3.3.38 Radiant Panel Index (I_s). The product of the flame spread factor (F_s) and the heat evolution factor (Q_s), as determined in ASTM E 162.

3.3.39 Replace in Kind. As applied to vehicles and facilities, to furnish with new parts or equipment of the same type but not necessarily of identical design.

3.3.40 Retrofit. As applied to vehicles and facilities, to furnish with new parts or equipment to constitute a deliberate modification of the original design (as contrasted with an overhaul or a replacement in kind).

3.3.41 Smoke Obscuration. The reduction of light transmission by smoke, as measured by light attenuation. [271:3.3]

3.3.42 Specific Extinction Area. A measure of smoke obscuration potential per unit mass burnt, determined as the product of the specific extinction coefficient and the volumetric mass flow rate, divided by the mass loss rate.

3.3.43 Specific Optical Density (D_s). The optical density, as measured in ASTM E 662, over unit path length within a chamber of unit volume, produced from a specimen of unit surface area, that is irradiated by a heat flux of 2.5 W/cm^2 for a specified period of time.

3.3.44 Station. A place designated for the purpose of loading and unloading passengers, including patron service areas and ancillary spaces associated with the same structure.

3.3.44.1 *Enclosed Station.* A station or portion thereof that does not meet the definition of an open station.

3.3.44.2 *Open Station.* A station that is constructed in such a manner that it is open to the atmosphere, and smoke and heat are allowed to disperse directly into the atmosphere.

3.3.45 Station Platform. The area of a station used primarily for loading and unloading transit vehicle passengers.

3.3.46 Structure.

3.3.46.1 *Elevated Structure.* Any structure not otherwise defined as a surface or underground structure.

3.3.46.2 *Surface Structure.* Any at-grade or unroofed structure other than an elevated or underground structure.

3.3.47 System. See 3.3.52.1, Fixed Guideway Transit System, or 3.3.52.2, Passenger Rail System.

3.3.48 Tenable Environment. An environment that permits the self-rescue of occupants for a specific period of time.

3.3.49 Total Fire Load. The total heat energy of all combustibles available from the constituent materials of a certain fuel package (units: joules or Btu). This can include a transit and/or passenger rail vehicle(s), luggage, fuel, and/or wayside facilities or structures.

3.3.50 Tourist, Scenic, Historic, or Excursion Operations. Railroad operations that carry passengers, often using antiquated equipment, with the conveyance of the passengers to a particular destination not being the principal purpose.

3.3.51 Trainway. That portion of the guideway in which the fixed guideway transit or passenger rail vehicles operate.

3.3.52 Transportation Systems.

3.3.52.1 *Fixed Guideway Transit System.* An electrified transportation system, utilizing a fixed guideway, operating on right-of-way for the mass movement of passengers within a metropolitan area, and consisting of its fixed guideways, transit vehicles, and other rolling stock; power system; buildings; maintenance facilities; stations; transit vehicle yard; and other stationary and movable apparatus, equipment, appurtenances, and structures.

3.3.52.1.1 *Automated Fixed Guideway Transit System.* A fixed guideway transit system that operates fully automated, driverless vehicles along an exclusive right-of-way.

3.3.52.2 *Passenger Rail System.* A transportation system, utilizing a rail guideway, operating on right-of-way for the movement of passengers within and between metropolitan areas, and consisting of its rail guideways, passenger rail vehicles, and other rolling stock; power systems; buildings; maintenance facilities; stations; passenger rail vehicle yard; and other stationary and movable apparatus, equipment, appurtenances, and structures.

3.3.53 Underground System. The system or that part of the system located beneath the surface of the earth or of the water.

Chapter 4 General

4.1 Characteristics of Fire Safety.

4.1.1 Fire safety on fixed guideway transit and passenger rail systems shall be achieved through a composite of facility design, operating equipment, hardware, procedures, and software subsystems that are integrated to provide requirements for the protection of life and property from the effects of fire.

4.1.2 The level of fire safety desired for the whole system shall be achieved by integrating the required levels for each subsystem.

4.2 Goal.

4.2.1 The goal of this standard is to provide an environment for occupants of fixed guideway and passenger rail system elements that is safe from fire and similar to a practical extent based on the following measures:

(1) Protect occupants not intimate with the initial fire development
(2) Maximize the survivability of occupants intimate with the initial fire development

4.2.2 This standard is prepared with the intent of providing minimum requirements for those instances where noncombustible materials (as defined in 3.3.29) are not used due to other considerations in the design and construction of the fixed guideway and passenger rail system elements.

4.3 Objectives.

4.3.1 Occupant Protection. Fixed guideway transit and passenger rail systems shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the time needed to evacuate or relocate them, or defend such occupants in place during a fire or fire-related emergency.

4.3.2 Structural Integrity. Structural integrity of stations, trainways, and vehicles shall be maintained for the time needed to evacuate, relocate, or defend in place occupants who are not intimate with the initial fire development.

4.3.3 Systems Effectiveness. Systems utilized to achieve goals stated in Section 4.2 shall be effective in mitigating the hazard

or condition for which they are being used, shall be reliable, shall be maintained to the level at which they were designed to operate, and shall remain operational.

4.4 **Assumption of a Single Fire Source.** The protection methods described in this standard shall assume a single fire source.

Chapter 5 Stations

5.1 General.

5.1.1* Application. This chapter shall apply to all fixed guideway transit and passenger rail stations whether they are entirely, or in any part, below, at, or above grade.

5.1.2 Occupancy.

5.1.2.1 The primary purpose of a station shall be for the use of the fixed guideway transit and passenger rail passengers who normally stay in a station structure for a period of time no longer than that necessary to wait for and enter a departing transit or passenger rail vehicle or to exit the station after arriving on an incoming transit or passenger rail vehicle.

5.1.2.2 Where contiguous commercial occupancies are in common with the station, or where the station is integrated into a building the occupancy of which is neither for transit nor for passenger rail, special considerations beyond this standard shall be necessary.

5.1.2.3 A station shall also be for the use of employees whose work assignments require their presence in the station structures.

5.2 Construction.

5.2.1 Construction Materials. Building construction for all new stations shall be not less than Type I– or Type II– or combinations of Type I– and Type II–approved noncombustible construction as defined in NFPA 220, as determined by an engineering analysis of potential fire exposure hazards to the structure.

5.2.2 Safeguards During Construction. During the course of construction or major modification of any structure, provisions of NFPA 241 shall apply.

5.2.3 Compartmentation and Fire Separation.

5.2.3.1 Stair and Escalator Enclosure. Stairs and escalators regularly used by passengers shall not be required to be enclosed.

5.2.3.1.1 Such stairs and escalators shall be included in exit capacity calculations as detailed in 5.5.3 and 5.5.4.

5.2.3.2 Ancillary Spaces. In all stations, fire resistance ratings of separations between occupancies shall be established as required by the local building code in accordance with NFPA 251.

5.2.3.2.1 All power substations shall have a fire separation of at least 3 hours from all other occupancies.

5.2.3.2.2 Electrical control rooms, auxiliary electrical rooms, and associated battery rooms shall have a fire separation of at least 2 hours from all other occupancies.

5.2.3.2.3 Trash rooms shall have a fire separation of at least 1 hour from all other occupancies.

5.2.3.2.4 Train control rooms and associated battery rooms shall have a fire separation of at least 2 hours from all other occupancies.

5.2.3.2.5 All public areas shall have a fire separation of at least 2 hours from nonpublic areas.

5.2.3.3 Doors and Openings. Doors and other openings through the separations identified in 5.2.3.2, including 5.2.3.2.2 through 5.2.3.2.5, shall be protected by fire door assemblies having a protection rating of 1½ hours.

5.2.3.3.1 Power substations, identified in 5.2.3.2.1, shall be protected by fire door assemblies having a protection rating of 3 hours.

5.2.3.4 Agents' and Information Booths. Agents' or information booths shall be constructed of approved noncombustible materials.

5.2.3.5 Fire Separation.

5.2.3.5.1* All station public areas shall have a fire separation of at least 3 hours from all nontransit occupancies.

5.2.3.5.2 The fire separation for stations shall be permitted to be modified based on an engineering analysis of potential fire exposure hazards.

5.2.3.6 Openings.

5.2.3.6.1 All openings (e.g., private entrances) from station public areas to all nontransit occupancies shall be protected by approved fire-protective assemblies with an appropriate rating for the location in which they are installed.

5.2.3.6.2 Where a fire door is required to be open, one of the following shall apply:

(1) The door shall be of the automatic closing type.
(2) The door shall be activated by listed smoke detectors.
(3) Where a separate smoke barrier is provided, the operation shall be permitted to be by fusible links.

5.2.3.6.3 Fire doors shall be installed in accordance with NFPA 80.

5.2.4 Automatic Sprinkler System Requirements. See 5.7.3.

5.3 Ventilation. Emergency ventilation shall be provided in enclosed stations in accordance with Chapter 7.

5.4 Wiring Requirements.

5.4.1 All wiring materials and installations within stations other than for traction power shall conform to requirements of NFPA 70 and, in addition, shall satisfy the requirements of 5.4.2 through 5.4.9.

5.4.2 Materials manufactured for use as conduits, raceways, ducts, boxes, cabinets, equipment enclosures, and their surface finish materials shall be capable of being subjected to temperatures up to 500°C (932°F) for 1 hour and shall not support combustion under the same temperature condition.

5.4.2.1 Other materials when encased in concrete shall be acceptable.

5.4.3 All conductors shall be insulated. Ground wires shall be permitted to be bare.

5.4.3.1 All thicknesses of insulation and all thicknesses of jackets shall conform to NFPA 70.

5.4.4 All insulations shall conform to Article 310 of NFPA 70 and shall be moisture- and heat-resistant types carrying temperature ratings corresponding to the conditions of application and in no case lower than 90°C (194°F).

5.4.5 Wire and cable constructions intended for use in operating train signal circuits, power circuits to emergency lights, and so forth shall be listed as being resistant to the spread of fire and shall have reduced smoke emissions.

5.4.5.1 Cable shall be permitted to be listed in accordance with any of the following methods:

(1) The cable does not spread fire to the top of the tray in the vertical-tray flame test in UL 1581, Section 1160, and the cable exhibits a specific optical density of smoke at 4 minutes into the test that does not exceed 200 (in the flaming mode) or 75 (in the nonflaming mode), when tested in accordance with ASTM E 662.

(2) The cable exhibits damage (char length) that does not exceed 1.5 m (4.9 ft) when the vertical flame test, with cables in cable trays, is performed as described in CSA C22.2 No. 0.3, and the cable exhibits a specific optical density of smoke at 4 minutes into the test that does not exceed 200 (in the flaming mode) or 75 (in the nonflaming mode), when tested in accordance with ASTM E 662.

(3) The cable is listed as a limited smoke cable (/LS) by meeting the cable damage height, total smoke released, and peak smoke release rate criteria required when tested in the vertical tray flame test in UL 1685. The following performance criteria shall be met when testing according to UL 1685.

  (a) When testing in the UL vertical tray flame exposure:
    i. The cable damage height shall be less than 2.44 m (8 ft) when measured from the bottom of the cable tray.
    ii. The total smoke released shall not exceed 95 m^2 (1023 ft^2).
    iii. The peak smoke release rate shall not exceed 0.25 m^2/s (2.69 ft^2/s).

  (b) Alternatively, when testing in the IEEE 1202 flame exposure:
    i. The cable damage height shall be less than 1.5 m (4.9 ft) when measured from the lower edge of the burner face.
    ii. The total smoke released shall not exceed 150 m^2 (1615 ft^2).
    iii. The peak smoke release rate shall not exceed 0.40 m^2/s (4.3 ft^2/s).

(4) The cable is listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor, by being capable of passing the requirements of ANSI/UL 1666, and the cable exhibits a specific optical density of smoke at 4 minutes into the test that does not exceed 200 (in the flaming mode) or 75 (in the nonflaming mode), when tested in accordance with ASTM E 662.

(5) The cable is listed as having adequate fire-resistant and low-smoke-producing characteristics, by having a flame travel distance that does not exceed 1.52 m (5 ft), generating a maximum peak optical density of smoke of 0.5 and a maximum average optical density of smoke of 0.15 when tested in accordance with NFPA 262.

5.4.6 All conductors, except radio antennas, shall be enclosed in their entirety in armor sheaths, conduits, or enclosed raceways, boxes, and cabinets except in ancillary areas or other nonpublic areas.

5.4.6.1 Conductors in conduits or raceways shall be permitted to be embedded in concrete or run in concrete electrical duct banks, but they shall not be installed exposed or surface-mounted in air plenums that might carry air at the elevated temperatures accompanying fire-emergency conditions.

5.4.7 Overcurrent elements that are designed to protect conductors serving emergency equipment motors (pumps, etc.), emergency lighting, and communications equipment that are located in spaces other than the main electrical distribution system equipment rooms shall not depend on thermal properties for operation.

5.4.8 Conductors for emergency lighting and communications shall be protected from physical damage by transit or passenger rail vehicles or other normal system operations and from fires in the system by either of the following:

(1) Suitable embedment or encasement
(2) Routing of such conductors external to the interior underground portions of the transit system facilities

5.4.9 Power Supply for Emergency Ventilation Fans. See Chapter 7.

5.5 Means of Egress. See also Annex C.

5.5.1 General. The provisions for means of egress for a station shall comply with Chapter 7 and Chapter 12 of NFPA *101*, except as herein modified.

5.5.1.1* For a station, the design of the means of egress shall be based on an emergency condition requiring evacuation of the train(s) and station occupants to a point of safety.

5.5.2 Occupant Load. See also Annex C.

5.5.2.1 The occupant load for a transit station shall be determined based on the emergency condition requiring evacuation of that station to a point of safety.

5.5.2.2 The occupant load shall be based on the calculated train load of trains simultaneously entering the station on all tracks in normal traffic direction during the peak 15-minute period plus the simultaneous entraining load awaiting a train.

5.5.2.3 As a basis for computing the detraining load during an emergency, not more than one train will unload at any one track to a platform during an emergency.

5.5.2.4 The required egress capacity in stations shall be based on evacuation of the occupant load calculated in accordance with 5.5.2.7 and 5.5.2.8.

5.5.2.4.1 The basis for calculating the platform occupant load shall be the peak hour patronage figures as projected for design of a new transit system or as updated for an operating system.

5.5.2.5* Special consideration shall be given to station(s) servicing areas such as civic centers, sports complexes, and convention centers, where events that occur establish occupant loads not included in normal passenger loads.

5.5.2.6 At multiplatform stations, each platform shall be considered separately, and the arrival of trains from all normal traffic directions plus entraining loads shall be considered.

5.5.2.6.1 At concourses, mezzanines, or multilevel stations, simultaneous loads shall be considered for all egress routes passing through that area.

5.5.2.7 Where an area within a station is intended for use by other than passengers or employees, the occupant load for that area shall be determined in accordance with the provisions of NFPA *101* as appropriate for the class of occupancy.

5.5.2.7.1 The additional occupant load shall be included in determining the required egress from that area.

5.5.2.7.2 The additional occupant load is not required to be added to the station occupant load when the area has independent means of egress of sufficient number and capacity.

5.5.2.8 **Calculation of Platform Occupant Load.** The platform occupant load for each platform in a station shall be the greater of the peak period loads calculated as follows.

5.5.2.8.1 The peak period occupant load for each platform shall be based on the simultaneous evacuation of the entraining load and the train load for that platform in the peak period.

5.5.2.8.2 The entraining load for each platform shall be the sum of the entraining loads for each track serving that platform. The entraining load for each track shall be based on the entraining load per train headway multiplied by both of the following:

(1)*The system surge factor
(2) In the peak direction for each route, an additional factor of 2 to account for one missed headway

5.5.2.8.3 The train load for each platform shall be the sum of the train loads for each track serving that platform. The train load for each track shall be the train load per train headway multiplied by both of the following:

(1)*The system surge factor
(2) In the peak direction for each route, an additional factor of 2 to account for one missed headway

5.5.2.8.4* The maximum train load at each track shall be the maximum passenger train capacity.

5.5.3 Number and Capacity of Exits.

5.5.3.1 **Platform Evacuation Time.** There shall be sufficient egress capacity to evacuate the platform occupant load as defined in 5.5.2.8 from the station platform in 4 minutes or less.

5.5.3.1.1 The maximum travel distance on the platform to a point at which a means of egress route leaves the platform shall not exceed 91.4 m (300 ft).

5.5.3.1.2 Modification of the evacuation time shall be permitted based on an engineering analysis by evaluating material heat release rates, station geometry, and emergency ventilation systems.

5.5.3.2 **Evacuation Time to a Point of Safety.** The station also shall be designed to permit evacuation from the most remote point on the platform to a point of safety in 6 minutes or less.

5.5.3.2.1 For at-grade and elevated structures where the station platform is open to the elements and where the concourse is below or protected from the platform by distance or materials as determined by an appropriate engineering analysis, that concourse shall be permitted to be defined as a point of safety.

5.5.3.2.2 For an underground or enclosed station equipped with an emergency ventilation system designed in accordance with Chapter 7, where the emergency ventilation system provides protection for the concourse from exposure to the effects of a train fire at the platform as confirmed by engineering analysis, that concourse is permitted to be defined as a point of safety.

5.5.3.2.3 Modification of the evacuation time shall be permitted based on an engineering analysis by evaluating material heat release rates, station geometry, and emergency ventilation systems.

5.5.3.3 **Exit Lanes, Doors, and Gates.** The capacity in persons per inch per minute (pim), passenger travel speeds in feet per minute (fpm), and for gates in people per minute (ppm) shall be in accordance with 5.5.3.3.1 through 5.5.3.3.3.

5.5.3.3.1 **Platforms, Corridors, and Ramps of 4 Percent Slope or Less.**

5.5.3.3.1.1 Exit corridors and ramps shall be a minimum of 1.73 m (5 ft 8 in.) wide.

5.5.3.3.1.2 In computing the capacity available, 304.8 mm (1 ft) shall be deducted at each side wall and 457.2 mm (1 ft 6 in.) at platform edges.

(A) Capacity shall be 2.27 pim.

(B) Travel speed shall 61 m/min (200 fpm).

5.5.3.3.2* **Stairs, Stopped Escalators, and Ramps of Over 4 Percent Slope.**

5.5.3.3.2.1 Exit stairs shall be a minimum of 1.12 m (44 in.) wide.

5.5.3.3.2.2 Stopped escalators shall be permitted to be considered as emergency exits.

5.5.3.3.2.3 Exit ramps shall be a minimum of 1.83 m (6 ft) wide.

5.5.3.3.2.4 Capacities and travel speeds for stairs, stopped escalators, and ramps of over 4 percent slope shall be as follows:

(1) Up direction
  (a) Capacity — 0.0626 p/mm-min (1.59 pim)
  (b) Travel speed — 15.24 m/min (50 fpm) (indicates vertical component of travel speed)
(2) Down direction
  (a) Capacity — 0.0716 p/mm-min (1.82 pim)
  (b) Travel speed — 18.3 m/min (60 fpm) (indicates vertical component of travel speed)

5.5.3.3.2.5 Escalators shall not account for more than half of the units of exit at any one level.

5.5.3.3.2.6 In the calculation of egress requirements, one escalator at each station shall be considered as being out of service.

5.5.3.3.2.7 The escalator chosen shall be the one having the most adverse effect upon egress capacity.

5.5.3.3.3 **Doors and Gates.**

5.5.3.3.3.1 Exit doors and gates shall be a minimum of 914.4 mm (36 in.) wide.

5.5.3.3.3.2 Capacity shall be 0.0893 p/mm-min (2.27 pim).

5.5.3.3.4 **Fare Collection Gates.**

5.5.3.3.4.1 Fare collection gates shall meet the following criteria:

(1) They shall provide a minimum of 508 mm (20 in.) clear width when deactivated.
(2) Consoles shall not exceed 1016 mm (40 in.) in height.
(3) They shall have a capacity of 50 people per minute (ppm) for egress calculations.

5.5.3.3.4.2 Turnstile-type fare collection gates shall meet the following criteria:

(1) They shall provide a minimum of 457.2 mm (18 in.) clear width.
(2) They shall have a maximum height of 914.4 mm (36 in.) at the turnstile bar.
(3) They shall free-wheel in the direction of egress when deactivated.
(4) They shall have a capacity of 25 people per minute (ppm) for egress calculations.

5.5.3.4 Emergency exit gates shall be in accordance with NFPA *101*.

5.5.3.4.1 Gate-type exits shall be provided for at least 50 percent of the required emergency exit capacity unless fare collection equipment provides unobstructed exiting under all conditions.

5.5.3.5 A second means of egress at least 1120 mm (44 in.) wide shall be provided from each station platform.

5.5.3.5.1 Means of egress from separate platforms shall be permitted to converge.

5.5.3.5.2 Where means of egress routes from separate platforms converge, the subsequent capacity of the egress route shall be sufficient to maintain the required evacuation time from the incident platform.

5.5.3.6 A common path of travel from the platform ends shall not exceed 22.8 m (75 ft) or one car length, whichever is greater.

5.5.4 **Escalators.** *(See also Section C.2.)*

5.5.4.1 Escalators shall be permitted as a means of egress in stations provided the following criteria are met:

(1)*The escalators are constructed of noncombustible materials.
(2) Escalators running in the direction of egress shall be permitted to remain operating.
(3) Escalators running reverse to the direction of egress shall be capable of being stopped remotely or manually. *(See Section C.2.)*

5.5.4.2 Escalators with or without intermediate landings shall be acceptable as a means of egress, regardless of vertical rise.

5.5.4.3 Escalators exposed to the outdoor environment shall be provided with slip-resistant landing and floor plates, and if they are exposed to freezing temperatures, the landing and floor plates and steps shall be heated to prevent the accumulation of ice and snow.

5.5.5 **Fare Collection Gates or Turnstiles.** The following design features shall be provided to facilitate the exit of passengers in the event of an emergency.

5.5.5.1 The fare gates or turnstiles shall assume an emergency exit mode in the event of loss of power to the fare gates or turnstiles or upon actuation of a manual or remote control.

5.5.5.2 Fare collection gates or turnstiles shall be designed so that their failure to operate properly will not prohibit movement of passengers in the direction of the emergency egress.

5.5.6 **Platform Edge Doors.** Horizontal sliding platform screen or platform edge doors shall be permitted to separate the platform from the trainway in stations provided that the following criteria are met:

(1) The doors permit emergency egress from the train to the platform regardless of the stopping position of the train.
(2) The doors provide egress when a force not exceeding 222 N (50 lb) is applied from the train side of the doors.
(3) The doors are designed to withstand positive and negative pressures caused by passing trains.

5.6 **Emergency Lighting.**

5.6.1 Stations shall be provided with a system of emergency lighting in accordance with NFPA *101*, except as otherwise noted in this standard.

5.6.2 Emergency lighting for stairs and escalators shall be designed to emphasize illumination on the top and bottom steps and landings.

5.6.2.1 All newel- and comb-lighting on escalator steps shall be on emergency power circuits.

5.7 **Fire Protection.**

5.7.1 **Protective Signaling Systems.**

5.7.1.1 Stations equipped with fire alarm devices shall be protected by a proprietary system as defined in *NFPA 72*.

5.7.1.2* Each station having fire alarm initiating devices shall be provided with a fire alarm annunciator panel at a location that is accessible to emergency response personnel in accordance with *NFPA 72*.

5.7.1.2.1 The location shall be approved by the authority having jurisdiction.

5.7.1.2.2 Annunciator panels shall announce by audible alarm the activation of any fire alarm–initiating device in the station and visually display the location of the actuated device.

5.7.1.3 All fire alarm, smoke detection, valve switches, and water flow indicator signals — when activated — shall be transmitted simultaneously to the local station and to the central supervising station.

5.7.1.4* Separate zones shall be established on local station annunciator panels to monitor water flow on sprinkler systems and supervise main control valves.

5.7.1.5 Automatic fire detection shall be provided in all ancillary spaces by the installation of listed combination fixed-temperature and rate-of-rise heat detectors or listed smoke detectors except where protected by automatic sprinklers.

5.7.2 **Emergency Communication.**

5.7.2.1 A public address (PA) system and emergency voice alarm reporting devices, such as emergency telephone boxes or manual fire alarm boxes, conforming to *NFPA 72* shall be required in stations.

5.7.2.2 The central supervising station and each passenger station shall be equipped with an approved emergency voice/alarm communication system so that appropriate announcements can be made regarding fire alarms, including provisions for giving necessary information and directions to the public upon receipt of any manual or automatic fire alarm signal.

5.7.2.2.1 These notification devices shall be placed in approved locations at each facility.

5.7.2.3 Emergency alarm reporting devices shall be located on passenger platforms and throughout the passenger station such that the travel distance from any point in the public area shall not exceed 91.4 m (300 ft) unless otherwise approved by the authority having jurisdiction.

5.7.2.3.1 Such emergency devices shall be distinctive in color, and their location shall be plainly indicated by appropriate signs.

5.7.3 Automatic Sprinkler Systems.

5.7.3.1 An automatic sprinkler protection system shall be provided in areas of stations used for concessions, in storage areas, in trash rooms, and in the steel truss area of all escalators and other similar areas with combustible loadings, except trainways.

5.7.3.1.1 Sprinkler protection is not required in areas of open stations remotely located from public spaces.

5.7.3.2 Installation of sprinkler systems shall comply with NFPA 13 or applicable local codes as required.

5.7.3.3 A sprinkler system water flow alarm and supervisory signal service shall be installed.

5.7.3.4 Other approved fire suppression systems shall be permitted to be substituted for automatic sprinkler systems in the areas listed in 5.7.3.1 with the approval of the authority having jurisdiction.

5.7.4 Standpipe and Hose Systems.

5.7.4.1 Each underground transit station shall be equipped with a standpipe system of either Class I or Class III type, as defined in NFPA 14.

5.7.4.1.1 Class of service shall be determined by the authority having jurisdiction. *(See A.5.7.4.3.)*

5.7.4.2 The authority having jurisdiction shall be consulted as to location, spacing, and number of standpipe hose outlets and valves and shall determine the need for provision and type of hose.

5.7.4.3* Fire department connections for fire department use in supplying the standpipe system shall be located as follows:

(1) Within 30.5 m (100 ft) of vehicular access
(2) Within operating distance of fire hydrants as determined by the local authority having jurisdiction

5.7.4.3.1 In addition to the usual identification required on fire department connections for standpipes, there shall also be wording to identify the fire department connection as part of the transit station system.

5.7.4.4 Where underground stations include more than one platform level (such as crossover subway lines), there shall be a cross-connection pipe of a minimum size of 101.6 mm (4 in.) in diameter between each standpipe system, so that supplying water through any fire department connection will furnish water throughout the entire system.

5.7.5 Portable Fire Extinguishers. Portable fire extinguishers in such number, size, type, and location as determined by the authority having jurisdiction shall be provided.

5.7.6* Fire Command Center. Underground stations shall be provided with a fire command center in accordance with *NFPA 72*.

5.7.6.1 The ventilation systems at adjacent tunnels and stations shall be permitted to be omitted from the controls of the fire command center.

5.8 Storage Tanks and Service Stations.

5.8.1 Aboveground storage tanks above subsurface stations shall meet the requirements of 6.2.8.4.

5.8.2 Underground storage tanks above subsurface station structures shall meet the requirements of 6.2.8.5.

5.8.3 Service stations above subsurface station structures shall meet the requirements of 6.2.8.6.

5.8.4 Existing storage tanks in or under buildings shall meet the requirements of 6.2.8.7.

Chapter 6 Trainways

6.1 General.

6.1.1* Application. This chapter contains requirements for all fixed guideway transit and passenger rail trainways whether they are entirely or in any part below, at, or above grade.

6.1.2 Occupancy.

6.1.2.1 Passengers shall enter the trainways only in the event that it becomes necessary to evacuate a disabled train.

6.1.2.2 Evacuation shall take place only under the guidance and control of authorized, trained transit system employees or other authorized personnel as warranted under an emergency situation.

6.1.3 Warning Signs.

6.1.3.1 Warning signs shall be posted on entrances to the trainway (e.g., station platforms and portals), on fences or barriers adjacent to the trainway, and at such other places where nontransit authority employees might trespass.

6.1.3.2 The warning signs shall clearly state the hazard (e.g., DANGER HIGH VOLTAGE — 750 VOLTS) with letter sizes and colors in conformance with NFPA 70 and Occupational Safety and Health Administration (OSHA) requirements.

6.1.4 Blue Light Station.

6.1.4.1* Blue light stations shall be provided at the following locations:

(1) At the ends of station platforms
(2) At cross passageways *(see 6.2.4.3)*
(3) At emergency access points
(4) At traction power substations
(5) In underground trainways as required by the authority having jurisdiction

6.1.4.2 Adjacent to each blue light station, information shall be provided that identifies the location of that station and the distance to an exit in each direction.

6.2 Underground (Subways).

6.2.1 Construction Materials.

6.2.1.1 **General.** Where line sections are to be constructed by the cut-and-cover method, perimeter walls and related construction shall be not less than Type I- or Type II- or combinations of Type I- or Type II-approved noncombustible construction as defined in NFPA 220, as determined by an engineering analysis of potential fire exposure hazards to the structure.

6.2.1.2 **Lining.** Where line sections are to be constructed by a tunneling method through earth, unprotected steel liners, reinforced concrete, shotcrete, or equivalent shall be used.

6.2.1.2.1 Rock tunnels shall be permitted to utilize steel bents with concrete liner if lining is required.

6.2.1.3 Walking Surfaces. Walking surfaces designated for evacuation of passengers shall be constructed of noncombustible materials.

6.2.1.3.1 Walking surfaces shall have a slip-resistant design.

6.2.1.4 Underwater Tubes. Underwater tubes shall be not less than Type II (000) approved noncombustible construction as defined in NFPA 220, as applicable.

6.2.1.5 Rail Ties. Noncombustible rail ties shall be used in underground locations except at switch or crossover locations, where fire-retardant, pressure-treated ties shall be permitted to be used.

6.2.1.6 Structures. Remote vertical exit shafts and ventilation structures shall be not less than Type I (332) approved noncombustible construction as defined in NFPA 220.

6.2.1.7 Ancillary Areas. Ancillary areas shall be separated from trackway areas within underwater line sections by a minimum of 3-hour fire-resistive construction.

6.2.1.7.1 Ancillary areas shall be separated from trackway areas within underground line sections by a minimum of 2-hour fire-resistive construction.

6.2.2 Ventilation. Emergency ventilation shall be provided in enclosed trainways in accordance with Chapter 7.

6.2.3 Wiring Requirements. *(See Section 5.4.)*

6.2.3.1 All wiring materials and installations within trainways, other than for traction power, shall conform to the requirements of NFPA 70 and, in addition, shall satisfy the requirements of 6.2.3.2 through 6.2.3.9.

6.2.3.1.1 Where the top of the subsurface trainway or station is more than 15 m (50 ft) below the surface of the earth, an engineering analysis to determine the need for the requirement of 6.2.3.1 shall be permitted to be conducted.

6.2.3.2 Materials manufactured for use as conduits, raceways, ducts, boxes, cabinets, equipment enclosures, and their surface finish materials shall be capable of being subjected to temperatures up to 932°F (500°C) for 1 hour and shall not support combustion under the same temperature condition.

6.2.3.2.1 Other materials, where encased in concrete or suitably protected, shall be acceptable.

6.2.3.3 All conductors shall be insulated.

6.2.3.3.1 Ground wires shall be permitted to be bare.

6.2.3.3.2 All thicknesses of insulation and all thicknesses of jackets shall conform to NFPA 70.

6.2.3.4 All insulations shall conform to Article 310 of NFPA 70 and shall be moisture- and heat-resistant types carrying temperature ratings corresponding to the conditions of application and in no case lower than 90°C (194°F).

6.2.3.5 All wire and cable constructions intended for use in trainways, other than traction power cables, shall be listed as being resistant to the spread of fire and shall have reduced smoke emissions in accordance with 6.2.3.5.1.

6.2.3.5.1 Cable shall be permitted to be listed by any of the following methods:

(1) The cable does not spread fire to the top of the tray in the vertical-tray flame test in UL 1581, Section 1160, and the cable exhibits a specific optical density of smoke at 4 minutes into the test that does not exceed 200 (in the flaming mode) or 75 (in the nonflaming mode) when tested in accordance with ASTM E 662.
(2) The cable exhibits damage (char length) that does not exceed 1.5 m (4.9 ft) when the vertical flame test, with cables in cable trays, is performed as described in CSA C22.2 No. 0.3, and the cable exhibits a specific optical density of smoke at 4 minutes into the test that does not exceed 200 (in the flaming mode) or 75 (in the nonflaming mode) when tested in accordance with ASTM E 662.
(3) The cable is listed as a limited smoke cable (/LS) by meeting the cable damage height, total smoke released, and peak smoke release rate criteria required when tested in the vertical tray flame test in UL 1685. The following performance criteria shall be met when testing by UL 1685.
    (a) When testing in the UL vertical tray flame exposure:
        i. The cable damage height shall be less than 2.44 m (8 ft) when measured from the bottom of the cable tray.
        ii. The total smoke released shall not exceed 95 m^2 (1023 ft^2).
        iii. The peak smoke release rate shall not exceed 0.25 m^2/s (4.3 ft^2/s).
    (b) Alternatively, when testing in the IEEE 1202 flame exposure:
        i. The cable damage height shall be less than 1.5 m (4.9 ft) when measured from the lower edge of the burner face.
        ii. The total smoke released shall not exceed 150 m^2 (1615 ft^2).
        iii. The peak smoke release rate shall not exceed 0.40 m^2/s (4.5 ft^2/s).
(4) The cable is listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor, by being capable of passing the requirements of ANSI/UL 1666, and the cable exhibits a specific optical density of smoke at 4 minutes into the test that does not exceed 200 (in the flaming mode) or 75 (in the nonflaming mode) when tested in accordance with ASTM E 662.
(5) The cable is listed as having adequate fire-resistant and low smoke-producing characteristics, by having a flame travel a distance that does not exceed 1.52 m (5 ft), generating a maximum peak optical density of smoke of 0.5 and a maximum average optical density of smoke of 0.15 when tested in accordance with NFPA 262.

6.2.3.6* All conductors, except radio antennas, shall be enclosed in their entirety in armor sheaths, conduits, or enclosed raceways, boxes, and cabinets.

6.2.3.6.1 Conductors in conduits or raceways shall be permitted to be embedded in concrete or run in protected electrical duct banks, but shall not be installed exposed or surface mounted in air plenums that could carry air at the elevated temperatures accompanying fire emergency conditions.

6.2.3.7 Overcurrent elements that are designed to protect conductors serving emergency equipment motors (pumps, etc.), emergency lighting, and communications equipment and that are located in spaces other than the main electrical distribution system equipment rooms shall not depend on thermal properties for operation.

6.2.3.8 Conductors for emergency lighting and communications shall be protected from physical damage by vehicles or other normal system operations and from fires in the system by suitable embedment or encasement, or by routing such conductors external to the interior underground portions of the system facilities.

6.2.3.9 Power Supply for Emergency Ventilation. See Chapter 7.

6.2.4 Emergency Exit Details.

6.2.4.1 General. Emergency exits shall be provided from tunnels to a point of safety.

6.2.4.2* Number and Location of Means of Egress Routes. Within underground or enclosed trainways, the maximum distance between exits shall not exceed 762 m (2500 ft).

6.2.4.3 Cross Passageways.

6.2.4.3.1 Cross passageways shall be permitted to be used in lieu of emergency exit stairways to the surface where trainways in tunnels are divided by a minimum of 2 hour–rated fire walls or where trainways are in twin bores.

6.2.4.3.2 Where cross passageways are utilized in lieu of emergency exit stairways, the following shall apply:

(1) Cross passageways shall not be farther than 244 m (800 ft) apart.
(2) Openings in open passageways shall be protected with fire door assemblies having a fire protection rating of 1½ hours with a self-closing fire door.
(3) A noncontaminated environment shall be provided in that portion of the trainway that is not involved in an emergency and that is being used for evacuation.
(4) A ventilation system for the contaminated tunnel shall be designed to control smoke in the vicinity of the passengers.
(5) An approved method shall be provided for evacuating passengers in the uncontaminated trainway.
(6) An approved method for protecting passengers from oncoming traffic shall be provided.
(7) An approved method for evacuating the passengers to a nearby station or other emergency exit shall be provided.

6.2.4.4 Doors.

6.2.4.4.1 Doors in the means of egress, except cross passageway doors, shall open in the direction of exit travel and comply with both of the following criteria:

(1) Open fully when a force not exceeding 222 N (50 lb) is applied to the latch side of the door
(2) Be adequate to withstand positive and negative pressures caused by passing trains

6.2.4.4.2 Horizontal sliding doors shall be permitted in cross passageways.

6.2.4.5 Exit Hatches.

6.2.4.5.1 Exit hatches shall be permitted in the means of egress provided the following conditions are met:

(1) Hatches shall be equipped with a manual opening device that can be readily opened from the egress side.
(2) Hatches shall be operable with not more than one releasing operation.
(3) The force required to open the hatch when applied at the opening device shall not exceed 133 N (30 lb).
(4) The hatch shall be equipped with a hold-open device that automatically latches the door in the open position to prevent accidental closure.

6.2.4.5.2 Exit hatches shall be capable of being opened from the discharge side to permit access by authorized personnel.

6.2.4.5.3* Exit hatches shall be conspicuously marked on the discharge side to prevent possible blockage.

6.2.4.6 Identification. Emergency exit facilities shall be suitably identified and maintained to allow for their intended use.

6.2.4.7 Emergency Lighting.

6.2.4.7.1 The requirements of 6.2.4.7.2 through 6.2.4.7.5.1 shall apply to all underground or enclosed trainways that are greater than 30.5 m (100 ft) in length or 2 car lengths, whichever is greater.

6.2.4.7.2 Emergency lighting systems shall be installed and maintained in accordance with NFPA 70.

6.2.4.7.3 Exit lights, essential signs, and emergency lights shall be included in the emergency lighting system and shall be powered by a standby power supply or a supply independent of the traction power system.

6.2.4.7.4 Emergency fixtures, exit lights, and signs shall be wired separately from emergency distribution panels.

6.2.4.7.5* The illumination levels of underground or enclosed trainway walkways and walking surfaces (i.e., track way and bench wall walkway) shall not be less than 2.69 lx (0.25 ft-candles) at the walking surface.

6.2.4.7.5.1 The emergency lighting system in the trainway shall produce illumination on the walkway that does not exceed a uniformity ratio of 10:1 for the maximum maintained horizontal illuminance to the minimum maintained horizontal illuminance.

6.2.4.8* Directional Signs.

6.2.4.8.1 Underground or enclosed trainways greater in length than the minimum length of one train shall be provided with directional signs as appropriate for the emergency procedures developed for the fixed guideway transit or passenger rail system in accordance with Chapter 10.

6.2.4.8.2 Signs shall be installed at maximum 22.8 m (75 ft) intervals on either side of the underground or enclosed trainways indicating station or portal directions.

6.2.4.8.3 Signs shall be readily visible by passengers for emergency evacuation.

6.2.4.8.4 Points of exit from elevated and underground or enclosed trainways shall be marked with signs internally or externally illuminated signs.

6.2.5 Traction Power.

6.2.5.1 Application.

6.2.5.1.1* Subsection 6.2.5 shall apply to life safety and fire protection criteria for the traction power subsystem installed in the underground trainway.

6.2.5.1.2 Subsection 6.2.5 shall apply to traction power, which shall include the wayside pothead, the cable between the pothead and the contact (third) rail or overhead contact system (OCS), the contact rail or OCS supports, and special warning and identification devices, as well as electrical appurtenances associated with overhead contact systems.

6.2.5.2 Traction Power Contact Rail Protection.

6.2.5.2.1 To provide safety isolation from the contact rail, the requirements of 6.2.5.2.2 through 6.2.5.2.6 shall apply.

6.2.5.2.2 Power rail conductor(s) (dc or ac, which supply power to the vehicle for propulsion and other loads) shall be secured to insulating supports, bonded at joints, and protected to prevent contact with personnel.

6.2.5.2.3 The design shall include measures to prevent inadvertent contact with the live power rails where such power rails are adjacent to emergency or service walkways and where walkways cross over trainways.

6.2.5.2.4 Coverboards, where used, shall be capable of supporting a vertical load of 1112 N (250 lb) at any point with no visible permanent deflection.

6.2.5.2.5 Coverboard or protective material shall have a flame spread rating of not more than 25 when tested in accordance with NFPA 255 (ASTM E 84).

6.2.5.2.6 Insulating material for the cable connecting power to the rail shall meet the requirements of IEEE 383, Section 2.5.

6.2.5.3 Traction Power Overhead Contact System Protection.

6.2.5.3.1 To provide isolation from the overhead contact system, the requirements of 6.2.5.3.2 and 6.2.5.3.3 shall apply.

6.2.5.3.2 Power conductor(s) (dc or ac, which supply power to the vehicle for propulsion and other loads) shall be secured to insulating supports, bonded at joints, and protected to prevent contact with personnel.

6.2.5.3.3 Insulating material for the cable connecting power to the overhead contact system shall meet the requirements of IEEE 383, Section 2.5.

6.2.6 Egress for Passengers.

6.2.6.1 The system shall incorporate means for passengers to evacuate a train at any point along the trainway and reach a point of safety.

6.2.6.2 System egress points shall be illuminated.

6.2.6.3 Where the trainway track bed serves as the emergency egress pathway, it shall be nominally level and free of obstructions.

6.2.6.4 Walking surfaces shall have a uniform, slip-resistant design.

6.2.6.5 In areas where cross passageways are provided, walkways shall be provided on the cross passageway side of the trainway for unobstructed access to the cross passageway.

6.2.6.6 Raised walkways, ramps, and stairs shall be provided with a handrail that shall not obstruct egress from the train.

6.2.6.7 Crosswalks shall be provided at track level to ensure walkway continuity.

6.2.6.8 Crosswalks shall have uniform walking surface at the top of the rail.

6.2.6.9 Walkway continuity shall be maintained at special track sections (e.g., crossovers, pocket tracks).

6.2.6.10 A guard shall not be required on the trackside of raised walkways in trainways.

6.2.6.11 The minimum unobstructed width of egress facilities located within or directly adjacent to the trainway shall be 610 mm (24 in.) measured at the walkway surface and 762 mm (30 in.) measured at a height of 1422 mm (56 in.) above the walkway surface.

6.2.7 Protection.

6.2.7.1 Automatic Fire Detection.

6.2.7.1.1 Heat and smoke detectors shall be installed at traction power substations and signal bungalows and shall be connected to the central supervising station.

6.2.7.1.2 Signals received from such devices shall be identifiable as to origin of signals.

6.2.7.2 Standpipe and Hose Systems.

6.2.7.2.1 Standpipes for Class I or Class III service, as described in NFPA 14, shall be installed in all underground or enclosed trainways according to the calculation in 6.2.7.2.3.

6.2.7.2.2 Standpipes shall be permitted to be of the dry type with the approval of the authority having jurisdiction.

6.2.7.2.3 A fire standpipe system shall be provided for all underground or enclosed trainways if the length of the trainway, L_T, is greater than the length allowable for participating agency personnel to reach every conceivable fire location within the trainway, according to the following calculated length:

$$L_t > L_H - D_p$$

where:

L_H = maximum length of fire hose permitted by the authority having jurisdiction

D_p = maximum of the distances (measured along the route of the hose) from each trainway portal to the nearest fire hydrant or approved water source

6.2.7.2.4 Standpipe lines shall be a minimum size of 101.6 mm (4 in.) in diameter, or sized by hydraulic calculations.

6.2.7.2.4.1 The authority having jurisdiction shall specify the required water flow and pressure.

6.2.7.2.5 Identification numbers and letters conforming to the sectional identification numbers and letters of the fixed guideway transit or passenger trainway system shall be provided at each surface fire department connection and at each hose valve on the standpipe lines.

6.2.7.2.5.1 Identifying numbers and letters shall be on conspicuous, durable, and legible signs affixed to, or immediately adjacent to, ground-level fire department connections.

6.2.7.2.5.2 Identifying signs shall be affixed to underground or enclosed trainway walls at each hose outlet valve or shall be painted directly on the standpipe in white letters next to each hose outlet valve.

6.2.7.2.5.3 Exposed tunnel standpipe lines and identification signs shall be painted as required by the authority having jurisdiction.

6.2.7.3 Standpipe Installations in Tunnels Under Construction.

6.2.7.3.1 A standpipe system, either temporary or permanent in nature, shall be installed in tunnels under construction before the tunnel has exceeded a length of 61 m (200 ft) beyond any access shaft and shall be extended as tunnel work progresses.

6.2.7.3.2 Permanent and temporary standpipes shall conform to NFPA 14, as outlined in 6.2.7.2.

6.2.8.6.4 No connection (such as venting or drainage) of any storage tanks and related piping of Class I flammable liquids and Class II and Class III combustible liquids to a subsurface fixed guideway transit structure shall be permitted.

6.2.8.6.5 Dispensing pumps for Class I flammable liquids and Class II and Class III combustible liquids shall not be located less than 7.6 m (25 ft) from the face of such pump to the nearest side of a tunnel vent grating or subway entrance or exit.

6.2.8.7 Existing Storage Tanks in or Under Buildings.

6.2.8.7.1 Existing storage tanks for Class I flammable liquids and Class II and Class III combustible liquids located in or under buildings, and located directly above a subsurface transit structure or within 7.6 m (25 ft) (measured horizontally) from the outside wall of the subsurface transit structure, shall be removed and relocated outside the prohibited area.

6.2.8.7.1.1 Where the top of the subsurface trainway or station is more than 15.2 m (50 ft) below the surface of the earth, an engineering analysis to determine the need for the requirement of 6.2.8.7.1 shall be permitted to be conducted.

6.2.8.7.2 Where it is not possible to remove and relocate tanks for Class I flammable and Class II combustible liquids due to limited space, such underground tanks shall be abandoned in accordance with the provisions of Annex C of NFPA 30.

6.2.8.7.3 Where it is not possible to remove and relocate tanks for Class III combustible liquids located in buildings, such tanks shall be provided with leak detection and a secondary containment system of adequate capacity to contain the contents of the tank.

6.2.8.7.4 Tanks shall be abandoned in accordance with the provisions of Annex C of NFPA 30.

6.2.8.7.5 Where it is not possible to remove and relocate tanks for Class III combustible liquids located under a building, such tanks shall be UL-listed double wall or installed in a cast-in-place reinforced concrete vault and shall be provided with an approved leak detection system.

6.2.8.7.6 Tanks shall be abandoned in accordance with the provisions of Annex C of NFPA 30.

6.2.9 Combustible Components.

6.2.9.1 General. Combustible components not covered in 6.2.1 through 6.2.3.8 shall comply with 6.2.9.

6.2.9.2 Engineering Analysis. An engineering analysis shall be conducted on nonstructural combustible components that includes, as a minimum, an examination of peak heat release rate for combustible elements, total heat released, ignition temperatures, radiant heating view factors, and behavior of the component during internal or external fire scenarios to determine that, if a fire propagates beyond involving the component of fire origin, a level of fire safety is provided within an enclosed trainway commensurate with this standard.

6.2.9.2.1 Computer modeling, material fire testing, or full-scale fire testing shall be conducted to assess durability performance in potential fire scenarios.

6.3 Surface Trainways.

6.3.1 General. Section 6.3 shall apply to any at-grade or unroofed structure other than elevated structures.

6.3.2 Construction Materials. Construction materials shall be not less than Type II (000) approved noncombustible material as defined in NFPA 220, as determined by an engineering analysis of potential fire exposure hazards to the structure.

6.3.3* Traction Power. Subsection 6.3.3 shall apply to life safety and fire protection criteria for the traction power subsystem installed in the trainway.

6.3.3.1 Traction power shall include the wayside pothead, the cable between the pothead and the contact (third) rail or overhead wire, the contact rail supports, and special warning and identification devices.

6.3.3.2 Life safety and fire protection criteria for the subsystem installed in the trainway shall conform to the requirements for underground trainways that are listed in 6.2.5.2.

6.3.4 Electrical Wiring and Cable Requirements. All wiring materials and installations other than those for traction power shall conform to the requirements of NFPA 70.

6.3.5 Emergency Access.

6.3.5.1 If security fences are used along the trainway, access gates shall be provided in security fences, as deemed necessary by the authority having jurisdiction.

6.3.5.2 Access gates shall be a minimum of 1118 mm (44 in.) wide and shall be of the hinged or sliding type.

6.3.5.3 Access gates shall be placed as close as practical to the portals to permit easy access to tunnels.

6.3.5.4 Information that clearly identifies the route and location of each gate shall be provided on the gates or adjacent thereto.

6.3.6 Egress for Passengers.

6.3.6.1 The system shall incorporate means for passengers to evacuate a train at any point along the trainway and reach a point of safety.

6.3.6.2 System egress points shall be illuminated.

6.4 Elevated Structures.

6.4.1 General. Elevated structures are all structures not defined in this standard as surface or underground structures.

6.4.2 Construction Materials. All structures necessary for lineway support and all structures and enclosures on or under trainways shall be of not less than Type I or Type II (000) or combinations of Type I- or Type II-approved noncombustible construction as defined in NFPA 220, as determined by an engineering analysis of potential fire exposure hazards to the structure.

6.4.3* Traction Power. This subsection shall apply to life safety and fire protection criteria for the traction power subsystem installed in the trainway.

6.4.3.1 Traction power shall include the wayside pothead, the cable between the pothead and the contact (third) rail or overhead wire, the contact rail supports walkways, and special warning and identification devices.

6.4.3.2 Life safety and fire protection criteria for the subsystem installed in the trainway shall conform to the requirements for underground trainways that are listed in 6.2.5.2.

6.4.4 Electric Wire and Cable Requirements. All wiring materials and installations other than for traction power shall conform to the requirements of NFPA 70.

6.2.8.6.4 No connection (such as venting or drainage) of any storage tanks and related piping of Class I flammable liquids and Class II and Class III combustible liquids to a subsurface fixed guideway transit structure shall be permitted.

6.2.8.6.5 Dispensing pumps for Class I flammable liquids and Class II and Class III combustible liquids shall not be located less than 7.6 m (25 ft) from the face of such pump to the nearest side of a tunnel vent grating or subway entrance or exit.

6.2.8.7 Existing Storage Tanks in or Under Buildings.

6.2.8.7.1 Existing storage tanks for Class I flammable liquids and Class II and Class III combustible liquids located in or under buildings, and located directly above a subsurface transit structure or within 7.6 m (25 ft) (measured horizontally) from the outside wall of the subsurface transit structure, shall be removed and relocated outside the prohibited area.

6.2.8.7.1.1 Where the top of the subsurface trainway or station is more than 15.2 m (50 ft) below the surface of the earth, an engineering analysis to determine the need for the requirement of 6.2.8.7.1 shall be permitted to be conducted.

6.2.8.7.2 Where it is not possible to remove and relocate tanks for Class I flammable and Class II combustible liquids due to limited space, such underground tanks shall be abandoned in accordance with the provisions of Annex C of NFPA 30.

6.2.8.7.3 Where it is not possible to remove and relocate tanks for Class III combustible liquids located in buildings, such tanks shall be provided with leak detection and a secondary containment system of adequate capacity to contain the contents of the tank.

6.2.8.7.4 Tanks shall be abandoned in accordance with the provisions of Annex C of NFPA 30.

6.2.8.7.5 Where it is not possible to remove and relocate tanks for Class III combustible liquids located under a building, such tanks shall be UL-listed double wall or installed in a cast-in-place reinforced concrete vault and shall be provided with an approved leak detection system.

6.2.8.7.6 Tanks shall be abandoned in accordance with the provisions of Annex C of NFPA 30.

6.2.9 Combustible Components.

6.2.9.1 General. Combustible components not covered in 6.2.1 through 6.2.3.8 shall comply with 6.2.9.

6.2.9.2 Engineering Analysis. An engineering analysis shall be conducted on nonstructural combustible components that includes, as a minimum, an examination of peak heat release rate for combustible elements, total heat released, ignition temperatures, radiant heating view factors, and behavior of the component during internal or external fire scenarios to determine that, if a fire propagates beyond involving the component of fire origin, a level of fire safety is provided within an enclosed trainway commensurate with this standard.

6.2.9.2.1 Computer modeling, material fire testing, or full-scale fire testing shall be conducted to assess durability performance in potential fire scenarios.

6.3 Surface Trainways.

6.3.1 General. Section 6.3 shall apply to any at-grade or unroofed structure other than elevated structures.

6.3.2 Construction Materials. Construction materials shall be not less than Type II (000) approved noncombustible material as defined in NFPA 220, as determined by an engineering analysis of potential fire exposure hazards to the structure.

6.3.3* Traction Power. Subsection 6.3.3 shall apply to life safety and fire protection criteria for the traction power subsystem installed in the trainway.

6.3.3.1 Traction power shall include the wayside pothead, the cable between the pothead and the contact (third) rail or overhead wire, the contact rail supports, and special warning and identification devices.

6.3.3.2 Life safety and fire protection criteria for the subsystem installed in the trainway shall conform to the requirements for underground trainways that are listed in 6.2.5.2.

6.3.4 Electrical Wiring and Cable Requirements. All wiring materials and installations other than those for traction power shall conform to the requirements of NFPA 70.

6.3.5 Emergency Access.

6.3.5.1 If security fences are used along the trainway, access gates shall be provided in security fences, as deemed necessary by the authority having jurisdiction.

6.3.5.2 Access gates shall be a minimum of 1118 mm (44 in.) wide and shall be of the hinged or sliding type.

6.3.5.3 Access gates shall be placed as close as practical to the portals to permit easy access to tunnels.

6.3.5.4 Information that clearly identifies the route and location of each gate shall be provided on the gates or adjacent thereto.

6.3.6 Egress for Passengers.

6.3.6.1 The system shall incorporate means for passengers to evacuate a train at any point along the trainway and reach a point of safety.

6.3.6.2 System egress points shall be illuminated.

6.4 Elevated Structures.

6.4.1 General. Elevated structures are all structures not defined in this standard as surface or underground structures.

6.4.2 Construction Materials. All structures necessary for lineway support and all structures and enclosures on or under trainways shall be of not less than Type I or Type II (000) or combinations of Type I- or Type II-approved noncombustible construction as defined in NFPA 220, as determined by an engineering analysis of potential fire exposure hazards to the structure.

6.4.3* Traction Power. This subsection shall apply to life safety and fire protection criteria for the traction power subsystem installed in the trainway.

6.4.3.1 Traction power shall include the wayside pothead, the cable between the pothead and the contact (third) rail or overhead wire, the contact rail supports walkways, and special warning and identification devices.

6.4.3.2 Life safety and fire protection criteria for the subsystem installed in the trainway shall conform to the requirements for underground trainways that are listed in 6.2.5.2.

6.4.4 Electric Wire and Cable Requirements. All wiring materials and installations other than for traction power shall conform to the requirements of NFPA 70.

6.4.5 Emergency Access.

6.4.5.1 Access to the trainway shall be from stations or by mobile ladder equipment from roadways adjacent to the trackway.

6.4.5.2 If no adjacent or crossing roadways exist, access roads at a maximum of 762 m (2500 ft) intervals shall be required.

6.4.5.3 If security fences are used along the trackway, access gates shall be provided as deemed necessary by the authority having jurisdiction.

6.4.5.4 Information shall be provided adjacent to each blue light station that identifies the route and location of the access.

6.4.5.5 The graphics shall be legible from the ground level outside the trackway.

6.4.6 Egress for Passengers.

6.4.6.1 The system shall incorporate a walk surface or other means for passengers to evacuate a train at any point along the trainway so that they can proceed to the nearest station or other point of safety.

6.4.6.2 System egress points shall be illuminated.

Chapter 7 Emergency Ventilation System

7.1 General.

7.1.1* This chapter defines the requirements for the environmental conditions and the mechanical and nonmechanical ventilation systems used to meet those requirements for a fire emergency in a station or trainway as required by Section 5.3 and 6.2.2.

7.1.2 The requirement for a mechanical or nonmechanical system intended for the purpose of emergency ventilation shall be determined in accordance with 7.1.2.1 through 7.1.2.4.

7.1.2.1 For length determination, include all contiguous enclosed trainway and underground fixed guideway transit station segments between portals.

7.1.2.2 A mechanical emergency ventilation system shall be provided in the following locations:

(1) In an enclosed fixed guideway transit station
(2) In a fixed guideway transit underground or enclosed trainway that is greater in length than 304.8 m (1000 ft)

7.1.2.3 A mechanical emergency ventilation system shall not be required in the following locations:

(1) In an open fixed guideway transit station
(2) Where the length of an underground trainway is less than or equal to 61 m (200 ft)

7.1.2.4 Where supported by engineering analysis, a nonmechanical emergency ventilation system shall be permitted to be provided in lieu of a mechanical emergency ventilation system in the following locations:

(1) Where the length of the underground or enclosed trainway is less than or equal to 304.8 m (1000 ft) and greater than 61 m (200 ft)
(2) In an enclosed station where engineering analysis indicates that a nonmechanical emergency ventilation system supports the tenability criteria of the project.

7.1.2.5 In the event that an engineering analysis is not conducted, or does not support the use of a nonmechanical emergency ventilation system, for the configurations described in 7.1.2.4, a mechanical emergency ventilation system shall be provided.

7.1.3 The engineering analysis of the ventilation system shall include a validated subway analytical simulation program augmented as appropriate by a quantitative analysis of airflow dynamics produced in the fire scenario, such as would result from the application of validated computational fluid dynamics (CFD) techniques. The results of the analysis shall include the no-fire (or cold) air velocities that can be measured during commissioning to confirm that a mechanical ventilation system as built meets the requirements determined by the analysis.

7.1.4 Where required by 7.1.2, the mechanical emergency ventilation system shall make provisions for the protection of passengers, employees, and emergency personnel from fire and smoke during a fire emergency and shall be designed to maintain the required airflow rates for a minimum of 1 hour but not less than the anticipated evacuation time.

7.2 Design.

7.2.1 The emergency ventilation system shall be designed to do the following:

(1) Provide a tenable environment along the path of egress from a fire incident in enclosed stations and enclosed trainways
(2) Produce airflow rates sufficient to prevent backlayering of smoke in the path of egress within enclosed trainways
(3) Be capable of reaching full operational mode within 180 seconds
(4) Address the maximum number of trains that could be between ventilation shafts during an emergency

7.2.2 The design shall encompass the following:

(1) The heat release rate produced by the combustible load of a vehicle and any combustible materials that could contribute to the fire load at the incident site
(2) The fire growth rate
(3) Station and trainway geometries
(4) A system of fans, shafts, and devices for directing airflow in stations and trainways
(5) A program of predetermined emergency response procedures capable of initiating prompt response from the central supervising station in the event of a fire emergency

7.2.3 The design and operation of the signaling system, traction power blocks, and ventilation system shall be coordinated to match the total number of trains that could be between ventilation shafts during an emergency.

7.3 Emergency Ventilation Fans.

7.3.1 The ventilation system fans that are designated for use in fire emergencies shall be capable of satisfying the emergency ventilation requirements in either the supply mode or exhaust mode.

7.3.1.1 Individual emergency ventilation fan motors shall be designed to achieve their full operating speed in no more than 30 seconds from a stopped position when started across the line and in no more than 60 seconds for variable-speed motors.

7.3.2 Emergency ventilation fans, their motors, and all related components exposed to the exhaust airflow shall be designed to operate in an ambient atmosphere of 250°C (482°F) for a minimum of 1 hour.

7.3.2.1 A design analysis shall be permitted to be used to reduce this temperature; however, it shall not be less than 150°C (302°F).

7.3.3 Fans shall be rated in accordance with the ANSI/AMCA 210-99, AMCA 300-96, ASHRAE *Handbook Fundamentals*, and ASHRAE 149-2000.

7.3.4 Local fan motor starters and related operating control devices shall be located away from the direct airstream of the fans to the greatest extent practical.

7.3.4.1 Thermal overload protective devices on motor controls of fans used for emergency ventilation shall not be permitted.

7.3.5 Fans that are associated only with patron or employee comfort and that are not designed to function as a part of the emergency ventilation system shall shut down automatically on identification and initiation of a fire emergency ventilation program so as not to jeopardize or conflict with emergency airflows.

7.3.5.1 Nonemergency ventilation airflows that do not impact the emergency ventilation airflows shall be permitted to be left operational where identified in the engineering analysis.

7.3.6 Critical fans required in battery rooms or similar spaces where hydrogen gases or other hazardous gases might be released shall be designed to meet the ventilation requirements of NFPA 91.

7.3.6.1 These fans and other critical fans in automatic train control rooms, communications rooms, and so forth, shall be identified in the engineering analysis and shall remain operational as required during the fire emergency.

7.4 Devices.

7.4.1 Devices that are interrelated with the emergency ventilation system and that are required to meet the emergency ventilation system airflows shall be structurally capable of withstanding both maximum repetitive and additive piston pressures of moving trains and emergency airflow velocities.

7.4.2 Devices that are subject to exposure to the fire anticipated in the design of the emergency ventilation system and are critical to its effective functioning in the event of that emergency shall be constructed of noncombustible, fire-resistant materials and shall be designed to operate in an ambient atmosphere of 250°C (482°F) for a minimum of 1 hour.

7.4.2.1 A design analysis shall be permitted to be used to reduce this temperature; however, it shall not be less than 150°C (302°F).

7.4.2.2 Finishes applied to noncombustible devices are not required to meet the provisions of 7.4.2.

7.4.3 Devices shall be designed to operate throughout the maximum anticipated temperature range.

7.5 Shafts.

7.5.1 Shafts that penetrate the surface and that are used for intake and discharge in fire or smoke emergencies shall be positioned or protected to prevent recirculation of smoke into the system through surface openings.

7.5.2 If this is not possible, surface openings shall be protected by other means to prevent smoke from re-entering the system.

7.5.3 Adjacent structures and property uses also shall be considered.

7.6 Emergency Ventilation System Control/Operation.

7.6.1 Operation of the emergency ventilation system components shall be initiated from the central supervising station.

7.6.1.1 The central supervising station shall receive verification of proper response by emergency ventilation fan(s) and interrelated device(s).

7.6.1.2 Local controls shall be permitted to override the central supervising station in all modes in the event the central supervising station becomes inoperative or where the operation of the emergency ventilation system components is specifically redirected to another site.

7.6.2 Operation of the emergency ventilation system shall not be discontinued until directed by the incident commander.

7.7 Power and Wiring.

7.7.1 The power for the emergency ventilation fan plants shall be provided by feeders from two separate and distinct utility substations.

7.7.1.1 If a second feeder is not available, an emergency backup system shall be permitted to provide the second power source if designed to meet the demands of the emergency modes.

7.7.1.2 Where an emergency backup system is utilized, it shall comply with the provisions of NFPA 110.

7.7.2 All wiring materials and installations shall conform to the requirements of NFPA 70 and, in addition, shall satisfy the requirements of 7.7.3 through 7.7.8.

7.7.3 Materials manufactured for use as conduits, raceways, ducts, boxes, cabinets, equipment enclosures, and their surface finish materials shall withstand temperatures up to 500°C (932°F) for 1 hour and shall not support combustion under the same temperature condition. Other materials where encased in concrete shall be acceptable.

7.7.4 All conductors shall be insulated.

7.7.4.1 Ground wires shall be permitted to be bare.

7.7.4.2 All thicknesses of jackets shall conform to NFPA 70.

7.7.5 All insulations shall conform to Article 310 of NFPA 70 and shall be moisture- and heat-resistant types carrying temperature ratings corresponding to the conditions of application and in no case lower than 90°C (194°F).

7.7.6 Wire and cable constructions intended for use in control circuits and power circuits to related emergency devices shall be listed as being resistant to the spread of fire and shall have reduced smoke emissions.

7.7.6.1 Cable shall be permitted to be listed by any of the following methods:

(1) The cable does not spread fire to the top of the tray in the vertical-tray flame test in UL 1581, Section 1160, and the cable exhibits a specific optical density of smoke at 4 minutes into the test that does not exceed 200 (in the flaming mode) or 75 (in the nonflaming mode) when tested in accordance with ASTM E 662.
(2) The cable exhibits damage (char length) that does not exceed 1.5 m (4.9 ft) when the vertical flame test, with cables in cable trays, is performed as described in CSA C22.2 No. 0.3, and the cable exhibits a specific optical density of smoke at 4 minutes into the test that does not exceed 200 (in the flaming mode) or 75 (in the nonflaming mode) when tested in accordance with ASTM E 662.

(3) The cable is listed as a limited smoke cable (/LS) by meeting the cable damage height, total smoke released, and peak smoke release rate criteria required when tested in the vertical tray flame test in UL 1685. The following performance criteria shall be met when testing according to UL 1685:
   (a) When testing in the UL vertical tray flame exposure:
      i. The cable damage height shall be less than 2.44 m (8 ft) when measured from the bottom of the cable tray.
      ii. The total smoke released shall not exceed 95 m^2 (1023.6 ft^2).
      iii. The peak smoke release rate shall not exceed 0.25 m^2/s (2.7 ft^2/s).
   (b) Alternatively, when testing in the IEEE 1202 flame exposure:
      i. The cable damage height shall be less than 1.5 m (4.9 ft) when measured from the lower edge of the burner face.
      ii. The total smoke released shall not exceed 150 m^2 (1615 ft^2).
      iii. The peak smoke release rate shall not exceed 0.40 m^2/s (4.3 ft^2/s).
(4) The cable is listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor, by being capable of passing the requirements of the ANSI/UL 1666, and the cable exhibits a specific optical density of smoke at 4 minutes into the test that does not exceed 200 (in the flaming mode) or 75 (in the nonflaming mode) when tested in accordance with ASTM E 662.
(5) The cable is listed as having adequate fire-resistant and low smoke-producing characteristics, by having a flame travel distance that does not exceed 1.52 m (5 ft), generating a maximum peak optical density of smoke of 0.5 and a maximum average optical density of smoke of 0.15 when tested in accordance with NFPA 262.

7.7.7* All conductors for emergency ventilation fans and related emergency devices shall be protected from physical damage by transit vehicles or other normal system operations and from fires in the system by embedment, encasement, or location.

7.7.7.1 Except in ancillary areas or other nonpublic areas, encased conductors shall be enclosed in their entirety in armor sheaths, conduits, or enclosed raceway boxes and cabinets.

7.7.7.2 Conductors in conduits or raceways shall be permitted to be embedded in concrete or to run in concrete electrical duct banks.

7.7.7.3 Conductors in conduits or raceways shall not be installed exposed or surface mounted in air plenums that might carry elevated temperatures accompanying fire emergency conditions.

7.7.8 Overcurrent elements that are designed to protect conductors serving motors for both emergency fans and related emergency devices that are located in spaces other than the main electrical distribution system equipment rooms shall not depend on thermal properties for operation.

7.7.9 For electrical substations and distribution rooms serving emergency ventilation systems where the local environmental conditions require the use of mechanical ventilation or cooling to maintain the space temperature below the electrical equipment operating limits, such mechanical ventilation or cooling systems shall be designed so that failure of any single air moving or cooling unit does not result in the loss of the electrical supply to the tunnel ventilation fans during the specified period of operation.

Chapter 8 Vehicles

8.1 Applicability.

8.1.1 New Vehicles. All new fixed guideway transit and passenger rail vehicles shall be, at a minimum, designed and constructed to conform to the requirements set forth in this chapter.

8.1.2 Retrofit. Where existing fixed guideway transit and passenger rail vehicles are to be retrofitted, the appropriate sections of this standard shall apply only to the extent of such retrofit.

8.2 Compliance Options.

8.2.1 General. Fixed guideway and passenger rail vehicles meeting the goals and objectives of Sections 4.2 and 4.3 shall meet the requirements of either 8.2.2 or 8.2.3.

8.2.2 Prescriptive-Based Option. The prescriptive-based design option shall be conducted in accordance with Sections 8.2 through 8.10.

8.2.3 Performance-Based Option. The performance-based design option shall be conducted in accordance with Section 8.11.

8.3 Prescriptive-Based Construction Requirements.

8.3.1* General. This chapter describes test procedures and minimum performance requirements for materials used in the construction or retrofit of fixed guideway or passenger rail vehicles.

8.3.2 Equipment Arrangement.

8.3.2.1 Heat-producing equipment or equipment posing an ignition or fire threat in vehicles, including associated electrical services, shall be isolated from passenger and crew compartments by suitable construction.

8.3.2.2* Vehicle design shall arrange equipment apparatus external to the passenger and crew compartment where practical.

8.3.2.3 Materials used for ducting and plenums serving the vehicle interior shall be noncombustible or shall comply with the requirements in Table 8.4 for HVAC ducting materials.

8.3.2.4 Fuel tanks shall be designed to minimize passenger and crew exposure to fuel hazards.

8.4 Fire Propagation Resistance.

8.4.1 Interior Fire Propagation Resistance.

8.4.1.1 Interior materials and finishes shall resist an interior vehicle fire for a nominal time period determined by the authority having jurisdiction.

8.4.1.2 The nominal time period shall be a minimum of at least twice the maximum expected time period under normal circumstances for a vehicle to stop completely and safely from its maximum operating speed, plus the time necessary to evacuate all vehicle occupants to a safe area.

8.4.1.3 The nominal time period shall be consistent with the safe evacuation of a crush load of passengers from the vehicle under worst-case conditions.