened by a lever or other device attached to and operated by the door or gate

*(c)* be maintained in the open position by the action of gravity or by a restrained compression spring, or by both, or by positive mechanical means

*(d)* be so designed or located that they shall not be accessible from within the car

*(e)* not utilize mercury tube switches

**2.14.4.2.4** Car door interlocks shall

*(a)* prevent operation of the driving machine when the car door is not in the closed and locked position, except

*(1)* when the car is within the unlocking zone for that entrance

*(2)* under the conditions specified in 2.14.4.2.3(a)

*(b)* prevent opening of the car door from within the car, except when the car is in the unlocking zone for that entrance

*(c)* hold the car door in the locked position by means of gravity or by a restrained compression spring, or by both, or by means of a positive linkage

*(d)* be so located that they are not accessible from within the car when the car doors are closed

*(e)* be designed in accordance with 2.12.2.4

**2.14.4.2.5** Each type and make of car door electric contact, car gate electric contact, and car door interlock shall

*(a)* be type tested in conformance with 2.12.4.1

*(b)* be listed/certified in conformance with 2.12.4.2

*(c)* be marked in conformance with 2.12.4.3

**2.14.4.3 Type and Material for Doors.** Doors shall be of the horizontally or vertically sliding type and of material conforming to 2.14.2.1.

**2.14.4.4 Type of Gates.** Gates, where permitted, shall be of the horizontally sliding or vertically sliding type, conforming to 2.14.4.7, 2.14.5, and 2.14.6.

**2.14.4.5 Location**

**2.14.4.5.1** Doors or gates for automatic or continuous-pressure operation elevators, except freight elevators equipped with horizontally swinging doors and not accessible to the general public, located in factories, warehouses, garages, and similar buildings, shall be so located that the distance from the face of the car door or gate to the face of the hoistway door shall be not more than the following:

*(a)* where a swinging-type hoistway door and a car gate are used, 100 mm (4 in.)

*(b)* where a swinging-type hoistway door and a car door are used, 140 mm (5.5 in.)

*(c)* where a sliding-type hoistway door and a car door or gate are used, 140 mm (5.5 in.)

*(d)* on freight elevators that are equipped with horizontally swinging doors and that are not accessible to the general public (i.e., located in factories, warehouses, garages, and similar buildings), the distance specified in 2.14.4.5.1(a), (b), and (c) shall be not more than 165 mm (6.5 in.)

**2.14.4.5.2** The distances specified shall be measured as follows:

*(a)* where a multisection car door and multisection hoistway door are used, or where one of these doors is multisection and the other is single section, between the sections of the car door and the hoistway door nearest to each other

*(b)* where a multisection car door and a swinging-type hoistway door are used, between the hoistway door and the section of the car door farthest from it

*(c)* where a car gate is used, between the car gate and that section of the hoistway door nearest to the car gate

**2.14.4.6 Strength of Doors, Gates, and Their Guides, Guide Shoes, Tracks, and Hangers.** Doors and gates and their guides, guide shoes, tracks, and hangers shall be so designed, constructed, and installed that when the fully closed door or gate is subjected to a force of 335 N (75 lbf), applied on an area 300 mm (12 in.) square at right angles to and approximately at the center of the door or gate, it will not deflect beyond the line of the car sill.

When subjected to a force of 1 100 N (250 lbf) similarly applied, doors and vertically sliding gates shall not break or be permanently deformed and shall not be displaced from their guides or tracks.

Where multisection doors or gates are used, each panel shall withstand the forces specified.

**2.14.4.7 Vertically Sliding Doors and Gates.** Vertically sliding doors or gates shall conform to 2.14.4.7.1 through 2.14.4.7.5.

**2.14.4.7.1** They shall be of the balanced counterweighted type or the biparting counterbalanced type.

**2.14.4.7.2** Gates shall be constructed of wood or metal, and shall be of a design that will reject a ball 50 mm (2 in.) in diameter, except that if multisection vertical lift gates are used, the panel shall be designed to reject a ball 10 mm (0.375 in.) in diameter.

**2.14.4.7.3** Doors shall be constructed of material conforming to 2.14.2.1.

**2.14.4.7.4** Doors or gates shall guard the full width of the car entrance openings, and their height shall conform to 2.14.5.4 or 2.14.6.2.3.

**2.14.4.7.5** Balanced counterweighted doors or gates shall be either single or multiple section, and shall slide either up or down to open, conforming to 2.14.5.3 and 2.14.6.2.

**2.14.4.8 Weights for Closing or Balancing Doors or Gates.** Weights used to close or balance doors or gates shall be located outside the car enclosure and shall be

guided or restrained to prevent them from coming out of their runway.

The bottom of the guides or other restraining means shall be so constructed as to retain the weights if the weight suspension means breaks.

Weights that extend beyond the hoistway side of the car door or gate guide rail shall be guarded to prevent accidental contact.

**2.14.4.9 Factor of Safety for Suspension Members.** Suspension members of vertically sliding car doors or gates, and of weights used with car doors or gates, shall have a factor of safety of not less than 5. At least two independent suspension means shall be provided so that the failure of one suspension means shall not permit the car doors or gates to fall; or a safety device shall be provided to prevent the doors or gates from falling, if the suspension means fails.

**2.14.4.10 Power-Operated and Power-Opened or Power-Closed Doors or Gates.** The operation of power-operated and power-opened or power-closed doors or gates shall conform to 2.13.

**2.14.4.11 Closed Position of Car Doors or Gates.** Car doors or gates shall be considered to be in the closed position under the following conditions:

*(a)* for horizontally sliding doors or gates, when the clear open space between the leading edge of the door or gate and the nearest face of the jamb does not exceed 50 mm (2 in.) except where car doors are provided with a car door interlock(s), 10 mm (0.375 in.)

*(b)* for vertically sliding counterweighted doors or gates, when the clear open space between the leading edge of the door or gate and the car platform sill does not exceed 50 mm (2 in.)

*(c)* for horizontally sliding center-opening doors, or vertically sliding biparting counterbalanced doors, when the door panels are within 50 mm (2 in.) of contact with each other, except where horizontally sliding center-opening car doors are provided with a car door interlock(s), 10 mm (0.375 in.)

### 2.14.5 Passenger Car Doors

**2.14.5.1 Number of Entrances Permitted.** There shall be not more than two entrances to the car, except in existing buildings where structural conditions make additional entrances necessary.

**2.14.5.2 Type Required.** Horizontally or vertically sliding doors subject to the restrictions of 2.14.5.3 shall be provided at each car entrance.

**2.14.5.3 Vertically Sliding Doors.** Vertically sliding doors shall be

*(a)* of the balanced counterweighted type that slide in the up direction to open

*(b)* power operated where facing a power-operated vertically sliding counterbalanced or a vertically sliding-down-to-open hoistway door

**2.14.5.4 Dimensions of Doors.** Doors, when in the fully closed position, shall protect the full width and height of the car entrance opening.

**2.14.5.5 Openings in Doors.** There shall be no openings in doors, except where vision panels are used.

**2.14.5.6 Door Panels**

**2.14.5.6.1** Door panels shall have a flush surface on the side exposed to the car interior. The panels shall have no area or molding depressed or raised more than 3 mm (0.125 in.) and areas raised or depressed shall be beveled at not more than 30 deg to the panel surface.

**2.14.5.6.2** Panels shall overlap the top and sides of the car entrance opening by not less than 13 mm (0.5 in.) when in the closed position.

**2.14.5.6.3** The vertical clearance between a panel and the sill, or in the case of a vertically sliding door the vertical clearance between the leading edge and the sill, shall not exceed 10 mm (0.375 in.) when in the fully closed position.

**2.14.5.6.4** The horizontal clearance shall not exceed 13 mm (0.5 in.) for horizontally sliding panels and 25 mm (1 in.) for vertically sliding panels between

*(a)* the car side of a panel and the related car entrance jamb

*(b)* related panels of multispeed entrances

*(c)* the car side of the panel and the related car head jamb

**2.14.5.6.5** The leading edges of doors shall be free of sharp projections.

**2.14.5.6.6** The meeting panel edges of center-opening entrances shall be protected with not less than one resilient male member extending the full height of the panel. The meeting edges shall be permitted to interlock by not more than 10 mm (0.375 in.). When in the closed position, the distance between the metal parts of the meeting panels shall not exceed 13 mm (0.5 in.).

**2.14.5.6.7** The clearance between the leading edge of the trailing panel of multiple-speed panels and the jamb shall not exceed

*(a)* 13 mm (0.5 in.) for horizontal slide

*(b)* 25 mm (1 in.) for vertical slide

**2.14.5.7 Manual Opening of Car Doors.** Car doors shall be so arranged that when the car is stopped within the unlocking zone (see 2.12.5.3) and power to the door operator is cut off, they and the mechanically related hoistway door, if any, shall be movable by hand from inside the car. The force required at the edge of sliding doors to move them shall not exceed 330 N (75 lbf).

### 2.14.5.8 Glass in Car Doors

**2.14.5.8.1** Vision panels, where provided, shall conform to 2.14.2.5.

**2.14.5.8.2** Glass doors, where provided, shall conform to the following requirements:

*(a)* The glass shall be laminated glass conforming to the requirements of ANSI Z97.1, or 16 CFR Part 1201, or be laminated glass, safety glass, or safety plastic conforming to the requirements of CAN/CGSB-12.1, whichever is applicable (see Part 9). Markings as specified shall be on each separate piece, and shall remain visible after installation.

*(b)* The glass shall be not less than 60% of the total visible door panel surface area as seen from the car side of the doors. Door lap shall not be used in calculating glass size.

*(c)* In power-operated doors, the glass panel shall be substantially flush with the surface of the car side of the door.

*(d)* The glass shall conform to the applicable strength requirements of 2.14.4.6.

*(e)* The glass shall be so mounted that it, and its mounting structure, will withstand the required elevator tests without becoming damaged or dislodged.

*(f)* A nonglass edge shall be provided on the leading edge of the door panel.

## 2.14.6 Freight Elevator Car Doors and Gates

### 2.14.6.1 Type of Gates

**2.14.6.1.1** For elevators designed for Class A loading (see 2.16.2.2), car gates shall be either of the vertically sliding type (see 2.14.6.2) or the horizontally sliding collapsible type (see 2.14.6.3).

**2.14.6.1.2** For elevators designed for Class B or Class C loading (see 2.16.2.2), car gates shall be of the vertically sliding type (see 2.14.6.2).

### 2.14.6.2 Vertically Sliding Doors and Gates

(ED) **2.14.6.2.1** On elevators used exclusively for freight, car doors and gates shall be either of the balanced counterweighted type that slide up or down to open, or of the biparting counterbalanced type. They shall be manually operated or power operated.

**2.14.6.2.2** Where used on freight elevators permitted to carry passengers (see 2.16.4), car doors shall conform to 2.14.5.

**2.14.6.2.3** Car doors and gates shall protect the full width of the car entrance opening, and their height shall be determined as follows:

*(a)* car doors and gates shall extend from a point not more than 25 mm (1 in.) above the car floor to a point not less than 1 825 mm (72 in.) above the car floor

*(b)* where a vertically sliding car gate with a door reopening device is provided, the 25 mm (1 in.) maximum dimension specified shall be measured from the car floor to the bottom of the leading member

**2.14.6.2.4** The horizontal clearance between the car side of a panel and the related car entrance jamb or between related panels of multispeed doors or gates shall not exceed 25 mm (1 in.).

### 2.14.6.3 Collapsible-Type Gates

**2.14.6.3.1** Collapsible-type gates shall protect the full width of the car entrance opening, and they shall extend from the car floor to a height of not less than 1 825 mm (72 in.) when fully closed.

**2.14.6.3.2** When in the fully closed (extended) position, the opening between vertical members shall not be more than 115 mm (4.5 in.).

**2.14.6.3.3** Every vertical member shall be restricted from moving perpendicular to the direction of travel more than 13 mm (0.5 in.).

**2.14.6.3.4** They shall not be power opened, except as permitted by 2.13.2.1.2.

**2.14.6.3.5** When in the fully opened (collapsed) position, collapsible gates shall be permitted to be arranged to swing inward.

**2.14.6.3.6** Handles of manually operated collapsible gates nearest the car operating device on elevators operated from the car only shall be so located that the nearest handle is not more than 1 225 mm (48 in.) from the car operating device when the gate is closed (extended position), and not more than 1 225 mm (48 in.) above the car floor. Gate handles shall be provided with finger guards.

## 2.14.7 Illumination of Cars and Lighting Fixtures

**2.14.7.1 Illumination and Outlets Required.** Cars shall be provided with an electric light or lights conforming to 2.14.7.1.1 through 2.14.7.1.4.

**2.14.7.1.1** Not less than two lamps shall be provided.

**2.14.7.1.2** The minimum illumination at the car threshold, with the door closed, shall be not less than

*(a)* 50 lx (5 fc) for passenger elevators

*(b)* 25 lx (2.5 fc) for freight elevators

**2.14.7.1.3** Passenger elevators shall be provided with auxiliary lighting on each elevator conforming to the following:

*(a)* The intensity of auxiliary lighting illumination 1 225 mm (48 in.) above the car floor and approximately 300 mm (12 in.) in front of the car operating device shall be not less than 2 lx (0.2 fc). Auxiliary Lights shall be automatically turned on in all elevators in service after

normal car lighting power fails. The power system shall be capable of maintaining the above light intensity for a period of at least 4 h.

*(b)* Not less than two lamps of approximately equal wattage shall be used and battery-operated units shall

*(1)* comply with CSA C22.2 No. 141 (see Part 9)

*(2)* have a 4 h rating

*(3)* be permanently connected to the car light branch circuit

*(4)* have an output rating that includes the auxiliary lights and if connected, the emergency signaling device (see 2.27.1.1.3)

**2.14.7.1.4** Each elevator shall be provided with an electric light and convenience outlet fixture on the car top.

### 2.14.7.2 Light Control Switches

**2.14.7.2.1** Light control switches for in-car lighting shall be permitted. When provided, they shall

*(a)* be located in or adjacent to the operating device in the car.

*(b)* in elevators having automatic operation, be of the key-operated type or located in a fixture with a locked cover. The key shall be Group 2 Security (see 8.1).

**2.14.7.2.2** Automatic operation of the car lights shall be permitted. When provided, the operating circuit shall be arranged to turn off the lights only when the following conditions exist for not less than 5 min:

*(a)* the car is at a floor

*(b)* the doors are closed

*(c)* there is no demand for service

*(d)* the car is on automatic operation

Momentary interruption of any of the above conditions shall cause the car lights to turn on.

### 2.14.7.3 Car Lighting Devices

**2.14.7.3.1** Glass used for lighting fixtures shall conform to 2.14.1.8.

**2.14.7.3.2** Suspended glass used in lighting fixtures shall be supported by a metal frame secured at not less than three points.

**2.14.7.3.3** Fastening devices shall not be removable from the fixture.

**2.14.7.3.4** Glass shall not be drilled for attachment.

**2.14.7.3.5** Light troughs supporting wiring raceways and other auxiliary lighting equipment, where used, shall be of metal, except where lined with noncombustible materials.

**2.14.7.3.6** Materials for light diffusion or transmission shall be of metal, glass, or materials conforming to 2.14.2.1.1 and shall not come in contact with light bulbs and tubes.

### 2.14.7.4 Protection of Light Bulbs and Tubes.

Light bulbs and tubes within the car shall

*(a)* be equipped with guards, be recessed, or be mounted above a drop ceiling to prevent accidental breakage. Cars that operate with the drop ceiling removed shall have a permanent separate guard for the light bulb or tube.

*(b)* be so mounted in the structure that the structure and the bulb or tube will withstand the required elevator tests without being damaged or becoming dislodged.

## SECTION 2.15
## CAR FRAMES AND PLATFORMS

### 2.15.1 Car Frames Required

Every elevator shall have a car frame (see 1.3).

### 2.15.2 Guiding Members (ED)

Car frames shall be guided on each guide rail by upper and lower guiding members attached to the frame.

Retention means shall be provided to prevent the car from being displaced by more than 13 mm (0.5 in.) from its normal running position should any part of the guiding means fail, excluding the guiding member base and its attachment to the frame. The retention means shall be permitted to be integral with the base.

### 2.15.3 Design of Car Frames and Guiding Members

The frame and its guiding members shall be designed to withstand the forces resulting under the loading conditions for which the elevator is designed and installed (see 2.16).

### 2.15.4 Underslung or Sub-Post Frames

The vertical distance between the centerlines of the top and bottom guide shoes of an elevator car having a sub-post car frame or having an underslung car frame located entirely below the car platform shall be not less than 40% of the distance between guide rails.

### 2.15.5 Car Platforms

**2.15.5.1** Every elevator car shall have a platform consisting of a nonperforated floor attached to a platform frame supported by the car frame, and extending over the entire area within the car enclosure.

**2.15.5.2** The platform frame members and the floor shall be designed to withstand the forces developed under the loading conditions for which the elevator is designed and installed.

**2.15.5.3** Platform frames are not required where laminated platforms are provided.

**2.15.5.4** Laminated platforms shall be permitted to be used for passenger elevators having a rated load of 2 300 kg (5,000 lb) or less.

**2.15.5.5** The deflection at any point of a laminated platform, when uniformly loaded to rated capacity, shall not exceed $^{1}/_{960}$ of the span. The stresses in the steel facing shall not exceed one-fifth of its ultimate strength, and the stresses in the plywood core shall not exceed 60% of the allowable stresses in Section 3.14 of the American Plywood Association Plywood Design Specification or CSA O86.1, as applicable (see Part 9).

### 2.15.6 Materials for Car Frames and Platform Frames

**2.15.6.1 Materials Permitted.** Materials used in the construction of car frames and platforms shall conform to 2.15.6.1.1 through 2.15.6.1.4.

**2.15.6.1.1** Car frames and outside members of platform frames shall be made of steel or other metals.

**2.15.6.1.2** Platform stringers of freight elevators designed for Class B or Class C loading shall be of steel or other metals.

**2.15.6.1.3** Platform stringers of passenger elevators and of freight elevators designed for Class A loading shall be made of steel or other metals, or of wood.

(ED) **2.15.6.1.4** Cast iron shall not be used for any part subject to tension, torsion, or bending, except for guiding supports and guide shoes.

**2.15.6.2 Requirements for Steel.** Steel used in the construction of car frames and platforms shall conform to 2.15.6.2.1 through 2.15.6.2.3.

**2.15.6.2.1 Car-Frame and Platform-Frame Members.** Steel shall be rolled, formed, forged, or cast, conforming to the requirements of the following specifications:

*(a) Rolled and Formed Steel.* ASTM A 36 or ASTM A 283 Grade D or CAN/CSA-G40.21.

*(b) Forged Steel.* ASTM A 668 Class B.

*(c) Cast Steel.* ASTM A 27 Grade 60/30.

**2.15.6.2.2 Rivets, Bolts, and Rods.** Steel used for rivets, bolts, and rods shall conform to the following specifications:

*(a)* ASTM A 502, Rivets

*(b)* ASTM A 307, Bolts and Rods

(ED) **2.15.6.2.3 Steels of Other Strength.** Steels of greater or lesser strength than those specified by 2.15.6.2.1 shall be permitted to be used, provided they have an elongation of not less than 20% in a length of 50 mm (2 in.) when tested in accordance with ASTM E8, and provided that the stresses and deflections conform to 2.15.10 and 2.15.11, respectively.

Rivets, bolts, and rods made of steel having greater strength than specified by ASTM A 307 and ASTM A 502 shall be permitted to be used and the maximum allowable stresses increased proportionally, based on the ratio of the ultimate strengths. Elongation shall conform to the requirements of the corresponding ASTM specifications.

(ED) **2.15.6.3 Requirements for Metals Other Than Steel.** Metals other than steel shall be permitted to be used in the construction of car frames and platforms, provided the metal used has the essential properties to meet all the requirements for the purpose in accordance with good engineering practice, and provided the stresses and deflections conform to 2.15.10 and 2.15.11, respectively.

(ED) **2.15.6.4 Requirements for Wood Used for Platform Floors and Stringers.** Wood used for platform stringers and platform floors and sub-floors shall be of structural quality lumber or exterior-type plywood conforming to the requirements of the following:

*(a)* ASTM D 245, Structural Grades of Lumber

*(b)* ASTM D 198, Static Tests of Structural Timbers

*(c)* ANSI Voluntary Product Standard PS 1-74 or CSA O151, Softwood Plywood, Construction and Industrial

### 2.15.7 Car Frame and Platform Connections

**2.15.7.1 Internal Connections.** Connections between members of car frames and platforms shall be riveted, bolted, or welded, and shall conform to 2.15.7.3.

**2.15.7.2 Connection Between Car Frame and Platform.** The attachment of the platform to the car frame shall be done in accordance with good engineering practice and shall develop the required strength to transmit the forces safely from the platform to the car frame in accordance with 2.15.10. Bolts, nuts, and welding, where used, shall conform to 2.15.7.3.

#### 2.15.7.3 Bolts, Nuts, and Welding

**2.15.7.3.1** Bolts, where used through greater than 5 deg sloping flanges of structural members, shall have bolt heads of the tipped-head type or shall be fitted with bevelled washers.

**2.15.7.3.2** Nuts used on greater than 5 deg sloping flanges of structural members shall sit on beveled washers.

**2.15.7.3.3** All welding shall conform to 8.8.

### 2.15.8 Protection of Platforms Against Fire

All platform materials exposed to the hoistway shall be either of the following:

*(a)* metal

*(b)* other materials that, in their end-use configuration, conform to the following requirements, based on the tests conducted in accordance with the requirements of ASTM E 84, UL 723, NFPA 255, or CAN/ULC-S102.2, whichever is applicable (see Part 9):

*(1)* flame spread rating of 0 to 75

*(2)* smoke development of 0 to 450

### 2.15.9 Platform Guards (Aprons)

The entrance side of the platform of passenger and freight elevators shall be provided with smooth metal

guard plates of not less than 1.5 mm (0.059 in.) thick steel, or material of equivalent strength and stiffness, adequately reinforced and braced to the car platform and conforming to 2.15.9.1 through 2.15.9.4.

**2.15.9.1** The guard plate shall extend not less than the full width of the widest hoistway-door opening.

**2.15.9.2** The guard plate shall have a straight vertical face, extending below the floor surface of the platform, conforming to one of the following:

*(a)* where the elevator is required to conform to 2.19.2.2(b) the depth of the truck zone, where provided, plus 75 mm (3 in.), but in no case less than 1 220 mm (48 in.)

*(b)* where the elevator is not required to conform to 2.19.2.2(b) the depth of the leveling zone or truck zone, where provided, plus 75 mm (3 in.); but in no case less than 525 mm (21 in.)

**2.15.9.3** The lower portion of the guard shall be bent back at an angle of not less than 60 deg nor more than 75 deg from the horizontal.

**2.15.9.4** The guard plate shall be securely braced and fastened in place to withstand a constant force of not less than 650 N (145 lbf) applied at right angles to and at any position on its face without deflecting more than 6 mm (0.25 in.), and without permanent deformation.

Where the car entrance on the truck loading side is provided with a collapsible-type gate and the height of the hoistway door opening is greater than the distance from the car floor to the car top, a head guard extending the full width of the door opening shall be provided on the car to close the space between the car top and the soffit of the hoistway-door opening when the car platform is level with the floor at the truck loading landing entrance.

### 2.15.10 Maximum Allowable Stresses in Car Frame and Platform Members and Connections

**2.15.10.1** The stresses in car frame and platform members and their connections, based on the static load imposed upon them, shall not exceed the following:

*(a)* for steels meeting the requirements of 2.15.6.2.1 and 2.15.6.2.2, as listed in Table 2.15.10.1

*(b)* for steels of greater or lesser strength, as permitted by 2.15.6.2.3, the allowable stresses listed in Table 2.15.10.1 are to be adjusted proportionally, based on the ratio of the ultimate strengths

*(c)* for metals other than steel, as permitted by 2.15.6.3, the allowable stresses listed in Table 2.15.10.1 are to be adjusted proportionally, based on the ratio of the ultimate strengths

**2.15.10.2** Car frame members, brackets, and their connections subject to forces due to the application of the emergency brake (see 2.19.4) shall be designed to withstand the maximum forces developed during the retardation phase of the emergency braking so that the resulting stresses due to the emergency braking and all other loading acting simultaneously, if applicable, shall not exceed 190 MPa (27,500 psi).

### 2.15.11 Maximum Allowable Deflections of Car Frame and Platform Members

The deflections of car frame and platform members based on the static load imposed upon them shall be not more than the following:

*(a)* for crosshead, plank, and platform frame members, $1/960$ of the span

*(b)* for uprights (stiles), as determined by 8.2.2.5.3

### 2.15.12 Car Frames With Sheaves

Where a hoisting rope sheave is mounted on the car frame, the construction shall conform to 2.15.12.1 through 2.15.12.3.

**2.15.12.1** Where multiple sheaves mounted on separate sheave shafts are used, provision shall be made to take the compressive forces, developed by tension in the hoisting ropes between the sheaves, on a strut or struts between the sheave shaft supports, or by providing additional compressive strength in the car frame or car-frame members supporting sheave shafts.

**2.15.12.2** Where the sheave shaft extends through the web of a car-frame member, the reduction in area of the member shall not reduce the strength of the member below that required. Where necessary, reinforcing plates shall be welded or riveted to the member to provide the required strength. The bearing pressure shall in no case be more than that permitted in Table 2.15.10.1 for bolts in clearance holes.

**2.15.12.3** Where the sheave is attached to the car crosshead by means of a single threaded rod or specially designed member or members in tension, the requirements of 2.15.12.3.1 and 2.15.12.3.2 shall be conformed to.

**2.15.12.3.1** The single rod, member, or members shall have a factor of safety 50% higher than the factor of safety required for the suspension wire ropes, but in no case shall have a factor of safety of less than 15.

**2.15.12.3.2** The means for fastening the single-threaded rod, member, or members to the car frame shall conform to 2.15.13.

### 2.15.13 Suspension-Rope Hitch Plates or Shapes

Where cars are suspended by hoisting ropes attached to the car frame or to the overhead supporting beams by means of rope shackles, the shackles shall be attached to steel hitch plates or to structural or formed steel shapes.

Such plates or shapes shall be secured to the underside or to the webs of the car-frame member with bolts, rivets,

**Table 2.15.10.1 Maximum Allowable Stresses in Car Frame and Platform Members and Connections, for Steels Specified in 2.15.6.2.1 and 2.15.6.2.2**

| Member Type | Stress Type | Maximum Stress, MPa (psi) | Area Basis |
|---|---|---|---|
| Car crosshead | Bending | 95 (14,000) | Gross section |
| Car frame plank (normal loading) | Bending | 95 (14,000) | Gross section |
| Car frame plank (buffer reaction) | Bending | 190 (27,500) | Gross section |
| Car frame uprights (stiles) | Bending plus tension | 115 (17,000) | Gross section |
| | | 140 (20,200) | Net section |
| Hoisting rope hitch plate and shapes | Bending plus tension | 75 (11,000) | Net section |
| Platform framing | Bending | 95 (14,000) | Gross section |
| Platform stringers | Bending | 115 (17,000) | Gross section |
| Threaded brace rods and other tension members except bolts | Tension | 60 (9,000) | Net section |
| Bolts | Tension | 55 (8,000) | Net section |
| Bolts in clearance holes | Shear | 55 (8,000) | Actual area in shear plane |
| | Bearing | 120 (17,500) | Gross section |
| Rivets or tight body-fit bolts | Shear | 75 (11,000) | Actual area in shear plane |
| | Bearing | 140 (20,000) | Gross section |
| Any framing member normal loading | Compression | Note (1) | Gross section |

NOTE:
(1) The maximum allowable compressive stress in any member at normal loading shall not exceed 80% of those permitted for static loads by the AISC #S326 or CSA S16.1.

or welds so located that the tensions in the hoisting ropes will not develop direct tension in the bolts or rivets.

The stresses shall not exceed those permitted by 2.9.3.3.

### 2.15.14 Calculation of Stresses in Car-Frame and Platform-Frame Members

The calculation of the stresses and deflection in the car-frame plank and uprights and platform frames shall be based on the formulas and data in 8.2.2.

### 2.15.15 Platform Side Braces

Where side bracing and similar members are attached to car-frame uprights, the reduction in area of the upright shall not reduce the strength of the upright below that required by 2.15.

### 2.15.16 Hinged Platform Sills

Hinged platform sills, where used, shall conform to 2.15.16.1 through 2.15.16.3.

**2.15.16.1** Hinged platform sills shall be provided with electric contacts conforming to 2.12.5, which will prevent operation of the elevator by the normal operating device unless the hinged sill is within 50 mm (2 in.) of its fully retracted position, provided that when in this position, the sill does not reduce the clearance specified in 2.5.1.4.

**2.15.16.2** The elevator shall be permitted to be operated by the leveling device in the leveling zone with the sill in any position.

**2.15.16.3** The strength of the sills shall conform to 2.11.11.1.

### 2.15.17 Fastening of Compensation Means

Fastenings to the car of the suspension ropes' compensation means shall conform to 2.21.4.

## SECTION 2.16
## CAPACITY AND LOADING

### 2.16.1 Minimum Rated Load for Passenger Elevators

**2.16.1.1 Minimum Load Permitted.** The rated load in kg (lb) for passenger elevators shall be based on the inside net platform area, and shall be not less than shown by Fig. 8.2.1.2 (see Nonmandatory Appendix D and 2.26.11). (ED)

The inside net platform area shall be determined at a point 1 000 mm (39 in.) above the floor and inside of any panels or wall surfaces, but exclusive of any handrails and space for doors as shown in Fig. 2.16.1.1. To allow for variations in car designs, an increase in the maximum inside net area not exceeding 5% shall be permitted for the various rated loads. See Table 2.16.1.1.

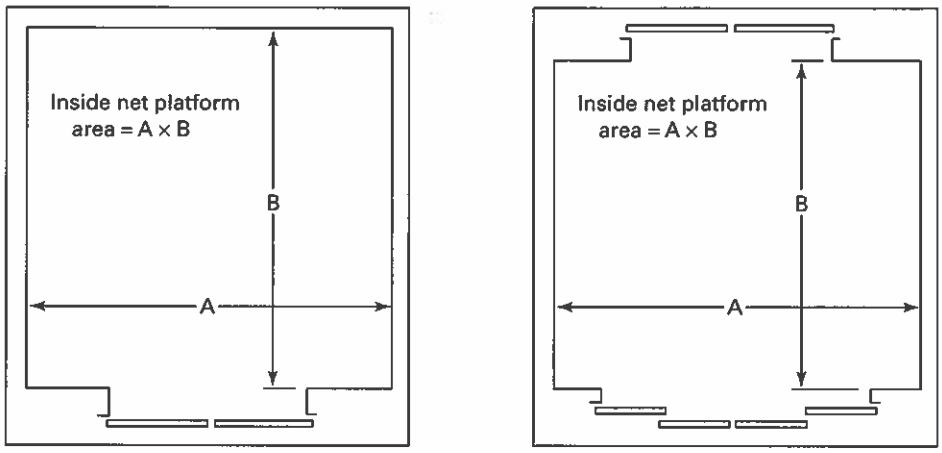



**Fig. 2.16.1.1 Inside Net Platform Areas for Passenger Elevators**

**Table 2.16.1.1 Maximum Inside Net Platform Areas for the Various Rated Loads**

| SI Units | | Imperial Units | |
|---|---|---|---|
| Rated Load, kg | Inside Net Platform Area, $m^2$ | Rated Load, lb | Inside Net Platform Area, $ft^2$ |
| 230 | 0.65 | 500 | 7.0 |
| 270 | 0.77 | 600 | 8.3 |
| 320 | 0.89 | 700 | 9.6 |
| 450 | 1.23 | 1,000 | 13.3 |
| 550 | 1.45 | 1,200 | 15.6 |
| 700 | 1.76 | 1,500 | 18.9 |
| 800 | 2.05 | 1,800 | 22.1 |
| 900 | 2.25 | 2,000 | 24.2 |
| 1 150 | 2.70 | 2,500 | 29.1 |
| 1 350 | 3.13 | 3,000 | 33.7 |
| 1 600 | 3.53 | 3,500 | 38.0 |
| 1 800 | 3.92 | 4,000 | 42.2 |
| 2 000 | 4.29 | 4,500 | 46.2 |
| 2 250 | 4.65 | 5,000 | 50.0 |
| 2 700 | 5.36 | 6,000 | 57.7 |
| 3 200 | 6.07 | 7,000 | 65.3 |
| 3 600 | 6.77 | 8,000 | 72.9 |
| 4 100 | 7.48 | 9,000 | 80.5 |
| 4 500 | 8.18 | 10,000 | 88.0 |
| 5 400 | 9.57 | 12,000 | 103.0 |
| 7 000 | 11.62 | 15,000 | 125.1 |
| 8 000 | 13.65 | 18,000 | 146.9 |
| 9 000 | 14.98 | 20,000 | 161.2 |
| 11 500 | 18.25 | 25,000 | 196.5 |
| 13 500 | 21.46 | 30,000 | 231.0 |

GENERAL NOTE: To allow for variations in cab designs, an increase in the maximum inside net platform area not exceeding 5% shall be permitted for the various rated loads.

**2.16.1.2 Use of Partitions for Reducing Inside Net Platform Area.** Where partitions are installed in elevator cars for the purpose of restricting the platform net area for passenger use, they shall be permanently bolted, riveted, or welded in place. Gates, doors, or handrails shall not be used for this purpose. Partitions shall be so installed as to provide for approximately symmetrical loading.

**2.16.1.3 Carrying of Freight on Passenger Elevators.** When freight is to be carried on a passenger elevator, the requirements of 2.16.1.3.1 and 2.16.1.3.2 shall be conformed to.

**2.16.1.3.1** The minimum rated load shall conform to 2.16.1 or 2.16.2, whichever is greater.

**2.16.1.3.2** The elevator shall be designed for applicable class of freight elevator loading.

### 2.16.2 Minimum Rated Load for Freight Elevators

**2.16.2.1 Minimum Load Permitted.** The minimum rated load for freight elevators in pounds shall be based on the weight and class of the load to be handled, but shall in no case be less than the minimum specified in 2.16.2.2 for each class of loading based on the inside net platform area.

**2.16.2.2 Classes of Loading and Design Requirements.** Freight elevators shall be designed for one of the following classes of loading.

**2.16.2.2.1 Class A: General Freight Loading.** Where the load is distributed, the weight of any single piece of freight or of any single hand truck and its load is not more than 25% of the rated load of the elevator, and the load is handled on and off the car platform manually or by means of hand trucks.

For this class of loading, the rated load shall be based on not less than 240 kg/m$^2$ (49 lb/ft$^2$) of inside net platform area.

**2.16.2.2.2 Class B: Motor Vehicle Loading.** Where the elevator is used solely to carry automobile trucks or passenger automobiles up to the rated capacity of the elevator.

For this class of loading, the rated load shall be based on not less than 145 kg/m$^2$ (30 lb/ft$^2$) of inside net platform area.

**2.16.2.2.3 Class C.** There are three types of Class C loadings:

*(a) Class C1: Industrial Truck Loading.* Where the static load during loading and unloading does not exceed the rated load.

*(b) Class C2: Industrial Truck Loading.* Where the static load during loading and unloading is permitted to exceed the rated load.

*(c) Class C3: Other Loading With Heavy Concentrations.* Where the static load during loading and unloading does not exceed the rated load.

**2.16.2.2.4** Class C loadings in 2.16.2.2.3 apply where the weight of the concentrated load including a powered industrial or hand truck, if used, is more than 25% the rated load and where the load to be carried does not exceed the rated load. (For concentrated loads exceeding the rated load, see 2.16.6.)

The following are additional requirements:

*(a)* For Class C1, Class C2, and Class C3 loadings, the rated load of the elevator shall be not less than the load (including any truck) to be carried, and shall in no case be less than 240 kg/m$^2$ (49 lb/ft$^2$) of inside net platform area.

The elevator shall be provided with a two-way automatic leveling device (see 1.3).

*(b)* For Class C1 and Class C2 loadings, the following additional requirements shall apply:

*(1)* For elevators with rated loads of 9 000 kg (20,000 lb) or less, the car platform shall be designed for a loaded truck of weight equal to the rated load or for the actual weight of the loaded truck to be used, whichever is greater.

*(2)* For elevators with rated loads exceeding 9 000 kg (20,000 lb), the car platform shall be designed for a loaded truck weighing 9 000 kg (20,000 lb), or for the actual weight of the loaded truck to be used, whichever is greater.

*(c)* For Class C2 loading, the following requirements shall apply:

*(1)* The maximum load on the car platform during loading or unloading shall not exceed 150% of rated load.

*(2)* For any load in excess of rated load on elevators with a rated load of 9 000 kg (20,000 lb) or less, the driving-machine motor, brake, and traction relation shall be adequate to sustain and level the full 150% of rated load.

*(3)* For any load in excess of the rated load on elevators with a rated load exceeding 9 000 kg (20,000 lb), the driving machine motor, brake, and traction relation shall be adequate to sustain and level the rated load plus either 4 500 kg (10,000 lb), or the weight of the unloaded truck to be used, whichever is greater.

NOTES (2.16.2):

(1) When the entire rated load is loaded or unloaded in increments by an industrial truck, the load imposed on the car platform, while the last increment is being loaded or the first increment unloaded, will exceed the rated load by part of the weight of the empty industrial truck.

(2) Requirement 2.16.2 does not prohibit the carrying of an industrial truck on a freight elevator of Class C2 or Class C3 loading, provided that the total weight on the elevator does not exceed the rated load of the elevator, and the elevator is designed to meet the requirements of 8.2.2 and 8.2.9, as appropriate, for the load involved.

### 2.16.3 Capacity and Data Plates

**2.16.3.1 Plates Required and Locations.** Every elevator shall be provided with a capacity plate and a data plate permanently and securely attached.

The capacity plate shall be located in a conspicuous position inside the car.

The data plate shall be located on the car crosshead, or inside the car for underslung elevators having no crosshead.

#### 2.16.3.2 Information Required on Plates

**2.16.3.2.1** Capacity plates shall indicate the rated load of the elevator in kilograms or pounds or both (see Nonmandatory Appendix D), and, in addition, this plate or a separate plate shall indicate

*(a)* the capacity lifting one-piece loads where the elevator conforms to 2.16.7

*(b)* for freight elevators designed for Class C2 loading, the maximum load the elevator is designed to support while being loaded or unloaded [see 2.16.2.2.4(c)]

**2.16.3.2.2** Data plates shall indicate

*(a)* the weight of the complete car, including the car safety and all auxiliary equipment attached to the car

*(b)* the rated load and speed

*(c)* the wire rope data required by 2.20.2.1

*(d)* the name or trademark of the manufacturer and year manufactured

*(e)* rail lubrication instructions (see 2.17.16)

**2.16.3.3 Material and Marking of Plates.** Plates shall be of such material and construction that the letters and figures stamped, etched, cast, or otherwise applied to the faces shall remain permanently and readily legible.

The height of the letters and figures shall be not less than

*(a)* 6 mm (0.25 in.) for passenger elevator capacity plates

*(b)* 25 mm (1 in.) for freight elevator capacity plates

*(c)* 3 mm (0.125 in.) for data plates

### 2.16.4 Carrying of Passengers on Freight Elevators

Freight elevators conforming to 2.16.4.1 through 2.16.4.9 shall be permitted to carry passengers.

**2.16.4.1** The elevator shall not be accessible to the general public.

**2.16.4.2** The rated load shall not be less than that required by 2.16.1.

**2.16.4.3** The elevator shall conform to 2.16.8.

**2.16.4.4** Hoistway entrances shall conform to 2.12.1.1 and 2.11.2.1, or shall be power-operated doors conforming to 2.11.2.2(e).

**2.16.4.5** Car doors shall be provided, and shall conform to 2.14.5.

**2.16.4.6** Openings in car enclosures shall conform to 2.14.2.2.

**2.16.4.7** Hoistway doors and/or car doors shall conform to 2.12.5.

**2.16.4.8** The factors of safety for suspension wire ropes shall conform to Table 2.20.3 for passenger elevators.

**2.16.4.9** Power-operated vertically sliding doors shall be power closed conforming to the following:

*(a)* requirements 2.13.3.2 or 2.13.3.4.

*(b)* shall be provided with a reopening device conforming to 2.13.5. The reopening device shall detect obstruction in the path of closing door travel without the necessity of physical contact. This can be provided by mounting the protection device(s) on the car door itself or on the car or door jamb.

*(c)* vertically sliding hoistway and car doors shall conform to 2.13.6.

*(d)* supporting chains, cables, or ropes shall not be exposed to the car interior.

*(e)* when closed by automatic means, shall be provided with a visual warning to function over the same period as the audible signal in 2.13.3.4.1.

### 2.16.5 Signs Required in Freight Elevator Cars

**2.16.5.1 Signs Required.** Signs, in addition to the capacity and data plates required by 2.16.3.1, shall be provided inside the car and shall be located in a conspicuous position and permanently and securely fastened to the car enclosure, subject to the requirements of 2.16.5.1.1 through 2.16.5.1.3.

**2.16.5.1.1** For every freight elevator, the sign shall specify the type of loading (see 2.16.2.2) for which the elevator is designed and installed, with one of the following markings.

*(a)* "CLASS A LOADING. ELEVATOR TO BE LOADED OR UNLOADED MANUALLY OR BY MEANS OF HAND TRUCKS ONLY. NO SINGLE PIECE OF FREIGHT OR SINGLE HAND TRUCK AND ITS LOAD SHALL EXCEED ____ KG (____ LB)."

*(b)* "CLASS B LOADING. THIS ELEVATOR DESIGNED TO TRANSPORT MOTOR VEHICLES HAVING A MAXIMUM GROSS WEIGHT NOT TO EXCEED ____ KG (____ LB)."

*(c)* "CLASS C1 LOADING. THIS ELEVATOR DESIGNED TO TRANSPORT LOADED INDUSTRIAL TRUCK. MAXIMUM COMBINED WEIGHT OF INDUSTRIAL TRUCK AND LOAD NOT TO EXCEED ____ KG (____ LB)."

*(d)* "CLASS C2 LOADING. THIS ELEVATOR DESIGNED FOR LOADING AND UNLOADING BY INDUSTRIAL TRUCK. MAXIMUM LOADING AND UNLOADING WEIGHT WHILE PARKED NOT TO EXCEED ____ KG ( ____ LB). MAXIMUM WEIGHT

TRANSPORTED NOT TO EXCEED ____ KG (____ LB)."

*(e)* "CLASS C3 LOADING. THIS ELEVATOR DESIGNED TO TRANSPORT CONCENTRATED LOADS NOT TO EXCEED ____ KG (____ LB)."

**2.16.5.1.2** For elevators not permitted to carry passengers, the sign shall read: "THIS IS NOT A PASSENGER ELEVATOR. NO PERSONS OTHER THAN THE OPERATOR AND FREIGHT HANDLERS ARE PERMITTED TO RIDE ON THIS ELEVATOR."

**2.16.5.1.3** For freight elevators permitted to carry passengers (see 2.16.4), a sign reading "PASSENGERS ARE PERMITTED TO RIDE THIS ELEVATOR."

**2.16.5.2 Material and Marking of Signs.** The material and marking of all signs shall conform to 2.16.3.3, except that the letters shall be not less than 13 mm (0.5 in.) high.

### 2.16.6 Overloading of Freight Elevators

Freight elevators shall not be loaded in excess of their rated load as specified on the capacity plate required by 2.16.3, except for

*(a)* static loads on elevators loaded and unloaded by industrial trucks as noted on capacity or separate plate [see 2.16.2.2.3 and 2.16.3.2.1(b)]

*(b)* elevators designed and installed to conform to 2.16.7 to carry one-piece loads exceeding their rated load

### 2.16.7 Carrying of One-Piece Loads Exceeding the Rated Load

Passenger and freight elevators shall be permitted to be used, where necessary, to carry one-piece loads greater than their rated load, provided they are designed, installed, and operated to conform to 2.16.7.1 through 2.16.7.11.

**2.16.7.1** A locking device shall be provided that will hold the car at any landing, independently of the hoisting ropes, while the car is being loaded or unloaded.

**2.16.7.2** The locking device shall be so designed that it cannot be unlocked until the entire weight of the car and load is suspended on the ropes.

**2.16.7.3** A removable wrench or other device shall be provided to operate the locking device.

**2.16.7.4** The locking device shall be so designed that the locking bars will be automatically withdrawn should they come into contact with the landing locks when the car is operated in the up direction.

**2.16.7.5** A special capacity plate shall be provided inside the elevator car and located in a conspicuous place that shall bear the words "CAPACITY LIFTING ONE-PIECE LOADS" in letters, followed by figures giving the special capacity in kilograms (pounds) for lifting one-piece loads for which the machine is designed. For material and size of letters, see 2.16.3.3.

**2.16.7.6** The car frame, car platform, sheaves, shafts, ropes, and locking devices shall be designed for the specified "Capacity Lifting One-Piece Loads," provided that

*(a)* in the design of the car frame, platform, sheaves, shafts, and ropes, the allowable stress is permitted to be 20% higher than those permitted for normal loading

*(b)* the factor of safety for the locking device is not less than 5 (ED)

**2.16.7.7** The car safeties shall be designed to stop and hold the specified "Capacity Lifting One-Piece Loads" with the ropes intact. The safety is not required to conform to the safety stopping distances specified in Table 2.17.3 if applied while the elevator is carrying a one-piece load exceeding the rated load.

**2.16.7.8** Where there is an occupied space, or an unoccupied space not secured against unauthorized access (see 2.6), under the hoistway, the requirements of 2.16.7.8.1 through 2.16.7.8.4 shall be conformed to.

**2.16.7.8.1** The machine shall be designed to operate the "Capacity Lifting One-Piece Loads" at slow speed.

**2.16.7.8.2** The car safety shall be designed to stop and hold the car with this load, independently of the hoisting ropes.

**2.16.7.8.3** The counterweight safety, where required by 2.6, shall be designed to stop and hold the entire weight of the counterweight, independently of the ropes.

**2.16.7.8.4** Under the conditions described in 2.16.7.8.2 and 2.16.7.8.3, the car and counterweight safeties are not required to conform to the safety stopping distances specified in Table 2.17.3 when the elevator is carrying a one-piece load exceeding the rated load and the counterweight is provided with additional weight as required by 2.16.7.9.

**2.16.7.9** For traction machines, where it is necessary to secure adequate traction, an additional counterweight shall be added during the period of use with one-piece loads so that the total overbalance is at least equal to 45% of the "Capacity Lifting One-Piece Loads."

**2.16.7.10** A special operating device of the car switch or continuous-pressure type shall be provided in the machine room, located near the driving machine, to operate the elevator. When this device is operative, all other operating devices shall be inoperative (see 2.26.1.3).

**2.16.7.11** The "Capacity Lifting One-Piece Loads" of any passenger traction elevator shall not exceed 1.33 times the rated load of the elevator.

### 2.16.8 Additional Requirements for Passenger Overload in the Down Direction

Passenger elevators and freight elevators permitted by 2.16.4 to carry passengers shall be designed and installed to safely lower, stop, and hold the car with an additional load up to 25% in excess of the rated load.

The elevator is not required to attain rated load performance under the passenger overload conditions specified but shall conform to

*(a)* requirement 2.17.2, except that 125% of the rated load shall be used in place of the rated load.

*(b)* requirement 2.17.3, except that 125% of the rated load shall be used in the first paragraph in place of the rated load. Second paragraph of 2.17.3, except that 125% of the rated load shall be used in place of the rated load, and the rated load performance including safety stopping distance is not required.

*(c)* requirement 2.24.2.3, except that 125% of rated load shall be used in place of the rated load.

*(d)* requirement 2.24.8, except that 125% of the rated load shall be used in place of the rated load.

*(e)* requirement 2.25.2.1, except that 125% of the rated load shall be used in place of the rated load.

*(f)* requirement 2.26.9.8, except that 125% of the rated load shall be used in place of the rated load.

*(g)* requirement 2.26.10, except that 125% of the rated load shall be used in place of the rated load.

*(h)* requirement 2.19.2.2(b), except that 125% of the rated load shall be used in place of the rated load.

*(i)* requirement 2.27.2.1, except that 125% of rated load shall be used in place of rated load.

### 2.16.9 Special Loading Means

Where special means (lift hooks, conveyor tracks, and support beams) that exert loads upon the car frame or platform, or both, are used to carry loads other than as described in 2.16.2.2, the effects of their loading on the car frame and platform shall be considered in accordance with 8.2.2.1 and 8.2.9.1. The allowable stresses and deflections shall be as specified in 2.15.10 and 2.15.11. The connections shall conform to 2.15.7.

## SECTION 2.17
## CAR AND COUNTERWEIGHT SAFETIES

### 2.17.1 Where Required and Location

The car of every elevator suspended by wire ropes shall be provided with one or more car safety devices of one of the types identified in 2.17.5. The safeties shall be attached to the car frame, and one safety shall be located within or below the car frame.

All car safeties shall be mounted on a single car frame and shall operate only on one pair of guide rails between which the frame is located.

### 2.17.2 Duplex Safeties

Where duplex (two) safeties are provided, the lower safety device shall be capable of developing not less than one-half of the force required to stop the entire car with rated load (see 2.16.8). Duplexed safety devices shall be arranged so as to function approximately simultaneously.

Type A or Type C safety devices (see 2.17.5) shall not be used in multiple (duplexed).

### 2.17.3 Function and Stopping Distance of Safeties (ED)

The safety device, or the combined safety devices, where furnished, shall be capable of stopping and sustaining the entire car with its rated load from governor tripping speed (see also 2.16.8).

Type B safeties shall stop the car with its rated load from governor tripping speed within the range of the maximum and minimum stopping distances as determined by the formulas in 8.2.6. Table 2.17.3 and Fig. 8.2.6 show the maximum and minimum stopping distances for various governor tripping speeds, when tested in conformance with 8.10 and 8.11.

### 2.17.4 Counterweight Safeties

Counterweight safeties, where furnished [see 2.6 and 2.19.3.2(a)(1)], shall conform to the requirements for car safeties, except as specified in 2.17.7 and 2.18.1.

### 2.17.5 Identification and Classification of Types of Safeties

Car safety devices (safeties) are identified and classified on the basis of performance characteristics after the safety begins to apply pressure on the guide rails. On this basis, there are three types of safeties.

**2.17.5.1 Type A Safeties.** Safeties that develop a rapidly increasing pressure on the guide rails during the stopping interval, the stopping distance being very short due to the inherent design of the safety. The operating force is derived entirely from the mass and the motion of the car or the counterweight being stopped. These safeties apply pressure on the guide rails through eccentrics, rollers, or similar devices, without any flexible medium purposely introduced to limit the retarding force and increase the stopping distance.

**2.17.5.2 Type B Safeties.** Safeties that apply limited pressure on the guide rails during the stopping interval, and which provide stopping distances that are related to the mass being stopped and the speed at which application of the safety is initiated. Retarding forces are reasonably uniform after the safety is fully applied. Safeties that require or do not require continuous tension in the governor rope to operate the safety during the entire stopping interval shall be permitted. Minimum and maximum distances are specified on the basis of governor tripping speed (see 2.17.3). (ED)

**Table 2.17.3 Maximum and Minimum Stopping Distances for Type B Car Safeties With Rated Load and Type B Counterweight Safeties**

| SI Units | | | | Imperial Units | | | |
|---|---|---|---|---|---|---|---|
| Rated Speed, m/s | Maximum Governor Trip Speed, m/s | Stopping Distances, mm | | Rated Speed, ft/min | Maximum Governor Trip Speed, ft/min | Stopping Distances, in. | |
| | | Min. | Max. | | | Min. | Max. |
| 0–0.63 | 0.90 | 25 | 380 | 0–125 | 175 | 1 | 15 |
| 0.75 | 1.05 | 50 | 415 | 150 | 210 | 2 | 16 |
| 0.87 | 1.25 | 75 | 485 | 175 | 250 | 3 | 19 |
| 1.00 | 1.40 | 100 | 540 | 200 | 280 | 4 | 22 |
| 1.12 | 1.55 | 125 | 605 | 225 | 308 | 5 | 24 |
| 1.25 | 1.70 | 150 | 675 | 250 | 337 | 6 | 27 |
| 1.50 | 2.00 | 200 | 840 | 300 | 395 | 8 | 33 |
| 1.75 | 2.30 | 250 | 1 025 | 350 | 452 | 10 | 40 |
| 2.00 | 2.55 | 330 | 1 200 | 400 | 510 | 13 | 48 |
| 2.25 | 2.90 | 430 | 1 480 | 450 | 568 | 17 | 58 |
| 2.50 | 3.15 | 505 | 1 700 | 500 | 625 | 20 | 68 |
| 3.00 | 3.70 | 710 | 2 250 | 600 | 740 | 28 | 91 |
| 3.50 | 4.30 | 940 | 2 950 | 700 | 855 | 38 | 128 |
| 4.00 | 4.85 | 1 200 | 3 680 | 800 | 970 | 49 | 150 |
| 4.50 | 5.50 | 1 540 | 4 660 | 900 | 1,085 | 61 | 183 |
| 5.00 | 6.00 | 1 835 | 5 500 | 1,000 | 1,200 | 75 | 222 |
| 5.50 | 6.60 | 2 220 | 6 600 | 1,100 | 1,320 | 90 | 268 |
| 6.00 | 7.20 | 2 640 | 7 800 | 1,200 | 1,440 | 107 | 316 |
| 6.50 | 7.80 | 3 100 | 9 110 | 1,300 | 1,560 | 126 | 371 |
| 7.00 | 8.40 | 3 595 | 10 530 | 1,400 | 1,680 | 146 | 427 |
| 7.50 | 9.00 | 4 125 | 12 050 | 1,500 | 1,800 | 168 | 490 |
| 8.00 | 9.60 | 4 695 | 13 670 | 1,600 | 1,920 | 191 | 555 |
| 8.50 | 10.20 | 5 300 | 15 400 | 1,700 | 2,040 | 215 | 628 |
| 9.00 | 10.80 | 5 940 | 17 240 | 1,800 | 2,160 | 241 | 700 |
| 9.50 | 11.40 | 6 620 | 19 180 | 1,900 | 2,280 | 269 | 779 |
| 10.00 | 12.00 | 7 335 | 21 220 | 2,000 | 2,400 | 299 | 862 |

**2.17.5.3 Type C Safeties (Type A With Oil Buffers).** Safeties that develop retarding forces during the compression stroke of one or more oil buffers interposed between the lower members of the car frame and a governor-operated Type A auxiliary safety plank applied on the guide rails. The stopping distance is equal to the effective stroke of the buffers.

### 2.17.6 Reserved for Future Use

### 2.17.7 Governor-Actuated Safeties and Car Safety Mechanism Switches Required

(ED) **2.17.7.1** Counterweight safeties, where provided for rated speeds over 0.75 m/s (150 ft/min), and car safeties, shall be actuated by separate speed governors.

Counterweight safeties for rated speeds of not over 0.75 m/s (150 ft/min) shall be permitted to be operated as a result of the breaking or slackening of the suspension ropes and shall be permitted to be of the inertia or other approved type without governors.

Where counterweight safeties are furnished to provide ascending car overspeed protection in accordance with 2.19.1.1, they shall be actuated by a counterweight speed governor (see 2.17.4).

**2.17.7.2** Every car safety shall be provided with a switch, operated by the car safety mechanism (see 2.26.2.9).

A switch operated by the safety mechanism is not required on counterweight safeties.

**2.17.7.3** The car safety mechanism switch shall operate before or at the time of application of the safety.

**2.17.7.4** Switches operated by the car safety mechanism shall be of a type that cannot be reset until the car safety mechanism has been returned to the unapplied position.

### 2.17.8 Limits of Use of Various Types of Safeties

**2.17.8.1 Type A (Instantaneous) Safeties.** Type A (ED) safeties shall be permitted on elevators having a rated

speed of not more than 0.75 m/s (150 ft/min).

When overspeed occurs, with the hoisting rope intact, such safeties shall be actuated by the governor.

On the parting of the hoisting ropes (free fall), Type A governor-operated safeties shall apply without appreciable delay, and their application shall be independent of the speed action of the governor and of the location of the break in the hoisting ropes (inertia application), and shall be permitted to be accomplished by the use of a governor and governor rigging having a sufficiently high value of inertia to apply the safety on free fall independently of the speed action of the governor (see 8.10 for inertia-application test of car safety).

**2.17.8.2 Type C (Combination Instantaneous and Oil-Buffer Safety).** Type C safeties shall be permitted subject to the requirements of 2.17.8.2.1 through 2.17.8.2.8.

**2.17.8.2.1** The rated speed shall be not more than 2.5 m/s (500 ft/min).

**2.17.8.2.2** The oil buffers shall conform to all requirements specified in 2.22 for oil buffers, except that the stroke shall be based on governor tripping speed and on an average retardation not exceeding 9.81 $m/s^2$ (32.2 $ft/s^2$).

**2.17.8.2.3** After the buffer stroke, as defined in 2.17.8.2.2, has been completed, provision shall be made for an additional travel of the plunger or piston of not less than 10% of the buffer stroke, to prevent excessive impact on the buffer parts and the auxiliary safety plank.

**2.17.8.2.4** Where the distance between guide rails exceeds 2 450 mm (96 in.), the safety shall be provided with two oil buffers of substantially identical calibration, and the buffers shall be so located as to develop minimum stresses in the auxiliary safety plank during safety operation.

Buffers shall be located in line with and symmetrically between the guide rails.

**2.17.8.2.5** The auxiliary safety plank shall be so supported and guided below the car frame that the clearances specified in 2.17.10 for the safety parts are maintained during normal operation.

The auxiliary safety plank shall be so designed that the maximum stresses in the plank shall not exceed those specified for similar car-frame members in 2.15.

**2.17.8.2.6** The rail-gripping device of the auxiliary safety plank shall be so arranged and connected as to prevent the plank from being out of level more than 13 mm (0.5 in.) in the length of the plank when the safety is operated to stop the car.

**2.17.8.2.7** An electric switch shall be provided and so arranged and connected that the elevator cannot be operated by means of the normal operating device if any buffer is compressed more than 10% of its stroke (see 2.26.2.13).

**2.17.8.2.8** Means shall be provided to prevent operation of the elevator by means of the normal operating device if the oil level in buffer is below the minimum level (see 2.26.2.13).

### 2.17.9 Application and Release of Safeties

**2.17.9.1 Means of Application.** Safeties shall be applied mechanically. Electric, hydraulic, or pneumatic devices shall not be used to apply the safeties required by 2.17, nor to hold such safeties in the retracted position.

**2.17.9.2 Level of Car on Safety Application.** The application of a Type A or Type B safety to stop the car, with its rated load centered on each quarter of the platform symmetrically with relation to the centerlines of the platform, shall not cause the platform to be out of level more than 30 mm/m (0.36 in./ft) in any direction. (See 2.17.8.2.6 for Type C safeties.)

**2.17.9.3 Release.** When car safeties are applied, no decrease in tension in the governor rope or motion of the car in the down direction shall release the safeties, but such safeties shall be permitted to be released by the motion of the car in the up direction.

**2.17.9.4 Force Providing Stopping Action to Be Compressive.** Safeties shall be so designed that, on their application, the forces that provide the stopping action shall be compressive forces on each side of the guide-rail section.

### 2.17.10 Minimum Permissible Clearance Between Rail-Gripping Faces of Safety Parts

In the normally retracted position of the safety, the distance between the rail-gripping faces of the safety parts shall be not less than the thickness of the guide rail plus 3.5 mm (0.14 in.), and the clearance on any side between the gripping face and the guide rail shall be not less than 1.5 mm (0.06 in.), as measured on the side of the rail toward which the car frame is pressed with sufficient force to take up all clearances in the guide-shoe assembly. Safety jaws, while in the retracted position, shall be so restrained as to prevent a reduction of this minimum clearance.

### 2.17.11 Maximum Permissible Movement of Governor Rope to Operate the Safety Mechanism

For all Type B safeties, the movement of the governor rope, relative to the car or the counterweight, respectively, required to operate the safety mechanism from its fully retracted position to a position where the safety jaws begin to exert pressure against the guide rails, shall not exceed the following values based on rated speed:

*(a)* for car safeties

*(1)* 1 m/s (200 ft/min) or less, 1 070 mm (42 in.)

(2) 1.01 m/s (201 ft/min) to 1.9 m/s (375 ft/min), 915 mm (36 in.)

(3) over 1.9 m/s (375 ft/min), 756 mm (30 in.)

(b) for counterweight safeties, all speeds, 1 070 mm (42 in.)

Drum-operated car and counterweight safeties, requiring continual unwinding of the safety drum rope to fully apply the safety, shall be so designed that not less than three turns of the safety rope will remain on the drum after the overspeed test of the safety has been made with rated load in the car.

### 2.17.12 Minimum Factors of Safety and Stresses of Safety Parts and Rope Connections

**2.17.12.1** Parts of safeties, except springs, safety-rope drums, leading sheaves, and their supporting brackets and safety-jaw gibs, shall have a factor of safety of not less than 3.5, and the materials used shall have an elongation of not less than 15% in a length of 50 mm (2 in.) when tested in accordance with ASTM E 8. Forged, cast, or welded parts shall be stress relieved.

**2.17.12.2** Springs are permitted in the operation of car or counterweight safeties. Where used, and where partially loaded prior to safety operation, the loading on the spring shall not produce a fibre stress exceeding one-half the elastic limit of the material. During operation of the safety, the fibre stress shall not exceed 85% of the elastic limit of the material. Helical springs, where used, shall be in compression.

**2.17.12.3** Safety-rope drums, leading sheaves, and their supporting brackets and safety-jaw gibs, are permitted to be made of cast iron and other metals provided such parts have a factor of safety of not less than 10.

**2.17.12.4** Rope used as a connection from the safety to the governor rope, including rope wound on the safety-rope drum, shall be not less than 9.5 mm (0.375 in.) in diameter, shall be made of metal, and shall be corrosion resistant. The factor of safety of the rope shall be not less than 5. Tiller-rope construction shall not be used.

**2.17.12.5** The factors of safety shall be based upon the maximum stresses developed in the parts during the operation of the safety when stopping rated load from governor tripping speed.

**2.17.12.6** Safety-rope leading sheave brackets and other safety operating parts shall not be attached to or supported by wood platform members.

### 2.17.13 Corrosion-Resistant Bearings in Safeties and Safety Operating Mechanisms

Bearings in safeties and in the safety-operating mechanisms shall be of corrosion-resistant construction, with one or both members of the bearing made of, or electroplated with, a corrosion-resistant material.

### 2.17.14 Marking Plates for Safeties

A metal plate shall be securely attached to each safety so as to be readily visible, and shall be marked in a legible and permanent manner with letters and figures not less than 6 mm (0.25 in.) in height indicating:

(a) the type of safety, based on 2.17.5

(b) the maximum tripping speed in m/s (ft/min) for which the safety is permitted

(c) the maximum weight in kg (lb), which the safety is designed and installed to stop and sustain

(d) the force in N (lbf) required to activate the safety or rope releasing carrier, if provided

(e) the manufacturer's name or trademark

### 2.17.15 Governor-Rope Releasing Carriers

Where a governor-rope releasing carrier is used to prevent actuation of the safety by the inertial forces of the governor-rope system, or used for any other purpose, the governor-rope releasing carrier on the car (or on the counterweight) shall be set to require a tension in the governor rope, to pull the rope from the carrier, of not more than 60% of the pull-through tension developed by the governor. The means to regulate the governor-rope pull-out force shall be mechanical and shall be sealed. The carrier shall be designed so that the pull-out tension cannot be adjusted to exceed the amount specified without breaking the seal.

### 2.17.16 Rail Lubricants and Lubrication Plate

Rail lubricants or coatings that will reduce the holding power of the safety, or prevent its functioning as required in 2.17.3, shall not be used (see 8.7 for maintenance requirements).

A metal plate as required by 2.16.3.2 shall be securely attached to the car crosshead in an easily visible location, and, where lubricants are to be used, shall carry the notation, "CONSULT MANUFACTURER OF THE SAFETY FOR THE CHARACTERISTICS OF THE RAIL LUBRICANT TO BE USED." If lubricants are not to be used, the plate shall so state.

If lubricants other than those recommended by the manufacturer are used, a safety test shall be made to demonstrate that the safety will function as required by 2.17.3.

## SECTION 2.18
## SPEED GOVERNORS

### 2.18.1 Speed Governors Required and Location

**2.18.1.1** Counterweight safeties, where provided with rated speeds over 0.75 m/s (150 ft/min), and car safeties shall be actuated by separate speed governors.

Where counterweight safeties are furnished to provide ascending car overspeed protection in accordance with 2.19.1.1, they shall be actuated by a counterweight speed governor (see 2.17.4.)

**Table 2.18.2.1 Maximum Car Speeds at Which Speed Governor Trips and Governor Overspeed Switch Operates**

| SI Units | | | Imperial Units | | |
|---|---|---|---|---|---|
| Rated Speed, m/s | Maximum Car Governor Trip Speed, m/s | Maximum Car Speed at Which Governor Overspeed Switch Operates, Down, m/s [Note (1)] | Rated Speed, ft/min | Maximum Car Governor Trip Speed, ft/min | Maximum Car Speed at Which Governor Overspeed Switch Operates, Down, ft/min [Note (1)] |
| 0–0.63 | 0.90 | 0.81 | 0–125 | 175 | 175 |
| 0.75 | 1.05 | 0.95 | 150 | 210 | 210 |
| 0.87 | 1.25 | 1.13 | 175 | 250 | 225 |
| 1.00 | 1.40 | 1.26 | 200 | 280 | 252 |
| 1.12 | 1.55 | 1.40 | 225 | 308 | 277 |
| 1.25 | 1.70 | 1.53 | 250 | 337 | 303 |
| 1.50 | 2.00 | 1.80 | 300 | 395 | 355 |
| 1.75 | 2.30 | 2.07 | 350 | 452 | 407 |
| 2.00 | 2.55 | 2.30 | 400 | 510 | 459 |
| 2.25 | 2.90 | 2.61 | 450 | 568 | 512 |
| 2.50 | 3.15 | 2.84 | 500 | 625 | 563 |
| 3.00 | 3.70 | 3.52 | 600 | 740 | 703 |
| 3.50 | 4.30 | 4.09 | 700 | 855 | 812 |
| 4.00 | 4.85 | 4.61 | 800 | 970 | 921 |
| 4.50 | 5.50 | 5.23 | 900 | 1,085 | 1,031 |
| 5.00 | 6.00 | 5.70 | 1,000 | 1,200 | 1,140 |
| 5.50 | 6.60 | 6.27 | 1,100 | 1,320 | 1,254 |
| 6.00 | 7.20 | 6.84 | 1,200 | 1,440 | 1,368 |
| 6.50 | 7.80 | 7.41 | 1,300 | 1,560 | 1,482 |
| 7.00 | 8.40 | 7.98 | 1,400 | 1,680 | 1,596 |
| 7.50 | 9.00 | 8.55 | 1,500 | 1,800 | 1,710 |
| 8.00 | 9.60 | 9.12 | 1,600 | 1,920 | 1,824 |
| 8.50 | 10.20 | 9.69 | 1,700 | 2,040 | 1,938 |
| 9.00 | 10.80 | 10.26 | 1,800 | 2,160 | 2,052 |
| 9.50 | 11.40 | 10.83 | 1,900 | 2,280 | 2,166 |
| 10.00 | 12.00 | 11.40 | 2,000 | 2,400 | 2,280 |

NOTE:
(1) See 2.18.4.2.5.

**2.18.1.2** The governor shall be located where it cannot be struck by the car or the counterweight in case of overtravel, and where there is adequate space for full movement of governor parts.

### 2.18.2 Tripping Speeds for Speed Governors

**2.18.2.1 Car Speed Governors.** Speed governors for car safeties shall be set to trip at car speeds as follows:

*(a)* at not less than 115% of the rated speed.

(ED) *(b)* at not more than the tripping speed listed opposite the applicable rated speed in Table 2.18.2.1. Maximum tripping speeds for intermediate rated speeds shall be determined from Fig. 8.2.5. For rated speeds exceeding 10 m/s (2,000 ft/min), the maximum tripping speeds shall not exceed 120% of the rated speed.

**2.18.2.2 Counterweight Speed Governors.** Speed governors, where provided for counterweight safeties, shall be set to trip at an overspeed greater than that at which the car speed governor is to trip, but not more than 10% higher.

### 2.18.3 Sealing and Painting of Speed Governors

**2.18.3.1** Speed governors shall have their means of speed adjustment sealed after test. If speed governors are painted after sealing, all bearing and rubbing surfaces shall be kept free or freed of paint and a hand test made to determine that all parts operate freely as intended.

**2.18.3.2** Where the rope retarding means provides for adjustment of the rope pull-through force (tension),

means shall be provided to seal the means of adjustment of the rope tension.

(ED) **2.18.3.3** Seals shall be of a type that will prevent readjustment of the sealed governor adjustments without breaking the seal. Provision shall be made to enable affixing seals after tests.

### 2.18.4 Speed-Governor Overspeed Switch

#### 2.18.4.1 Where Required and Function

**2.18.4.1.1** A switch shall be provided on every car and counterweight speed governor (see 2.26.2.10).

**2.18.4.1.2** The switches required in 2.18.4.1.1 shall be operated by the overspeed action of the governor, except that the counterweight governor switch shall be permitted to be operated upon activation of the counterweight governor-rope retarding means (see 2.18.6.1).

**2.18.4.2 Setting of Car Speed-Governor Overspeed Switches.** The setting of the car speed-governor overspeed switch shall conform to 2.18.4.2.1 through 2.18.4.2.6.

**2.18.4.2.1** For rated speeds more than 0.75 m/s (150 ft/min), up to and including 2.5 m/s (500 ft/min), the car speed-governor overspeed switch shall open in the down direction of the elevator at not more than 90% of the speed at which the governor is set to trip in the down direction.

**2.18.4.2.2** For rated speeds more than 2.5 m/s (500 ft/min), the car speed-governor overspeed switch shall open in the down direction of the elevator at not more than 95% of the speed at which the governor is set to trip in the down direction.

**2.18.4.2.3** For elevators with static control, the car speed-governor overspeed switch shall open in the down direction of the elevator at not more than 90% of the speed at which the governor is set to trip in the down direction.

**2.18.4.2.4** The switch, when set as specified in either 2.18.4.2.1, 2.18.4.2.2, or 2.18.4.2.3, shall open in the up direction at not more than 100% of the speed at which the governor is set to trip in the down direction.

**2.18.4.2.5** The speed-governor overspeed switch shall be permitted to open in the down direction of the elevator at not more than 100% of the speed at which the governor is set to trip in the down direction, subject to the following requirements:

*(a)* A speed-reducing switch of the manually reset type is provided on the governor, which will reduce the speed of the elevator in case of overspeed, and which shall be set to open as specified in 2.18.4.2.1, 2.18.4.2.2, or 2.18.4.2.3.

*(b)* Subsequent to the first stop of the car following the opening of the speed-reducing switch, the car shall remain inoperative until the switch is manually reset.

**2.18.4.3 Setting of the Counterweight Governor Switch.** Where the counterweight governor switch is operated by the overspeed action (see 2.18.2.2), the switch shall be set to open when the counterweight is descending at a speed greater than the elevator rated speed, but not more than the speed at which the counterweight governor is set to trip.

**2.18.4.4 Type of Speed-Governor Overspeed Switches and Speed-Reducing Switches.** Switches used to perform the function specified shall be positively opened. Overspeed and speed-reducing switches permitted by 2.18.4.2.5 and operated by the speed governor shall remain in the open position until manually reset.

### 2.18.5 Governor Ropes

**2.18.5.1 Material and Factor of Safety.** Governor ropes shall be of iron, steel, monel metal, phosphor bronze, or stainless steel. They shall be of a regular-lay construction and not less than 9.5 mm (0.375 in.) in diameter. The factor of safety of governor ropes shall be not less than 5. Tiller-rope construction shall not be used.

**2.18.5.2 Speed-Governor-Rope Clearance.** During normal operation of the elevator, the governor rope shall run free and clear of the governor jaws, rope guards, or other stationary parts.

**2.18.5.3 Governor-Rope Tag.** A metal data tag shall be securely attached to the governor rope fastening. This data tag shall bear the following wire-rope data:

*(a)* the diameter (mm or in.)
*(b)* the manufacturer's rated breaking strength
*(c)* the grade of material used
*(d)* the year and month the rope was installed
*(e)* whether nonpreformed or preformed
*(f)* construction classification
*(g)* name of the person or organization who installed the rope
*(h)* name or trademark by which the manufacturer of the rope can be identified

A new tag shall be installed at each rope renewal. The material and marking of the rope data tag shall conform to 2.16.3.3, except that the height of the letters and figures shall be not less than 1.5 mm (0.06 in.).

### 2.18.6 Design of Governor-Rope Retarding Means for Type B Safeties

Type B car and counterweight safeties shall be activated by a speed governor with a governor-rope retarding means conforming to 2.18.6.1 through 2.18.6.5.

**2.18.6.1** Upon activation at the tripping speeds given by 2.18.2, the means shall retard the rope with a force that is at least 67% greater than the force required to activate the safety or to trip the governor-rope releasing carrier, where used (see 2.17.15).

**2.18.6.2** The means shall be set to allow the governor rope to slip through the speed governor at a rope tension (the governor pull-through tension) higher than required to activate the safety or to trip the releasing carrier as specified in 2.17.15. The maximum tension in the rope shall not exceed one-fifth of the rated ultimate strength of the rope.

**2.18.6.3** The means shall be designed to prevent appreciable damage to, or deformation of, the governor rope resulting from its application (stopping action).

**2.18.6.4** The means shall provide a continuous tension in the governor rope as required to operate the safety during the entire stopping interval in accordance with 2.17.5.2.

**2.18.6.5** The governor shall be arranged to be tripped by hand to facilitate the tests specified in 8.10.

### 2.18.7 Design of Speed-Governor Sheaves and Traction Between Speed-Governor Rope and Sheave

**2.18.7.1** The arc of contact between the governor rope and the governor sheave shall, in conjunction with a governor-rope tension device, provide sufficient traction to cause proper functioning of the governor.

**2.18.7.2** Where the rope force imparted to the governor rope (see 2.18.6.1) necessary to activate the safety, or to trip the releasing carrier, if used, is dependent upon the tension in the governor rope prior to governor tripping, a switch or switches mechanically opened by the governor tension sheave before the sheave reaches its upper or lower limit of travel shall be provided. This switch shall be of the manually reset type and shall conform to 2.26.4.3. Subsequent to the first stop of the car following the opening of the switch, the car shall remain inoperative until the switch is manually reset.

**2.18.7.3** Governor sheave grooves shall have machine-finished surfaces. Governor tension sheaves shall have machine-finished grooves for rated car speeds of more than 0.75 m/s (150 ft/min). Machined governor sheave grooves shall have a groove diameter of not more than 1.15 times the diameter of the governor rope.

**2.18.7.4** The pitch diameter of governor sheaves and governor tension sheaves shall be not less than the product of the diameter of the rope and the applicable multiplier listed in Table 2.18.7.4, based on the rated speed and the number of strands in the rope.

### 2.18.8 Factors of Safety in Load-Bearing Parts of Speed Governor

**2.18.8.1** Material, except cast iron, used in load-bearing parts of speed governors shall have a factor of safety of not less than 3.5, and the materials used shall have an elongation of not less than 15% in a length of 50 mm (2 in.) when tested in accordance with ASTM E 8. Forged, cast, or welded parts shall be stress relieved. Cast iron shall have a factor of safety of not less than 10.

**Table 2.18.7.4 Multiplier for Determining Governor Sheave Pitch Diameter**

| Rated Speed, m/s (ft/min) | Number of Strands | Multiplier |
|---|---|---|
| 1.00 or less (200 or less) | 6 | 42 |
| 1.00 or less (200 or less) | 8 | 30 |
| Over 1.00 (over 200) | 6 | 46 |
| Over 1.00 (over 200) | 8 | 32 |

**2.18.8.2** The factors of safety shall be based upon the maximum stresses developed in the parts during normal or governor tripping operation.

### 2.18.9 Speed-Governor Marking Plate

A metal plate shall be securely attached to each speed governor and shall be marked in a legible and permanent manner with letters and figures not less than 6 mm (0.25 in.) in height indicating the following:

*(a)* the speed in m/s (ft/min) at which the governor is set and sealed to trip the governor-rope retarding means

*(b)* the size, material, and construction of the governor rope on which the governor-rope retarding means were designed to operate

*(c)* the governor pull-through tension (force) in N (lbf) (see 2.18.6.2)

*(d)* manufacturer's name or trademark

*(e)* statement "DO NOT LUBRICATE GOVERNOR ROPE"

## SECTION 2.19
## ASCENDING CAR OVERSPEED AND UNINTENDED CAR MOVEMENT PROTECTION

### 2.19.1 Ascending Car Overspeed Protection

**2.19.1.1 Purpose.** Ascending car overspeed protection shall be provided to prevent the car from striking the hoistway overhead structure as a result of a failure in

*(a)* the electric driving-machine motor, brake, coupling, shaft, or gearing

*(b)* the control system

*(c)* any other component upon which the speed of the car depends, except the suspension ropes and the drive sheave of the traction machine

**2.19.1.2 Where Required and Function.** All electric traction elevators, except those whose empty car weight exceeds the total weight of the suspension ropes and counterweight, shall be provided with a device to prevent an ascending elevator from striking the hoistway overhead structure. This device (see 2.26.2.29) shall

*(a)* detect an ascending car overspeed condition at a speed not greater than 10% higher than the speed at which the car governor is set to trip (see 2.18.2.1).

*(1)* If the overspeed detection means requires electrical power for its functioning

*(a)* a loss of electrical power to the ascending car overspeed detection and control means shall cause the immediate activation of the emergency brake as required in 2.19.1.2(b)

*(b)* the occurrence of a single ground, or the failure of any mechanically operated switch that does not meet the requirements of 2.26.4.3, any single magnetically operated switch, contactor, or relay, or any single solid-state device, or a software system failure, shall not render the detection means inoperative

*(2)* The failure of any single mechanically operated switch that does not meet the requirements of 2.26.4.3 shall not render the detection means inoperative.

*(3)* When a fault specified in 2.19.1.2(a)(1)(b) or 2.19.1.2(a)(2) is detected, the car shall stop at or before the next landing for which a demand was registered, and shall not be permitted to restart.

*(4)* Once actuated by overspeed, the overspeed detection means shall remain actuated until manually reset, and the car shall not start or run unless the detection means is reset.

*(b)* decelerate the car when loaded with any load up to its rated load [see 2.16.8(h)] by applying an emergency brake conforming to 2.19.3. The car shall not start or run unless the emergency brake is reset.

### 2.19.2 Protection Against Unintended Car Movement

**2.19.2.1 Purpose.** Protection shall be provided with a device to prevent unintended car movement away from the landing with the hoistway door not in the locked position and the car door not in the closed position, as a result of failure in

*(a)* the electric driving-machine motor, brake, coupling, shaft, or gearing

*(b)* the control system

*(c)* any other component upon which the speed of the car depends, except the suspension ropes and the drive sheave of the traction machine

**2.19.2.2 Where Required and Function.** All electric traction elevators shall be provided with a device (see 2.26.2.30) that shall

*(a)* detect unintended car movement away from the landing with the hoistway door not in the locked position and the car door not in the closed position.

NOTE: Freight elevators provided with combination mechanical locks and contacts on the hoistway door shall detect the closed position of the hoistway door and the closed position of the car door.

*(1)* If the detection means requires electrical power for its functioning

*(a)* a loss of electrical power to the unintended movement detection and control means shall cause the immediate activation of the emergency brake as required in 2.19.2.2(b)

*(b)* the occurrence of a single ground, or the failure of any mechanically operated switch that does not meet the requirements of 2.26.4.3, any single magnetically operated switch, contactor, or relay, or any single solid-state device, or software system failure, shall not render the detection means inoperative

*(2)* The failure of any single mechanically operated switch that does not meet the requirements of 2.26.4.3, shall not render the detection means inoperative.

*(3)* When a fault specified in 2.19.2.2(a)(1)(b) or 2.19.2.2(a)(2) is detected, the car shall stop at or before the next landing for which a demand was registered, and shall not be permitted to restart.

*(4)* Once actuated by unintended movement, the detection means shall remain actuated until manually reset, and the car shall not start or run unless the detection means is reset.

*(b)* upon detection of unintended car movement, stop and hold the car, with any load up to rated load [see also 2.16.8(h)], by applying an emergency brake conforming to 2.19.3, with the car movement limited in both directions, to a maximum of 1 220 mm (48 in.). The car shall not start or run unless the emergency brake provided for the unintended movement protection is reset.

### 2.19.3 Emergency Brake (See Nonmandatory Appendix F)

#### 2.19.3.1 Where Required

**2.19.3.1.1** When required by 2.19.1 for protection against ascending car overspeed, an emergency brake (see 1.3) conforming to 2.19.3.2 shall be provided.

**2.19.3.1.2** When required by 2.19.2 for protection against unintended car movement, an emergency brake (see 1.3) conforming to 2.19.3.2 shall be provided.

**2.19.3.1.3** A single device shall be permitted to meet the requirements of both 2.19.3.1.1 and 2.19.3.1.2, or separate devices shall be provided.

**2.19.3.2 Requirements.** The emergency brake is permitted to consist of one or more devices and shall

*(a)* function to decelerate the car by acting on one or more of the following (see also 2.19.4):

*(1)* counterweight [e.g., counterweight safety (see 2.17.4 and 2.17.7)].

*(2)* car.

*(3)* suspension or compensation rope system.

*(4)* drive sheave of a traction machine.

*(5)* brake drum or braking surface of the driving-machine brake, provided that the driving-machine brake surface is integral (cast or welded) with or directly

attached to the driving-machine sheave. Attachments, where used, shall conform to 2.24.3 and 2.24.4.1. Welding, where used, shall conform to 8.8.

*(b)* be independent of the driving-machine brake.

*(c)* not be used to provide, or assist in providing, the normal stopping of the car. When the emergency brake is activated during normal elevator stops, it shall only be applied to and released from a stationary braking surface.

*(d)* not require the application of electrical power for its activation, nor be rendered inoperative by the failure of any power supply.

*(e)* not on its own cause the car average retardation to exceed 9.8 $m/s^2$ (32.2 $ft/s^2$) during the stopping or slowdown phase during ascending car overspeed.

*(f)* be designed so that the factors of safety based on the maximum stresses developed in the parts subject to load during the operation of the emergency brake shall comply with the following:

*(1)* Where an emergency brake is activated only when protecting against either an ascending car overspeed condition or unintended car movement with the car and hoistway doors open, the minimum factors of safety, when applied during the retardation phase of emergency braking, shall be not less than those specified in 2.17.12.1.

*(2)* Where an emergency brake is activated during normal stops of the elevator, the minimum factors of safety, when applied during the retardation phase of emergency braking, shall be not less than those specified in 2.24.3.1 and 2.24.3.2.

*(3)* Where an emergency brake acts on the suspension or compensation rope system

*(a)* the factor of safety with respect to the breaking strength of the ropes shall be not less than 5 at any time during the retardation phase

*(b)* it shall be designed to prevent appreciable damage or deformation to the ropes resulting from its activation

*(g)* be arranged to be tested in accordance with the requirements specified in 8.10.2.

**2.19.3.3 Marking Plate Requirements.** The emergency brake shall be provided with a marking plate indicating the range of total masses (car with attachments and its load) for which it is permitted to be used, the range of speeds at which it is set to operate, and the criteria such as rail lubrication requirements that are critical to the performance.

### 2.19.4 Emergency Brake Supports

All components and structural members, including their fastenings, subjected to forces due to the application of the emergency brake shall be designed to withstand the maximum forces developed during the retardation phase of the emergency braking so that the resulting stresses shall not exceed those permitted for the applicable type of equipment as follows:

*(a)* machinery and sheave beams (see 2.9.6)

*(b)* guide rails and their supports (see 2.23.5.3)

*(c)* counterweight frames (see 2.21.2.3.3)

*(d)* car frames (see 2.15.10.2)

*(e)* machines, sheaves, and bedplates (see 2.24.3.2)

## SECTION 2.20
## SUSPENSION ROPES AND THEIR CONNECTIONS

### 2.20.1 Suspension Means

Elevator cars shall be suspended by steel wire ropes attached to the car frame or passing around sheaves attached to the car frame specified in 2.15.1. Ropes that have previously been installed and used on another installation shall not be reused.

Only iron (low-carbon steel) or steel wire ropes, having the commercial classification "Elevator Wire Rope," or wire rope specifically constructed for elevator use, shall be used for the suspension of elevator cars and for the suspension of counterweights. The wire material for ropes shall be manufactured by the open-hearth or electric furnace process or their equivalent.

### 2.20.2 Wire Rope Data

**2.20.2.1 On Crosshead Data Plate.** The crosshead data plate required by 2.16.3 shall bear the following wire-rope data:

*(a)* the number of ropes

*(b)* the diameter in millimeters (mm) or inches (in.)

*(c)* the manufacturer's rated breaking strength per rope in kilo Newton (kN) or pounds (lb)

**2.20.2.2 On Rope Data Tag.** A metal data tag shall be securely attached to one of the wire-rope fastenings. This data tag shall bear the following wire-rope data:

*(a)* the diameter in millimeters (mm) or inches (in.)

*(b)* the manufacturer's rated breaking strength

*(c)* the grade of material used

*(d)* the month and year the ropes were installed

*(e)* the month and year the ropes were first shortened

*(f)* whether the ropes were nonpreformed or preformed

*(g)* construction classification

*(h)* name of the person or organization who installed the ropes

*(i)* name or trademark of the manufacturer of the ropes

*(j)* lubrication information

A new tag shall be installed at each rope renewal.

The material and marking of the rope data tag shall conform to 2.16.3.3, except that the height of the letters and figures shall be not less than 1.5 mm (0.06 in.).

### 2.20.3 Factor of Safety

The factor of safety of the suspension wire ropes shall be not less than shown in Table 2.20.3. Figure 8.2.7 gives

**Table 2.20.3 Minimum Factors of Safety for Suspension Wire Ropes**

| Rope Speed, m/s (ft/min) | Minimum Factor of Safety | |
|---|---|---|
| | Passenger | Freight |
| 0.25 (50) | 7.60 | 6.65 |
| 0.37 (75) | 7.75 | 6.85 |
| 0.50 (100) | 7.97 | 7.00 |
| 0.62 (125) | 8.10 | 7.15 |
| 0.75 (150) | 8.25 | 7.30 |
| 0.87 (175) | 8.40 | 7.45 |
| 1.00 (200) | 8.60 | 7.65 |
| 1.12 (225) | 8.75 | 7.75 |
| 1.25 (250) | 8.90 | 7.90 |
| 1.50 (300) | 9.20 | 8.20 |
| 1.75 (350) | 9.50 | 8.45 |
| 2.00 (400) | 9.75 | 8.70 |
| 2.25 (450) | 10.00 | 8.90 |
| 2.50 (500) | 10.25 | 9.15 |
| 2.75 (550) | 10.45 | 9.30 |
| 3.00 (600) | 10.70 | 9.50 |
| 3.25 (650) | 10.85 | 9.65 |
| 3.50 (700) | 11.00 | 9.80 |
| 3.75 (750) | 11.15 | 9.90 |
| 4.00 (800) | 11.25 | 10.00 |
| 4.25 (850) | 11.35 | 10.10 |
| 4.50 (900) | 11.45 | 10.15 |
| 4.75 (950) | 11.50 | 10.20 |
| 5.00 (1,000) | 11.55 | 10.30 |
| 5.25 (1,050) | 11.65 | 10.35 |
| 5.50 (1,100) | 11.70 | 10.40 |
| 5.75 (1,150) | 11.75 | 10.45 |
| 6.00 (1,200) | 11.80 | 10.50 |
| 6.25 (1,250) | 11.80 | 10.50 |
| 6.50 (1,300) | 11.85 | 10.55 |
| 6.75 (1,350) | 11.85 | 10.55 |
| 7.00–10.00 (1,400–2,000) | 11.90 | 10.55 |

the minimum factor of safety for intermediate rope speeds. The factor of safety shall be based on the actual rope speed corresponding to the rated speed of the car.

The factor of safety shall be calculated by the following formula:

$$f = \frac{S \times N}{W}$$

where

$N$ = number of runs of rope under load. For 2:1 roping, $N$ shall be two times the number of ropes used, etc.

$S$ = manufacturer's rated breaking strength of one rope

$W$ = maximum static load imposed on all car ropes with the car and its rated load at any position in the hoistway

### 2.20.4 Minimum Number and Diameter of Suspension Ropes

The minimum number of hoisting ropes used shall be three for traction elevators and two for drum-type elevators.

Where a car counterweight is used, the number of counterweight ropes used shall be not less than two.

The term "diameter," where used in reference to ropes, shall refer to the nominal diameter as given by the rope manufacturer.

The minimum diameter of hoisting and counterweight ropes shall be 9.5 mm (0.375 in.). Outer wires of the ropes shall be not less than 0.56 mm (0.024 in.) in diameter.

### 2.20.5 Suspension-Rope Equalizers

**2.20.5.1** Suspension-rope equalizers, where provided, shall be of the individual compression spring type or shall meet the requirements of 2.20.5.3. Springs in tension shall not be used to attach suspension ropes.

**2.20.5.2** Single-bar-type equalizers shall be permitted only for winding drum machines with two ropes, to attach the ropes to the dead-end hitch plate, provided it meets the requirements of 2.20.5.3.

**2.20.5.3** Equalizers other than the individual compression spring type shall be permitted, provided that their strength is established through tensile engineering tests. Such tests shall show the ultimate strength of the equalizers and its fastenings in its several parts and assembly to be not less than 10% in excess of the strength of the suspension ropes as required by 2.20.3.

### 2.20.6 Securing of Suspension Wire Ropes to Winding Drums

Suspension wire ropes of winding-drum machines shall have the drum ends of the ropes secured on the inside of the drum by clamps.

Where the ropes extend beyond their clamps or sockets, means shall be provided to prevent the rope ends from coming out of the inside of the drum and to prevent interference with other parts of the machine.

### 2.20.7 Spare Rope Turns on Winding Drums

Suspension wire ropes of winding drum machines shall have not less than one turn of the rope on the drum when the car is resting on the fully compressed buffers.

### 2.20.8 Reserved

### 2.20.9 Suspension-Rope Fastening

**2.20.9.1 Type of Rope Fastenings.** The car and counterweight ends of suspension wire ropes, or the stationary hitch-ends where multiple roping is used, shall be

fastened in such a manner that all portions of the rope, except the portion inside the rope sockets, shall be readily visible.

Fastening shall be

*(a)* by individual tapered rope sockets (see 2.20.9.4) or other types of rope fastenings that have undergone adequate tensile engineering tests, provided that

*(1)* such fastenings conform to 2.20.9.2 and 2.20.9.3;

(ED) *(2)* the rope socketing is such as to develop at least 80% of the ultimate breaking strength of the strongest rope to be used in such fastenings; or

*(b)* by individual wedge rope sockets (see 2.20.9.5); and

*(c)* U-bolt-type rope clamps or similar devices shall not be used for suspension rope fastenings.

**2.20.9.2 Adjustable Shackle Rods.** The car ends, or the car or counterweight dead ends where multiple roping is used, of all suspension wire ropes of traction-type elevators shall be provided with shackle rods of a design that will permit individual adjustment of the rope lengths. Similar shackle rods shall be provided on the car or counterweight ends of compensating ropes.

**2.20.9.3 General Design Requirements.** Wire-rope fastenings shall conform to 2.20.9.3.1 through 2.20.9.3.8.

(ED) **2.20.9.3.1** The portion of the rope fastening that holds the wire rope (rope socket) and the shackle rod shall be in one piece (unit construction), or separate.

**2.20.9.3.2** The rope socket shall be either cast or forged steel, provided that where the rope socket and the shackle rod are in one piece (unit construction), the entire fastening shall be of forged steel.

**2.20.9.3.3** Where the shackle rod and rope socket are not in one piece, the shackle rod shall be of forged or rolled steel.

**2.20.9.3.4** Cast or forged steel rope sockets, shackle rods, and their connections shall be made of unwelded steel, having an elongation of not less than 20% in a gauge length of 50 mm (2 in.), when measured in accordance with ASTM E 8, and conforming to ASTM A 668, Class B for forged steel, and ASTM A 27, Grade 60/30 for cast steel, and shall be stress relieved. Steels of greater strength shall be permitted, provided they have an elongation of not less than 20% in a length of 50 mm (2 in.).

**2.20.9.3.5** Where the shackle rod is separate from the rope socket, the fastening between the two parts shall be positive, and such as to prevent their separation under all conditions of operation of the elevator.

Where the connection of the two parts is threaded, the thread design, tolerance, and manufacture shall conform to the requirements of ASME B1.13M, M-6H/6g, coarse or fine threads (ASME B1.1, UNC or UNF Class 2A and Class 2B threads). The length of the thread engagement of the rod in the socket shall be not less than 1.5 times the root diameter of the thread on the rod, and a cotter pin or equivalent means shall in addition be provided to restrict the turning to the rod in the socket and prevent unscrewing of the connection in normal operation.

Eye bolts used as connections with clevis-type sockets shall be of forged steel conforming to ASTM A 668, Class B (heat treated), without welds.

**2.20.9.3.6** Rope sockets shall be of such strength that the rope will break before the socket is materially deformed.

**2.20.9.3.7** The shackle rod, eye bolt, or other means used to connect the rope socket to the car or counter weight shall have a strength at least equal to the manufacturer's rated breaking strength of the rope.

**2.20.9.3.8** Rope fastenings incorporating antifriction devices that will permit free spinning of the rope shall not be used.

**2.20.9.4 Tapered Rope Sockets.** Tapered rope sockets shall be of a design as shown in Fig. 2.20.9.4, and shall conform to 2.20.9.2 and 2.20.9.3, and 2.20.9.4.1 through 2.20.9.4.5.

**2.20.9.4.1** The axial length $L$ of the tapered portion of the socket shall be not less than 4.75 times the diameter of the wire rope used.

**2.20.9.4.2** The axial length, $L'$, of the open portion of the rope socket shall be not less than 4 times the diameter of the wire rope used.

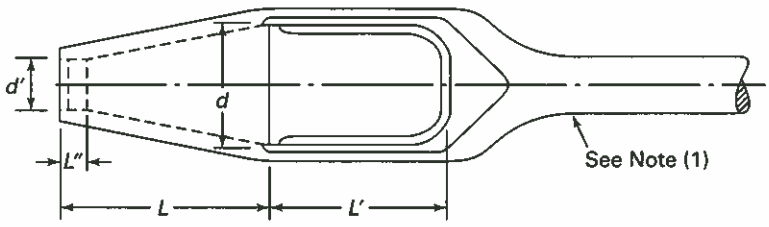
**2.20.9.4.3** The length of the straight bore, $L''$, at the small end of the socket shall be not more than 13 mm (0.5 in.) nor less than 3 mm (0.125 in.), and its outer edge shall be rounded and free from cutting edges.

**2.20.9.4.4** The diameter, $d$, of the hole at the large end of the tapered portion of the socket shall be not less than 2.25 times nor more than 3 times the diameter of the wire rope used.

**2.20.9.4.5** The diameter, $d'$, of the hole at the end of the tapered portion of the socket shall be not more than shown in Table 2.20.9.4.5.

**2.20.9.5 Wedge Rope Sockets.** Wedge socket assemblies shall be of a design as shown in Fig. 2.20.9.5, and shall conform to 2.20.9.2 and 2.20.9.3, and 2.20.9.5.1 through 2.20.9.5.6.

**2.20.9.5.1** A test specimen consisting of the strongest elevator wire rope for a given diameter and wedge socket assembly shall be subjected to a destructive tensile engineering test. The rope socketing shall develop at least 80% of the ultimate breaking strength of the strongest rope to be used in such a fastening without the rope slipping through the assembly.

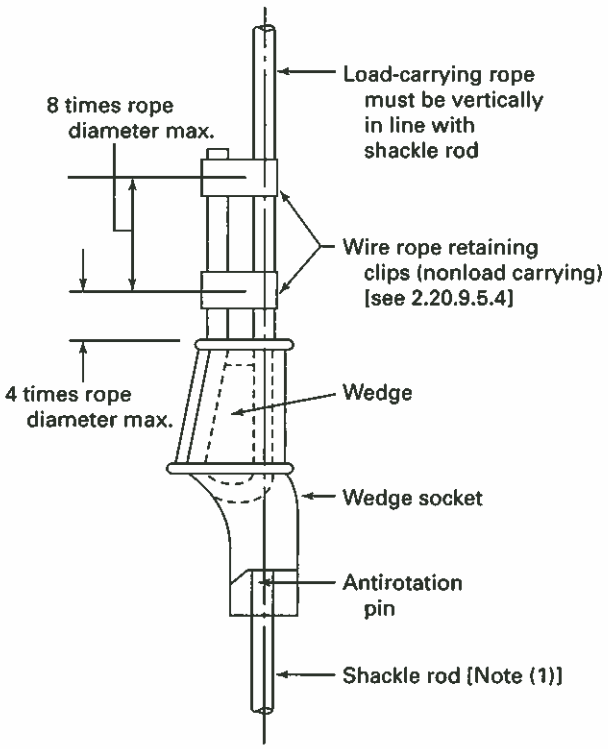



NOTE:
(1) Rope socket and shackle rod may be in one piece, as shown (unit construction) or the socket and rod may be separate (see 2.20.9.3).

**Fig. 2.20.9.4 Tapered Rope Sockets**

**Table 2.20.9.4.5 Relation of Rope Diameter to Diameter of the Small Socket Hole**

| Nominal Rope Diameter, mm | Maximum Diameter of Hole, *d'*, mm | Nominal Rope Diameter, in. | Maximum Diameter of Hole, *d'*, in. |
|---|---|---|---|
| 10 to 12 inclusive | 2.5 larger than nominal rope diameter | $\frac{3}{8}$ to $\frac{7}{16}$ inclusive | $\frac{3}{32}$ larger than nominal rope diameter |
| 13 to 19 inclusive | 3 larger than nominal rope diameter | $\frac{1}{2}$ to $\frac{3}{4}$ inclusive | $\frac{1}{8}$ larger than nominal rope diameter |
| 22 to 29 inclusive | 4 larger than nominal rope diameter | $\frac{7}{8}$ to $1\frac{1}{8}$ inclusive | $\frac{5}{32}$ larger than nominal rope diameter |
| 32 to 40 inclusive | 5 larger than nominal rope diameter | $1\frac{1}{4}$ to $1\frac{1}{2}$ inclusive | $\frac{3}{16}$ larger than nominal rope diameter |




NOTE:
(1) Rope socket and shackle rod may be in one piece, as shown (unit construction) or the socket and rod may be separate (see 2.20.9.3).

**Fig. 2.20.9.5 Wedge Rope Sockets**

**2.20.9.5.2** Wedge socket assemblies shall be of such a strength that when tested as in 2.20.9.5.1, the rope shall break before the socket or wedge is materially deformed.

**2.20.9.5.3** Suppliers of wedge sockets shall submit certification showing that the sockets, with visible permanent manufacturer's identification, have successfully passed the tests described in 2.20.9.5.1 and 2.20.9.5.2 at a testing laboratory.

**2.20.9.5.4** When the rope has been seated in the wedge socket by the load on the rope, the wedge shall be visible, and at least two wire-rope retaining clips shall be provided to attach the termination side to the load-carrying side of the rope (see Fig. 2.20.9.5). The first clip shall be placed a maximum of 4 times the rope diameter above the socket, and the second clip shall be located within 8 times the rope diameter above the first clip. The purpose of the two clips is to retain the wedge and prevent the rope from slipping in the socket should the load on the rope be removed for any reason. The clips shall be designed and installed so that they do not distort or damage the rope in any manner.

**2.20.9.5.5** Markings on the wedge socket assembly components shall be as follows:

*(a)* Each socket shall be permanently and legibly marked or color-coded to identify the corresponding wedge, or wedges, and rope size to be used in the assembly. The markings shall be visible after installation.

*(b)* Each wedge shall be permanently and legibly marked or color coded to identify the corresponding socket, or sockets, and rope size, within which it is to

be inserted to form an assembly. The markings shall be visible after installation.

(ED) **2.20.9.5.6** Load-carrying rope shall be in line with shackle rod, and the sockets shall be permitted to be staggered in the direction of travel of the elevator and counterweight, where used.

**2.20.9.6 Rope Socket Embedment Medium.** Only babbitt metal or thermosetting resin compositions intended for elevator wire rope socketing shall be used to secure ropes in tapered sockets. The embedment material shall conform to 2.20.9.6.1 through 2.20.9.6.3.

**2.20.9.6.1 Babbitt Metal.** Babbitt metal shall contain at least 9% of antimony and shall be clean and free from dross.

**2.20.9.6.2 Thermosetting Resin Composition**

*(a) Physical Properties.* The thermoset resin composition shall have the following properties:

*(1) Uncured (Liquid) Material*

*(a) Viscosity of Resin-Catalyst Mixture.* The viscosity of the resin-catalyst mixture shall be sufficiently low to permit rapid, complete saturation of the rope rosette in order to prevent entrapment of air.

*(b) Flash Point.* All components shall have a minimum flash point of 27°C (80°F).

*(c) Shelf Life.* All components shall have a minimum of 1 year shelf life at 21°C (70°F).

*(d) Pot Life and Cure Time.* After mixing, the resin-catalyst mixture shall be pourable for a minimum of 8 min at 21°C (70°F) and shall cure within 1 h after hardening. Heating of the resin mixture in the socket to accelerate curing shall follow the resin manufacturer's instructions.

*(2) Cured Resin*

*(a) Socket Performance.* Resin, when cured, shall develop sufficient holding strength to solvent-washed wire in wire-rope sockets to develop 80% of the ultimate strength of all types of elevator wire rope. No slippage of wire is permissible when testing resin-filled rope socket assemblies in tension; however, after testing, some seating of the resin cone shall be permitted to be apparent and is acceptable. Resin terminations shall also be capable of withstanding tensile shock loading.

*(b) Shrinkage.* The volumetric shrinkage of fully cured resin shall not exceed 2%. The use of an inert filler in the resin is permissible.

*(c) Curing.* The resin-catalyst mixture shall be capable of curing either at ambient [16°C to 38°C (60°F to 100°F)] or elevated temperatures. At temperatures below 16°C (60°F), an elevated temperature cure shall be used.

*(b) Materials Required.* The thermoset resin composition intended for elevator wire rope socketing shall be supplied in two parts consisting of preweighed resin and preweighed catalyst, each packaged separately within a kit. Each kit containing the thermoset resin composition shall consist of the following:

*(1)* preweighed thermoset resin
*(2)* preweighed catalyst
*(3)* necessary materials for mixing and pouring
*(4)* detachable label on resin container

*(c) Marking*

*(1) Resin Container.* The label on the resin container shall show the following information:

*(a)* product name
*(b)* part designation (e.g., "Part A" or "Resin")
*(c)* manufacturer's name or trademark and address
*(d)* mixing instructions
*(e)* ICC information
*(f)* safety warnings and cautions
*(g)* packaging date
*(h)* flash point
*(i)* shelf life
*(j)* storage instructions
*(k)* curing instructions
*(l)* net weight
*(m)* a statement certifying that the product conforms to 2.20.9.6.2 of ASME A17.1 or CSA B44

**2.20.9.6.3 Catalyst Container.** The label on the catalyst container shall show the following information:

*(a)* product name
*(b)* part designation (e.g., "Part B," "Catalyst," or "Hardener")
*(c)* manufacturer's name or trademark and address;
*(d)* safety warnings and cautions
*(e)* flash point
*(f)* storage instructions
*(g)* net weight

**2.20.9.7 Method of Securing Wire Ropes in Tapered Sockets.** Where the tapered type of socket is used, the method and procedure to be followed in making up the fastening shall conform to the following as applicable.

**2.20.9.7.1 Handling.** The rope to be socketed shall be carefully handled to prevent twisting, untwisting, or kinking.

**2.20.9.7.2 Seizing of Rope Ends.** The rope ends to be socketed shall be seized before cutting with seizing in accordance with the following:

*(a)* The seizing shall be done with annealed iron wire, provided that other methods of seizing be permitted, which give the same protection from loss of rope lay. Where iron wire is used for seizing, the length of each seizing shall be not less than the diameter of the rope.

*(b)* For nonpreformed rope, three seizings shall be made at each side of the cut in the rope. The first seizing shall be close to the cut end of the rope, and the second seizing shall be spaced back from the first the length of the end of the rope to be turned in. The third seizing

shall be at a distance from the second equal to the length of the tapered portion of the socket.

*(c)* For preformed rope, one seizing shall be made at each side of the cut in the rope. The seizing shall be at a distance from the end of the rope equal to the length of the tapered portion of the socket plus the length of the portion of the rope to be turned in.

**2.20.9.7.3 Spreading of Rope Strands.** After the rope has been seized, it shall be inserted into the socket through the hole in the small end, a sufficient distance for manipulation, and where nonpreformed rope is used, the first two seizings shall be removed. The rope strands shall then be spread apart, and where rope with fibre core is used, the fibre core shall be cut away as close as possible to the remaining seizing.

**2.20.9.7.4 Removal of Grease or Oil.** Thorough cleaning of the outer wires of the strand surface and the inside of the rope socket is required for good adhesion. Brush or dip in clean solvents is recommended.

**2.20.9.7.5 Turning in of Rope Strands.** The exposed rope strands shall then be bent, turned in, and bunched closely together, each strand being turned back the same distance. The portion turned in (rope rosette) shall have a length of not less than 2.5 times the diameter of the rope, and such that, when the rope is pulled as far as possible into the socket, the bend of the turned-in strands shall be slightly overflush with the mouth of the tapered socket (large end) and will be visible when the socket has been completed (see 2.20.9.7.9). Where rope with steel core is used, the steel core shall be cut off even with tops of the looped strands.

**2.20.9.7.6 Insertion of Bent-In Rope Strands in Socket.** The rope end shall be pulled as far as possible into the socket, so that the remaining seizing projects outside the hole at the small end of the socket.

(ED) **2.20.9.7.7 Position of Socket Preparatory to Pouring Embedment Medium.** The socket shall be held in a vertical position with the large end up, and the rope held in a position truly axial with the socket. Tape or waste shall be permitted to be wound around the rope at the small end of the socket to prevent the embedment medium from seeping through, but shall be removed after completion of the socket.

**2.20.9.7.8 Preparation of Embedment Medium**

*(a) Babbitt Metal*

*(1) Heating of Babbitt.* The babbitt shall be heated to a fluidity just sufficient to char a piece of soft wood such as white pine without igniting it. Care shall be taken not to overheat the babbitt sufficiently to damage the rope.

*(2) Heating of Socket Basket and Pouring of Babbitt.* The rope socket basket shall be heated by a blowtorch flame sufficiently to prevent chilling of the babbitt and to ensure that the babbitt, when poured, will completely fill the basket, including all the spaces between the rope strands. Following this the molten babbitt shall be poured slowly and evenly into the basket until it is filled to a point level with the top of the opening in the large end.

*(b) Thermosetting Resin Composition*

*(1)* The manufacturer's directions shall be strictly followed in handling, mixing, pouring, and curing the resin material.

*(2)* New containers of resin and catalyst shall be utilized for each set of rope sockets. The entire quantity of resin and catalyst shall be mixed when the containers are opened.

*(3)* Resin sockets shall not be poured at a temperature below 16°C (60°F) without first warming the socket and the resin composition to 21°C to 32°C (70°F to 90°F). The socket shall be permitted to be warmed using the electrical resistance heating devices intended for curing resin sockets.

*(4)* Curing of resin sockets shall be accomplished by heating at elevated temperature following the manufacturer's suggested schedule and directions. Cure time shall not exceed 30 min. Electrical resistance heating devices designed to fit around the sockets, or other means of providing controlled, evenly distributed heat, shall be used to provide the elevated temperature for curing. Open flames or exposed electrical resistance heating elements shall not be used.

*(5)* Upon completion of the socketing, the label from the container of resin shall be attached to one of the rope sockets for inspection purposes and shall be suitably protected.

**2.20.9.7.9 Inspection of Sockets After Completion.** A visual inspection of the completed sockets shall be made after they have cooled and the tape or waste has been removed from the small end of the sockets. The visual inspection shall verify that

*(a)* the embedment medium is visible at the small end of the socket

*(b)* the bends of all of the individual rope strands (see 2.20.9.7.5) are approximately the same height above the embedment medium and visible within the range of not less than one-half the diameter of the rope strand above the embedment medium and that there is not more than 1.5 mm (0.06 in.) clearance between the embedment medium and the underside of the bend in the rope strand

*(c)* no loss of rope lay has occurred where the wire rope enters the socket

**2.20.9.7.10 Lubrication of Wire Rope After Socket Attachment.** After the resin has cured, the wire ropes shall be lubricated at the base of the socket (small end) to replace the lubricant that was removed during the cleaning operation required under 2.20.9.7.4.

**2.20.9.8 Antirotation Devices.** Following the completion of the rope socketing and any adjustments of individual shackle rods as provided for in 2.20.9.2, means shall be provided to prevent the rotation of the suspension ropes without restricting their movement horizontally or vertically.

### 2.20.10 Auxiliary Rope Fastening Devices

Auxiliary rope fastening devices, designed to support elevator cars or counterweights if any regular rope fastening fails, shall be permitted to be provided, subject to the requirements of 2.20.10.1 through 2.20.10.9.

**2.20.10.1** They shall be approved on the basis of adequate tensile and fatigue engineering tests.

**2.20.10.2** The device and its fastenings, in its several parts and assembly, shall have a strength at least equal to that of the manufacturer's breaking strength of the rope to which it is to be attached.

**2.20.10.3** Steel parts used in the device shall be cast or forged with an elongation of not less than 20%, conforming to ASTM A 668, Class B, for forgings and ASTM A 27, Grade 60/30 for cast steel, and shall be stress relieved.

**2.20.10.4** The device shall be so designed and installed that

*(a)* it will not become operative unless there is a failure of the normal rope fastening

*(b)* it will function in a rope movement of not over 38 mm (1.5 in.)

*(c)* it will not interfere with the vertical or rotational movements of the rope during normal service

**2.20.10.5** Means shall be provided to cause the electric power to be removed from the driving-machine motor and brake when any auxiliary fastening device operates. Such means shall

*(a)* have all electrical parts enclosed

*(b)* be of the manually reset type that can be reset only when the wire rope or ropes have been resocketed and the auxiliary rope fastening device has been restored to its normal running position

**2.20.10.6** The method used to attach the device to the rope shall be such as to prevent injury to, or appreciable deformation of, the rope.

**2.20.10.7** The installation of the device shall not reduce the required overhead clearances.

(ED) **2.20.10.8** The car-frame supports for the fastening members of the device shall conform to 2.15.13, or where existing conditions will not permit compliance with this requirement, other means of fastening shall be permitted to be used subject to the approval of the enforcing authority.

**2.20.10.9** Each device shall be permanently marked with the name or trademark of the manufacturer by means of metal tags or plates with the following data of the wire rope for which they are designated to be used:

*(a)* diameter of the rope in millimeters (mm) or inches (in.)

*(b)* manufacturer's rated breaking strength of the rope

*(c)* construction classification of the wire rope

The material and marking of the tags or plates shall conform to 2.16.3.3, except that the height of the letters and figures shall be not less than 1.5 mm (0.06 in.).

## SECTION 2.21
## COUNTERWEIGHTS

### 2.21.1 General Requirements

**2.21.1.1 Frames.** Weight sections of a counterweight shall be mounted in structural or formed metal frames so designed as to retain them securely in place (see 2.21.2.6).

**2.21.1.2 Retention of Weight Sections.** Means shall be provided to retain weight sections in place in the event of buffer engagement or safety application or if they become broken.

Where tie rods are used, a minimum of two shall be provided, which shall pass through all weight sections. Tie-rods shall be provided with a lock nut and cotter pin at each end.

**2.21.1.3 Guiding Members.** Counterweight frames shall be guided on each guide rail by upper and lower guiding members attached to the frame. (ED)

Retention means shall be provided to prevent the counterweight from being displaced by more than 13 mm (0.5 in.) from its normal running position should any part of the guiding means fail, excluding the guiding member base and its attachment to the frame. The retention means shall be permitted to be integral with the base.

**2.21.1.4 Independent Car Counterweights.** Where an independent car counterweight is provided, it shall run in separate guide rails and shall not be of sufficient weight to cause undue slackening of the hoisting ropes during acceleration or retardation of the elevator car.

### 2.21.2 Design Requirements for Frames and Rods

**2.21.2.1 Material.** Frames and rods shall be made of steel or other metals conforming to 2.15.6.2 and 2.15.6.3, provided that where steels of greater strength than those specified, or where metals other than steel are used, the factor of safety used in the design shall conform to 2.21.2.3.

**2.21.2.2 Frame Connections.** Connections between frame members shall conform to 2.15.7.

#### 2.21.2.3 Factor of Safety

**2.21.2.3.1** The frame members and their connections shall be designed with a factor of safety of not less than 5 with the elevator at rest and the counterweight at the top of its travel.

**2.21.2.3.2** The counterweight frame shall be designed with a factor of safety of not less than 2.5 at buffer engagement or safety application.

**2.21.2.3.3** The frame members, brackets, and their connections subject to forces due to the application of the emergency brake (see 2.19.4) shall be designed to withstand the maximum forces developed during the retardation phase of the emergency braking so that the resulting stresses due to the emergency braking and all other loading acting simultaneously, if applicable, shall not exceed 190 MPa (27,500 psi).

**2.21.2.4 Sheaves.** Where a hoisting sheave or sheaves are mounted in the frame, the requirements of 2.15.12 shall apply (see also 2.24.2 and 2.24.3 for requirements for sheaves).

**2.21.2.5 Suspension Rope Hitch or Shapes.** Where counterweights are suspended by ropes attached directly to the frames by means of rope fastenings, the rope attachments shall conform to 2.15.13.

**2.21.2.6 Securing of Weights in Frames.** The weights shall be so mounted and secured in the frames as to prevent shifting of the weights by an amount that will reduce the running clearances to less than those specified in 2.5.1.2.

### 2.21.3 Cars Counterbalancing One Another

An elevator car shall not be used to counterbalance another elevator car.

### 2.21.4 Compensation Means

Compensation means, such as compensating ropes or chains or other mechanical means and their attachments (except for safety hooks, where used) to tie the counterweight and car together, shall be capable of withstanding, with a factor of safety of 5, any forces to which the means is subjected with the elevator at rest.

The maximum suspended weight of compensation means with car or counterweight at the top of its travel and one-half total weight of tension sheave assembly, where used, shall be included.

The factor of safety for compensation means shall be based on the proof load, breaking strength, or test reports.

**2.21.4.1 Connections.** The connections between the car or counterweight and the compensation means, shall be bolted or welded and shall conform to 2.15.7.3.

**2.21.4.1.1** Cast iron, where used, shall have a factor of safety of not less than 10, based on maximum stress developed.

**2.21.4.1.2** When compensation ropes are used with a tension sheave, one end of each rope shall be provided with a means to individually adjust rope length.

**2.21.4.2 Tie-Down Compensation Means.** For rated speeds greater than 3.5 m/s (700 ft/min), a tie-down compensation means device shall be provided and fastened to the building structure to limit the jump of the car or counterweight as a result of car or counterweight buffer engagement or safety application.

The device components, compensation means, connection, building structural members, and fastenings, shall be capable of withstanding with a factor of safety of not less than 2.5 the maximum forces to which they are subjected due to car or counterweight buffer engagement or safety application.

## SECTION 2.22
## BUFFERS AND BUMPERS

### 2.22.1 Type and Location

**2.22.1.1 Type of Buffers.** Buffers of the spring, oil, or equivalent type shall be installed under the cars and counterweights of passenger and freight elevators subject to the requirements of 2.22.1.1.1 through 2.22.1.1.3.

**2.22.1.1.1** Spring buffers or their equivalent shall be permitted to be used where the rated speed is not in excess of 1 m/s (200 ft/min).

**2.22.1.1.2** Oil buffers or their equivalent shall be used where the rated speed is in excess of 1 m/s (200 ft/min).

**2.22.1.1.3** Where Type C safeties are used (see 2.17.8.2), car buffers are not required if solid bumpers are installed.

**2.22.1.2 Location.** Buffers or bumpers shall be located so as to retard the car and counterweight without exceeding allowable design stresses in the car frame and counterweight frame.

### 2.22.2 Solid Bumpers

Solid bumpers, where permitted, shall be made of wood or other suitably resilient material of sufficient strength to withstand without failure the impact of the car with rated load, or the counterweight, descending at governor tripping speed.

The material used shall be of a type that will resist deterioration or be so treated as to resist deterioration.

**Table 2.22.3.1 Minimum Spring Buffer Stroke**

| Rated Car Speed, m/s (ft/min) | Minimum Stroke, mm (in.) |
|---|---|
| 0.5 or less (100 or less) | 38 (1.5) |
| 0.51 to 0.75 (101 to 150) | 63 (2.5) |
| 0.76 to 1.00 (151 to 200) | 100 (4.0) |

### 2.22.3 Spring Buffers

**2.22.3.1 Stroke.** The stroke of the buffer spring, as marked on its marking plate, shall be equal to or greater than the value specified in Table 2.22.3.1.

**2.22.3.2 Load Rating**

**2.22.3.2.1** Buffers for cars and counterweights shall be capable of supporting, without being compressed solid or to a fixed stop, a static load having a minimum of 2 times the total weight of

*(a)* the car and its rated load for car buffers

*(b)* the counterweight for counterweight buffers

**2.22.3.2.2** Buffers for cars and counterweights shall be compressed solid or to a fixed stop with a static load of three times the weight of

*(a)* the car and its rated load for car buffers

*(b)* the counterweight for counterweight buffers

**2.22.3.2.3** Where the space below the hoistway is not permanently secured against access, the load rating specified in 2.22.3.2.1 shall be increased to meet the requirements of 2.6.1(b) and 2.6.2.

**2.22.3.3 Marking Plates.** Each spring buffer shall be provided with a marking plate showing its load rating and stroke and the number of springs. Where the springs are removable, each spring shall be identified, and the assembly marking plate shall indicate this identification. Markings shall be made in a permanent and legible manner.

### 2.22.4 Oil Buffers

**2.22.4.1 Stroke.** The minimum stroke of oil buffers shall be based on the requirements of 2.22.4.1.1 or 2.22.4.1.2.

**2.22.4.1.1** The stroke shall be such that the car or the counterweight, on striking the buffer at 115% of the rated speed, shall be brought to rest with an average retardation of not more than 9.81 $m/s^2$ (32.2 $ft/s^2$).

**2.22.4.1.2** Where terminal speed reducing device is installed that conforms to 2.25.4.1, and that will limit the speed at which the car or counterweight can strike its buffer, the buffer stroke shall be based on at least 115% of such reduced striking speed and on an average retardation not exceeding 9.81 $m/s^2$ (32.2 $ft/s^2$). In no case shall the stroke used be less than 50% of the stroke required by 2.22.4.1.1 for rated speeds under 4 m/s (800 ft/min), nor less than 33⅓%, or 450 mm (18 in.), whichever is greater, for rated speeds of 4 m/s (800 ft/min) or more.

NOTE (2.22.4.1): Figure 8.2.4 indicates the minimum buffer strokes for various initial velocities. Table 2.22.4.1 indicates the minimum buffer strokes for the most usual rated speeds. See formula in 8.2.4 for calculation of buffer strokes differing from or exceeding those listed in Table 2.22.4.1.

**2.22.4.2 Retardation.** Oil buffers shall develop an average retardation not in excess of 9.81 $m/s^2$ (32.2 $ft/s^2$), and shall develop no peak retardation greater than 24.5 $m/s^2$ (80.5 $ft/s^2$), having a duration exceeding 0.04 s with any load in the car, from rated load to a minimum load of 70 kg (154 lb), when the buffers are struck with an initial speed of not more than

*(a)* 115% of the rated speed for buffers conforming to 2.22.4.1.1

*(b)* 115% of the predetermined reduced speed for buffers conforming to 2.22.4.1.2

**2.22.4.3 Factor of Safety for Oil-Buffer Parts.** The factor of safety of parts of oil buffers, based on the yield point for compression members and on the ultimate strength and elongation for other parts, at gravity retardation with the maximum load for which the buffer is designed, when tested in accordance with ASTM E8 using a 50 mm (2 in.) gauge length, shall be not less than

*(a)* 3 for materials having an elongation 20% or more

*(b)* 3.5 for materials having an elongation from 15% to 20%

*(c)* 4 for materials having an elongation from 10% to 15%

*(d)* 5 for materials having an elongation less than 10%

*(e)* 10 for cast iron parts

**2.22.4.4 Slenderness Ratio for Members Under Compression as Columns.** The slenderness ratio ($L/R$) for members of oil buffers under compression as columns shall be not more than 80.

The slenderness ratio ($L/R$) specified applies only to those main buffer members that are subject to the impact of the fully loaded car when striking the buffer.

**2.22.4.5 Plunger Return Requirements.** Oil buffers shall be so designed that

*(a)* the buffer plunger of gravity-return and spring-return-type oil buffers, when the buffer is filled with oil shall, when released after full compression, return to its fully extended position within 90 s

*(b)* the plunger of a spring-return-type oil buffer with a 20 kg (44 lb) weight resting on it shall, when released after being depressed 50 mm (2 in.), return to the fully extended position within 30 s

*(c)* gas spring-return oil buffers shall be provided with a switch conforming to 2.26.2.22 which shall be actuated if the plunger is not within 13 mm (0.5 in.) of the fully extended position

**Table 2.22.4.1 Minimum Oil Buffer Strokes**

| SI Units | | | Imperial Units | | |
|---|---|---|---|---|---|
| Rated Speed, m/s | 115% of Rated Speed, m/s | Minimum Stroke, mm | Rated Speed, ft/min | 115% of Rated Speed, ft/min | Minimum Stroke, in. |
| 1.00 | 1.15 | 65 | 200 | 230 | 2.75 |
| 1.12 | 1.29 | 85 | 225 | 269 | 3.50 |
| 1.25 | 1.44 | 105 | 250 | 288 | 4.25 |
| 1.50 | 1.73 | 155 | 300 | 345 | 6.25 |
| 1.75 | 2.01 | 205 | 350 | 402 | 8.25 |
| 2.00 | 2.30 | 270 | 400 | 460 | 11.00 |
| 2.25 | 2.59 | 340 | 450 | 517 | 13.75 |
| 2.50 | 2.88 | 425 | 500 | 575 | 17.00 |
| 3.00 | 3.45 | 605 | 600 | 690 | 24.75 |
| 3.50 | 4.03 | 825 | 700 | 805 | 33.25 |
| 4.00 | 4.60 | 1 080 | 800 | 920 | 43.75 |
| 4.50 | 5.18 | 1 365 | 900 | 1,035 | 55.50 |
| 5.00 | 5.75 | 1 685 | 1,000 | 1,150 | 68.50 |
| 5.50 | 6.32 | 2 040 | 1,100 | 1,265 | 83.00 |
| 6.00 | 6.90 | 2 425 | 1,200 | 1,380 | 98.50 |
| 6.50 | 7.48 | 2 845 | 1,300 | 1,495 | 115.50 |
| 7.00 | 8.05 | 3 300 | 1,400 | 1,610 | 134.50 |
| 7.50 | 8.63 | 3 790 | 1,500 | 1,725 | 154.00 |
| 8.00 | 9.20 | 4 310 | 1,600 | 1,840 | 175.25 |
| 8.50 | 9.78 | 4 870 | 1,700 | 1,955 | 197.75 |
| 9.00 | 10.35 | 5 460 | 1,800 | 2,070 | 221.75 |
| 9.50 | 10.93 | 6 080 | 1,900 | 2,105 | 247.00 |
| 10.00 | 11.50 | 6 740 | 2,000 | 2,300 | 273.75 |

**2.22.4.6 Means for Determining Oil Level.** Oil buffers shall be provided with means for determining that the oil level is within the maximum and minimum allowable limits. Glass sight gauges shall not be used.

**2.22.4.7 Type Tests and Certification for Oil Buffers**

**2.22.4.7.1** Each type of oil buffer shall be subjected to the type tests as specified in 8.3.2 and to the certification process as specified in 8.3.1.

(ED) **2.22.4.7.2** A type test on an oil buffer shall be permitted to be acceptable for similarly designed buffers, provided that the longest stroke of the type is subjected to the type test; and the load range of the buffer is within the maximum and minimum range for the oil portings of the given buffer.

**2.22.4.7.3** Oil buffers tested in accordance with the test requirements of prior editions of ASME A17.1 or CSA B44 shall be acceptable without being retested, provided the buffer has been listed/certified to a previous edition of the Code or on submittal by the person or organization installing the buffers of the test certificate stating that the buffer, when tested, met the specified test requirements of that edition of the Code.

**2.22.4.8 Compression of Buffers When Car Is Level With Terminal Landings.** (ED) Car and counterweight oil buffers of the mechanical spring-return type shall be permitted to be compressed not to exceed 25% of their stroke when the car is level with the terminal landings (see 2.4.2.1).

**2.22.4.9 Buffer Oil Requirements.** Oils used in oil buffers shall have a pour point of −18°C (0°F), or lower, as defined in ASTM D 97, and a viscosity index of 75, or higher, as defined in ASTM D 2270.

**2.22.4.10 Load Ratings of Oil Buffers.** The minimum and maximum load ratings of car and counterweight oil buffers, as indicated on the buffer marking plate, shall conform to 2.22.4.10.1 through 2.22.4.10.3.

**2.22.4.10.1** The minimum load rating shall be not greater than

*(a)* for car oil buffers, the total weight of the car as marked on the car crosshead data plate plus 70 kg (150 lb)

*(b)* for counterweight oil buffers, the weight of the counterweight used

**2.22.4.10.2** The maximum load rating shall be not less than

*(a)* for car oil buffers, the total weight of the car as marked on the crosshead data plate plus the rated load

*(b)* for counterweight oil buffers, the weight of the counterweight used

**2.22.4.10.3** When compensating rope tie-down is present, the increase in load shall be taken into account (see 2.17.17).

**2.22.4.11 Buffer Marking Plate.** Every installed oil buffer shall have permanently attached thereto a metal plate, marked by the manufacturer in a legible and permanent manner, indicating

(ED) *(a)* the maximum and minimum loads and the maximum striking speeds for which the buffer has been rated for use in conformance with the requirements in 2.22

*(b)* the permissible range in viscosity of the buffer oil to be used, stated in Saybolt Seconds Universal at 38°C (100°F)

*(c)* the viscosity index number of the oil to be used

*(d)* the pour point in degrees Celsius (Fahrenheit) of the oil to be used

*(e)* the stroke of the buffer in mm (in.)

*(f)* the composition of the gas, if used

*(g)* the name, trademark, or file number by which the organization that manufactured the product can be identified

*(h)* the certification marking in accordance with 8.3.1.3

## SECTION 2.23
## CAR AND COUNTERWEIGHT GUIDE RAILS, GUIDE-RAIL SUPPORTS, AND FASTENINGS

### 2.23.1 Guide Rails Required

Elevator cars and counterweights shall be provided with guide rails.

### 2.23.2 Material

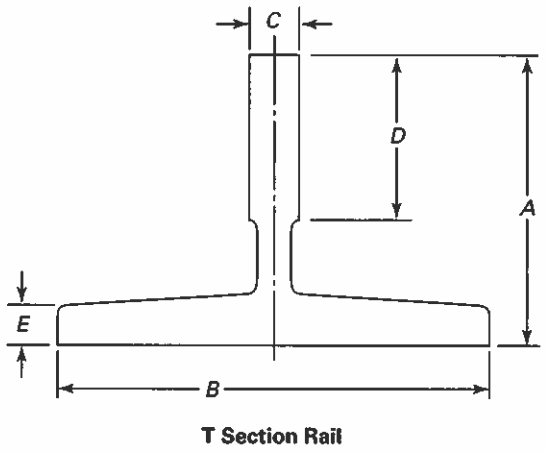
Guide rails, guide-rail brackets, rail clips, fishplates, and their fastenings shall be either

*(a)* of steel or other metals conforming to 2.23; or

(ED) *(b)* where steel presents an accident hazard, as in chemical or explosive plants, guide rails shall be permitted to be of selected wood or other suitable nonmetallic materials, provided the rated speed of the car does not exceed 0.75 m/s (150 ft/min).

#### 2.23.2.1 Requirements for Steel, Where Used

*(a)* Rails, brackets, fishplates, and rail clips shall be made of open-hearth steel, or its equivalent, having a tensile strength of not less than 380 MPa (55,000 psi) and having an elongation of not less than 22% in a length of 50 mm (2 in.) when measured in accordance with ASTM E 8.




T Section Rail

**Fig. 2.23.3 Elevator Guide Rails**

*(b)* Bolts shall conform to ASTM A 307.

*(c)* Rivets shall conform to ASTM A 502.

*(d)* Maximum permissible stresses and deflections shall conform to 2.23.5.

**2.23.2.2 Requirements for Metals Other Than Steel.** Metals other than steel shall be permitted to be used, provided the factor of safety is not less than, and the deflections are not more than, the values specified in this section, and provided that cast iron is not used.

### 2.23.3 Rail Section

Guide rails shall be either

*(a)* T-section, conforming to the nominal weights and dimensions shown in Fig. 2.23.3 and Table 2.23.3; or

*(b)* other shapes, subject to the following requirements:

*(1)* They shall have a section modulus and moment of inertia equal to or greater than that of the section shown in Fig. 2.23.3 for a given loading condition.

*(2)* They shall have a sectional area sufficient to withstand the compressive forces resulting from the application of the car or counterweight safety device, if used.

### 2.23.4 Maximum Load on Rails in Relation to the Bracket Spacing

**2.23.4.1 With Single Car or Counterweight Safety.** (ED) Where a single car or counterweight safety is used, the maximum suspended weight of the car and its rated load, or the maximum suspended weight of the counterweight, including the weight of any compensation means and of any traveling cables suspended therefrom per pair of guide rails, shall not exceed the maximum specified in Fig. 2.23.4.1-1 for the size of the rail and the bracket spacing used, except that the bracket spacing shall be permitted to exceed the values specified in Fig. 2.23.4.1-1, provided that

**Table 2.23.3 T-Section Guide-Rail Dimensions**

| SI Units | | | | | | Imperial Units | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal Mass, kg/m | Nominal Dimensions, mm | | | | | Nominal Weight, lb/ft | Nominal Dimensions, in. | | | | |
| | *A* | *B* | *C* | *D* | *E* | | *A* | *B* | *C* | *D* | *E* |
| 8.5 | 68.3 | 82.6 | 9.1 | 25.4 | 6.0 | 5¾ | 2 11/16 | 3¼ | 23/64 | 1 | 15/64 |
| 9.5 | 49.2 | 69.9 | 15.9 | 25.4 | 7.9 | 6¼ | 1 15/16 | 2¾ | 5/8 | 1 | 5/16 |
| 12.0 | 61.9 | 88.9 | 15.9 | 31.8 | 7.9 | 8 | 2 7/16 | 3½ | 5/8 | 1¼ | 5/16 |
| 16.5 | 88.9 | 114.3 | 15.9 | 38.1 | 7.9 | 11 | 3½ | 4½ | 5/8 | 1½ | 5/16 |
| 18.0 | 88.9 | 127.0 | 15.9 | 44.5 | 7.9 | 12 | 3½ | 5 | 5/8 | 1¾ | 5/16 |
| 22.5 | 88.9 | 127.0 | 15.9 | 50.0 | 12.7 | 15 | 3½ | 5 | 5/8 | 1 31/32 | ½ |
| 27.5 | 108.0 | 139.7 | 19.1 | 50.0 | 12.7 | 18½ | 4¼ | 5½ | ¾ | 1 31/32 | ½ |
| 33.5 | 101.6 | 139.7 | 28.6 | 50.8 | 14.3 | 22½ | 4 | 5½ | 1⅛ | 2 | 9/16 |
| 44.5 | 127.0 | 139.7 | 31.8 | 57.2 | 17.5 | 30 | 5 | 5½ | 1¼ | 2¼ | 11/16 |

*(a)* the guide rail is reinforced or a rail of larger size is used

*(b)* the moment of inertia of a single reinforced rail or of a single larger size T-section about the *x-x* axis parallel to the base of the rail is not less than that required by Fig. 2.23.4.1-1 for the given weight of car plus load, or the counterweight with safety device, at the bracket spacing used

*(c)* where the bracket spacings exceed those shown on Figs. 2.23.4.1-1 and 2.23.4.1-2, the rail system

*(1)* conforms to 2.23.5

*(2)* is designed to limit the deflection during the application of the safety with a fully loaded car to not more than 6 mm (0.25 in.) per rail

EXAMPLES [2.23.4.1(c)]:

(1) *SI Units.* For 5 500 kg total weight of car plus load and a bracket spacing of 4 875 mm, there is required
  *(a)* 27.5 kg/m rail without reinforcement; or
  *(b)* 22.5 kg/m rail with reinforcement having a combined moment of inertia of 3.3 mm × $10^6$ $mm^4$.

(2) *Imperial Units.* For 12,000 lb total weight of car plus load and a bracket spacing of 16 ft 0 in., there is a required
  *(a)* 18.5 lb rail without reinforcement; or
  *(b)* 15 lb rail with reinforcement having a combined moment of inertia of 8 $in.^4$

**2.23.4.2 With Two (Duplex) Car or Counterweight Safeties.** Where the car or counterweight is provided with two safety devices, the loads specified in Fig. 2.23.4.1-1 shall be permitted to be increased by the factors specified in Table 2.23.4.2.

### 2.23.4.3 Counterweight With No Safety

**2.23.4.3.1** Guide rails for counterweights not provided with a safety device shall be fastened to the building structure at intervals specified in Table 2.23.4.3.1, except as specified in 2.23.4.3.2, and the weight of the counterweight for each size of guide rail shall not exceed that specified in Table 2.23.4.3.1.

**2.23.4.3.2** The bracket spacing specified shall be permitted to be increased by an amount determined by Figs. 2.23.4.1-1 and 2.23.4.1-2, subject to the following requirements:

*(a)* where guide rails are reinforced or a larger rail section is used having a moment of inertia, about an axis parallel to the base [*x-x* axis in Fig. 2.23.4.1-2], at least equal to that of the rail sections shown in Table 2.23.3, based on the weight of the counterweight

*(b)* where intermediate tie brackets, approximately equally spaced, are provided between the guide rails at intervals of not over 2 130 mm (84 in.)

**2.23.4.3.3** Intermediate tie brackets, approximately equally spaced, shall be provided between the guide rails at intervals as specified in Table 2.23.4.3.3. Intermediate tie brackets are not required to be fastened to the building structure.

## 2.23.5 Stresses and Deflections

### 2.23.5.1 Guide Rails

**2.23.5.1.1** For steels conforming to 2.23.2.1, the stresses in a guide rail, or in the rail and its reinforcement, due to the horizontal forces imposed on the rail during loading, unloading, or running, calculated without impact, shall not exceed 105 MPa (15,000 psi), based upon the class of loading, and the deflection shall not exceed 6 mm (0.25 in.) (see 2.16.2.2 and 8.2.2.6).

**2.23.5.1.2** Where steels of greater strength than those specified in 2.23.2.1 are used, the stresses specified may be increased proportionately, based on the ratio of the ultimate strengths.

**2.23.5.2 Brackets, Fastenings, and Supports.** The guide-rail brackets, their fastenings, and supports, such as building beams and walls, shall be capable of resisting the horizontal forces imposed by the class of loading

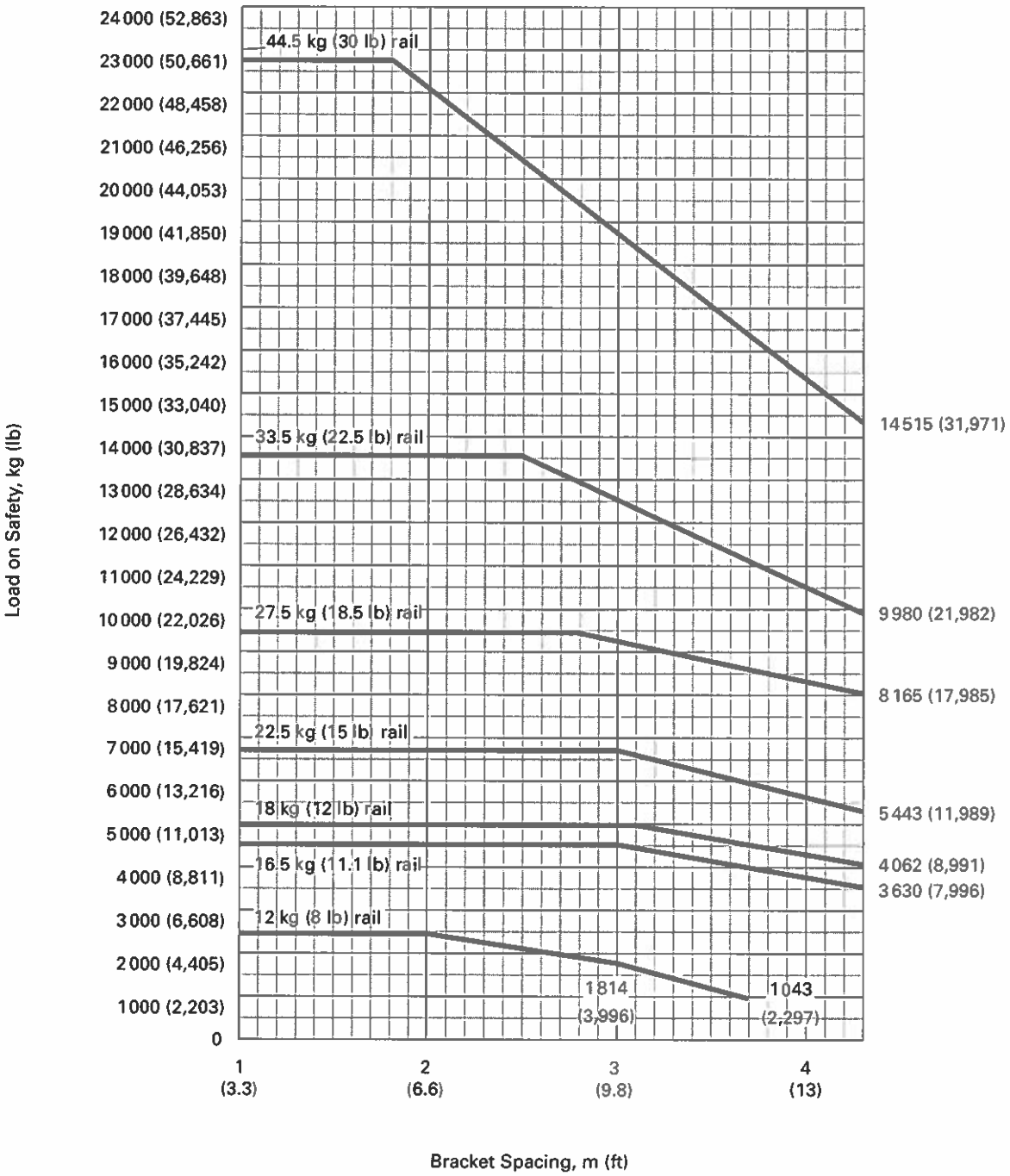



**Fig. 2.23.4.1-1 Maximum Weight of a Car With Rated Load or of Counterweight With Safety Device for a Pair of Guide Rails as Specified in 2.23.4.1**

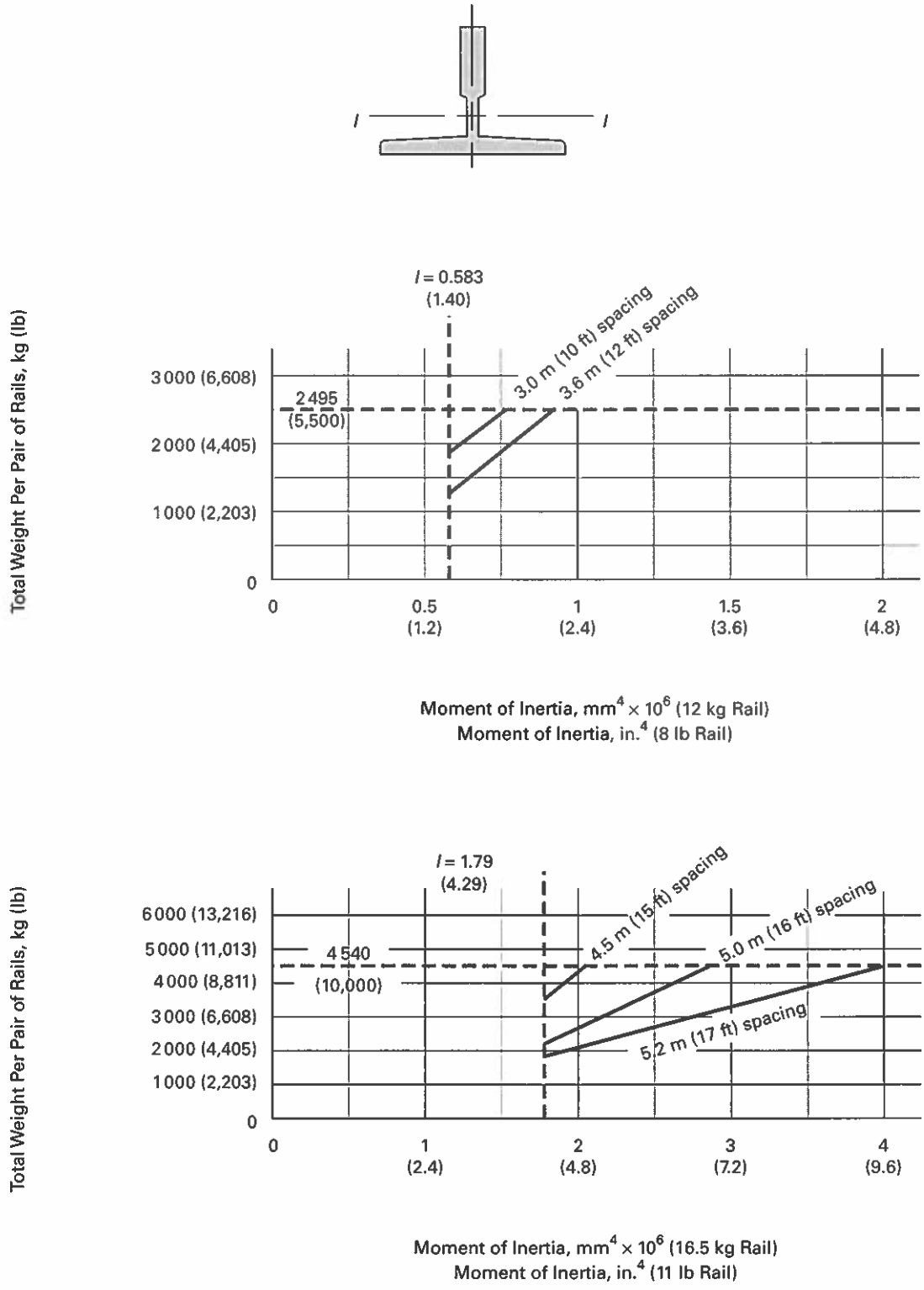
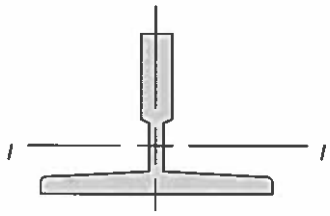
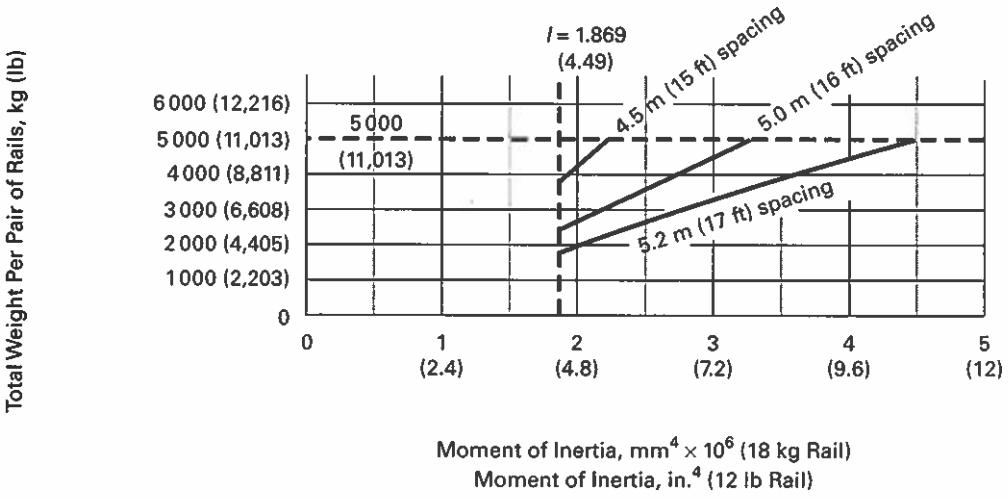



**Fig. 2.23.4.1-2 Minimum Moment of Inertia About *x-x* Axis for a Single Guide Rail With Its Reinforcement**



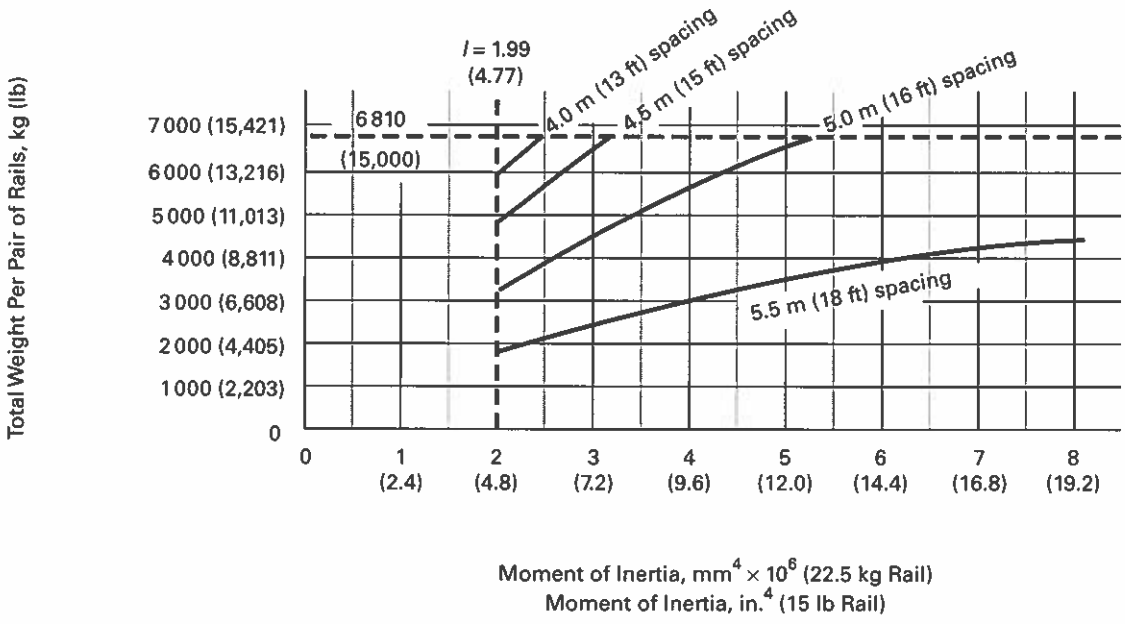




**Fig. 2.23.4.1-2 Minimum Moment of Inertia About *x-x* Axis for a Single Guide Rail With Its Reinforcement (Cont'd)**

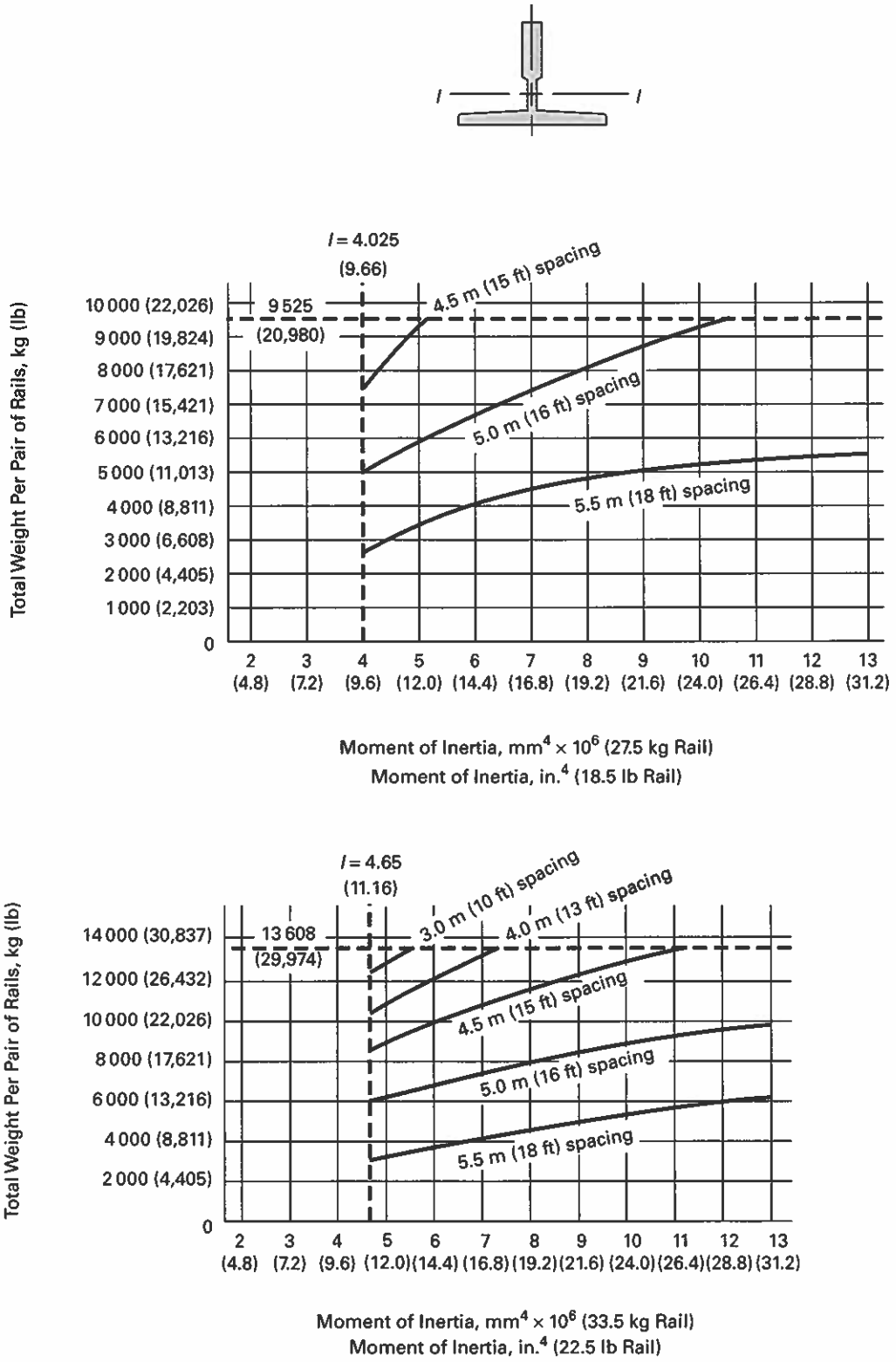



**Fig. 2.23.4.1-2 Minimum Moment of Inertia About *x-x* Axis for a Single Guide Rail With Its Reinforcement (Cont'd)**

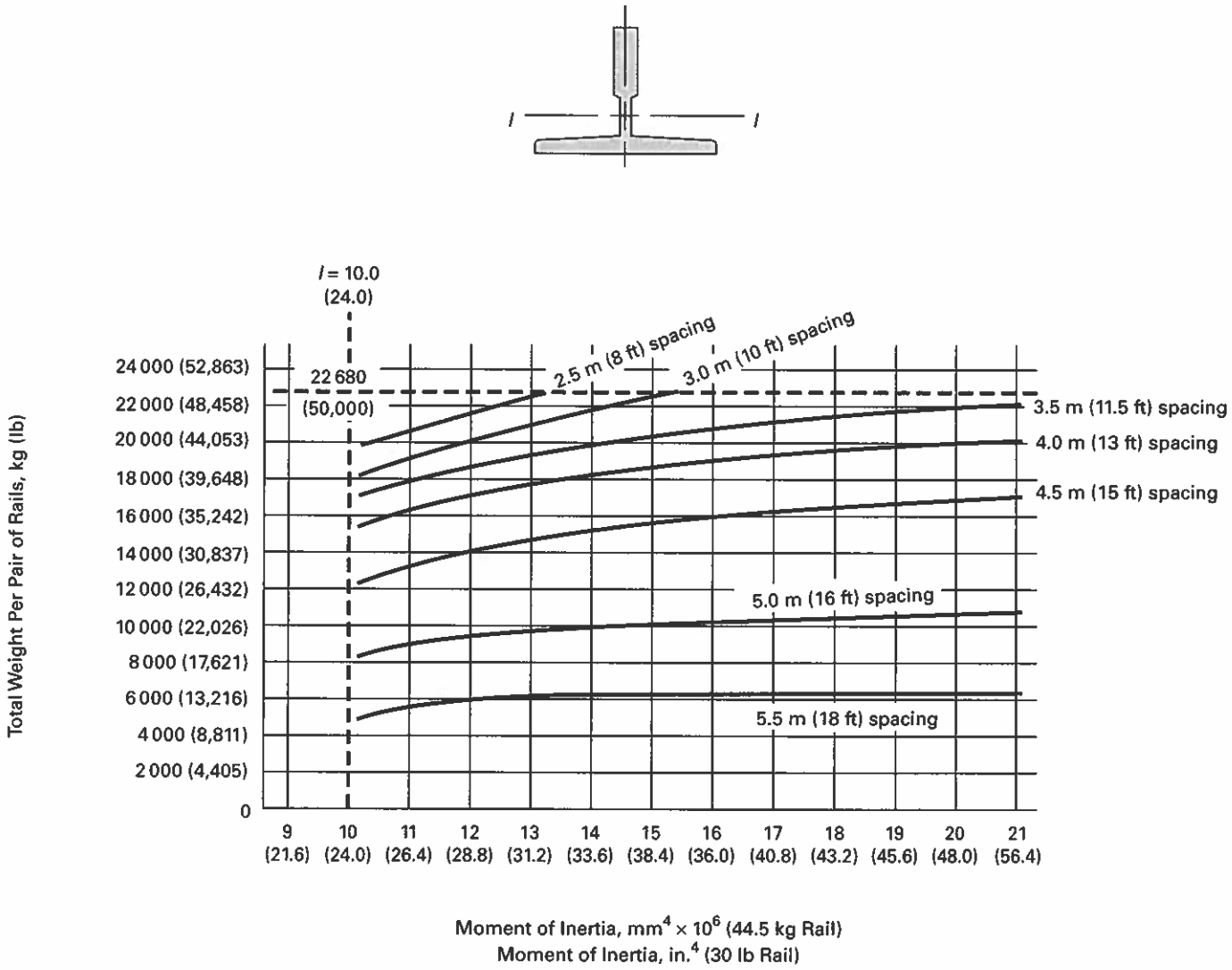



**Fig. 2.23.4.1-2 Minimum Moment of Inertia About *x-x* Axis for a Single Guide Rail With Its Reinforcement (Cont'd)**

**Table 2.23.4.2 Load Multiplying Factor for Duplex Safeties**

| Vertical Distance Between Safeties, mm (in.) | Multiply Load in Fig. 2.23.4.1-1 by |
|---|---|
| 5 400 (212 or more) | 2.00 |
| 4 600 (182) | 1.83 |
| 3 700 (146) | 1.67 |
| 2 700 (106) | 1.50 |

(see 2.16.2.2 and 8.2.2.6) with a total deflection at the point of support not in excess of 3 mm (0.125 in.).

**2.23.5.3 Allowable Stresses Due to Emergency Braking.** Guide rails, brackets, supports, and their fastenings subject to forces due to the application of the emergency brake (see 2.19.4) shall be designed to withstand the maximum forces developed during the retardation phase of the emergency braking so that the resulting stresses due to the emergency braking and all other loading acting simultaneously, if applicable, shall not exceed 190 MPa (27,500 psi).

### 2.23.6 Guide-Rail Surfaces

Guide-rail surfaces used for guiding a car or counterweight shall be sufficiently smooth and true to operate properly with the guiding members. Those surfaces that

**Table 2.23.4.3.1 Guide Rails for Counterweight Without Safeties**

| SI Units | | | Imperial Units | | |
|---|---|---|---|---|---|
| Mass of Counterweight, kg | Nominal Mass of Guide Rail, kg/m | Maximum Bracket Spacing Without Reinforcement, mm | Weight of Counterweight, lb | Nominal Weight of Guide Rail, lb/ft | Maximum Bracket Spacing Without Reinforcement, ft |
| 3 000 | 9.5 | 3 000 | 6,600 | 6¼ | 10 |
| 4 000 | 8.5 | 4 400 | 8,800 | 5¾ | 14.5 |
| 7 000 | 12.0 | 4 900 | 15,000 | 8 | 16 |
| 12 000 | 16.5 | 4 900 | 27,000 | 11 | 16 |
| 13 000 | 18.0 | 4 900 | 29,000 | 12 | 16 |
| 18 000 | 22.5 | 4 900 | 40,000 | 15 | 16 |
| 25 000 | 27.5 | 4 900 | 56,000 | 18½ | 16 |
| 36 000 | 33.5 | 4 900 | 80,000 | 22½ | 16 |
| 60 000 | 44.5 | 4 900 | 133,000 | 30 | 16 |

**Table 2.23.4.3.3 Intermediate Tie Brackets**

| Nominal Distance Between Fastenings to Building Structure, mm (in.) | | Number of Intermediate Tie Brackets |
|---|---|---|
| For 8.5 kg (6¼ lb) Rail | For All Other Rails | |
| 0–3 300 (0–130) | 0–3 700 (0–146) | 0 |
| 3 301–3 800 (130–150) | 3 701–4 300 (147–169) | 1 |
| 3 801–4 400 (150–173) | 4 301–4 900 (170–193) | 2 |

the car or counterweight safeties engage shall be smooth and true within the tolerances required to ensure proper safety application without excessive retardation or excessive out-of-level platform conditions resulting (see 2.17.3, 2.17.9.2, and 2.17.16).

### 2.23.7 Rail Joints and Fishplates

**2.23.7.1 Type and Strength of Rail Joints.** Metal guide-rail sections shall be joined together as specified in 2.23.7.2. The jointed rail sections shall withstand the forces specified in 2.23.5.1 without exceeding the stress and deflection limitations.

#### 2.23.7.2 Design and Construction of Rail Joints

**2.23.7.2.1** The joints of metal guide rails with T-section profiles as specified in 2.23.3(a) shall conform to the following requirements:

*(a)* The ends of the rails shall be accurately machined with a tongue and matching groove centrally located in the web.

*(b)* The backs of the rail flanges shall be accurately machined, in relation to the rail guiding surfaces, to a uniform distance front to back of the rails to form a flat surface for the fishplates.

*(c)* The ends of each rail shall be bolted to the fishplates with not fewer than four bolts that conform to Table 2.23.7.2.1.

*(d)* The width of the fishplate shall be not less than the width of the back of the rail.

*(e)* The thickness of the fishplates and the diameter of the bolts for each size of guide rail shall be not less than specified in Table 2.23.7.2.1.

*(f)* The diameter of bolt holes shall not exceed the diameter of the bolts by more than 2 mm (0.08 in.) for guide rails nor 3 mm (0.125 in.) for fishplates.

**2.23.7.2.2** Joints of different design and construction shall be permitted to be used, provided they are equivalent in strength and will adequately maintain the accuracy of the rail alignment.

### 2.23.8 Overall Length of Guide Rails

The car and counterweight guide rails shall extend at the top and bottom to prevent the guiding members (see 2.15.2 and 2.21.1.3) from disengaging from the guide rails in the event that either the car or counterweight reaches its extreme limit of travel.

### 2.23.9 Guide-Rail Brackets and Building Supports

#### 2.23.9.1 Design and Strength of Brackets and Supports

**2.23.9.1.1** The building construction forming the supports for the guide rails and the guide-rail brackets shall be designed to

*(a)* safely withstand the application of the car or counterweight safety when stopping the car and its rated load or the counterweight

*(b)* withstand the forces specified in 2.23.5.2 within the deflection limits specified

**2.23.9.1.2** Walls of bricks, terra-cotta, hollow blocks, and similar materials shall not be used for attachment of guide-rail brackets unless adequately reinforced.

**2.23.9.1.3** Where necessary, the building construction shall be reinforced to provide adequate support for the guide rails.

**Table 2.23.7.2.1 Minimum Thickness of Fishplates and Minimum Diameter of Fastening Bolts**

| SI Units | | | Imperial Units | | |
|---|---|---|---|---|---|
| Nominal Mass of Guide Rail, kg/m | Minimum Thickness of Fish Plates, mm | Minimum Diameter of Bolts, mm | Nominal Weight of Guide Rail, lb/ft | Minimum Thickness of Fish Plates, in. | Minimum Diameter of Bolts, in. |
| 8.5 | 9.5 | M12 | 5¾ | ⅜ | ½ |
| 9.5 | 9.5 | M12 | 6¼ | ⅜ | ½ |
| 12.0 | 14.0 | M12 | 8 | 9/16 | ½ |
| 16.5 | 17.0 | M16 | 11 | 11/16 | ⅝ |
| 18.0 | 17.0 | M16 | 12 | 11/16 | ⅝ |
| 22.5 | 17.0 | M16 | 15 | 11/16 | ⅝ |
| 27.5 | 20.0 | M20 | 18½ | 13/16 | ¾ |
| 33.5 | 20.0 | M20 | 22½ | 13/16 | ¾ |
| 44.5 | 23.0 | M20 | 30 | 15/16 | ¾ |

### 2.23.9.2 Bracket Fastenings

**2.23.9.2.1** Guide-rail brackets shall be secured to their supporting structure by one of the following means:

*(a)* by bolts or rivets

*(b)* by using clip fastenings to mount brackets to the building structure, provided that

*(1)* the friction force of such clips has a minimum factor of safety of 10

*(2)* an additional means, having a safety factor of not less than 5, of resisting horizontal shear is incorporated

*(c)* by welding conforming to 8.8

**2.23.9.2.2** Fastening bolts and bolt holes in brackets and their supporting beams shall conform to 2.23.10.

**2.23.9.3** Slotted guide-rail brackets having single-bolt fastenings shall be provided with an additional means to prevent lateral movement of the rail bracket. Such means shall have a factor of safety of not less than 5.

### 2.23.10 Fastening of Guide Rails to Rail Brackets

**2.23.10.1 Type of Fastenings.** Guide rails shall be secured to their brackets by clips, welds, or bolts.

Bolts used for fastening shall be of such strength as to withstand the forces specified in 2.23.5.2 and 2.23.9.1.

Welding, where used, shall conform to 8.8.

**2.23.10.2 Size of Bolts for Fastening.** The size of bolts used for fastening the guide rails or rail clips to the brackets shall be not less than specified in Table 2.23.10.2.

**2.23.10.3 Bolt Holes for Fastenings.** The diameter of holes or the width of slots for fastening bolts shall not exceed the diameter of the bolt by more than 2 mm (0.08 in.).

**Table 2.23.10.2 Minimum Size of Rail-Fastening Bolts**

| SI Units | | Imperial Units | |
|---|---|---|---|
| Nominal Mass of Guide Rail, kg/m | Minimum Diameter of Rail Bolts, mm | Nominal Weight of Guide Rail, lb/ft | Minimum Diameter of Rail Bolts, in. |
| 8.5 | M12 | 5¾ | ½ |
| 9.5 | M12 | 6¼ | ½ |
| 12.0 | M12 | 8 | ½ |
| 16.5 | M16 | 11 | ⅝ |
| 18.0 | M16 | 12 | ⅝ |
| 22.5 | M16 | 15 | ⅝ |
| 27.5 | M16 | 18½ | ⅝ |
| 33.5 | M20 | 22½ | ¾ |
| 44.5 | M20 | 30 | ¾ |

## SECTION 2.24
## DRIVING MACHINES AND SHEAVES

### 2.24.1 Type of Driving Machines

All driving machines shall be of the traction type, except that winding-drum machines shall be permitted for freight elevators, subject to the following:

*(a)* They shall not be provided with counterweights.

*(b)* The rated speed of the elevator shall not exceed 0.25 m/s (50 ft/min).

*(c)* The travel of the elevator car shall not exceed 12.5 m (40 ft).

NOTE (2.24.1): See 4.1 for rack-and-pinion machines and 4.2 for screw machines.

### 2.24.2 Sheaves and Drums

**2.24.2.1 Material and Grooving.** Sheaves and drums used with suspension and compensating ropes shall be

of metal and provided with finished grooves for ropes or shall be permitted to be lined with nonmetallic groove material.

**2.24.2.2 Minimum Pitch Diameter.** Sheaves and drums used with suspension and compensating ropes shall have a pitch diameter of not less than

*(a)* 40 times the diameter of the rope where used with suspension ropes

*(b)* 32 times the diameter of the ropes where used with compensating ropes

**2.24.2.3 Traction**

**2.24.2.3.1** Where the grooves are used to transmit power, sufficient traction shall be provided between the rope and groove, and in the event of nonmetallic lining failure, between the rope and the remaining sheave groove, to safely stop and hold the car with rated load [see 2.16.8(c)] from rated speed in the down direction.

**2.24.2.3.2** If either the car or the counterweight bottoms on its buffers or becomes otherwise immovable

*(a)* the ropes shall slip in the drive sheave grooves and not allow the car or counterweight to be raised; or

*(b)* the driving system shall stall and not allow the car or counterweight to be raised.

**2.24.2.4 Minimum Sheave and Drum Diameter.** Drive sheaves and drums shall be permanently and legibly marked to state the minimum sheave or drum diameter, measured at the bottom of the groove, that is required to maintain structural integrity (see 2.24.3).

### 2.24.3 Factor of Safety for Driving Machines and Sheaves

The factor of safety to be used in the design of driving machines, and in the design of sheaves used with suspension and compensating ropes, shall be not less than

*(a)* 8 for metals having an elongation of at least 14% in a gauge length of 50 mm (2 in.) when tested in accordance with ASTM E 8

*(b)* 10 for cast iron, or for metals having an elongation of less than 14% in a gauge length of 50 mm (2 in.) when tested in accordance with ASTM E 8

The load to be used in determining the factor of safety shall be the resultant of the maximum tensions in the ropes leading from the sheave or drum with the elevator at rest and with the rated load in the car.

**2.24.3.1 Factors of Safety Based on Alternating/Reversing Stresses**

**2.24.3.1.1** Driving-machine components subjected to alternating or reversing stresses shall have a factor of safety of not less than 1.5.

**2.24.3.1.2** This factor of safety shall be the ratio of the endurance limit of the components (see 1.3) to the actual alternating or reversing stress to which the components can be subjected under any normal operating condition. The endurance limit shall be based on $10^7$ cycles of stress reversals. The actual stress shall include all designed or anticipated load conditions and stress risers, such as sharp corners, shock loading, surface finish, key ways, material variations, alignment tolerances, etc.

**2.24.3.2 Factors of Safety at Emergency Braking.** Driving-machine components including bedplate, where used, subject to forces due to the application of the emergency brake (see 2.19.4) shall be designed to withstand the maximum forces developed during the retardation phase of the emergency braking so that the factor of safety resulting from the emergency braking and all other loading acting simultaneously, if applicable, shall be not less than those specified in 2.24.3(a) and 2.24.3(b).

### 2.24.4 Fasteners Transmitting Load

**2.24.4.1 Fasteners and Rigid Connections.** Set screws or threaded portions located in the shear plane of bolts and screws shall not be used to transmit load.

Means shall be provided to ensure that there is no relative motion between rigidly joined components transmitting load.

The factors of safety to be used in the design of fasteners transmitting load in driving machines and sheaves shall be not less than those specified in 2.24.3.

**2.24.4.2 Flexible Connections.** Where flexible couplings are used to transmit load, means shall be provided to prevent disengagement of the coupling components in the event of the failure of or excessive motion in the flexible connection.

### 2.24.5 Shaft Fillets and Keys

A fillet shall be provided at any point of change in the diameter of driving-machine shafts and sheave shafts to prevent excessive stress concentrations in the shafts (see 2.24.3.1).

Shafts that support drums, sheaves, gears, couplings, and other members, and that transmit torque, shall be provided with tight-fitting keys.

### 2.24.6 Cast-Iron Worms and Worm Gears

Worms and worm gears made of cast iron shall not be used in elevator driving machines.

### 2.24.7 Friction Gearing and Clutches

Friction gearing or a clutch mechanism shall not be used to connect a driving-machine drum or sheave to the main driving mechanism.

### 2.24.8 Braking System and Driving-Machine Brakes (See Nonmandatory Appendix F, Table F1)

**2.24.8.1 General Requirements.** The elevator shall be provided with a braking system conforming to 2.24.8.2.

### 2.24.8.2 Braking System

**2.24.8.2.1** The braking system shall consist of a driving machine brake and in addition shall be permitted to include other braking means, such as electrically assisted braking.

**2.24.8.2.2** The braking system shall be capable of decelerating the car from its rated speed when it is carrying its rated load (see 2.16.8) in the down direction, or empty car in the up direction from the speed at which the governor overspeed switch is set. Any deceleration not exceeding 9.8 $m/s^2$ (32.2 $ft/s^2$) is acceptable, provided that all factors such as, but not limited to, system heat dissipation and allowable buffer striking speeds are considered. The loss of main line power shall not reduce the braking system capacity below the requirements stated here.

**2.24.8.3 Driving-Machine Brake.** The driving-machine shall be equipped with a friction brake applied by a spring or springs, or by gravity, and released electromechanically or electrohydraulically (see 1.3) in conformance with 2.26.8. The driving-machine brake, on its own, shall be capable of

*(a)* holding the car at rest with its rated load (see 2.16.8 and 2.26.8).

*(b)* holding the empty car at rest.

*(c)* decelerating the empty car traveling in the up direction from the speed at which the governor overspeed switch is set. Any deceleration not exceeding 9.8 $m/s^2$ (32.2 $ft/s^2$) is acceptable provided that all factors such as, but not limited to, system heat dissipation and allowable buffer striking speeds are considered.

**2.24.8.4 Means for Manual Release.** Means shall be permitted for manual release of the driving-machine brake. The means shall permit car movement in a gradual, controllable manner. Provision shall be made to prevent unintended actuation of the device. The manual release device shall be designed to be hand applied only with continuous effort. The brake shall reapply at its fully adjusted capacity in the absence of the hand-applied effort.

**2.24.8.5 Marking Plates for Brakes.** The brake setting and method of measurement shall be permanently and legibly marked on the driving machine.

**2.24.8.6 Driving-Machine Brake Design.** The driving-machine brake design shall ensure contact of the friction material on the braking surface consistent with good engineering practice. Means shall be provided to protect the braking surfaces from contamination caused by any driving-machine fluid leak.

### 2.24.9 Indirect Driving Machines

**2.24.9.1 Belt and Chain Drives.** Indirect driving machines, utilizing V-belt drives, tooth drive belts, or drive chains, shall include not less than three belts or chains operating together in parallel as a set. Belt and chain drive sets shall be preloaded and matched for length in sets.

### 2.24.9.2 General Requirements

**2.24.9.2.1** Belt sets shall be selected on the basis of the manufacturer's rated breaking strength and a factor of safety of 10. Chain and sprocket sets shall be selected on the basis of recommendations set forth in the Supplementary Information section of ASME B29.1M, using a service factor of 2. Offset links in chain are not permitted.

**2.24.9.2.2** Sprockets in a chain drive set and also a driven set shall be assembled onto a common hub, with teeth cut in-line after assembly to assure equal load distribution on all chains. Tooth sheaves for a belt drive shall be constructed in a manner to assure equal load distribution on each belt in the set.

**2.24.9.2.3** Load determination for both the belt and chain sets shall be based on the maximum static loading on the elevator car, which is the full load in the car at rest and at a position in the hoistway that creates the greatest load, including either the car or counterweight resting on its buffer.

**2.24.9.2.4** Chain drives and belt drives shall be guarded to protect against accidental contact and to prevent foreign objects from interfering with the drives.

**2.24.9.3 Monitoring and Brake Location.** Each belt or chain in a set shall be continuously monitored by a broken belt or chain device, which shall function to automatically interrupt power to the machine and apply the brake in the event that any belt or chain in the set breaks or becomes excessively slack. The driving-machine brake shall be located on the traction sheave or drum assembly side of the driving machine so as to be fully effective in the event that the entire belt set or chain set should break.

### 2.24.10 Means for Inspection of Gears

Each gear case of geared machines shall have access to permit inspection of the contact surfaces of the gears. Such access need not provide a direct view of all gears, but shall be located and sized adequately to allow access by fibre optic or similar visual inspection instrumentation.

## SECTION 2.25
## TERMINAL STOPPING DEVICES

### 2.25.1 General Requirements

**2.25.1.1** Normal terminal stopping devices required by 2.25.2, emergency terminal stopping devices required

by 2.25.4.2, and emergency terminal speed-limiting devices required by 2.25.4.1 shall be permitted to use mechanically operated, magnetically operated, optical, or solid-state devices for determining car position and speed.

**2.25.1.2** Final terminal stopping devices required by 2.25.3 shall use only mechanically operated switches for determining car position.

**2.25.1.3** Terminal stopping devices that are located on the car or in the hoistway shall be of the enclosed type and securely mounted in such a manner that horizontal movement of the car shall not affect the operation of the device.

### 2.25.2 Normal Terminal Stopping Devices

**2.25.2.1 Where Required and Function.** Normal terminal stopping devices shall conform to 2.25.2.1.1 through 2.25.2.1.3.

**2.25.2.1.1** Normal terminal stopping devices shall be provided and arranged to slow down and stop the car automatically, at or near the top and bottom terminal landings, with any load up to and including rated load in the car and from any speed attained in normal operation (see 2.16.8).

**2.25.2.1.2** Such devices shall function independently of the operation of the normal stopping means and of the final terminal stopping device, except that on elevators with a rated speed of 0.75 m/s (150 ft/min) or less, the normal terminal stopping device shall be permitted to be used as the normal stopping means.

**2.25.2.1.3** The device shall be so designed and installed that it will continue to function until the final terminal stopping device operates.

**2.25.2.2 Location of Stopping Devices.** Normal terminal stopping devices shall be located as specified in 2.25.2.2.1 and 2.25.2.2.2.

**2.25.2.2.1** Stopping devices for traction machines shall be located on the car, in the hoistway, or in the machine room, and shall be operated by the movement of the car.

**2.25.2.2.2** Stopping devices for winding drum machines shall be located on the car or in the hoistway, and shall be operated by the movement of the car.

**2.25.2.3 Indirectly Operated Normal Terminal Stopping Devices.** Stopping devices that are not located on the car or in the hoistway shall conform to 2.25.2.3.1 through 2.25.2.3.3.

**2.25.2.3.1** The stopping device shall be mounted on and operated by a stopping means mechanically connected to and driven by the car.

Stopping means depending on friction or traction shall not be used.

**2.25.2.3.2** Tapes, chains, ropes, or similar devices mechanically connecting the stopping device to the car and used as a driving means shall be provided with a device that will cause the electric power to be removed from the elevator driving-machine motor and brake if the driving means fails (see 2.26.2.6).

**2.25.2.3.3** If mechanically operated switches are used, only one set of floor-stopping contacts is necessary for each terminal landing on floor controllers or other similar devices used to stop the car automatically at the landings (such as automatic operation, signal operation, etc.), provided these contacts and the means for operating them conform to 2.25.2.3.1 and 2.25.2.3.2. These contacts shall be permitted to serve also as the normal terminal stopping devices.

### 2.25.3 Final Terminal Stopping Devices

**2.25.3.1 General Requirements.** Final terminal stopping devices shall conform to 2.25.1 and the following:

*(a)* They shall be mechanically operated.

*(b)* Operating cams shall be of metal.

*(c)* The switch contacts shall be directly opened mechanically.

**2.25.3.2 Where Required and Function.** Final terminal stopping devices shall be provided and arranged to cause the electric power to be removed automatically from the elevator driving-machine motor and brake after the car has passed a terminal landing.

The device shall be set to function as close to the terminal landing as practicable, but so that under normal operating conditions it will not function when the car is stopped by the normal terminal stopping device.

Where spring buffers are provided, the device shall function before the buffer is engaged.

The device shall be so designed and installed that it will continue to function

*(a)* at the top terminal landing, until the car has traveled above this landing a distance equal to the counterweight runby plus 1.5 times the buffer stroke, but in no case less than 0.6 m (2 ft)

*(b)* at the bottom terminal landing, until the car rests on its fully compressed buffer

The operation of final terminal stopping devices shall prevent movement of the car by the normal operating devices in both directions of travel.

**2.25.3.3 Location.** Final terminal stopping devices shall be located as specified in 2.25.3.3.1 and 2.25.3.3.2.

**2.25.3.3.1** Traction machine elevators shall have final terminal stopping switches located in the hoistway and operated by cams attached to the car.

**2.25.3.3.2** Winding drum machine elevators shall have two sets of final terminal stopping switches, one located on and operated by the driving machine, and

the other located in the hoistway and operated by cams attached to the car (see 2.25.3.5).

(ED) **2.25.3.4 Controller Switches Controlled by Final Terminal Stopping Device.** The normal and final terminal stopping devices shall not control the same controller switches unless two or more separate and independent switches are provided, two of which shall be closed to complete the driving-machine motor and brake circuit in either direction of travel.

Where a two- or three-phase AC driving-machine motor is used, these switches shall be of the multipole type.

The control shall be so designed and installed that a single ground or short circuit may permit either, but not prevent both, the normal or final stopping device circuits from stopping the car.

**2.25.3.5 Additional Requirements for Winding Drum Machines.** Final terminal stopping devices for winding-drum machines shall conform to 2.25.3.5.1 through 2.25.3.5.3.

**2.25.3.5.1** Stopping switches, located on and operated by the driving machine, shall not be driven by chains, ropes, or belts.

**2.25.3.5.2** Where a two- or three-phase AC driving-machine motor is used, the mainline circuit to the driving-machine motor and the circuit of the driving-machine brake coil shall be directly opened either by the contacts of the machine stop switch or by stopping switches mounted in the hoistway and operated by a cam attached to the car. The opening of these contacts shall occur before or coincident with the opening of the final terminal stopping switch required by 2.25.3.2.

**2.25.3.5.3** Driving machines equipped with a direct-current brake and having a DC mainline control switch in the driving-machine motor circuit controlled by a final terminal stopping switch located in the hoistway and operated by a cam attached to the car need not conform to 2.25.3.5.2. This does not eliminate the need for a machine-operated switch.

### 2.25.4 Emergency Terminal Stopping Means

**2.25.4.1 Emergency Terminal Speed Limiting Device.** Emergency terminal speed-limiting devices shall be installed on all elevators where reduced stroke buffers are used (see 2.22.4.1.2 and 2.26.2.12), and shall conform to 2.25.4.1.1 through 2.25.4.1.9.

**2.25.4.1.1** The operation of the emergency terminal speed-limiting devices shall be entirely independent of the operation of the normal terminal stopping device. The emergency terminal speed-limiting device shall automatically reduce the car and counterweight speed by removing power from the driving-machine motor and brake, such that the rated buffer striking speed is not exceeded if the normal terminal stopping device fails to slow down the car at the terminal as intended.

**2.25.4.1.2** The car speed sensing device shall be independent of the normal speed control system.

**2.25.4.1.3** The emergency terminal speed-limiting device shall provide a retardation not in excess of 9.81 $m/s^2$ (32.2 $ft/s^2$).

**2.25.4.1.4** The emergency terminal speed-limiting devices shall not apply the car safety.

**2.25.4.1.5** The emergency terminal speed-limiting devices shall be so designed and installed that a single short circuit caused by a combination of grounds, or by other conditions, shall not render the device ineffective.

**2.25.4.1.6** The emergency terminal speed-limiting devices shall be located on the car, in the hoistway, or in the machine room, and shall be operated by the movement of the car.

**2.25.4.1.7** Mechanically operated switches, where located on the car or in the hoistway, shall conform to 2.25.3.1.

**2.25.4.1.8** Where the operation of emergency terminal-speed-limiting devices is dependent on car position relative to the terminal landings

*(a)* friction or traction drives shall not be used

*(b)* if tape, chain, or rope is used for connection to the car, a switch shall be provided to remove electrical power from the driving-machine motor and brake should this connection fail (see 2.26.2.6)

**2.25.4.1.9** Where magnetically operated, optical, or solid-state devices are used for position sensing, a single short circuit caused by a combination of grounds or by other conditions, or the failure of any single magnetically operated, optical, or solid-state device shall not

*(a)* render the emergency terminal speed-limiting device inoperative

*(b)* permit the car to restart after a normal stop

**2.25.4.2 Emergency Terminal Stopping Device.** Elevators with static control and rated speeds over 1 m/s (200 ft/min) shall be provided with an emergency terminal stopping device that will cause power to be removed from the driving-machine motor and brake should the normal stopping means and the normal terminal stopping device fail to cause the car to slow down at the terminal as intended.

The emergency terminal stopping device shall function independently of the normal terminal stopping device and the normal speed control system.

Elevators with static generator-field control that use the normal terminal stopping device to limit the generator-field current directly, or elevators that have an emergency terminal speed-limiting device that complies with 2.25.4.1, are not required to have an emergency terminal stopping device.

## SECTION 2.26
## OPERATING DEVICES AND CONTROL EQUIPMENT

### 2.26.1 Operation and Operating Devices

**2.26.1.1 Types of Operating Devices.** All operating devices shall be of the enclosed electric type.

Rope or rod operating devices actuated directly by hand, or rope operating devices actuated by wheels, levers, or cranks, shall not be used.

**2.26.1.2 For Car-Switch Operation Elevators.** Handles of lever-type operating devices of car-switch operation elevators shall be so arranged that they will return to the stop position and latch there automatically when the hand of the operator is removed.

**2.26.1.3 Additional Operating Devices for Elevators Equipped to Carry One-Piece Loads Greater Than the Rated Load.** Elevators equipped to carry one-piece loads greater than their rated load shall be provided with an additional operating device of the continuous-pressure type, located near the driving machine, to operate the elevator at a speed not exceeding 0.75 m/s (150 ft/min) under such conditions. The normal operating devices shall be inoperative during such operation (see 2.16.7.10).

**2.26.1.4 Inspection Operation**

**2.26.1.4.1 General Requirements**

*(a)* Operating devices for inspection operation shall be provided on the top of the car and shall also be permitted in the car and in the machine room.

*(b)* A switch for transferring control of the elevator to the operating devices for inspection operation shall be provided, which shall

*(1)* be manually operated

*(2)* be labeled "INSPECTION"

*(3)* have two positions, labeled "INSPECTION" or "INSP" and "NORMAL" or "NORM"

*(4)* when in the "INSPECTION" position

*(a)* enable inspection operation by means of the inspection operating devices

*(b)* except as provided, in 2.26.1.4.2(f), cause the movement of the car to be solely under the control of the inspection operating devices through a contact that shall be positively opened mechanically and whose opening shall not depend solely on springs

*(c)* disable automatic power door opening and closing and car leveling, except as provided in 2.26.1.4.2(f)

*(5)* when in the "NORMAL" position, disable inspection operation by means of the inspection operating devices

*(c)* Inspection operating devices shall

*(1)* be of the continuous-pressure type

*(2)* be labeled "UP" and "DOWN," respectively

*(d)* Inspection operation shall conform to the following:

*(1)* the speed of the car shall not exceed 0.75 m/s (150 ft/min)

*(2)* be subject to the electrical protective devices required by 2.26.2, except as permitted by 2.26.1.5

*(3)* fully closed doors shall be permitted to be held in the closed position with power applied

*(e)* Inspection operation shall be used only by elevator personnel.

**2.26.1.4.2 Top-of-Car Inspection Operation.** Top-of-car inspection operation shall conform to 2.26.1.4.1 and the following:

*(a)* A stop switch (see 2.26.2.8) shall be permanently located on the car top and readily accessible to a person, while standing at the hoistway entrance normally used for access to the car top.

*(b)* The transfer switch [see 2.26.1.4.1(b)] shall be located on the car top and shall be so designed as to prevent accidental transfer from the "INSPECTION" to "NORMAL" position.

*(c)* A separate device of the continuous-pressure type labeled "ENABLE" shall be provided adjacent to the inspection operating devices.

*(d)* The inspection operating devices shall become effective only when the "ENABLE" device is activated.

*(e)* The inspection operating devices [see 2.26.1.4.1(c)], shall be permitted to be of the portable type, provided that

*(1)* the "ENABLE" device [see 2.26.1.4.2(c)], and a stop switch, in addition to the stop switch required in 2.26.1.4.2(a) are included in the portable unit

*(2)* the flexible cord is permanently attached so that the portable unit cannot be detached from the car top

*(f)* Separate additional devices of the continuous-pressure type shall be permitted to be provided on the car top to make power door opening and closing and automatic car leveling operative from the top of the car for testing purposes.

**2.26.1.4.3 In-Car Inspection Operation.** When in-car inspection operation is provided, it shall conform to 2.26.1.4.1, and the transfer switch [see 2.26.1.4.1(b)]

*(a)* shall be located in the car.

*(b)* shall be key-operated or placed behind a locked cover. Keys to operate or access the switch shall be Group 1 Security (see 8.1).

*(c)* shall be rendered ineffective if top-of-car inspection operation is activated.

*(d)* when in the "INSPECTION" position, shall not enable hoistway access switch(es). A third switch position shall be permitted to enable the hoistway access switches [see 2.12.7.3.3(a)].

**2.26.1.4.4 Machine Room Inspection Operation.** When machine room inspection operation is provided,

it shall conform to 2.26.1.4.1, and the transfer switch [see 2.26.1.4.1(b)] shall be

*(a)* located in the machine room

*(b)* rendered ineffective if top-of-car inspection operation, in-car inspection operation, or hoistway access operation is activated, or when a car door or hoistway door bypass switch is in the "BYPASS" postion

**2.26.1.5 Inspection Operation With Open Door Circuits.** The machine room elevator controller shall have switches marked "CAR DOOR BYPASS" and "HOISTWAY DOOR BYPASS" that will prepare the control system so that, only when top-of-car or in-car inspection operation is activated, the car shall be permitted to be moved with open door contacts. The switches shall conform to 2.26.1.5.1 through 2.26.1.5.8.

**2.26.1.5.1** They shall have contacts that are positively opened mechanically, when switching to either "BYPASS" or "OFF" positions, and their opening shall not be solely dependent on springs.

**2.26.1.5.2** The positions of the "BYPASS" switches shall be clearly marked "BYPASS" and "OFF."

**2.26.1.5.3** The related circuits shall comply with 2.26.9.3 and 2.26.9.4.

**2.26.1.5.4** When either or both of the switches are in the "BYPASS" position, all means of operation shall be made inoperative except top-of-car and in-car inspection operation.

**2.26.1.5.5** When the "CAR-DOOR BYPASS" switch is in the "BYPASS" position, it shall permit top-of-car and in-car inspection operation with open car door (or gate) contacts.

**2.26.1.5.6** When the "HOISTWAY DOOR BYPASS" switch is in the "BYPASS" position, it shall permit top-of-car and in-car inspection operation with open hoistway door interlocks or contacts.

**2.26.1.5.7** Each of the "BYPASS" switches shall be permitted to be replaced by a set of switches used to bypass individual groups of door contacts. Each switch in this set shall be marked to identify the specific door contacts bypassed.

**2.26.1.5.8** A warning sign shall be mounted adjacent to the "BYPASS" switches stating, "Jumpers shall not be used to bypass hoistway door or car door electric contacts."

**2.26.1.6 Operation in Leveling or Truck Zone.** Operation of an elevator in a leveling or truck zone at any landing by a car leveling or truck zoning device, when the hoistway doors, or the car doors or gates, or any combination thereof, are not in the closed position, is permissible, subject to the requirements of 2.26.1.6.1 through 2.26.1.6.7.

**2.26.1.6.1** Operating devices of manually operated car leveling devices or truck zoning devices shall be of the continuous-pressure type and located in the car.

**2.26.1.6.2** Car platform guards, conforming to 2.15.9, shall be provided. Where a car leveling device is used, landing sill guards, conforming to 2.11.12.7, shall also be provided.

**2.26.1.6.3** The leveling zone at any landing shall not extend more than 450 mm (18 in.) above and below any landing where an automatic leveling device is used, and not more than 250 mm (10 in.) above and below any landing where a manually operated leveling device is used.

**2.26.1.6.4** The truck zone at any landing shall not extend more than 1 700 mm (67 in.) above the landing.

**2.26.1.6.5** Where a truck or leveling zone for one hoistway entrance extends into the door interlocking zone for a second entrance, the truck zoning or leveling operation shall be inoperative unless the hoistway door at the second entrance is in the closed position.

Where a truck or leveling zone for one hoistway entrance extends into the leveling zone for a second entrance, the leveling operation for the second entrance shall be inoperative while the hoistway door at the first entrance is open.

**2.26.1.6.6** A leveling or truck-zoning device shall not move the car at a speed exceeding 0.75 m/s (150 ft/min).

For elevators with static control, an independent means shall be provided to limit the leveling speed to a maximum of 0.75 m/s (150 ft/min) with the doors open, should the normal means to control this speed (mechanical, electrical, or solid state devices) fail to do so.

**2.26.1.6.7** For elevators with static control, an inner landing zone extending not more than 75 mm (3 in.) above and 75 mm (3 in.) below the landing shall be provided. A car shall not move if it stops outside of the inner landing zone unless the doors are fully closed.

## 2.26.2 Electrical Protective Devices

When an electrical protective device is activated (operated, opened), it shall cause the electric power to be removed from the elevator driving machine motor and brake. [See also 2.26.3, 2.26.4.3, 2.26.4.4, 2.26.7, 2.26.8.3(c), 2.26.9.3, and 2.26.9.4]. Electrical protective devices shall be provided as specified in 2.26.2.1 through 2.26.2.32.

**2.26.2.1 Slack-Rope Switch.** Winding drum machines shall be provided with a slack-rope device equipped with a slack-rope switch of the enclosed manually reset type. This switch shall operate whenever the ropes are slack.

**2.26.2.2 Motor-Generator Running Switch.** Where generator-field control is used, means shall be provided to prevent the application of power to the elevator driving machine motor and brake unless the motor generator set connections are properly switched for the running condition of the elevator. It is not required that the electrical connections between the elevator driving machine motor and the generator be opened in order to remove power from the elevator motor.

**2.26.2.3 Compensating-Rope Sheave Switch.** Compensating-rope sheaves shall be provided with a compensating-rope sheave switch or switches mechanically opened by the compensating-rope sheave before the sheave reaches its upper or lower limit of travel.

**2.26.2.4 Motor Field Sensing Means.** Where direct current is supplied to an armature and shunt field of an elevator driving-machine motor, a motor field current sensing means shall be provided, which shall cause the electric power to be removed from the driving-machine motor armature, and brake unless current is flowing in the shunt field of the motor, except for static control elevators provided with a device to detect an overspeed condition prior to, and independent of, the operation of the governor overspeed switch. This device shall cause power to be removed from the elevator driving-machine motor armature and machine brake.

**2.26.2.5 Emergency Stop Switch.** An emergency stop switch shall not be provided on passenger elevators. On all freight elevators, an emergency stop switch shall be provided in the car, and located in or adjacent to each car operating panel.

When open ("STOP" position), this switch shall cause the electric power to be removed from the elevator driving-machine motor and brake.

Emergency stop switches shall

*(a)* be of the manually opened and closed type

*(b)* have red operating handles or buttons

*(c)* be conspicuously and permanently marked "STOP," and shall indicate the "STOP" and "RUN" positions

*(d)* while opened, cause the audible device to sound (see 2.27.1.1.1)

NOTE (2.26.2.5): See 2.26.2.21 for in-car stop switch requirements for passenger elevators.

**2.26.2.6 Broken Rope, Tape, or Chain Switches.** The switch or switches that shall be opened by a failure of a rope, tape, or chain, shall be provided when required by 2.25.2.3.2 or 2.25.4.1.8(b).

**2.26.2.7 Stop Switch in Pit.** A stop switch conforming to 2.26.2.5(a), (b), (c) shall be provided in the pit of every elevator (see 2.2.6).

**2.26.2.8 Stop Switch on Top of Car.** A stop switch conforming to 2.26.2.5(a), (b), and (c) shall be provided on the top of every elevator car.

**2.26.2.9 Car Safety Mechanism Switch.** A switch, conforming to 2.17.7 shall be required where a car safety is provided.

**2.26.2.10 Speed-Governor Overspeed Switch.** A speed-governor overspeed switch shall be provided when required by 2.18.4.1 and shall conform to 2.18.4.1.2, 2.18.4.2, and 2.18.4.3.

**2.26.2.11 Final Terminal Stopping Devices.** Final terminal stopping devices, conforming to 2.25.3, shall be provided for every electric elevator.

**2.26.2.12 Emergency Terminal Speed Limiting Devices.** Where reduced-stroke oil buffers are provided, as permitted by 2.22.4.1.2, emergency terminal speed-limiting devices conforming to 2.25.4.1 shall be provided.

**2.26.2.13 Buffer Switches for Oil Buffers Used With Type C Car Safeties.** Oil level and compression switches conforming to 2.17.8.2.7 and 2.17.8.2.8 shall be provided for all oil buffers used with Type C safeties (see 2.17.5.3).

**2.26.2.14 Hoistway Door Interlocks and Hoistway Door Electric Contacts.** Hoistway door interlocks or hoistway door electric contacts conforming to 2.12 shall be provided for all elevators.

**2.26.2.15 Car Door and Gate Electric Contacts.** Car door or gate electric contacts, conforming to 2.14.4.2, shall be provided for all elevators; except when car door interlock, conforming to 2.26.2.28 is provided.

**2.26.2.16 Emergency Terminal Stopping Devices.** Emergency terminal stopping devices conforming to 2.25.4.2 shall be provided for all elevators where static control is used, unless exempted by 2.25.4.2.

**2.26.2.18 Car Top Emergency Exit Electrical Device.** An electrical device conforming to 2.14.1.5.1(f) shall be provided on the car top emergency exit cover.

**2.26.2.19 Motor-Generator Overspeed Protection.** Means shall be provided to cause the electric power to be removed automatically from the elevator driving-machine motor and brake should a motor-generator set, driven by a DC motor, overspeed excessively.

**2.26.2.20 Electric Contacts for Hinged Car Platform Sills.** Hinged car platform sills, where provided, shall be equipped with electric contacts conforming to 2.15.16.

**2.26.2.21 In-Car Stop Switch.** On passenger elevators, a stop switch, either key operated or behind a locked cover, shall be provided in the car and located in or adjacent to the car operating panel. The key shall be Group 1 Security (see 8.1).

The switch shall be clearly and permanently marked "STOP" and shall indicate the "STOP" and "RUN" positions.

When opened ("STOP" position), this switch shall cause the electric power to be removed from the elevator driving-machine motor and brake.

**2.26.2.22 Buffer Switches for Gas Spring-Return Oil Buffers.** Buffer switches conforming to 2.22.4.5(c) shall be provided.

**2.26.2.23 Stop Switch in Remote Machine and Control Rooms.** A stop switch conforming to 2.26.2.5(a), (b), and (c) shall be provided in remote machine and control rooms where required by 2.7.8.

**2.26.2.24 Stop Switch in Overhead Machinery Space in the Hoistway.** A stop switch conforming to 2.26.2.5(a), (b), and (c) shall be provided in the overhead machinery space in the hoistway where required by 2.7.3.5.

**2.26.2.25 Blind Hoistway Emergency Door Locking Device.** A locking device conforming to 2.11.1.2(e) shall be provided on every emergency door in a blind hoistway.

**2.26.2.26 Pit Access Door Electric Contact.** An electric contact shall be provided on each pit access door where required by 2.2.4.4.

**2.26.2.27 Stop Switch in Remote Counterweight Hoistways.** A stop switch conforming to 2.26.2.5(a), (b), and (c) shall be provided in the remote counterweight hoistway where required by 2.3.3.3.

**2.26.2.28 Car Door Interlock.** An interlock conforming to 2.14.4.2 shall be provided where required by 2.14.4.2.1.

**2.26.2.29 Ascending Car Overspeed Protection Device.** An overspeed device shall be provided when required by 2.19.1 and shall meet the requirements of 2.19.1.2(a).

**2.26.2.30 Unintended Car Movement Device.** An unintended car movement device shall be provided when required by 2.19.2 and shall meet the requirements of 2.19.2.2(a). Where generator-field control is used, this electrical protective device shall also cause the power to be removed from the drive motor of the motor-generator set.

**2.26.2.31 Car Access Panel Locking Device.** A locking device conforming to 2.14.2.6 shall be provided where required by 2.14.2.6(e).

**2.26.2.32 Hoistway Access Opening Locking Device.** Access openings in the hoistway shall be provided with a locking device where required by 2.11.1.4.

(04) **2.26.2.33 Firefighter's Stop Switch.** A firefighter's stop switch that conforms to the requirements of 2.26.2.5(a), (b), and (c) shall be provided where required by 2.27.3.3.1(m).

### 2.26.3 Contactors and Relays for Use in Critical Operating Circuits

Where electromechanical contactors or relays are provided to fulfill the requirements of 2.26.8.2, and 2.26.9.3 through 2.26.9.7, they shall be considered to be used in critical operating circuits. If contact(s) on these electromechanical contactors or relays are used for monitoring purposes, they shall be prevented from changing state if the contact(s) utilized in a critical operating circuit fail to open in the intended manner. The ability of the monitoring contact(s) to perform this function shall not be solely dependent upon springs.

### 2.26.4 Electrical Equipment and Wiring

**2.26.4.1** All electrical equipment and wiring shall conform to NFPA 70 or CSA C22.1, whichever is applicable (see Part 9).

**2.26.4.2** Drive-machine controllers, logic controllers, and operating devices accessory thereto for starting, stopping, regulating, controlling, or protecting electric motors, generators, or other equipment shall be listed/certified and labeled/marked to the requirements of CAN/CSA-B44.1/ASME A17.5.

**2.26.4.3** The devices covered by 2.26.2 shall have contacts that are positively opened mechanically; their opening shall not be solely dependent on springs. Exceptions are devices described by 2.26.2.4, 2.26.2.19, 2.26.2.29, and 2.26.2.30; and 2.26.2.12 and 2.26.2.16 where magnetically operated, optical, or static-type switches are used.

**2.26.4.4** Control equipment shall be tested in accordance with the testing requirements of EN 12016 by exposing it to interference levels at the test values specified for "safety circuits." The interference shall not cause any of the conditions described in 2.26.9.3(a) through (e) and shall not cause the car to move while on inspection operation. (04)

If enclosure doors or suppression equipment must remain installed to meet the above requirements, warning signs to that effect shall be posted on the control equipment.

**2.26.4.5** In jurisdictions enforcing CSA C22.1, power supply line disconnecting means, shall not be opened automatically by a fire alarm system.

### 2.26.5 System to Monitor and Prevent Automatic Operation of the Elevator With Faulty Door Contact Circuits

Means shall be provided to monitor the position of power-operated car doors that are mechanically coupled with the landing doors while the car is in the landing zone, in order

*(a)* to prevent the operation of the car if the car door is not closed (see 2.14.4.11), regardless whether the portion of the circuits incorporating the car door contact or

the interlock contact of the landing door coupled with car door, or both, are closed or open, except as permitted in 2.12.7, 2.26.1.5, and 2.26.1.6

*(b)* to prevent, except as permitted in 2.26.1.5, the power closing of the doors if the car door is fully open and any of the following conditions exist:

*(1)* the car door contact is closed or the portion of the circuit, incorporating this contact is bypassed

*(2)* the interlock contact of the landing door that is coupled to the opened car door is closed or the portion of the circuit, incorporating this contact is bypassed

*(3)* the car door contact and the interlock contact of the door that is coupled to the opened car door are closed, or the portions of the circuits incorporating these contacts are bypassed

(ED) **2.26.6 Phase Protection of Motors**

Elevators having a polyphase AC power supply shall be provided with means to prevent the starting of the elevator drive motor or door motor if a reversal of phase rotation, or phase failure of the incoming polyphase AC power, will cause the elevator car or elevator door(s) to operate in the wrong direction.

**2.26.7 Installation of Capacitors or Other Devices to Make Electrical Protective Devices Ineffective**

The installation of capacitors or other devices, the operation or failure of which will cause an unsafe operation of the elevator, is prohibited.

No permanent device that will make any required electrical protective device ineffective shall be installed except as provided in 2.12.7.1, 2.26.1.5, 2.26.1.6, and 2.27.3.1.6(c) (see 8.6.1.6.1).

**2.26.8 Release and Application of Driving-Machine Brakes**

**2.26.8.1** Driving-machine brakes shall not be electrically released until power has been applied to the driving machine motor.

**2.26.8.2** Two devices shall be provided to independently remove power from the brake. If the brake circuit is ungrounded, all power feed lines to the brake shall be opened.

**2.26.8.3** The brake shall apply automatically when

*(a)* the operating device of a car switch or continuous-pressure operation elevator is in the stop position;

*(b)* a normal stopping means functions

*(c)* any electrical protective device is activated

*(d)* there is a loss of power to the driving machine brake

**2.26.8.4** The application of the brake shall be permitted to occur on or before the completion of the slowdown and leveling operations, under conditions described in 2.26.8.3(a) and (b).

**2.26.8.5** The brake shall not be permanently connected across the armature or field of a direct-current elevator driving-machine motor.

**2.26.9 Control and Operating Circuits**

The design and installation of the control and operating circuits shall conform to 2.26.9.1 through 2.26.9.8.

**2.26.9.1** If springs are used to actuate switches, contactors, or relays to break the circuit to stop an elevator at the terminal landings, they shall be of the compression type.

**2.26.9.2** The completion or maintenance of an electric circuit shall not be used to interrupt the power to the elevator driving-machine motor or brake at the terminal landings, nor to stop the car when any of the electrical protective devices (see 2.26.2) operate. Requirement 2.26.9.2 does not apply to dynamic braking, nor to speed control switches.

**2.26.9.3** The occurrence of a single ground or the failure of any single magnetically operated switch, contactor, or relay, or any single device that limits the leveling or truck zone, or any single solid state device; or a software system failure, shall not

*(a)* render any electrical protective device ineffective (see 2.26.2)

*(b)* permit the car to move beyond the leveling or truck zone if any hoistway door interlock is unlocked or if any hoistway door or car door or gate electric contact is not in the closed position (see 2.26.1.6)

*(c)* permit speeds in excess of those specified in 2.12.7.3.2, 2.26.1.4.1(d)(1), 2.26.1.5.10(b), and 2.26.1.6.6

*(d)* permit the car to revert to normal operation when on hoistway access switch operation (see 2.12.7.3) or on inspection operation (see 2.26.1.4) or on bypass operation (see 2.26.1.5)

*(e)* continue to make ineffective any hoistway-door interlock or car door or gate electric contact when either a hoistway access switch (see 2.12.7.3) or a "BYPASS" switch (see 2.26.1.5) is turned to the "OFF" position.

**2.26.9.4** Redundant devices used to satisfy 2.26.9.3 in the determination of the occurrence of a single ground, or the failure of any single magnetically operated switch, contactor or relay, or of any single solid state device, or any single device that limits the leveling or truck zone, or a software system failure, shall be checked prior to each start of the elevator from a landing, when on automatic operation. When a single ground or failure, as specified in 2.26.9.3, occurs, the car shall not be permitted to restart. Implementation of redundancy by a software system is permitted, provided that the removal of power from the driving-machine motor and brake shall not be solely dependent on software-controlled means.

**2.26.9.5** Except for elevators employing alternating-current hoist motors driven from a direct-current source through a static inverter (see 2.26.9.6), elevators with driving motors employing static control without motor-generator sets shall conform to 2.26.9.5.1 through 2.26.9.5.6.

**2.26.9.5.1** Two devices shall be provided to remove power independently from the driving-machine motor. At least one device shall be an electromechanical contactor.

**2.26.9.5.2** The contactor shall be arranged to open each time the car stops.

**2.26.9.5.3** The contactor shall cause the driving-machine brake circuit to open.

**2.26.9.5.4** An additional contactor shall be provided to also open the driving-machine brake circuit. This contactor is not required to have contacts in the driving-machine motor circuit.

**2.26.9.5.5** The electrical protective devices required by 2.26.2 shall control the solid state device and both contactors, except that leveling shall be permitted to take place with power opening of doors and gates in conformance with 2.13.2.1.1 and 2.13.2.2.1.

**2.26.9.5.6** After each elevator stop, the car shall not respond to a signal to start unless both contactors are in the de-energized position.

**2.26.9.6** Elevators employing alternating-current driving motors driven from a direct-current power source through a static inverter shall conform to 2.26.9.6.1 through 2.26.9.6.6.

**2.26.9.6.1** Two separate means shall be provided to independently inhibit the flow of alternating-current through the solid state devices that connect the direct-current power source to the alternating-current driving motor. At least one of the means shall be an electromechanical relay.

**2.26.9.6.2** The relay shall be arranged to open each time the car stops.

**2.26.9.6.3** The relay shall cause the driving-machine brake circuit to open.

**2.26.9.6.4** An additional contactor shall be provided to also open the driving-machine brake circuit. This contactor is not required to have contacts in the driving machine motor circuit.

**2.26.9.6.5** The electrical protective devices required by 2.26.2 shall control both the means that inhibit the flow of alternating current through the solid state devices and the contactors in the brake circuit, except that leveling shall be permitted to take place with power opening of the doors and gates as restricted by 2.13.2.1.1 and 2.13.2.2.1.

**2.26.9.6.6** After each elevator stop, the car shall not respond to a signal to start unless the relay that inhibits the flow of alternating current through the solid-state devices, as well as the contactors in the brake circuit, are in the de-energized position.

**2.26.9.7** Where generator-field control is used, means shall be provided to prevent the generator from building up and applying sufficient current to the elevator driving-machine motor to move the car when the elevator motor control switches are in the "OFF" position. The means used shall not interfere with maintenance of an effective dynamic-braking circuit during stopping and standstill conditions.

**2.26.9.8** The control circuits shall be so designed and installed that the car speed in the down direction with rated load in the car, under normal operating conditions with the power supply on or off, shall not exceed governor tripping speed, or 125% of rated speed, whichever is the lesser (see also 2.16.8).

### 2.26.10 Absorption of Regenerated Power

When a power source is used that, in itself, is incapable of absorbing the energy generated by an overhauling load, means for absorbing sufficient energy to prevent the elevator from attaining governor tripping speed or a speed in excess of 125% of rated speed, whichever is less, shall be provided on the load side of each elevator power supply line disconnecting means (see 2.16.8).

### 2.26.11 Car Platform to Hoistway Door Sills Vertical Distance

Where ANSI/ICC A117.1 or ADAAG is not applicable, the vertical distance between the car platform sill and the hoistway door sill on passenger elevators shall be in accordance with the following:

*(a)* it shall not exceed 13 mm (0.5 in.) on initial stop at a landing

*(b)* the car shall relevel if the vertical distance exceeds 25 mm (1 in.) while loading or unloading

### 2.26.12 Symbols

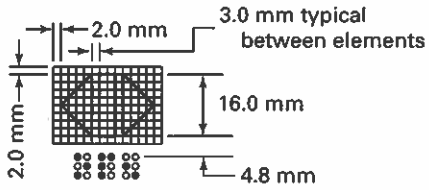
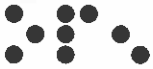
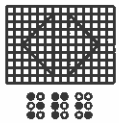
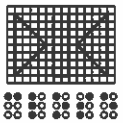
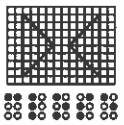
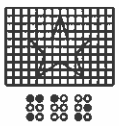
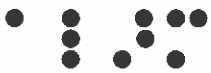
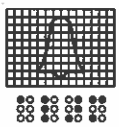
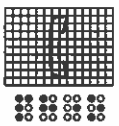
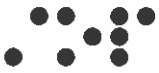
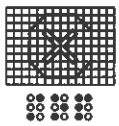
**2.26.12.1** Where reference is made requiring wording to designate a specific function, the symbols as shown in Table 2.26.12.1 shall be substituted for, or used in conjunction with, the required wording.

**2.26.12.2** The emergency stop switch shall have the "STOP" and "RUN" positions conspicuously and permanently marked as required by 2.26.2.5(c).

**2.26.12.3** Where Braille is provided it shall conform to the requirements in Table 2.26.12.1.

NOTE (2.26.12): See also ANSI/ICC A117.1, ADAAG and B44 Appendix F.

**Table 2.26.12.1 Symbol Identification**

| Function | Tactile Symbol | Braille Message Where Provided | Proportions (Open Circles Indicate Unused Dots Within Each Braille Cell) |
|---|---|---|---|
| Door Open |  |  OP"EN" |   |
| Rear/Side Door Open |  |  REAR/SIDE OP"EN" |  |
| Door Close |  |  CLOSE |  |
| Rear/Side Door Close |  |  REAR/SIDE CLOSE |  |
| Main |  |  MA"IN" |  |
| Alarm |  |  AL"AR"M |  |
| Phone |  |  PH"ONE" |  |
| Emergency Stop |  |  "ST"OP |  |

**2.26.12.4** Identify "HELP" button [see 2.27.1.1.3(b)] and visual indication [see 2.27.1.1.3(c)] with the phone symbol.

## SECTION 2.27
## EMERGENCY OPERATION AND SIGNALING DEVICES

NOTE (2.27): Additional requirements may be found in the building code.

### 2.27.1 Car Emergency Signaling Devices

#### 2.27.1.1 Emergency Communications

**2.27.1.1.1** A two-way communications means between the car and a location in the building, that is readily accessible to authorized and emergency personnel shall be provided.

**2.27.1.1.2** When the two-way communications location in the building is not staffed 24 h a day, by authorized personnel who can take appropriate action, the means of two-way communications shall automatically be directed within 30 s to an additional on- or off-site location, staffed by authorized personnel, where an appropriate response can be taken.

**2.27.1.1.3** The two-way communication means within the car shall comply with the following requirements:

*(a)* In jurisdictions enforcing NBCC, Appendix E of CAN/CSA B44, or in jurisdictions not enforcing NBCC, ICC/ANSI A117.1.

*(b)* A push button to actuate the two-way communication means shall be provided in or adjacent to a car operating panel. The push button shall be visible and permanently identified as "HELP." The identification shall be on or adjacent to the "HELP" button. When the push button is actuated, the emergency two-way communication means shall initiate a call for help and establish two-way communications.

*(c)* A visual indication on the same panel as the "HELP" push button shall be provided, which is activated by authorized personnel, to acknowledge that two-way communications link has been established. The visual indication shall be extinguished when the two-way communication link is terminated.

*(d)* The two-way communication means shall provide on demand to authorized personnel, information that identifies the building location and elevator number and that assistance is required.

*(e)* After the call acknowledgement signals are sent [2.27.1.1.3(c)], the two-way voice communications shall be available between the car and authorized personnel.

*(f)* The two-way communications, once established, shall be disconnected only when authorized personnel outside the car terminate the call.

*(g)* The two-way communication means shall not use a handset in the car.

*(h)* The two-way communications shall not be transmitted to an automated answering system. The call for help shall be answered by authorized personnel.

*(i)* Operating instructions shall be incorporated with or adjacent to the "HELP" button.

**2.27.1.1.4** Where the elevator travel is 18 m (60 ft) or more, a two-way voice communication means within the building shall be provided and comply with the following requirements:

*(a)* The means shall enable emergency personnel within the building to establish two-way voice communications to each car individually. Two-way voice communication shall be established without any intentional delay and shall not require intervention by a person within the car. The means shall override communications to outside of the building.

*(b)* Two-way voice communications, once established, shall be disconnected only when emergency personnel outside the car terminates the call.

*(c)* Once the two-way voice communication has been established, the visual indication [see 2.27.1.1.3(c)] within the car shall illuminate. The visual indication shall be extinguished when the two-way communication is terminated.

*(d)* Operating instructions shall be incorporated with or adjacent to the two-way voice communication outside the car. Instructions shall conform to 2.27.7.3.

**2.27.1.1.5** If the emergency communication means is normally connected to the building power supply, it shall automatically transfer to a source of standby or emergency power as required by the applicable building code or, where applicable, Standard for Health Care Facilities (ANSI/NFPA-99), after the normal power supply fails. The power source shall be capable of providing for illumination of the visual indication [see 2.27.1.1.3(c)] within the car, and the means of emergency communications for at least 4 h; and the audible signaling device (see 2.27.1.2) for at least 1 h.

**2.27.1.2 Emergency Stop Switch Audible Signal.** When an emergency stop switch (2.26.2.5) is provided, an audible signaling device shall be provided. The audible signaling device shall

*(a)* have a rated sound pressure rating of not less than 80 dBA nor greater than 90 dBA at 3 m (10 ft)

*(b)* respond without delay after the switch has been activated

*(c)* be located inside the building and audible inside the car and outside the hoistway

*(d)* for elevators with a travel greater than 30 m (100 ft), be duplicated as follows:

*(1)* one device shall be mounted on the car

*(2)* a second device shall be placed at the designated level

### 2.27.2 Emergency or Standby Power System

Where an emergency or standby power system is provided to operate an elevator in the event of normal power supply failure, the requirements of 2.27.2.1 through 2.27.2.5 shall be complied with.

**2.27.2.1** The emergency or standby power system shall be capable of operating the elevator(s) with rated load (see 2.16.8), at least one at a time, unless otherwise required by the building code.

**2.27.2.2** The transfer between the normal and the emergency or standby power system shall be automatic.

**2.27.2.3** An illuminated signal marked "ELEVATOR EMERGENCY POWER" shall be provided in the elevator lobby at the designated level to indicate that the normal power supply has failed and the emergency or standby power is in effect.

**2.27.2.4** Where the emergency or standby power system is not capable of operating all elevators simultaneously, requirements of 2.27.2.4.1 through 2.27.2.4.5 shall be conformed to.

**2.27.2.4.1** A selector switch(es) marked "ELEVATOR EMERGENCY POWER" in red lettering a minimum of 5 mm (0.25 in.) in height, which is key-operated or under a locked cover (see 2.27.8), shall be provided to permit the selection of the elevator(s) to operate on the emergency or standby power system. The key shall be Group 3 Security (see 8.1).

**2.27.2.4.2** The selector switch(es) positions shall be marked to correspond with the elevator identification number (see 2.29) and a position marked "AUTO."

**2.27.2.4.3** The selector switch(es) shall be located at the designated level in view of all elevator entrances, or if located elsewhere means shall be provided adjacent to the selector switch(es) to indicate that the elevator is at the designated level with the doors in the normally open position.

**2.27.2.4.4** When the selector switch is in the "AUTO" position, automatic power selection shall be provided, which will return each elevator that is not on designated attendant operation, inspection operation or Phase II In-Car Emergency Operation, one or more at a time, to the recall level. Failure of the selected car to move shall cause power to be transferred to another car.

**2.27.2.4.5** The selector switch(es) positions corresponding to the elevator identification numbers (see 2.29.1) shall override the automatic power selection. Operation of the selector switch(es) shall not cause power to be removed from any elevator until the elevator is stopped.

NOTE (2.27.2.4): The selector switch(es) should normally be placed in the "AUTO" position.

**2.27.2.5** When the emergency or standby power system is designed to operate only one elevator at a time, the energy absorption means (if required) shall be permitted to be located on the supply side of the elevator power disconnecting means, provided all other requirements of 2.26.10 are conformed to when operating any of the elevators the power might serve. Other building loads, such as power and lights that can be supplied by the emergency or standby power system, shall not be considered as a means of absorbing the regenerated energy for the purposes of conforming to 2.26.10, unless such loads are normally powered by the emergency or standby power system.

### 2.27.3 Firefighters' Emergency Operation: Automatic Elevators

Firefighters' Emergency Operation shall apply to all automatic elevators except

*(a)* where the hoistway or a portion thereof is not required to be fire-resistive construction (see 2.1.1.1), the travel does not exceed 2 000 mm (80 in.), and the hoistway does not penetrate a floor

*(b)* in jurisdictions enforcing the NBCC where the NBCC does not require Firefighters' Emergency Operation

Where Firefighters' Emergency Operation is provided voluntarily these requirements shall also apply.

#### 2.27.3.1 Phase I Emergency Recall Operation

**2.27.3.1.1** A three-position key-operated switch shall be

*(a)* provided only at the designated level for each single elevator or for each group of elevators.

*(b)* labeled "FIRE RECALL" and its positions marked "RESET," "OFF," and "ON" (in that order), with the "OFF" position as the center position. The "FIRE RECALL" letters shall be a minimum of 5 mm (0.25 in.) high in red or a color contrasting with a red background.

*(c)* located in the lobby within sight of the elevator or all elevators in that group and shall be readily accessible.

**2.27.3.1.2** An additional key-operated "FIRE RECALL" switch, with two positions, marked "OFF" and "ON" (in that order), shall be permitted only at the building fire control station.

**2.27.3.1.3** The switch(es) shall be rotated clockwise to go from the "RESET" (designated level switch only), to "OFF" to "ON" positions. Keys shall be removable only in the "OFF" and "ON" positions.

**2.27.3.1.4** Only the "FIRE RECALL" switch(es) or fire alarm initiating device located at floors that are served by the elevator, or in the hoistway, or in the elevator machine room (see 2.27.3.2) shall initiate Phase I Emergency Recall Operation.

**2.27.3.1.5** All "FIRE RECALL" switches shall be provided with an illuminated visual signal to indicate

when Phase I Emergency Recall Operation is in effect.

**2.27.3.1.6** When a "FIRE RECALL" switch is in the "ON" position all cars controlled by the switch shall operate as follows:

*(a)* A car traveling towards the designated level shall continue nonstop to the designated level and power-operated doors shall open and remain open.

On cars with two entrances, if both entrances can be opened at the designated level, only the doors serving the lobby where the "FIRE RECALL" switch is located shall open and remain open.

*(b)* A car traveling away from the designated level shall reverse at or before the next available landing without opening its doors and proceed to designated level.

*(c)* A stopped car shall have the in-car stop switch (see 2.26.2.21) and the emergency stop switch in the car (see 2.26.2.5) when provided, rendered inoperative as soon as the car moves away from the landing. A moving car shall have the in-car stop switch and the emergency stop switch in the car when provided, rendered inoperative without delay. Once the emergency stop switch in the car and the in-car stop switch have been rendered inoperative, they shall remain inoperative while the car is on Phase I Emergency Recall Operation. All other stop switches required by 2.26.2 shall remain operative.

*(d)* A car standing at a landing other than the designated level, with the doors open and the in-car stop switch and the emergency stop switch in the car when provided, in the run position, shall conform to the following:

*(1)* Elevators having automatic power-operated horizontally sliding doors shall close the doors without delay and proceed to the designated level.

*(2)* Elevators having power-operated vertically sliding doors provided with automatic or momentary pressure closing operation per 2.13.3.4 shall have the closing sequence initiated without delay in accordance with 2.13.3.4.1, 2.13.3.4.2, 2.13.3.4.3, and 2.13.3.4.5, and the car shall proceed to the designated level.

*(3)* Elevators having power-operated doors provided with continuous pressure closing operation (see 2.13.3.2), or elevators having manual doors, shall be provided with a visual and audible signal system [see 2.27.3.1.6(h)] to alert an operator to close the doors and shall, when the doors are closed, proceed to the designated level. Sequence operation, if provided, shall remain effective.

*(e)* Door reopening devices for power-operated doors that are sensitive to smoke or flame shall be rendered inoperative without delay. Door reopening devices not sensitive to smoke or flame (e.g., mechanically actuated devices) are permitted to remain operative. Door closing for power-operated doors shall conform to 2.13.5.

*(f)* All car and corridor call buttons shall be rendered inoperative. All call-registered lights and directional lanterns shall be extinguished and remain inoperative. Car position indicators, where provided, shall remain operative. Where provided, landing position indicators shall be extinguished and remain inoperative, except at the designated level and the building fire control station, where they shall remain operative.

*(g)* Where provided on elevators with vertically sliding doors, corridor door open and door close buttons shall remain operative.

*(h)* An illuminated visual and audible signal system shall be activated. The visual signal shall be one of the symbols shown in Fig. 2.27.3.1.6(h) and located on the car-operating panel. The entire circular or square area or the outline of the hat, or the outline of the area shown in Fig. 2.27.3.1.6(h) shall be illuminated. The visual signal shall remain activated until the car is restored to automatic operation. When the door is open, the audible signal shall remain active until the door is closed. When the door is closed, the audible signal shall remain active for a minimum of 5 s. The audible signal shall not be active when the car is at the recall level. (04)

*(i)* A car stopped at a landing shall have the in-car door open button rendered inoperative as soon as the car moves away from the landing. The in-car door close button shall remain inoperative when a car stops to reverse direction. Once the in-car door open button has been rendered inoperative, it shall remain inoperative until the car has returned to the designated level.

*(j)* Where an additional "FIRE RECALL" switch is provided, both "FIRE RECALL" switches shall be in the "ON" position to recall the elevator to the designated level if the elevator was recalled to the alternate level (see 2.27.3.2.4).

*(k)* To remove the elevator(s) from Phase I Emergency Recall Operation, the "FIRE RECALL" switch shall be rotated first to the "RESET," and then to the "OFF" position, provided that

*(1)* the additional two-position "FIRE RECALL" switch, where provided, is in the "OFF" position

*(2)* no fire alarm initiating device is activated (see 2.27.3.2).

*(l)* Means used to remove elevators from normal operation, other than as specified in this Code, shall not prevent Phase I Emergency Recall Operation.

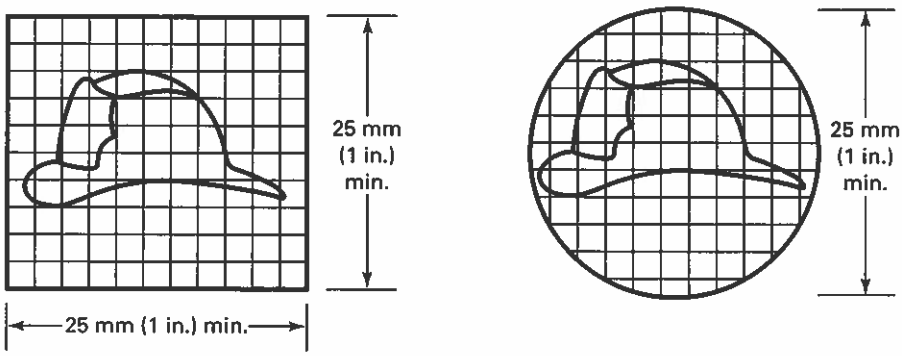
*(m)* No device, which measures load, shall prevent operation of the elevator at or below the capacity and loading required in 2.16.

### 2.27.3.2 Phase I Emergency Recall Operation by Fire Alarm Initiating Devices

**2.27.3.2.1** In jurisdictions not enforcing the NBCC, fire alarm initiating devices used to initiate Phase I Emergency Recall Operation shall be installed in conformance with the requirements of NFPA 72, and shall be located

*(a)* at each floor served by the elevator

*(b)* in the associated elevator machine room




GENERAL NOTE: Grid is for scaling purposes only.

**Fig. 2.27.3.1.6(h) Visual Signal**

*(c)* in the elevator hoistway, when sprinklers are located in those hoistways

**2.27.3.2.2** In jurisdictions enforcing the NBCC, automatic Emergency Recall Operation shall be permitted when the following devices, complying with the requirements in the NBCC, initiate the operation:

*(a)* smoke detectors installed in each elevator lobby, or the building fire alarm system

*(b)* smoke detectors installed in the elevator lobby at the designated level, if that floor area is not sprinklered throughout

*(c)* smoke detectors installed in the machine room if the machine room is sprinklered

**2.27.3.2.3** Phase I Emergency Recall Operation to the designated level shall conform to the following:

*(a)* The activation of a fire alarm initiating device specified in 2.27.3.2.1 or 2.27.3.2.2(a) at any floor, other than at the designated level, shall cause all elevators that serve that floor, and any associated elevator of a group automatic operation, to be returned nonstop to the designated level.

*(b)* The activation of a fire alarm initiating device specified in 2.27.3.2.1(b) or 2.27.3.2.2(c) shall cause all elevators having any equipment located in that machine room, and any associated elevators of a group automatic operation, to be returned nonstop to the designated level. If the machine room is located at the designated level, the elevator(s) shall be returned nonstop to the alternate level.

*(c)* The activation of a fire alarm initiating device specified in 2.27.3.2.1(c) shall cause all elevators having any equipment in that hoistway, and any associated elevators of a group automatic operation, to be returned nonstop to the designated level, except that initiating device(s) installed at or below the lowest landing of recall shall cause the car to be sent to the upper recall level.

*(d)* The Phase I Emergency Recall Operation to the designated level shall conform to 2.27.3.1.6(a) through (m).

**2.27.3.2.4** Phase I Emergency Recall Operation to an alternate level (see 1.3) shall conform to the following:

*(a)* the activation of a fire alarm initiating device specified in 2.27.3.2.1(a) or 2.27.3.2.2(a) that is located at the designated level, shall cause all elevators serving that level to be recalled to an alternate level, unless a "FIRE RECALL" switch is already in the "ON" position

*(b)* the requirements of 2.27.3.1.6(f), (j), and (m)

*(c)* the requirements of 2.27.3.1.6(a), (b), (c), (d), (e), (g), (h), (i), (k), and (l), except that all references to the "designated level" shall be replaced with "alternate level"

**2.27.3.2.5** The recall level shall be determined by the first activated fire alarm initiating device for that group [see 2.27.3.2.1 or 2.27.3.2.2, see also 2.27.3.1.6(j)].

**2.27.3.2.6** When a fire alarm initiating device in the machine room or hoistway initiates Phase I Emergency Recall Operation, as required by 2.27.3.2.3 or 2.27.3.2.4, the visual signal [see 2.27.3.1.6(h) and Fig. 2.27.3.1.6(h)] shall illuminate intermittently only in a car(s) with equipment in that machine room or hoistway. When activated, heat detector [2.27.3.2.1(d)] in the machine room shall cause the visual signal [see 2.27.3.1.6(h) and Fig. 2.27.3.1.6(h)] to illuminate intermittently only in a car(s) with equipment in that machine room. (04)

**2.27.3.3 Phase II Emergency In-Car Operation.** A three-position ("OFF," "HOLD," and "ON," in that order) key-operated switch shall be labeled "FIRE OPERATION"; provided in an operating panel in each car; and shall be readily accessible. The label "FIRE OPERATION" lettering shall be a minimum of 5 mm (0.25 in.) high in red or a color contrasting with a red

background. It shall become effective only when Phase I Emergency Recall Operation is in effect and the car has been returned to the recall level. The switch shall be rotated clockwise to go from "OFF" to "HOLD" to "ON."

The key shall only be removable in the "OFF" and "HOLD" position. The "OFF," "HOLD," and "ON" positions shall not change the mode of operation within Phase II Emergency In-Car Operation until the car is at a landing with the doors in the normal open position, except as required by 2.27.3.3.4.

(04) **2.27.3.3.1** When the "FIRE OPERATION" switch is in the "ON" position, the elevator shall be on Phase II Emergency In-Car Operation, for use by emergency personnel only, and the elevator shall operate as follows:

*(a)* The elevator shall be operable only by a person in the car.

*(b)* The car shall not respond to landing calls. Directional lanterns, where provided, shall remain inoperative. Car position indicators, where provided, shall remain operative. Landing position indicators, where provided, shall remain inoperative, except at the designated level and the building fire control station, where they shall remain operative.

*(c)* Door open and close buttons shall be provided for power-operated doors and located as required by 2.27.3.3.7. The door open and door close buttons shall be labeled "OPEN" and "CLOSE."

*(d)* The opening of power-operated doors shall be controlled only by a continuous pressure door open button. If the button is released prior to the doors reaching the normal open position, the doors shall automatically reclose. Requirements 2.13.3.3, 2.13.3.4, 2.13.4.2.1(b)(2), and 2.13.4.2.1(c) do not apply.

On cars with multiple entrances, if more than one entrance can be opened at the same landing, separate door open buttons shall be provided for each entrance.

*(e)* Open power-operated doors shall be closed only by continuous pressure on the door close button. If the button is released prior to the doors reaching the fully closed position, horizontally sliding doors shall automatically reopen, and vertically sliding doors shall automatically stop or stop and reopen.

On cars with multiple entrances, if more than one entrance can be opened at the same landing, a separate door close button shall be provided for each entrance.

*(f)* Opening and closing of power-operated car doors or gates that are opposite manual swing or manual slide hoistway doors shall conform to 2.27.3.3.1(d) and (e).

*(g)* All door reopening devices, except the door open button, shall be rendered inoperative. Full speed closing shall be permitted.

Landing door opening and closing buttons, where provided, shall be rendered inoperative.

*(h)* Every car shall be provided with a button labeled "CALL CANCEL," located as required in 2.27.3.3.7, which shall be effective during Phase II Emergency In-Car Operation. When activated, all registered calls shall be canceled and a traveling car shall stop at or before the next available landing.

*(i)* Floor selection buttons shall be provided in the car to permit travel to all landings served by the car, and they shall be operative at all times, except as in 2.27.3.3.2. Means to prevent the operation of the floor selection buttons or door-operating buttons shall be rendered inoperative.

*(j)* A traveling car shall stop at the next available landing for which a car call was registered. When a car stops at a landing, all registered car calls shall be canceled.

*(k)* Means used to remove elevators from normal operation, other than as specified in this Code, shall not prevent Phase II Emergency In-Car Operation.

*(l)* No device, which measures load, shall prevent operation of the elevator at or below the capacity and loading required in 2.16.

*(m)* Every car shall be provided with a switch, conforming to the requirements of 2.26.2.33 and located as required in 2.27.3.3.7. When the switch is in the "STOP" position, all registered calls shall be canceled and power shall be removed from the elevator driving-machine motor and brake. When the switch is moved to the "RUN" position from the "STOP" position, the car shall not move, except for leveling, until a call is entered.

**2.27.3.3.2** When the car is at a landing, with the doors open, and the "FIRE OPERATION" switch is in the "HOLD" position, the car shall remain at the landing with the doors open. The door close buttons shall be inoperative, and car calls shall not be registered.

**2.27.3.3.3** When the car is at a landing other than the recall level, with the doors in the normal open position, and, the "FIRE OPERATION" switch is in the "OFF" position, power-operated doors shall operate as follows:

*(a)* Horizontal sliding doors shall close automatically. All door reopening devices shall remain inoperative. Door open buttons shall remain operative. Full-speed closing is permitted. If the "FIRE OPERATION" switch is turned to the "ON" or "HOLD" position prior to the completion of door closing, the doors shall reopen.

*(b)* Elevators having vertically sliding doors shall have corridor "DOOR OPEN" and "DOOR CLOSE" buttons rendered operative. All door reopening devices shall remain inoperative. Door closing shall be in accordance with 2.27.3.3.1(e). Full-speed closing is permitted. If the "FIRE OPERATION" switch is turned to the "ON" or "HOLD" position prior to the completion of door closing, the doors shall reopen.

**2.27.3.3.4** When the car is stopped with the doors in the closed position, or in motion, and the "FIRE OPERATION" switch is in the "OFF" position, the elevator remains on Phase II Emergency In-Car Operation and

shall return to the designated level in conformance with 2.27.3.1.6(a) through (m).

**2.27.3.3.5** Elevators shall be removed from Phase II Emergency In-Car Operation only when the "FIRE OPERATION" switch is in the "OFF" position and the car is at the designated level and the doors are in the normal open position.

**2.27.3.3.6** The occurrence of an accidental ground or short circuit in elevator electrical equipment located on the landing side of the hoistway enclosure, and in associated wiring, shall not disable Phase II Emergency In-Car Operation once it has been activated.

(04) **2.27.3.3.7** The "FIRE OPERATION" switch (2.27.3.3), the "CALL CANCEL" button [2.27.3.3.1(h)], the "STOP" switch [2.27.3.3.1(m)], the door open button(s), the door close button(s), the additional visual signal (2.27.3.3.8), and the operating instructions shown in Fig. 2.27.7.2 shall be grouped together at the top of a main car operating panel behind a locked cover.

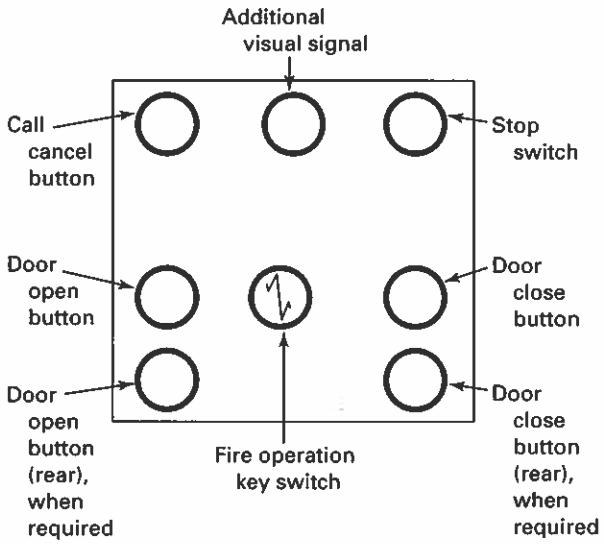
The firefighters' operation panel cover shall be openable by the same key that operates the "FIRE OPERATION" switch. The cover shall be permitted to open automatically when the car is on Phase I Emergency Recall Operation and at the recall level. When the key is in the "FIRE OPERATION" switch, the cover shall not be capable of being closed. When closed, the cover shall be self-locking.

Where rear doors are provided, buttons for both the front and rear doors shall be provided in the firefighters' operation panel. The door open and door close buttons for the rear entrance shall be labeled "OPEN REAR" and "CLOSE REAR."

All buttons and switches shall be readily accessible, located not more than 1 800 mm (72 in.) above the floor and shall be arranged as shown in Fig. 2.27.3.3.7. Requirement 2.26.1.2 does not apply to these buttons and switches. The front of the cover shall contain the words "FIREFIGHTERS' OPERATION" in red letters at least 10 mm (0.4 in.) high.

(04) **2.27.3.3.8** An additional visual signal shall be provided and located as required by 2.27.3.3.7. The additional visual signal shall be one of the symbols shown in Fig. 2.27.3.1.6(h). The entire circular or square area shown in Fig. 2.27.3.1.6(h) shall be illuminated. This additional visual signal shall be activated whenever the visual signal in 2.27.3.1.6(h) is activated.

**2.27.3.4 Interruption of Power.** Upon the resumption of power (normal, emergency, or standby), the car shall be permitted to move to reestablish absolute car position. Restoration of electrical power following a power interruption shall not cause any elevator to be removed from Phase I Emergency Recall Operation or Phase II Emergency In-Car Operation.




GENERAL NOTES:
(a) Switches and buttons show only the location not the labeling.
(b) When manually operated doors are provided, door open and close buttons and instructions for their use are not required.
(c) Not to scale.

**Fig. 2.27.3.3.7 Panel Layout** (04)

**2.27.3.5 Multicompartment Elevators.** Multicompartment elevators shall also conform to 2.27.3.5.1 and 2.27.3.5.2.

**2.27.3.5.1** The "FIRE RECALL" switch (2.27.3.1) shall be located at the designated level served by the upper compartment.

**2.27.3.5.2** The "FIRE OPERATION" switch (see 2.27.3.3) shall be located in the upper compartment. The elevator shall be provided with a means for placing the lower compartment out of service, located in that compartment or adjacent to the entrance at the lower lobby landing.

### 2.27.4 Firefighters' Emergency Operation: Nonautomatic Elevators

Firefighters' Emergency Operation shall apply to all nonautomatic elevators, except as follows:

*(a)* where the hoistway or a portion thereof is not required to be fire-resistive construction (see 2.1.1.1), the travel does not exceed 2 000 mm (80 in.), and the hoistway does not penetrate a floor

*(b)* in jurisdictions enforcing the NBCC where the NBCC does not require Firefighters' Emergency Operation

*(c)* where Firefighters' Emergency Operation is provided voluntarily these requirements shall also apply

**2.27.4.1 Phase I Emergency Recall Operation.** A three-position key-operated switch shall be provided at

the designated level for each single elevator or for each group of elevators. The three-position switch shall be labeled "FIRE RECALL" and its positions marked "RESET," "OFF," and "ON" (in that order), with the "OFF" position as the center position. The "FIRE RECALL" letters shall be a minimum of 5 mm (0.25 in.) high in red or a color contrasting with a red background. The three-position switch shall be located in the lobby within sight of the elevator or all elevators in that group and shall be readily accessible.

An additional "FIRE RECALL" switch with two-positions, "OFF" and "ON" (in that order), shall be permitted only at the building fire control station.

The switch(es) shall be rotated clockwise to go from the "RESET" (designated level switch only), to the "OFF" and to the "ON" positions. All keys shall be removable only in the "OFF" and "ON" positions.

Only the "FIRE RECALL" switch(es) or fire alarm initiating devices located at floors that are served by the elevator, or in the hoistway, or in the elevator machine room (see 2.27.3.2) shall initiate Phase I Emergency Recall Operation. All "FIRE RECALL" switches shall be provided with an illuminated visual signal to indicate when Phase I Emergency Recall Operation is in effect.

When all switches are in the "OFF" position, normal elevator service shall be in effect and the fire alarm initiating devices required by 2.27.4.2 shall be operative.

When a "FIRE RECALL" switch is in the "ON" position, a visual and audible signal shall be provided to alert the attendant to return nonstop to the designated or alternate level. The visual signal shall read "FIRE RECALL — RETURN TO _____" [insert level to which the car should be returned (the designated or alternate level)]. The signal system shall be activated when Phase I Emergency Recall Operation is in effect.

Where an additional "FIRE RECALL" switch is provided, both "FIRE RECALL" switches must be in the "ON" position to recall the elevator to the designated level if the elevator was recalled to the alternate level.

Where an additional "FIRE RECALL" switch is provided, it shall not affect the visual signal if the designated level fire alarm initiating device (see 2.27.3.2.4) has been activated.

To extinguish the audible and visual signals, the "FIRE RECALL" switch shall be rotated first to the "RESET" and then to the "OFF" position, provided that:

*(a)* the additional two-position "FIRE RECALL" switch, where provided, is in the "OFF" position

*(b)* no fire alarm initiating device is activated (see also 2.27.3.2.4)

No device, which measures load, shall prevent operation of the elevator at or below the capacity and loading required in 2.16.

(04) **2.27.4.2 Phase I Emergency Recall Operation by Fire Alarm Initiating Devices.** Fire alarm initiating devices shall be installed at each floor served by the elevator, and in the associated machine room and elevator hoistway, in compliance with the requirements in NFPA 72 or NBCC, whichever is applicable (see Part 9). In jurisdictions enforcing the NBCC, compliance with 2.27.4.2 is not required where the NBCC specifies manual Emergency Recall operations only.

Phase I Emergency Recall Operation, conforming to 2.27.4.1, shall be initiated when any Phase I Emergency Recall Operation fire alarm initiating device at the elevator lobbies, machine room, or hoistway is activated.

Phase I Emergency Recall Operation, when initiated by a Phase I Emergency Recall Operation fire alarm initiating device, shall be maintained until canceled by moving the "FIRE RECALL" switch to the "RESET" position.

When a fire alarm initiating device in the machine room or hoistway initiates Phase I Emergency Recall Operation, as required by 2.27.3.2.3 or 2.27.3.2.4, the visual signal [see 2.27.3.1.6(h) and Fig. 2.27.3.1.6(h)] shall illuminate intermittently only in a car(s) with equipment in that machine room or hoistway. When activated, a heat detector [2.27.3.2.1(d)] in the machine room shall cause the visual signal [see 2.27.3.1.6(h) and Fig. 2.27.3.1.6(h)] to illuminate intermittently only in a car(s) with equipment in that machine room.

### 2.27.5 Firefighters' Emergency Operation: Automatic Elevators With Designated-Attendant Operation

**2.27.5.1** When designated-attendant operation is not in effect, elevators shall conform to 2.27.3.

**2.27.5.2** When operated by a designated attendant in the car, except hospital service:

*(a)* elevators parked at a floor shall conform to 2.27.3.1.6(h). At the completion of a time delay of not less than 10 s and not more than 30 s, elevators shall conform to 2.27.3.

*(b)* A moving car shall conform to 2.27.3.

**2.27.5.3** When on hospital service, the elevator shall conform to 2.27.3.1.6(h) while Phase I Emergency Recall Operation is in effect. An elevator on firefighter emergency operation shall not be placed on hospital service.

### 2.27.6 Firefighters' Emergency Operation: Inspection Operation

When an elevator that is provided with firefighters' service is on inspection operation (see 2.26.1.4 and 2.26.1.5) or when the hoistway access switch(es) has been enabled [see 2.12.7.3.3(a)], a continuous audible signal, audible at the location where the operation is activated shall sound when the "FIRE RECALL" switch(es) (see 2.27.3.1) is in the "ON" position or when the fire alarm initiating device (see 2.27.3.2) is activated to alert the operator of an emergency. The car shall remain under the control of the operator until removed from inspection

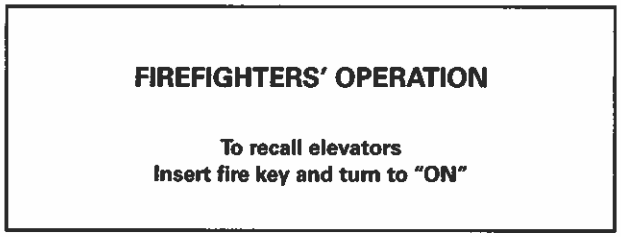



**Fig. 2.27.7.1 Phase I Emergency Recall Operation Instructions**

operation or hoistway access operation. Inspection operation or hoistway access operation shall take precedence over Phase I Emergency Recall Operation and Phase II Emergency In-Car Operation.

### 2.27.7 Firefighters' Emergency Operation: Operating Procedures

**2.27.7.1** Instructions for operation of elevators under Phase I Emergency Recall Operation shall be incorporated with or adjacent to the "FIRE RECALL" switch at the designated level. The instructions shall include only the wording shown in Fig. 2.27.7.1.

**2.27.7.2** Instructions for operation of elevators under Phase II Emergency In-Car Operation shall be incorporated with or adjacent to the switch, in or adjacent to the operating panel in each car. They shall include the wording shown in Fig. 2.27.7.2.

**2.27.7.3** Instructions shall be in letters not less than 3 mm (0.125 in.) in height and shall be permanently installed and protected against removal or defacement.

**2.27.7.4** In jurisdictions that enforce the NBCC, a symbol showing a red firefighters' hat on a contrasting background, as shown in Fig. 2.27.3.1.6(h) (figure not to scale), shall be used exclusively to identify elevators that comply with 2.27.3 and additional NBCC requirements. This identification shall be located on the elevator entrance frame or adjacent to it at each emergency recall level. The identification on the entrance frame, or adjacent to it, shall be a minimum of 50 mm (2 in.) in height.

### 2.27.8 Switch Keys

The key switches required by 2.27.2 through 2.27.5 for all elevators in a building shall be operable by the same key. The keys shall be Group 3 Security (see 8.1). There shall be a key for each switch provided.

These keys shall be kept on the premises in a location readily accessible to firefighters and emergency personnel, but not where they are available to the public. Where provided, a lock box, including its lock and other components, shall conform to the requirements of UL 1037 (see Part 9).

NOTE (2.27.8): Local authorities may specify additional requirements for a uniform keyed lock box and its location to contain the necessary keys.

## SECTION 2.28
## LAYOUT DRAWINGS

### 2.28.1 Information Required on Layout Drawings

Elevator layout drawings shall, in addition to other data, indicate the following:

*(a)* the maximum bracket spacing (see 2.23)

*(b)* the estimated maximum vertical forces on the guide rails on application of the safety or other retarding device (see 2.23 and 2.19.3)

*(c)* in the case of freight elevators for Class B or C loading (see 2.16.2.2), the horizontal forces on the guide-rail faces during loading and unloading, and the estimated maximum horizontal forces in a post-wise direction on the guide-rail faces on the application of the safety device (see 2.23)

*(d)* the size and linear weight kg/m (lb/ft) of any rail reinforcement, where provided (see 2.23)

*(e)* the impact loads imposed on machinery and sheave beams, supports, and floors or foundations (see 2.9)

*(f)* the impact load on buffer supports due to buffer engagement at the maximum permissible speed and load (see 8.2.3)

*(g)* where compensation tie-down is applied (see 2.21.4.2), the load on the compensation tie-down supports

*(h)* the total static and dynamic loads from the governor, ropes, and tension system

*(i)* the horizontal forces on the building structure stipulated by 2.11.11.8 and 2.11.11.9

## SECTION 2.29
## IDENTIFICATION

### 2.29.1 Identification of Equipment

In buildings with more than one elevator, each elevator in the building shall be assigned a unique alphabetical or numerical identification, a minimum of 50 mm (2 in.) in height unless otherwise specified. The identification shall be painted on, engraved, or securely attached to

*(a)* the driving machine

*(b)* MG set

*(c)* controller

*(d)* selector

*(e)* governor

*(f)* main line disconnect switch

*(g)* the crosshead, or where there is no crosshead, the car frame, such that it is visible from the top of the car

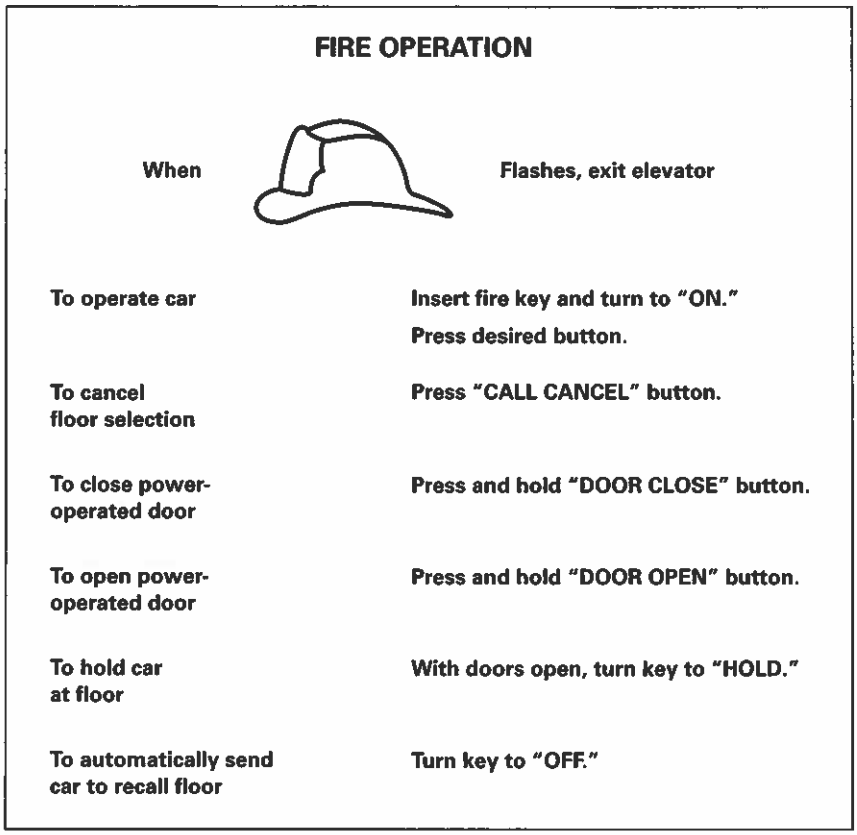



**Fig. 2.27.7.2 Phase II Emergency In-Car Operation**

*(h)* the car operating panel, minimum of 13 mm (0.5 in.) in height

*(i)* adjacent to or on every elevator entrance at the designated level, minimum of 75 mm (3 in.) in height

### 2.29.2 Identification of Floors

Hoistways shall have floor numbers, not less than 100 mm (4 in.) in height, on the hoistway side of the enclosure or hoistway doors.

# Part 3
# Hydraulic Elevators

(ED)

## SCOPE

Part 3 applies to direct-acting hydraulic elevators and the roped-hydraulic types.

NOTE: See also Part 8 for additional requirements that apply to *hydraulic elevators.*

## SECTION 3.1
## CONSTRUCTION OF HOISTWAYS AND HOISTWAY ENCLOSURES

Hoistways, hoistway enclosures, and related construction shall conform to 2.1.1 through 2.1.6 and 2.29.2, except 2.1.2.3, 2.1.3.1.2, and 2.1.3.2.

### 3.1.1 Strength of Pit Floor

The pit equipment, beams, floor, and their supports shall be designed and constructed to meet the applicable building code requirements and to withstand the following loads in the manner in which they occur:

*(a)* the impact load due to car buffer engagement (see 8.2.3 and 3.22.2)

*(b)* where a plunger gripper, or car, or counterweight safety is furnished, the part of the load transmitted by the application of such gripper(s) or safety(s)

*(c)* loads imposed by the hydraulic jack

*(1)* to the cylinder during normal operation

*(2)* to the buffer when resting on the buffer or during conditions described in 3.1.1(a)

*(d)* hoist rope up-pull, where applicable, for indirect roped-hydraulic elevators

### 3.1.2 Floors Over Hoistways

The floor shall be located entirely above the horizontal plane required for hydraulic elevator top car clearance.

When a hydraulic pump unit and/or control equipment is located on a floor over the hoistway, access shall comply with 2.7.3.

## SECTION 3.2
## PITS

Pits shall conform to 2.2, except 2.2.7.

### 3.2.1 Minimum Pit Depths Required

The pit depth shall not be less than is required for the installation of the buffers, hydraulic jack, platform guard (apron), and all other elevator equipment located therein, and to provide the minimum bottom clearance and runby required by 3.4.1 and 3.4.2, respectively.

## SECTION 3.3
## LOCATION AND GUARDING OF COUNTERWEIGHTS

The location and guarding of counterweights, where provided, shall conform to 2.3.

## SECTION 3.4
## BOTTOM AND TOP CLEARANCES AND RUNBYS FOR CARS AND COUNTERWEIGHTS

Requirement 2.4 does not apply to hydraulic elevators.

### 3.4.1 Bottom Car Clearance

**3.4.1.1** When the car rests on its fully compressed buffers or bumpers, there shall be a vertical clearance of not less than 600 mm (24 in.) between the pit floor and the lowest structural or mechanical part, equipment, or device installed beneath the car platform, including a plunger-follower guide, if provided, except as specified in 3.4.1.2.

**3.4.1.2** The 600 mm (24 in.) clearance does not apply to the following:

*(a)* any equipment on the car within 300 mm (12 in.) horizontally from any side of the car platform

*(b)* any equipment located on or traveling with the car located within 300 mm (12 in.) horizontally from either side of the car frame centerline parallel to the guide rails

*(c)* any equipment mounted in or on the pit floor located within 300 mm (12 in.) horizontally from either side of the car frame centerline parallel to the guide rails

**3.4.1.3** In no case shall the available refuge space be less than either of the following:

*(a)* a horizontal area 600 mm × 1 200 mm (24 in. × 47 in.), with a height of 600 mm (24 in.)

*(b)* a horizontal area 450 mm × 900 mm (18 in. × 35 in.), with a height of 1 070 mm (42 in.)

**3.4.1.4** Trenches and depressions or foundation encroachments permitted by 2.2.2 shall not be considered in determining these clearances.

**3.4.1.5** When the car is resting on its fully compressed buffers or bumpers, no equipment traveling

with the car, including a plunger-follower guide, if provided, shall strike any part of the pit or any equipment mounted therein.

**3.4.1.6** Where the vertical clearance outside the refuge space is less than 600 mm (24 in.), that area shall be clearly marked on the pit floor. Markings shall not be required in the area under the apron and guiding means. The marking shall consist of alternating 100 mm (4 in.) diagonal red and white stripes. In addition, a sign with the words "DANGER LOW CLEARANCE" shall be prominently posted on the hoistway enclosure and shall be visible from within the pit and at the entrance to the pit. The sign shall conform to ANSI Z535.2 or CAN/CSA-Z321, whichever is applicable (see Part 9). The sign shall be of such material and construction that the letters and figures stamped, etched, cast, or otherwise applied to the face remain permanently and readily legible.

### 3.4.2 Minimum Bottom and Top Car Runby

**3.4.2.1 Bottom Car Runby.** The bottom car runby shall be

*(a)* not less than 75 mm (3 in.) for operating speed(s) in the down direction up to 0.50 m/s (100 ft/min)

*(b)* increased from 75 mm (3 in.) to 150 mm (6 in.) in proportion to the increase in operating speed(s) in the down direction from 0.50 m/s (100 ft/min) to 1 m/s (200 ft/min)

*(c)* a minimum of 150 mm (6 in.) for operating speed(s) in the down direction exceeding 1 m/s (200 ft/min)

**3.4.2.2 Car Top Minimum Runby.** The top runby of the car shall be

*(a)* not less than 75 mm (3 in.) for rated speeds up to 0.50 m/s (100 ft/min)

*(b)* increased from 75 mm (3 in.) to 150 mm (6 in.) in proportion to the increase in rated speed from 0.50 m/s (100 ft/min) to 1 m/s (200 ft/min)

*(c)* a minimum of 150 mm (6 in.) for rated speeds exceeding 1 m/s (200 ft/min)

### 3.4.3 Car Top and Bottom Maximum Runby

Neither the top nor the bottom runby of the car shall be more than 600 mm (24 in.).

### 3.4.4 Top Car Clearance

The top car clearance shall be not less than the sum of the following two items (see Nonmandatory Appendix G):

*(a)* the top car runby

*(b)* the height of the refuge space on top of the car (see 3.4.7) or the clearance required for equipment projecting above the car top or crosshead (see 3.4.5), whichever is greater

### 3.4.5 Equipment Projecting Above the Car Top

When the car reaches its maximum upward movement

*(a)* all equipment attached to and projecting above the car top, other than equipment mentioned in 3.4.5(b) shall be at least 150 mm (6 in.) from striking any part of the overhead structure or any equipment located in the hoistway

*(b)* guide-shoe assemblies or gate posts for vertically sliding gates shall not strike any part of the overhead structure

*(c)* the car crosshead shall have a minimum of 300 mm (12 in.) vertical clearance to the horizontal plane described by the lowest point of the overhead structure (see 1.3)

### 3.4.6 Top Clearance and Bottom Runby of Counterweight

Where a counterweight is provided, the top clearance and the bottom runby of the counterweight shall conform to 3.4.6.1 and 3.4.6.2.

**3.4.6.1 Top Clearance.** The top clearance shall be not less than the sum of the following:

*(a)* the bottom car runby

*(b)* the stroke of the car buffers used

*(c)* 150 mm (6 in.)

**3.4.6.2 Bottom Runby.** The bottom runby shall be not less than the sum of the following:

*(a)* the distance the car can travel above its top terminal landing until the plunger strikes its mechanical stop

*(b)* 150 mm (6 in.)

The minimum runby specified shall not be reduced by rope stretch (see 3.22.2 prohibiting counterweight buffers).

### 3.4.7 Refuge Space on Top of Car Enclosure

An unobstructed horizontal area of not less than 0.51 $m^2$ (5.49 $ft^2$) shall be provided on top of the car enclosure for refuge space. It shall measure not less than 600 mm (24 in.) on any side. The area shall be permitted to include the space utilized for top emergency exit [see 2.14.1.5.1(f)]. The minimum vertical distance in the refuge area between the top of the car enclosure and the horizontal plane described by the lowest point of the overhead structure or other obstruction shall be not less than 1 100 mm (43 in.) when the car has reached its maximum upward movement.

### 3.4.8 Vertical Clearances With Underslung Car Frames

Where an underslung car frame is used, the clearances between the overhead car rope dead-end hitch, or overhead car sheave, and the portions of the car structure vertically below them, when the car floor is level with the top terminal landing, shall be not less than the following:

(a) where no counterweight is used, the sum of the following items:

(1) the car top runby

(2) 200 mm (8 in.)

(b) where a counterweight is used, the sum of the following items:

(1) the bottom counterweight runby (see 3.4.6.2)

(2) 150 mm (6 in.)

## SECTION 3.5
## HORIZONTAL CAR AND COUNTERWEIGHT CLEARANCES

The horizontal car and counterweight clearances shall conform to 2.5.

## SECTION 3.6
## PROTECTION OF SPACES BELOW HOISTWAY

Requirement 2.6 does not apply to hydraulic elevators.

Where there is space below the hoistway that is accessible to persons, requirements of 3.6.1 through 3.6.4 shall be conformed to.

(ED) **3.6.1 Jack-Supporting Structure**

The hydraulic jack shall be supported by a structure of sufficient strength to support the entire static load at rated capacity that is capable of being imposed upon it. The design factor of safety shall be not less than 5, based on ultimate strength for static loads transmitted.

**3.6.2 Counterweight Safety Actuation**

Where the space referred to in 3.6 falls underneath the counterweight and/or its guides, the counterweight shall be provided with a safety device that functions as a result of the breaking or slackening of the counterweight suspension ropes.

**3.6.3 Buffer Types**

The car shall be provided with buffers of either of the following types:

(a) oil buffers conforming to 3.22.1

(b) spring buffers of a design that will not be fully compressed when struck by a car with rated load at the operating speed in the down direction (see 3.22.1)

**3.6.4 Buffer Supports**

Car buffer supports shall be provided that will withstand, without permanent deformation, the impact resulting from buffer engagement by a car with rated load at the operating speed in the down direction. The design factor of safety shall conform to 2.22.4.3.

## SECTION 3.7
## MACHINE ROOMS AND MACHINERY SPACES

Machine rooms and machinery spaces shall conform to 2.7.1 through 2.7.5 and 2.7.7.

**3.7.1 Location of Machine Rooms** (ED)

Hydraulic elevator machine and control rooms shall be located overhead, adjacent to, underneath the hoistway, or at a remote location. They shall not be located in the hoistway.

Where hydraulic machines and electrical control equipment are located in spaces separated from the hoistway enclosure (see 2.1.1), such spaces shall be separated from other parts of the building by enclosures conforming to 2.7.1.2 and having an access door conforming to 2.7.3.4.

## SECTION 3.8
## ELECTRICAL EQUIPMENT, WIRING, PIPES, AND DUCTS IN HOISTWAY AND MACHINE ROOMS

Electrical equipment, wiring, pipes, and ducts shall conform to 2.8.

## SECTION 3.9
## MACHINERY AND SHEAVE BEAMS, SUPPORTS, AND FOUNDATIONS

Machinery and sheave beams, supports, and foundations shall conform to 2.9.

## SECTION 3.10
## GUARDING OF EXPOSED AUXILIARY EQUIPMENT

Guarding of exposed auxiliary equipment shall conform to 2.10.

## SECTION 3.11
## PROTECTION OF HOISTWAY LANDING OPENINGS

Protection of hoistway landing openings shall conform to 2.11, except as excluded by 3.11.1.

**3.11.1 Emergency Doors**

Emergency doors, where required by 2.11.1, are required only when car safeties are provided.

## SECTION 3.12
## HOISTWAY DOOR LOCKING DEVICES, CAR DOOR OR GATE ELECTRIC CONTACTS, AND HOISTWAY ACCESS SWITCHES

**3.12.1 Hoistway Door Locking Devices and Electric Contacts, and Hoistway Access Switches**

Hoistway door locking devices and electric contacts, and hoistway access switches shall conform to 2.12.

**3.12.2 Car Door or Gate Electric Contacts and Car Door Interlocks**

Car door or gate electric contacts and car door interlocks shall conform to 2.14.4.2.

## SECTION 3.13
## POWER OPERATION, POWER OPENING, AND POWER CLOSING OF HOISTWAY DOORS AND CAR DOORS OR GATES

Power operation, power opening, and power closing of hoistway doors and car doors or gates shall conform to 2.13.

## SECTION 3.14
## CAR ENCLOSURES, CAR DOORS AND GATES, AND CAR ILLUMINATION

Car enclosures, car doors and gates, and car illumination shall conform to 2.14.

## SECTION 3.15
## CAR FRAMES AND PLATFORMS

### 3.15.1 Requirements

**3.15.1.1** Direct-acting hydraulic elevators shall be provided with car frames and platforms conforming to 2.15, subject to the modification hereinafter specified. (See 3.18.2.3 for connection between plunger and platform or car frame.)

A car frame shall not be required, provided 3.15.1.1.1 through 3.15.1.1.6 are conformed to.

**3.15.1.1.1** The platform frame shall be of such design and construction that all eccentric loads are carried through the structure and plunger attachment into the hydraulic jack (see 3.18.2.3).

**3.15.1.1.2** The platform frame shall be guided on each guide rail by single-guiding members attached to the frame.

**3.15.1.1.3** The platform frame shall be designed to withstand the forces resulting from the class of loading for which the elevator is designed without exceeding the stresses and deflections in 2.15.10 and 2.15.11 (see 8.2.2.6).

**3.15.1.1.4** The hydraulic jack connection to the car shall be designed to transmit the full eccentric moment into the plunger with a factor of safety of not less than 4 (see 3.18.2.3).

**3.15.1.1.5** The hydraulic jack shall be designed to withstand the stresses due to bending during the loading and unloading of the platform based on the type of loading for which the elevator is designed (see 8.2.8.1.2).

**3.15.1.1.6** Car safeties shall not be provided.

**3.15.1.2** Roped-hydraulic elevators shall be provided with car frames and platforms conforming to 2.15.

### 3.15.2 Maximum Allowable Stresses and Deflections in Car Frame and Platform Members

**3.15.2.1 Direct-Acting Hydraulic Elevators.** The stresses and deflections in car frame and platform members and their connections, based on the static load imposed upon them, shall be not more than those permitted by 2.15, provided that the maximum stresses in the car frame uprights that are normally subject to compression shall conform to 8.2.9.1.1.

**3.15.2.2 Roped-Hydraulic Elevators.** The stresses and deflection in car frame and platform members and their connections, based on the static load imposed upon them, shall be not more than those permitted by 2.15, and shall conform to 8.2.2.

### 3.15.3 Calculations of Stresses and Deflections in Car Frame and Platform Members

**3.15.3.1 Direct-Acting Hydraulic Elevators.** The calculations of the stresses and deflections in side-post car frame and platform members shall be based on the formulas and data in 8.2.9.

For cars with corner-post or sub-post car frames, the formulas and specified methods of calculations do not generally apply and shall be modified to suit the specific conditions and requirements in each case.

**3.15.3.2 Roped-Hydraulic Elevators.** The calculations of the stresses and deflections in side-post car frame and platform members shall be based on the formulas and data in 8.2.2.

For cars with corner-post or sub-post car frames, or where the rope hitches are not on the crosshead, the formulas and specified methods of calculations do not generally apply and shall be modified to suit the specific conditions and requirements in each case.

## SECTION 3.16
## CAPACITY AND LOADING

### 3.16.1 Minimum Rated Load for Passenger Elevators

The requirements of 2.16.1 shall apply.

### 3.16.2 Minimum Rated Load for Freight Elevators

The requirements of 2.16.2 shall apply, except, in 2.16.2.2.4(c) the wording "hydraulic jack, hydraulic machine, pressure piping and fittings" shall be substituted for the wording "driving-machine motor, brake and traction relation."

### 3.16.3 Capacity and Data Plates

The requirements of 2.16.3 shall apply, except:

*(a)* requirement 2.16.3.2.1(a) shall not apply to hydraulic elevators.

*(b)* on data plates (see 2.16.3.2.2), the weight of the plunger is not to be included in the weight of the complete car, even though it is attached. The plunger weight

is to be indicated independently. The operating speed in the down direction shall also be indicated.

### 3.16.4 Carrying of Passengers on Freight Elevators

The requirements of 2.16.4 shall apply, except 2.16.4.3 shall not apply to hydraulic elevators.

### 3.16.5 Signs Required in Freight Elevators

The requirements of 2.16.5 shall apply.

### 3.16.6 Overloading of Freight Elevators

The requirements of 2.16.6 shall apply, except 2.16.6(b) shall not apply to hydraulic elevators.

### 3.16.7 One-Piece Loads Exceeding the Rated Load

Requirement 2.16.7 shall not apply. One-piece loads exceeding rated load shall not be carried on hydraulic elevators.

### 3.16.8 Additional Requirements for Passenger Overload

Requirement 2.16.8 shall not apply. Hydraulic passenger elevators shall be designed based on 100% of rated load.

### 3.16.9 Special Loading Means

The requirements of 2.16.9 shall apply.

## SECTION 3.17
## CAR AND COUNTERWEIGHT SAFETIES AND PLUNGER GRIPPER

### 3.17.1 Car Safeties

Car safeties shall be provided for roped-hydraulic elevators and shall be permitted to be provided for direct-acting hydraulic elevators. When provided, car safeties shall conform to 2.17, and to 3.17.1.1 through 3.17.1.3.

**3.17.1.1** The slack-rope device required by 3.18.1.2 shall be permitted to be an additional means of activating the car safety on roped-hydraulic elevators using hydraulic jacks equipped with plungers. The slack-rope device required by 3.18.1.2.7 shall be an additional means of activating the car safety on roped-hydraulic elevators using hydraulic jacks equipped with pistons.

**3.17.1.2** The safety shall be of a type that can be released only by moving the car in the up direction. To return a car to normal operation after a safety set, the car shall be moved hydraulically in the up direction. For repairs of obvious or suspected malfunction, the car shall be permitted to be raised by other means capable of holding the entire car weight. Prior to releasing the other means, the car shall be run hydraulically in the up direction.

**3.17.1.3** The switches required by 2.18.4.1 shall, when operated, remove power from the hydraulic machine motor and control valves before or at the time of application of the safety.

### 3.17.2 Counterweight Safeties

Counterweight safeties, where provided in accordance with 3.6.2, shall conform to 2.17, provided that safeties shall be operated as a result of the breaking or slackening of the counterweight suspension ropes, irrespective of the rated speed of the elevator.

### 3.17.3 Plunger Gripper

A plunger gripper shall be permitted to be provided for direct-acting hydraulic elevators using hydraulic jacks equipped with plungers. A plunger gripper shall be capable of stopping and holding the car with its rated load from the actual measured tripping speed per Table 2.18.2.1 and shall conform to 3.17.3.1 through 3.17.3.9. In Table 2.18.2.1 the words "rated speed" shall be replaced by "operating speed in the down direction."

**3.17.3.1 Limits of Application.** A plunger gripper shall be permitted, provided that (ED)

*(a)* the external pressure applied to the plunger by the device is symmetrically distributed at locations around the circumference of the plunger. The resulting stress in the plunger shall not exceed 67% of the yield strength at any point of the plunger.

*(b)* the external pressure applied to the plunger by the device does not exceed 67% of the value that will cause local buckling. Where the external pressure is applied over substantially the full circumference of the plunger, the maximum value shall be permitted to be determined by 8.2.8.6.

*(c)* during the application, the plunger and the plunger gripper are capable of withstanding any vertical forces imposed upon them, and transfer such forces to the supporting structure. During the application of the device, any loading on the plunger shall not damage the cylinder.

*(d)* power is removed from the hydraulic machine before or at the time of application.

**3.17.3.2 Means of Application.** A plunger gripper shall mechanically grip the plunger.

**3.17.3.2.1** Hydraulic means are permitted to be used to hold the gripper in the retracted position. A loss of hydraulic pressure or fluid causing uncontrolled downward motion is permitted to be used to apply the plunger gripper.

**3.17.3.2.2** When electrical means are used to actuate the gripper, the following shall apply:

*(a)* The plunger gripper shall be fully operational during a primary electrical system power failure.

*(b)* In the event of the failure of any single mechanically operated switch, contactor, relay, solenoid, or any single solid-state device, or a software system failure,

or the occurrence of a single ground, the elevator shall not be permitted to restart after a normal stop.

**3.17.3.3 Release**

**3.17.3.3.1** The plunger gripper shall be released by establishing at least no-load static pressure on the hydraulic system, or by other means capable of holding the entire car weight.

**3.17.3.3.2** The elevator shall not be permitted to be restarted without establishing at least no-load static pressure on the hydraulic system.

**3.17.3.4 Clearance.** In the normally retracted position of the plunger gripper, any contact between the gripping surface and the plunger shall not cause degradation of the plunger or premature degradation of the gripping surface.

**3.17.3.5 Deceleration.** The deceleration of the elevator upon actuation of the plunger gripper shall comply with the following criteria:

(04) *(a)* The average deceleration rate at rated load shall be not less than 0.1 gravity nor more than 1.0 gravity. (See Nonmandatory Appendix P for minimum and maximum stopping distances.)

*(b)* Any peak deceleration rate in excess of 2.0 gravity shall have a duration of not greater than 0.04 s.

**3.17.3.6 Minimum Factors of Safety and Stresses of Safety Parts and Rope Connections**

**3.17.3.6.1** Compliance with 2.17.12.1 and 2.17.12.6 is required. Springs shall be permitted in the operation of the plunger gripper. The maximum fiber stress in the spring shall not exceed 85% of the elastic limit in the material at any time. The factor of safety of wire ropes, if provided in the construction of the plunger gripper, shall not be less than 5. Tiller-rope construction shall not be used.

**3.17.3.6.2** Leaf and roller chains, if provided in the construction of the plunger gripper, shall conform to ASME B29.

**3.17.3.6.3** The factors of safety shall be based upon the maximum stresses developed in the parts during operation of the gripper when stopping rated load from the tripping speed (see 3.17.3) of the speed-measuring device.

**3.17.3.6.4** Rope or tape used to drive an electrical encoder is not required to comply with the requirements for governor rope.

**3.17.3.6.5** If a governor is used, it must comply with 2.18.5.1, except lang-lay construction is permitted and the diameter is permitted to be less than 9.5 mm (0.0375 in.).

**3.17.3.7 Corrosion-Resistant Bearings in Plunger Gripper and Gripper Operating Mechanisms.** Compliance with 2.17.13 is required.

**3.17.3.8 Marking Plates for a Plunger Gripper.** A permanent marking plate shall be securely attached to each plunger gripper so as to be readily visible, and shall be marked in a legible and permanent manner with letters and symbols not less than 6 mm (0.25 in.) in height, indicating

*(a)* that it is a plunger gripper.

*(b)* the maximum operating speed in the down direction in m/s (ft/min) for which the plunger gripper shall be permitted to be used.

*(c)* the maximum load in Newtons (pounds) for which the gripper is designed and installed to stop and sustain.

*(d)* the manufacturer's name or trademark and identification number of the device.

*(e)* space for date of acceptance test. Date to be permanently marked following test.

*(f)* the diameter and minimum wall thickness of the plunger for which the device is applicable.

**3.17.3.9 Flexible Hoses.** Flexible hoses used for the operation of a plunger gripper shall be permitted, provided that their failure does not cause an uncontrolled descent. These flexible hoses are not required to meet the requirements of 3.19.3.3.

## SECTION 3.18
## HYDRAULIC JACKS

### 3.18.1 Hydraulic Jack and Connections

Where multiple hydraulic jacks are used, they shall be hydraulically connected to form a single hydraulic system.

**3.18.1.1 Direct-Acting Hydraulic Elevators.** The driving member of the hydraulic jack shall be attached to the car frame or car platform with fastenings of sufficient strength to support that member with a factor of safety of not less than 4 and shall be capable of withstanding, without damage, any forces resulting from a plunger stop as described in 3.18.4.2.

Any plunger or cylinder head mechanical connector or connection shall conform to 3.18.2.1, 3.18.2.4, 3.18.4, and 3.18.5.

**3.18.1.2 Roped-Hydraulic Elevator**

**3.18.1.2.1** The driving member of the hydraulic jack shall be vertical. Cars shall be suspended with not less than two wire ropes per hydraulic jack in conformance with 2.15.13 and 2.20.

**3.18.1.2.2** Where three or more hydraulic jacks are utilized, one rope per hydraulic jack shall be permitted to be used. Should one hydraulic jack become disconnected, the remaining hydraulic jacks shall be capable

of supporting the load without exceeding allowable car frame stresses or hydraulic jack stress. The ropes shall conform to 2.15.13 and 2.20.

**3.18.1.2.3** Ropes passing through seals fixed in cylinder heads shall be permitted to have a clear plastic coating applied in order to seal properly and facilitate rope inspection.

**3.18.1.2.4** The roping ratio that relates the driving member of the hydraulic jack speed to the car speed shall not exceed 1:2.

**3.18.1.2.5** Sheaves used to transfer load from the hydraulic jack to the car frame through wire ropes shall conform to 2.24.2, 2.24.3, and 2.24.5.

**3.18.1.2.6** Means shall be provided to prevent the ropes, if slack, from leaving the sheave grooves.

**3.18.1.2.7** A slack-rope device with an enclosed manually reset switch shall be provided that shall cause the electric power to be removed from the hydraulic machine pump motor and the control valves should any rope become slack.

**3.18.1.2.8** The traveling sheave shall be attached with fastenings having a minimum factor of safety of 4, based upon the ultimate strength of the material used. The load to be used in determining the factor of safety shall be the resultant of the maximum tensions in the ropes leading from the sheave with the elevator at rest and with rated load in the car.

### 3.18.2 Plungers

**3.18.2.1 Material.** The plunger and connecting couplings for the plunger shall be of materials in accordance with 3.18.2.1.1 and 3.18.2.1.2.

**3.18.2.1.1** Tensile, compressive, bending, and torsional loading shall have a factor of safety of not less than 5, based on ultimate strength.

**3.18.2.1.2** Pressure loadings shall have a factor of safety not less than that calculated per 8.2.8.5.

**3.18.2.2 Plunger Design.** Plungers made of steel shall be designed and constructed in compliance with the applicable formula in 8.2.8.1 for calculation of elastic stability, bending, and external pressure. For other materials, the appropriate modulus of elasticity must be utilized.

Plungers subject to internal pressure shall also be designed and constructed in accordance with cylinder design formula in 8.2.8.2.

#### 3.18.2.3 Plunger Connection

**3.18.2.3.1** When the hydraulic jack is not subjected to eccentric loading, it shall

*(a)* carry in tension the weight of the plunger with a factor of safety not less than 4

*(b)* restrict total vertical movement to less than 20% of the buffer stroke, where vibration damping means are provided

**3.18.2.3.2** In addition, when the hydraulic jack is subjected to eccentric loading, the following shall also apply:

*(a)* The plunger connection to the car shall also be so designed and constructed as to transmit the full eccentric moment into the plunger with a factor of safety not less than 4.

*(b)* The plunger and the plunger connection to the car shall also be so designed and constructed that the total vertical deflection of the loading edge of the car platform due to eccentric loading of the car shall not exceed 19 mm (0.75 in.).

**3.18.2.4 Plunger Joints.** Plungers composed of more than one section shall have joints designed and constructed to

*(a)* carry in tension the weight of all plunger sections below the joint with a factor of safety of not less than 4

*(b)* transmit in compression the gross load on the plunger with a factor of safety of not less than 5, based on ultimate strength

*(c)* withstand without damage any forces resulting from a plunger stop as described in 3.18.4.2

*(d)* for eccentric loading, the joints shall conform to 3.18.2.2 and 3.18.2.3

**3.18.2.5 Plungers Subject to External Pressure.** For plungers subjected to external pressure, the working pressure shall be not greater than indicated by the formula in 8.2.8.1.3.

**3.18.2.6 Plunger Heads Subject to Fluid Pressure.** Heads of plungers subject to fluid pressure shall conform to 3.18.3.6.

#### 3.18.2.7 Plunger-Follower Guide

**3.18.2.7.1** A plunger-follower guide shall be permitted to be used, provided it is arranged so that the elevator is always in a position where the unsupported length of the plunger conforms to the "maximum free length" as defined in 8.2.8.1. If this length is exceeded, upward movement of the car shall immediately stop, and it shall be permitted to allow the car to return nonstop to the lowest landing; power-operated doors shall open, and electric power shall be removed from the motor and the control valve. After not less than 15 s nor more than 60 s, the doors shall close in compliance with 2.11.3. A manual reset of the means shall be required before the elevator is returned to service. The in-car door open button shall remain operative.

Plunger-follower guides shall be designed and constructed to comply with all applicable requirements of 2.15.

**3.18.2.7.2** Telescopic plungers shall have each plunger section internally guided. If more than two movable sections are used, external guides shall be provided for each plunger section. External guides shall be designed and constructed to comply with all applicable requirements of 2.15.

### 3.18.3 Cylinders

**3.18.3.1 Material.** The cylinder and connecting couplings for the cylinder shall be made of materials in compliance with 3.18.3.1.1 and 3.18.3.1.2.

**3.18.3.1.1** For tensile, compressive, bending, and torsional loading, the cylinder and connecting couplings shall have a factor of safety of not less than 5, based on ultimate strength.

**3.18.3.1.2** For pressure calculations, the cylinder and connecting coupling shall have a factor of safety not less than that calculated as specified in 8.2.8.5.

**3.18.3.2 Cylinder Design.** Cylinders shall be designed and constructed in accordance with the formula in 8.2.8.2.

**3.18.3.3 Clearance at Bottom of Cylinder.** Clearance shall be provided at the bottom of the cylinder so that the bottom of the plunger will not strike the safety bulkhead of the cylinder when the car is resting on its fully compressed buffer (see 3.22.1).

**3.18.3.4 Safety Bulkhead.** Cylinders buried in the ground shall be provided with a safety bulkhead having an orifice of a size that would permit the car to descend at a speed not greater than 0.075 m/s (15 ft/min), nor less than 0.025 m/s (5 ft/min). A space of not less than 25 mm (1 in.) shall be left between the welds of the safety bulkhead and the cylinder head. Safety bulkheads shall conform to 3.18.3.6.

A safety bulkhead shall not be required where a double cylinder is used and where both inner and outer cylinders conform to 3.18.3.

**3.18.3.5 Cylinder Packing Heads.** Cylinder packing heads shall conform to appropriate requirements of 3.18.4 and 8.2.8.3.

**3.18.3.6 Closed Cylinder and Plunger Heads.** Closed heads of cylinders, and heads of plungers subject to fluid pressure, shall conform to 3.18.3.6.1 through 3.18.3.6.3.

**3.18.3.6.1 Closed Cylinder Heads.** Closed heads of cylinders shall be only of dished seamless construction, concave to pressure, except if the bottom of the cylinder is supported, and if the cylinder is not buried.

**3.18.3.6.2 Design Formulas.** They shall be designed and constructed in accordance with the applicable formulas in 8.2.8.3, provided that steel heads shall in no case have a thickness less than that required for the adjoining shell.

**3.18.3.6.3 Dished Seamless Heads, Convex to Pressure.** Dished seamless heads, convex to pressure, if used on plungers, shall have a maximum allowable working pressure of not more than 60% of that for heads of the same dimensions with pressure on the concave side.

**3.18.3.7 Collection of Oil Leakage.** Means shall be provided to collect for removal any oil leakage from the cylinder head seals or packing gland. The amount collected before removal shall not exceed 19 L (5 gal). (04)

**3.18.3.8 Cylinders Buried in the Ground**

**3.18.3.8.1** Cylinders buried in the ground shall be protected from corrosion due to galvanic or electrolytic action, salt water, or other underground conditions.

**3.18.3.8.2** The methods specified in 3.18.3.8.3 shall be considered as acceptable, provided that they

*(a)* are designed and installed with means for monitoring and maintaining them in accordance with recognized industry standards applicable to the methods

*(b)* are effective for specific conditions where the cylinder is installed

*(c)* provide means for checking ongoing compliance with 3.18.3.8.1

**3.18.3.8.3** The following are the specified methods:

*(a)* the cylinder shall be constructed of a material that is immune to the stated conditions; or

*(b)* the cylinder shall be completely covered or encased in a material that completely surrounds the exterior surface and is immune to the stated conditions. If the space between the protective casing and the cylinder is empty, the casing must be designed to withstand a static head of water from ground level to the bottom of the cylinder, based on the manufacturer's rating of the material used; or

*(c)* the cylinder shall be protected by a monitored cathodic protection system; or

*(d)* the cylinder shall be protected by a means that will provide an immunity level not less than that provided by the above methods for the stated conditions.

**3.18.3.9 Means for Relief of Air or Gas.** Cylinders shall be provided with a means to release air or other gas.

### 3.18.4 Plunger Stops

**3.18.4.1 Metal Stops and/or Other Means.** Metal stops and/or other means shall be provided at one end of the plunger and at the packing head end of the cylinder to prevent the plunger from traveling beyond the limits of the cylinder.

The metal stops and/or other means shall be so designed and constructed as to stop the plunger traveling in the up direction at maximum speed under full load pressure, should the normal terminal stopping device (see 3.25.1) fail to operate, or at a reduced speed

when a terminal speed-reducing device is provided as required by 3.25.2. No running test onto the stop ring is required [see 8.10.3.2.2(s)].

(04) **3.18.4.2 Hydraulic System.** The connections to the hydraulic machine, plunger, plunger connection, couplings, plunger joints, cylinder, cylinder connecting couplings, or any other parts of the hydraulic system shall be designed and constructed to withstand, without damage, a plunger stop in accordance with 3.18.4.1.

### 3.18.5 Welding

All welding of hydraulic jack components shall conform to 8.8.

## SECTION 3.19
## VALVES, PRESSURE PIPING, AND FITTINGS

### 3.19.1 Materials and Working Pressures

**3.19.1.1 Materials.** Pressure piping, valves, fittings, and mufflers shall be designed and made of materials having properties such that a factor of safety not less than that calculated per 8.2.8.5 is achieved.

Piping and fittings of a grade not subjected to listed/certified testing (ASTM or equivalent) shall not be used for hydraulic pressure piping and fittings.

NOTE (3.19.1.1): Examples of two acceptable pipe standards are ASTM A106 and ASTM A 53, Type E or S.

**3.19.1.2 Working Pressures.** The working pressure (see 1.3) shall not exceed the component rated pressure (see 1.3) of the pipes, valves, mufflers, and fittings used on the pressure side of the hydraulic system.

**3.19.1.3 Component Proof Test.** For elongations greater than or equal to 10%, the component design shall be substantiated either in accordance with 8.2.8.5 or by an unrestrained proof test of 5 times the component rated pressure without resulting in fracture. For elongations of less than 10%, the test value shall be 1.5 times the value indicated by 8.2.8.5 multiplied by the component rated pressure.

**3.19.1.4 Component Markings.** Valves, fittings, and mufflers shall be pressure rated, and shall bear the manufacturer's name or trademark by which the organization that manufactured the product can be identified, and identification symbols to indicate the materials and service designations for which the manufacturer's rating applies.

NOTE: Valves and fittings rated for a different system may be used in hydraulic elevator systems when substantiated in accordance with the elevator code.

### 3.19.2 Pressure Piping

**3.19.2.1 Wall Thickness.** The minimum wall thickness shall conform to 8.2.8.4.

**3.19.2.2 Threading.** Pipe lighter than Schedule 40 shall not be threaded.

**3.19.2.3 Pipe Supports.** Piping shall be so supported as to eliminate undue stresses at joints and fittings, particularly at any section of the line subject to vibration.

**3.19.2.4 Pipe, Tubing, or Fittings.** Pipe, tubing, or fittings shall be permitted to be used for instrument or control purposes and shall conform to ASME B31.1, para. 122.3.

**3.19.2.5 Hydraulic Pipeline Identification.** A marking (04) shall be applied, to accessible piping that is located outside the elevator machine room or hoistway, stating "Elevator Hydraulic Line" in letters that are at least 19 mm (0.75 in.) high in a contrasting color. The marking shall be visible after installation and applied at intervals not greater than 3 000 mm (120 in.).

### 3.19.3 Connections and Fittings

**3.19.3.1 Connections.** All piping connections shall be of the welded, grooved, threaded, or bolted flange type. Threads of valves, piping, and fittings shall conform to the requirements of ASME B1.20.1, ASME B1.20.3, or ASME B1.20.4. Hydraulic tube fittings shall conform to SAE J514.

#### 3.19.3.2 Grooved Pipe Fittings

**3.19.3.2.1** Grooved pipe fitting assemblies shall be permitted to be used for hydraulic connections. They shall be installed in conformance with the manufacturer's specifications. They shall be installed in locations that will permit disassembly and inspection of all of their component parts.

**3.19.3.2.2** Grooved pipe fittings shall be so designed and constructed that failure of a sealing element will not permit separation of the parts connected. The devices or means used for preventing the separation of the parts connected shall be removable only with the use of tools. Devices or means removable with hand-operated quick-release levers or toggles are prohibited.

**3.19.3.3 Flexible Hydraulic Connections.** Flexible hose and fitting assemblies, and flexible couplings, shall be permitted to be used for hydraulic connections. Where installed between the check valve or control valve and the cylinder, they shall conform to 3.19.3.3.1 and 3.19.3.3.2.

**3.19.3.3.1** Flexible hose and fitting assemblies shall

*(a)* not be installed within the hoistway, nor project into or through any wall. Installation shall be accomplished without introducing any twist in the hose, and shall conform with the minimum bending radius of SAE 100, R2 type, high pressure, steel wire reinforced, rubber-covered hydraulic hose specified in SAE J517.

*(b)* have a bursting strength sufficient to withstand not less than 10 times working pressure (see 1.3). They shall be tested in the factory or in the field prior to installation at a pressure of not less than 5 times working pressure and shall be marked with date and pressure of test.

*(c)* conform to the requirements of SAE 100, R2 type hose specified in SAE J517 and be compatible with the fluid used.

*(d)* be of nonreusable-type fittings.

*(e)* be permanently labeled/marked, indicating

*(1)* the name or trademark by which the manufacturer of the hose and fittings can be identified

*(2)* the type of hose and fitting

*(3)* the minimum factory test pressure

*(4)* the minimum bending radius of hose

*(5)* the date of installation

*(6)* the inspection procedure

*(7)* the name of elevator contractor

*(f)* have a line overspeed valve conforming to 3.19.4.7.

**3.19.3.3.2** Flexible couplings are permitted for hydraulic connections. Such couplings shall be so designed and constructed that failure of the sealing element will not permit separation of the connected parts. The devices or means used to prevent the separation of the connected parts shall be removable only with the use of tools. Any devices or means that are removable with hand-operated quick-released levers are prohibited.

### 3.19.4 Valves

**3.19.4.1 Shutoff Valve.** A manually operated shutoff valve shall be provided between the hydraulic machines and the hydraulic jack and shall be located outside the hoistway and adjacent to the hydraulic machine on all hydraulic elevators.

#### 3.19.4.2 Pump Relief Valve

**3.19.4.2.1** Each pump or group of pumps shall be equipped with one or more relief valve(s) conforming to the following requirements:

*(a) Type and Location.* The relief valve shall be located between the pump and the check valve and shall be of such a type and so installed in the bypass connection that the valve cannot be shut off from the hydraulic system.

*(b) Size.* The size of the relief valve and bypass shall be sufficient to pass the maximum rated capacity of the pump without raising the pressure more than 50% above the working pressure. Two or more relief valves shall be permitted to be used to obtain the required capacity.

*(c) Sealing.* Relief valves shall be sealed after being set to the correct pressure.

**3.19.4.2.2** No relief valve is required for centrifugal pumps driven by induction motors, provided the shut-off, or maximum pressure that the pump can develop, is not greater than 135% of the working pressure at the pump.

**3.19.4.3 Check Valve.** A check valve shall be provided and shall be so installed that it will hold the elevator car with rated load at any point when the pump stops and the down valves are closed or the maintained pressure drops below the minimum operating pressure.

**3.19.4.4 Manual Lowering Valve.** A manually operated valve, located on or adjacent to the control valves, shall be provided and identified, which permits lowering the car at a speed not exceeding 0.10 m/s (20 ft/min). This valve shall be so marked to indicate the lowering position.

**3.19.4.5 Pressure Gauge Fittings.** A pressure gauge fitting with shutoff valve shall be provided on jack side of the check valve or immediately adjacent to the hydraulic control valve.

#### 3.19.4.6 Type Tests, Certification, and Marking Plates for Control Valves

**3.19.4.6.1** Each type or model and make of hydraulic control valve shall be subjected to the engineering tests and to the certification process as specified in 8.3.5.

**3.19.4.6.2** Hydraulic control valves shall be plainly marked in a permanent manner with the following information:

*(a)* certifying organization's name or identifying symbol

*(b)* the name, trademark, or file number by which the organization that manufactured the product can be identified

*(c)* statement of compliance with ASME A17.1 or CSA B44

*(d)* type designation

*(e)* component rated pressure

*(f)* electrical coil data

**3.19.4.7 Overspeed Valves.** When provided, overspeed valves and their connections and attachments shall conform to 3.19.4.7.1 through 3.19.4.7.6.

**3.19.4.7.1 Overspeed Valve Tests.** Each type or model of overspeed valve shall be subjected to the engineering tests specified in 8.3.9.

**3.19.4.7.2 Marking of Overspeed Valves.** The overspeed valves shall be plainly marked in a permanent manner with the following:

*(a)* the name or trademark by which the organization that manufactured the product can be identified

*(b)* type designation

*(c)* component rated pressure

*(d)* maximum and minimum rated flow

**3.19.4.7.3 Installation of Overspeed Valves.** Overspeed valves shall be installed and mounted as follows:

*(a) Single Jack Arrangements.* Where a single valve is used, it shall be located in the pressure piping within 300 mm (12 in.) of the hydraulic jack. Multiple parallel valves are permitted in lieu of a single valve. These shall be located so as to minimize the distance from the valves to the hydraulic jack.

*(b) Multiple Jack Arrangements.* Multiple jack arrangements shall conform with one of the following:

*(1)* A single overspeed valve shall be located in the pressure piping within 300 mm (12 in.) of each hydraulic jack. Multiple parallel valves are permitted in lieu of single valves at each hydraulic jack. These shall be located so as to minimize the distance from the valves to each hydraulic jack.

*(2)* A single overspeed valve shall be located in the pressure piping on the hydraulic machine side of, and immediately before, the tee junction, wye junction, or branch junction that connects the branch pressure pipes to the jacks. Multiple parallel valves are permitted in lieu of a single valve at the junction. For dual hydraulic jack systems, the total length of branch pressure pipe between the tee or wye junction and the jacks shall not exceed the distance between the jacks, measured horizontally, plus 1 m (39 in.). For multiple jack systems, the length of branch pressure piping shall be minimized.

**3.19.4.7.4 Strength of Overspeed Valve Pressure Piping and Fittings Between the Overspeed Valve and the Jacks.** The factor of safety of the overspeed valve pressure piping and fittings shall be not less than 1.5 times the value obtained using 8.2.8.5, provided that the minimum factor of safety is not less than 4.5, and the minimum percentage elongation is not less than 5 for the overspeed valve and fittings and not less than 20 for the pressure piping.

**3.19.4.7.5 Performance Requirements.** The overspeed valve shall be constructed, installed, and adjusted to ensure that the elevator obtains the following performance:

*(a)* The overspeed valve tripping speed shall be not less than 110% nor greater than 140% of the elevator operating speed in the down direction, but in no case shall exceed 0.3 m/s (60 ft/min) above the rated elevator speed.

*(b)* The average deceleration rate shall be not less than 1.96 $m/s^2$ (6.44 $ft/s^2$) nor more than 9.81 $m/s^2$ (32.2 $ft/s^2$).

*(c)* Any peak deceleration rate in excess of 24.53 $m/s^2$ (80.5 $ft/s^2$) shall have a duration of not greater than 0.04 s.

**3.19.4.7.6 Sealing of the Overspeed Valve.** Field-adjustable overspeed valves shall be sealed after field setting.

### 3.19.5 Piping Buried in the Ground

**3.19.5.1 Protection.** Piping buried in the ground shall be provided with protection from corrosion by one or more of the following methods:

*(a)* monitored cathodic protection

*(b)* a coating to protect the piping from corrosion that will withstand the installation process

*(c)* a protective casing, immune to galvanic or electrolytic action, salt water, and other known underground conditions, completely surrounding the exterior surfaces of the piping

**3.19.5.2 Seals.** Piping buried in the ground shall not include seals or other elements potentially requiring service or replacement.

### 3.19.6 Welding

**3.19.6.1** All welding of valves, pressure piping, and fittings shall conform to 8.8.

**3.19.6.2** Field welding of pressure piping and fittings shall also be permitted to be performed by welders certified to the requirements pertaining to pressure systems.

### 3.19.7 Electrical Requirements

Hydraulic control valves shall conform to the electrical requirements in Clause 4 of CSA C22.2 No. 139.

## SECTION 3.20
## ROPES AND ROPE CONNECTIONS

Where a counterweight is provided, the counterweight shall be connected to the car by not less than two steel wire ropes.

The wire ropes and their connections shall conform to 2.20, except that the factor of safety of the wire ropes shall be not less than 7.

## SECTION 3.21
## COUNTERWEIGHTS

Counterweights, where provided, shall conform to 2.21.

## SECTION 3.22
## BUFFERS AND BUMPERS

### 3.22.1 Car Buffers or Bumpers

Car buffers or bumpers shall be provided and shall conform to 2.22, provided that in applying the requirements of 2.22 to hydraulic elevators 3.22.1.1 through 3.22.1.5 are complied with.

**3.22.1.1** The term "operating speed in the down direction with rated load" shall be substituted for the words "rated speed" wherever these words appear.

**3.22.1.2** In place of 2.22.3.2, the requirements specified in 3.22.1.2.1 and 3.22.1.2.2 shall be substituted.

**3.22.1.2.1** Buffers shall be capable of withstanding without being compressed solid the loading per 8.2.3.2.

**3.22.1.2.2** Buffers shall be compressed solid with a loading of 2 times that described in 8.2.3.2.

**3.22.1.3** Requirement 2.22.4.1.2 shall not apply. Reduced stroke buffers shall not be provided on hydraulic elevators. Car buffers or bumpers shall be so located that the car will come to rest on the bumper or fully compressed buffer, or to a fixed stop, before the plunger reaches its down limit of travel.

**3.22.1.4** When multiple buffers are used, each shall be identical and designed for an equal proportion of the loading described in 3.22.1.2.

**3.22.1.5** Plunger weight, less buoyant effects of the plungers at the buffer strike point, shall be added, if applicable, and used in buffer calculations.

**3.22.1.6** Solid bumpers are permitted on hydraulic elevators having an operating speed in the down direction of 0.25 m/s (50 ft/min) or less. See 2.22.2 for solid bumper material.

### 3.22.2 Counterweight Buffers

Where counterweights are provided, counterweight buffers shall not be provided. (See 3.4.6 for required counterweight runby.)

## SECTION 3.23
## GUIDE RAILS, GUIDE-RAIL SUPPORTS, AND FASTENINGS

### 3.23.1 Direct-Acting Hydraulic Elevators

Guide rails, guide-rail supports, and their fastenings shall conform to 2.23, with the exceptions specified in 3.23.1.1 through 3.23.1.4.

**3.23.1.1** Requirement 2.23.4.1 shall apply only where car safeties are used and the maximum load on the car side for direct-acting hydraulic elevators is the maximum weight of the car and its rated load plus the weight of the plunger or cylinder as applicable.

**3.23.1.2** Requirement 2.23.4.2 shall apply only where safeties are used.

**3.23.1.3** Requirement 2.23.9.1(a) shall apply only where safeties are used.

**3.23.1.4** Requirement 2.28 shall not apply.

### 3.23.2 Roped-Hydraulic Elevators

**3.23.2.1** Car and counterweight guide rails, guide-rail supports, and their fastenings shall conform to 2.23.

**3.23.2.2** The traveling sheave, if provided, shall be guided by means of suitable guide shoes and guide rails adequately mounted and supported.

## SECTION 3.24
## HYDRAULIC MACHINES AND TANKS

### 3.24.1 Hydraulic Machines (Power Units)

**3.24.1.1 Marking Plates.** The working pressure that is developed in the system shall be measured at the acceptance inspection and test. This pressure shall be legibly and permanently labeled/marked on a data plate that shall be mounted on the hydraulic machine.

### 3.24.2 Tanks

**3.24.2.1 Capacity.** Tanks shall be of sufficient capacity to provide for an adequate liquid reserve in order to prevent the entrance of air or other gas into the system.

**3.24.2.2 Minimum Level Indication.** The permissible minimum liquid level shall be clearly indicated.

### 3.24.3 Atmosphere Storage and Discharge Tanks

**3.24.3.1 Covers and Venting.** Tanks shall be covered and suitably vented to the atmosphere.

**3.24.3.2 Factor of Safety.** Tanks shall be so designed and constructed that when completely filled, the factor of safety shall be not less than 4, based on the ultimate strength of the material.

**3.24.3.3 Means for Checking Liquid Level.** Tanks shall be provided with means for checking the liquid level. Such means shall be accessible without the removal of any cover or other part.

### 3.24.4 Welding

All welding of hydraulic machine components shall conform to 8.8.

### 3.24.5 Counterweight Sheaves

Sheaves for counterweight ropes shall conform to 2.24.2, 2.24.3, and 2.24.5.

## SECTION 3.25
## TERMINAL STOPPING DEVICES

### 3.25.1 Normal Terminal Stopping Devices

**3.25.1.1 Where Required and Function.** Upper and lower normal terminal stopping devices shall be provided and arranged to slow down and stop the car automatically, at or near the top and bottom terminal landings, with any load up to and including rated load in the car from any speed attained in normal operation. Such devices shall function independently of the operation of the normal stopping means and the terminal speed reducing device, where provided. The device shall

be so designed and installed that it will continue to function until the car reaches its extreme limits of travel.

The device shall be permitted to be rendered inoperative during recycling operation (see 3.26.7).

**3.25.1.2 Location of Stopping Switches.** Stopping switches shall be located on the car, in the hoistway, in the machine room, or in overhead spaces, and shall be operated by movement of the car.

**3.25.1.3 Requirements for Stopping Switches on the Car or in the Hoistway.** Stopping switches located on the car or in the hoistway and operated by cams on the car or in the hoistway shall conform to 2.25.1.

**3.25.1.4 Requirements for Stopping Switches in a Machine Room or Overhead Space.** Stopping switches located in a machine room or in an overhead space shall conform to 2.25.2.3, except that the device required by 2.25.2.3.2 shall cause the electric power to be removed from the main control valve or from its control switch operating magnets and, in the case of electrohydraulic elevators, where stopping the car is effected by stopping the pump motor, from the pump motor and associated valves.

### 3.25.2 Terminal Speed Reducing Devices

**3.25.2.1 Where Required.** Terminal speed reducing devices shall be installed for the up direction where the car speed exceeds 0.25 m/s (50 ft/min), to ensure that the plunger does not strike its solid limit of travel at a speed in excess of 0.25 m/s (50 ft/min) (see 3.18.4.1).

**3.25.2.2 Requirements.** Terminal speed reducing devices shall conform to 3.25.2.2.1 through 3.25.2.2.5.

**3.25.2.2.1** They shall operate independently of the normal terminal-stopping device and shall function to reduce the speed of the car if the normal terminal stopping device fails to slow down the car at the terminals as intended.

**3.25.2.2.2** They shall provide retardation not in excess of 9.81 $m/s^2$ (32.2 $ft/s^2$).

**3.25.2.2.3** They shall be so designed and installed that a single short circuit caused by a combination of grounds or by other conditions shall not render the device ineffective.

**3.25.2.2.4** Control means for electrohydraulic elevators shall conform to the following:

*(a)* For the up direction of travel, at least two control means are required; one or both to be controlled by the terminal speed reducing device and the other or both by the normal terminal stopping device.

If, in the up direction, the pump motor is the only control means, the pump motor control shall conform to the following:

*(1)* Two devices shall be provided to remove power independently from the pump motor. At least one device shall be an electromechanical contactor.

*(2)* The contactor shall be arranged to open each time the car stops.

*(3)* The electrical protective devices shall control both devices [see 3.25.2.2.4(b)(1)] in accordance with 3.26.4.

If, however, the pump motor is one control means, and there is a second control means (e.g., a valve), at least one of the means shall be directly controlled by an electromechanical contactor or relay.

*(b)* For the down direction, the terminal speed reducing and normal terminal stopping devices shall each directly, or through separate switches, affect the control valve. Where two devices are used, the terminal speed reducing and normal terminal stopping devices each shall be permitted to control one or both. (ED)

**3.25.2.2.5** Where magnetically operated, optical or solid-state devices are used for position sensing, a single short circuit caused by a combination of grounds or by other conditions, or the failure of any single magnetically operated, optical, or solid-state device, shall not

*(a)* render the terminal speed reducing device inoperative; or

*(b)* permit the car to restart after a normal stop.

### 3.25.3 Final Terminal Stopping Devices

Final terminal stopping devices are not required.

## SECTION 3.26
## OPERATING DEVICES AND CONTROL EQUIPMENT

### 3.26.1 Operating Devices and Control Equipment

Operating devices and control equipment shall conform to 2.26, except as modified by the following:

*(a)* Requirement 2.26.1.3 does not apply.

*(b)* Requirement 2.26.1.4 applies as specified by 3.26.2.

*(c)* Requirement 2.26.1.6 applies as specified by 3.26.3.

*(d)* Requirement 2.26.2 applies as specified by 3.26.4.

*(e)* Requirement 2.26.6 does not apply.

*(f)* Requirement 2.26.8 does not apply.

*(g)* Requirements 2.26.9.1, 2.26.9.2, 2.26.9.5, 2.26.9.6, and 2.26.9.7 do not apply.

*(h)* Requirement 2.26.10 does not apply.

### 3.26.2 Inspection Operation

Top-of-car operating devices shall be provided and shall conform to 2.26.1.4. In-car and machine room inspection operation conforming to 2.26.1.4 shall be permitted.

The bottom normal terminal stopping device shall be permitted to be made ineffective while the elevator is under the control of the inspection operation device.

### 3.26.3 Anticreep and Leveling Operation

**3.26.3.1 Anticreep Operation.** Each elevator shall be provided with an anticreep operation to correct automatically a change in car level. It shall conform to 2.26.1.6.2 and 2.26.1.6.3, and 3.26.3.1.1 through 3.26.3.1.5.

**3.26.3.1.1** The anticreep device shall operate the car at a speed not exceeding 0.125 m/s (25 ft/min).

**3.26.3.1.2** The anticreep device shall maintain the car within 25 mm (1 in.) of the landing, irrespective of the position of the hoistway door.

**3.26.3.1.3** For electrohydraulic elevators, the anticreep device shall be required to operate the car only in the up direction.

**3.26.3.1.4** Operation dependent on the availability of the electric power supply is permitted, provided that

*(a)* the mainline power disconnecting means is kept in the closed position at all times except during maintenance, repairs, and inspection

*(b)* a sign is placed on the switch stating, "KEEP SWITCH CLOSED EXCEPT DURING MAINTENANCE, REPAIRS, AND INSPECTIONS"

*(c)* the sign shall be made of durable material and securely fastened and have letters with a height of not less than 6 mm (0.25 in.)

**3.26.3.1.5** Only the following, when activated, shall prevent operation of the anticreep device:

*(a)* the electrical protective devices listed in 3.26.4.1

*(b)* recycling operation (see 3.26.7)

*(c)* inspection transfer switch

*(d)* hoistway access switch

*(e)* low oil protection means

*(f)* oil tank temperature shutdown devices

**3.26.3.2 Operation in Leveling or Truck Zone.** Operation of an elevator in a leveling or truck zone at any landing by a car-leveling or truck-zoning device, when the hoistway doors, or the car doors or gates, or any combination thereof, are not in the closed position, is permissible, subject to the requirements of 2.26.1.6.1 through 2.26.1.6.5. A leveling or truck-zoning device shall operate the car at a speed not exceeding 0.125 m/s (25 ft/min).

### 3.26.4 Electrical Protective Devices

Electrical protective devices shall be provided in conformance with 2.26.2, and the following requirements, except the words "driving machine motor and brake" in 2.26.2 shall be replaced with "hydraulic machine," and shall conform to 3.26.4.1 and 3.26.4.2.

**3.26.4.1** When in the open position, the electrical protective devices shall prevent operation by all operating means, except as specified in 3.26.4.2.

**3.26.4.2** When in the open position, the following devices shall initiate removal of power from the hydraulic machine in such a manner as to produce an average deceleration rate not greater than 9.8 m/s$^2$ (32.2 ft/s$^2$) and shall prevent operation by all operating means except the anticreep device:

*(a)* emergency stop switches, where required by 2.26.2.5

*(b)* broken rope, tape, or chain switches provided in connection with normal stopping devices, when such devices are located in the machine room or overhead space

*(c)* hoistway door interlocks or hoistway door contacts

*(d)* car door or gate electric contacts; or car door interlocks

*(e)* hinged car platform sill electric contacts

*(f)* in-car stop switch, where required by 2.26.2.21

### 3.26.5 Phase Reversal and Failure Protection (ED)

Hydraulic elevators powered by a polyphase AC motor shall be provided with the means to prevent overheating of the drive system (pump and motor) due to phase rotation reversals or failure.

### 3.26.6 Control and Operating Circuits

The design and installation of the control and operating circuits shall conform to 3.26.6.1 and 3.26.6.2.

**3.26.6.1** Springs, where used to actuate switches, contactors, or relays to stop an elevator at the terminals or to actuate electrically operated valves, shall be of the compression type.

**3.26.6.2** The completion or maintenance of an electric circuit shall not be used to interrupt the power to the control valve operating magnets, or to the pump driving motor of electrohydraulic elevators, or both under the following conditions:

*(a)* to stop the car at the terminals

*(b)* to stop the car when the emergency stop switch or any of the electrical protective devices operate

### 3.26.7 Recycling Operation for Multiple or Telescopic Plungers (ED)

Recycling operation shall permit the car to be lowered more than 25 mm (1 in.) below the bottom landing, but not require lowering in order to restore the relative vertical position of the multiple plunger sections, provided that

*(a)* the car is at rest at bottom landing

*(b)* the doors and gates are closed and locked

*(c)* no car calls are registered

*(d)* the speed during recycling does not exceed normal down leveling speed but in no case shall be more than 0.10 m/s (20 ft/min)

*(e)* normal operation cannot be resumed until car is returned to bottom landing and normal terminal stopping devices are restored to normal operation

### 3.26.8 Pressure Switch

When cylinders are installed with the top of the cylinder above the top of the storage tank, a pressure switch shall be provided in the line between the cylinder and the valve, which shall be activated by the loss of positive pressure at the top of the cylinder. The switch shall prevent automatic door opening and the operation of the lowering valve or valves. The door(s) shall be permitted to open by operation of the in-car open button, when the car is within the unlocking zone.

### 3.26.9 Low Oil Protection

A means shall be provided to render the elevator inoperative if for any reason the liquid level in the tank falls below the permissible minimum. Suitable means include, but are not limited to, the following:

*(a)* direct sensing of liquid level

*(b)* a pump-run timer

Actuation of the means shall automatically bring the car down to the lowest landing. The door(s) shall open and reclose within 15 s. The car shall then shut down. The means shall require manual reset before returning the car to service. The in-car door open button shall remain operative.

### 3.26.10 Auxiliary Power Lowering Operation

Where the auxiliary power supply is provided solely for the purpose of lowering the car, in the case of main power supply failure, the auxiliary lowering operation shall conform to 3.26.10.1 through 3.26.10.3.

**3.26.10.1** Auxiliary lowering shall be permitted to be initiated, provided that all operating and control devices, including door open and close buttons, function as with normal power supply, except that the following devices shall be permitted to be bypassed or made inoperative:

*(a)* landing and car floor registration devices (or call buttons)

*(b)* devices enabling operation by designated attendant (hospital service, attendant operation)

*(c)* devices initiating emergency recall operation to the recall level, unless otherwise specified in 3.27

*(d)* "FIRE OPERATION" switch, unless otherwise specified in 3.27

**3.26.10.2** When the auxiliary lowering operation has been initiated, the car shall descend directly to the lowest landing, except that the operating system shall be permitted to allow one or more intermediate stops, and then, after a predetermined interval, the car shall proceed to the lowest landing, provided the auxiliary power supply is of sufficient capacity to open and close doors at each intermediate stop.

**3.26.10.3** If the car and landing doors are power operated, and if the auxiliary power supply is of adequate capacity, the doors shall open when the car stops at the lowest landing and shall close after a predetermined interval.

NOTE (3.26.10): For the main disconnect switch auxiliary contact, see ANSI/NFPA 70 and CSA C22.1 requirements, where applicable (see Part 9).

## SECTION 3.27
## EMERGENCY OPERATION AND SIGNALING DEVICES

Emergency operation and signaling devices shall conform to 2.27, except as modified by the following: The requirements of 3.26.9 and 3.18.2.7 shall be modified when Phase I Emergency Recall Operation and Phase II Emergency In-Car Operation are in effect, as specified in 3.27.1 through 3.27.4.

### 3.27.1 Phase I Emergency Recall Operation After Device Actuation

If Phase I Emergency Recall Operation is activated while the elevator is responding to any of the following devices, the car shall return to the recall level:

*(a)* low oil protection (see 3.26.9)

*(b)* plunger follower guide protection, provided the car is capable of being moved (see 3.18.2.7)

*(c)* auxiliary power lowering device (see 3.26.10)

If the elevator is incapable of returning to the recall level, the car shall descend to an available floor. Upon arrival, automatic power-operated doors shall open, and then reclose within 15 s. The door open button shall remain operative.

### 3.27.2 Phase I Emergency Recall Operation Prior to Device Actuation

If any of the devices specified in 3.27.1(a), (b), or (c) is activated, while Phase I Emergency Recall Operation is in effect, but before the car reaches the recall level, the car shall

*(a)* complete Phase I Emergency Recall Operation, if the car is above the recall level; or

*(b)* descend to an available floor, if the car is below the recall level.

Upon arrival, automatic power-operated doors shall open, and then reclose within 15 s. The door open button shall remain operative.

### 3.27.3 Device Actuation at Recall Level

If either of the devices specified in 3.27.1(a) or (c) is activated while the car is stationary at the recall level and Phase I Emergency Recall Operation is in effect, the following shall apply:

*(a)* automatic power-operated doors shall close within 15 s

*(b)* the door open button shall remain operational

(c) the visual signal [see Fig. 2.27.3.1.6(h)] shall illuminate intermittantly

### 3.27.4 Device Actuation With Phase II Emergency In-Car Operation in Effect

If any of the devices specified in 3.27.1(a), (b), or (c) activate while the elevator is on Phase II Emergency In-Car Operation, a traveling car shall stop and all calls shall be canceled. The visual signal [see Fig. 2.27.3.1.6(h)] shall illuminate intermittently. The elevator shall accept calls only to landings below its location and respond in compliance with the requirements for Phase II Emergency In-Car Operation.

## SECTION 3.28
## LAYOUT DATA

### 3.28.1 Information Required on Layout Drawing

Elevator layout drawings shall, in addition to other data, indicate the following:

(a) required clearances and basic dimensions

(b) the bracket spacing (see 3.23)

(c) the estimated maximum vertical forces on the guide rails on application of the safety, where provided (see 3.23)

(d) in the case of freight elevators for Class B or Class C loading (see 2.16.2.2), the horizontal forces on the guide-rail faces during loading and unloading, and the estimated maximum horizontal forces in a post-wise direction on the guide-rail faces on the application of the safety device, where provided (see 3.23)

(e) the size and weight per meter (foot) of any rail reinforcement, where provided (see 3.23)

(f) the impact loads imposed on machinery and sheave beams, supports, and floors or foundations (see 2.9)

(g) the impact load on buffer supports due to buffer engagement at the maximum permissible load and operating speed in the down direction (see 8.2.3)

(h) the net vertical load from the elevator system, which includes the total car weight and rated load; plunger, cylinder, and oil; and any structural supports

(i) the outside diameter and wall thickness of the cylinder, plunger, and piping, and the working pressure

(j) the total static and dynamic loads from the governor, ropes, and tension system

(k) rated speed and operating speed in the down direction

(l) the minimum "grade" of pipe (ASTM or recognized standard) required to fulfill the installation requirements for pressure piping, or in lieu of a specific "grade" of pipe, the minimum tensile strength of pipe to be used for the installation (see 3.19)

(m) the horizontal forces on the building structure stipulated by 2.11.11.8

(n) the length of the plunger and cylinder

(o) the clearance between the bottom of the plunger and the bottom head of the cylinder as required by 3.18.3.3

## SECTION 3.29
## IDENTIFICATION

Identification of equipment and floors shall conform to 2.29, as applicable.