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StandardSpecification for Multi-Story Building External Evacuation Platform Rescue Systems[1]

This standard is issued under the fixed designation E2513; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers the specifications, safety requirements, performance, design, practices, marking instructions and test methods for Multi-Story Building External Evacuation Platform Rescue Systems (PRS) for emergency escape of persons who cannot use the normal means of egress to a safe area and for transport of emergency responders vertically.

1.2 This standard is applicable only to PRS's:

1.2.1 Permanently installed;

1.2.2 Designed for multi-cycle and repetitive use; and

1.2.3 Where descent is controlled to limit speed before arrival at a floor or landing zone.

1.3 This standard does not cover:

1.3.1 Platform devices that are used primarily for purposes other than emergency evacuation and/or access;

1.3.2 Helicopters or other flying platforms;

1.3.3 Any other devices covered under/within ASME A17.1;

1.3.4 A PRS utilizing platform(s) that can be transported to or between buildings during operations; and

1.3.5 A PRS using driving methods other than positive drive as drum and ropes.

1.4 Operation of a PRS is limited to trained and authorized operators.

1.5 The values given in SI units are to be considered as the standard.

1.6 *Table of Contents:*

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A36/A36M Specification for Carbon Structural Steel

E84 Test Method for Surface Burning Characteristics of Building Materials

E136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C

E631 Terminology of Building Constructions

G153 Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

[1] This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.77 on High Rise Building External Evacuation Devices.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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2.2 *ASCE Standards:*[3]
ASCE7–05 Minimum Design Loads for Building and Other Structures
2.3 *ASME Standards:*[4]
A120.1 Safety Requirements for Powered Platforms for Building Maintenance
A17.1 Safety Code for Elevators and Escalators
2.4 *ANSI Standards:*[5]
ANSI/ASSE A10.4 Safety Requirements for Personnel Hoists on Construction and Demolition Sites
ANSI/AWS D1.1 Structural Welding Code-Steel
ANSI/AWS D14.4 Specification for Welded Joints in Machinery and Equipment
ANSI Z535.4 Product Safety Signs and Labels
2.5 *NFPA Standards:*[6]
ANSI/NFPA 70 National Electrical Code
NFPA 255 Standard Method of Test of Surface Burning Characteristics of Building Materials
NFPA 1971 Standard on Protective Ensemble for Structural Fire Fighting
NFPA 1976 Standard on Protective Clothing for Proximity Fire Fighting
2.6 *UL Standards:*[7]
UL 723 Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 1523 Controlled Descent Devices for Marine Use
2.7 *Underwriters Laboratories of Canada Standard:*[8]
CAN-ULC-S102.2 Method of Test for Surface Burning Characteristics of Floor Covering, and Miscellaneous Materials and Assemblies
2.8 *EN (European Committee for Standardization) Standards:*[9]
EN 81.1 Safety Rules for the Construction and Installation of Lifts—Part 1
EN 341 Personal Protective Equipment for Protection Against Falls from Height
EN 1808 Safety Requirements on Suspended Mechanical Scaffolds
EN 12015 Electromagnetic Compatibility—Product Family Standard for Lifts, Escalators and Passenger Conveyors—Emission
EN 12016 Electromagnetic Compatibility—Product Family Standard for Lifts, Escalators and Passenger Conveyors—Immunity
EN 61000-6-2 Electromagnetic Compatibility (EMC)—Part 6-2 Generic Standards—Immunity for Industrial Environments
EN 61000-6-3 Electromagnetic Compatibility (EMC)—Part 6-3 Generic Standards—Emission Standard for Residential, Commercial and Light—Industrial Environments
EN 60529 Degrees of Protection Provided by Enclosures (IP-Code)
2.9 *BSi (British Standards Institute) Standard:*[10]
BSI-PD 7974-6 The Application of Fire Safety Engineering Principles to Fire Safety Design of Buildings. Human Factors: Life Safety Strategies. Occupant Evacuation, Behaviour and Condition (Subsystem 6)
2.10 *ISO International Standards:*[11]
ISO 14121 Safety of Machinery—Principles of Risk Assessment
ISO 14798 Lifts, Escalators and Moving Walks—Risk Assessment and Risk Reduction Methodology
ISO 9000 Quality Management and Manufacturing Quality Assurance
ISO 9002 Quality Systems—Model for Quality Assurance in Production, Installation and Servicing
2.11 *NEMA Standard:*[12]
NEMA 250 Enclosures for Electrical Equipment

3. Terminology

3.1 Refer to Terminology E631 for standard terminology related to building construction.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *abnormal conditions*—extreme conditions such as system malfunctions or environmental conditions beyond the conditions in which the system was designed to function by the manufacturer.

3.2.2 *anti-tilt detection device*—device which stops PRS motion when the longitudinal slope of the platform reaches a pre-set angle.

3.2.3 *approved*—accepted as satisfactory by a constituted administrative or regulatory authority.

3.2.4 *biparting door*—a vertically or horizontally sliding door consisting of two or more sections, arranged so the sections or groups of sections open away from each other and are interconnected so all sections operate simultaneously.

3.2.5 *building evacuation openings*—building's evacuation exits to the platform(s) such as windows or other openings.

3.2.6 *building evacuation strategy*—arrangements and plans for evacuation of the building in a catastrophic event such as a fire.

[3] American Society of Civil Engineers publications, *ASCE 7-05 Minimum Design Loads for Buildings and Other Structures*, Available at http://www.pubs.asce.org/.
[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.
[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[6] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.
[7] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, http://www.ul.com.
[8] Available from Underwriters Laboratories of Canada at http://www.ulc.ca/
[9] Available from European Committee for Standardization (CEN), 36 rue de Stassart, B-1050, Brussels, Belgium, http://www.cenorm.be.
[10] Available from British Standards Institute (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., http://www.bsi-global.com.
[11] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.
[12] Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 1752, Rosslyn, VA 22209, http://www.nema.org.

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3.2.7 *buffer*—a device designed to stop the PRS in limited deceleration by storing or absorbing and dissipating the superfluous kinetic energy of the platform(s), either by hydraulic or spring action depending on PRS speed.

3.2.8 *bypass mode of operation*—bypass mode of operation achieved by means of a manually operated device or standby power supply that allows platform(s) to descend at a limited speed with rated load in case of malfunction of the normal operation system or loss of power.

3.2.9 *certifying organization*—an approved or accredited independent organization concerned with product evaluation, that maintains periodic inspection of listed/certified equipment or material and whose listing/certification states whether that equipment meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE 1—"Accredited", in this definition, means that an organization has been evaluated and approved by an Authorized Agency to operate a Certification/Listing program, and is designated as such in a publication of the Authorized Agency.

3.2.10 *competent person*—a designated person that is suitably trained and qualified by knowledge and practical experience and provided with the necessary instructions to enable the required task to be carried out safely.

3.2.11 *control devices*—electrical contacts, relays, switches, push buttons, levers or other devices used to govern the starting, stopping, direction of motion, acceleration, speed and retardation of the platform(s).

3.2.11.1 *continuous-pressure operation*—buttons, switches or levers used to control movement of the PRS that must be manually held in the actuating position.

3.2.11.2 *automatic floor-stop operation*—movement initiated with a definite reference to the destination (floor or landing zone) where slowing down and stopping of the PRS is automatic.

3.2.12 *descent energy*—energy (measured in Joules) that results from the product of descent height, the descent load and the number of descents.

3.2.13 *descending cycle*—sequence of events, starting from the moment the PRS occupants safely enter the platform(s) and ending at their exit from the platform(s) in the landing zone.

3.2.14 *drive unit*—complete assembly comprising a prime mover, brake and gearing that drives the platform(s), absorbs the descent energy and controls the movement of the platform(s).

3.2.15 *duty cycle*—the proportion of time during which a component, device, or system is to be operated.

3.2.16 *emergency response personnel (responders)*— personnel who respond to fire, medical, and other emergency situations for the preservation of life and property.

3.2.17 *evacuation—(1)* an organized and controlled movement of persons in a building from a dangerous area to a safe zone; *(2)* movement of persons during an evacuation, using a PRS, from a dangerous area in a building to a safe zone, usually to the landing zone, but can also be from floor to floor.

3.2.18 *evacuation floors*—floors permitting access of persons to the platform(s) as determined by the building evacuation strategy.

NOTE 2—Some floors may not have access because of obstructions, or may be at safe zone level or below ground.

3.2.19 *guide rail*—fixed vertical sections designed to restrict lateral movement of the platform due to wind or other outside force.

3.2.20 *guide shoes, backup guide shoes and guide rollers*—devices attached to the platform frame that cause the platform to be guided by the guide rail members.

3.2.21 *landing zone*—area determined by the building evacuation strategy as the principal exit area from PRS platform(s), and entrance for operators and emergency responders.

NOTE 3—Usually, the landing zone is on the ground floor, but it can be at other levels due to building-specific circumstances, for example, on top of a plaza or garage.

3.2.22 *log*—a record of operation or maintenance of a PRS installation in which operators, responders, or maintenance personnel record anything that has or could affect the safe operation of the equipment and action taken to mitigate the deficiency.

3.2.23 *maintenance*—normal lubrication, adjusting, tightening, cleaning, protecting and inspecting of the hoist, appendages and their power supplies.

NOTE 4—It is not the repair, replacement or restoration of worn, damaged or broken parts, components or accessories.

3.2.24 *normal terminal stopping device*—a device or devices that slow down and stop the PRS automatically at or near the landing zone independently of the functioning of the control device.

3.2.25 *overload detection device*—device which acts automatically to stop the motion of a platform if the load in the platform reach(es) its tripping load for lifting and descending.

3.2.26 *over-speed governor*—device that causes the PRS to stop, by activating a secondary device, when the PRS attains a predetermined speed.

3.2.27 *platform operator*—person trained and authorized to operate a platform and responsible for the evacuees' safe entrance into and exit from the platform as well communications with the PRS Operator.

3.2.28 *platform*—portion of the PRS designed to carry persons and equipment.

3.2.29 *platform rescue system (PRS)*—an enclosed platform or set of enclosed platforms, moving vertically along guides or other means on the exterior of a building, intended for the evacuation of multiple occupants to a safe zone and may have the capability of transporting emergency responders.

3.2.29.1 *PRS, single platform*—a platform rescue system with only one platform.

3.2.29.2 *PRS, multi-platform*—a platform rescue system with two or more platforms, connected vertically.

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NOTE 5—PRSs consist of (a) platform(s) suspended from a suspension rig and a hoist, operating either on rails or concrete track. May also have monorails with traversing trolleys or other suspension rigs, for example, davits, fixed to the building, from which (a) platform(s) may be suspended. (See Fig. 1.)

3.2.30 *PRS commander*—PRS operator, in charge of supervising and commanding the platform operators.

3.2.31 *PRS occupants*—all persons traveling within the PRS: evacuees, emergency responders, platform operators.

3.2.32 *PRS operator*—person trained and authorized to operate the PRS.

3.2.33 *prime mover*—source of mechanical power for the hoisting device.

3.2.34 *PRS pathway*—a vertical distance; the space traveled by the platform(s), and the space occupied by its support members.

3.2.35 *repair*—replacement or restoration of worn, damaged or broken parts, components or accessories.

NOTE 6—Repair is not maintenance or alteration.

3.2.36 *responder*—see *emergency response personnel (responders)*.

3.2.37 *rated load (RL)*—maximum recommended load that can be exerted on the PRS, as specified by the manufacturer, consisting of the total weight of evacuees, and emergency response personnel with their tools and equipment.

3.2.38 *rated speed*—average speed measured during upward or downward travel of the PRS with its rated load. PRS may have two different speeds: upward rated speed and downward rated speed.

3.2.39 *safety device*—a mechanism (safety circuit or safety contact) placed in use for the specific purpose of: preventing continuation of an unsafe condition, warning of, limiting or eliminating the effects of a possible unsafe condition.

3.2.39.1 *safety circuit*—a portion of the PRS control wiring that includes a number of mechanical switch contacts, solid state electronic devices, and relay contacts in series.

NOTE 7—Usually includes the final limits switches, emergency stop button, governor contacts and a safety-contact. The cause of operation of any one of these contacts constitutes a possible hazardous operation of the PRS and therefore such operation stops all PRS operation.

3.2.39.2 *safety contact*—an electrical device, which prevents operation of a separate unit (for example, the driving machine), by the normal control device unless the switch (for example, limit switch) is in the closed position.

3.2.40 *secondary device*—device (secondary brake or safety gear) intended to stop the descent of the PRS under critical conditions such as: over speed, breaking of a suspension wire rope, or failure of the hoist.

3.2.40.1 *secondary brake*—acts directly on the drum, traction sheave, or final drive shaft to stop descent of the platform in case of hoist failure.

3.2.40.2 *safety gear*—a mechanical device that stops and holds the platform stationary on the guide rail in event of predetermined over speeding in downward direction or breaking of a suspension wire rope, or both.

3.2.41 *service brake*—mechanical brake automatically applied by stored energy (for example, spring force) until released with an external sustained power supply (electrically, hydraulically or pneumatically) under the control of the operator or automatically.

3.2.42 *slewing*—circular horizontal movement of the suspension rig about a vertical axis.

3.2.43 *storage unit*—place where the platform(s) are held on/in the building when the PRS is in stand-by mode.

3.2.44 *suspension rig/davit*—crane-like device (usually one of a pair) for suspending or lowering equipment.

3.2.45 *terminal speed-limiting device*—automatically reduces the speed of (a) platform(s) approaching the landing zone. This occurs independently of the normal terminal stopping devices if these devices fail to slow down the PRS.

3.2.46 *total suspended load (TSL)*—static force imposed on the suspension point(s), consisting of the rated load of platform(s), self load of platform(s), ancillary equipment, wire ropes and electric cable, if any.

3.2.47 *traversing*—longitudinal movement of a suspension rig.

3.2.48 *tripping load*—static load which cause the overload device to operate.

3.2.49 *trolley unit*—suspension rig mounted on wheels which is capable of traversing.

3.2.50 *trolley rail*—rails, normally installed at roof level, to support and guide a trolley unit.

3.2.51 *winding-drum machine*—a geared-drive machine in which hoisting ropes are fastened to and wind on a drum.

3.2.52 *working load limit (WLL)*—maximum mass or force which a PRS is authorized to support in general service, unless noted otherwise.

NOTE 8—The WLL of a component is specified by the manufacturer.

3.3 *may*—means permissive.

3.4 *shall*—means mandatory.

3.5 *should*—means advisory.

4. Building Interface Requirements and Installation

4.1 *General*—Prior to PRS installation, all loads and structural attachments to the building shall be approved by a registered architect or professional engineer.

4.2 *Installation Design Record*—The following shall be provided to the purchaser:

4.2.1 Design load information;

4.2.2 Portions of building supported and/or contacted by the equipment;

4.2.3 Engineering drawings of equipment anchorage and their means of attachment or support;

4.2.4 Certification verifying compliance of design with this standard (see 18.1.1);

4.2.5 Certification verifying compliance of the installation with this standard (see 18.1.2), and compatibility of the PRS with the building in accordance with all other portions of Section 4.

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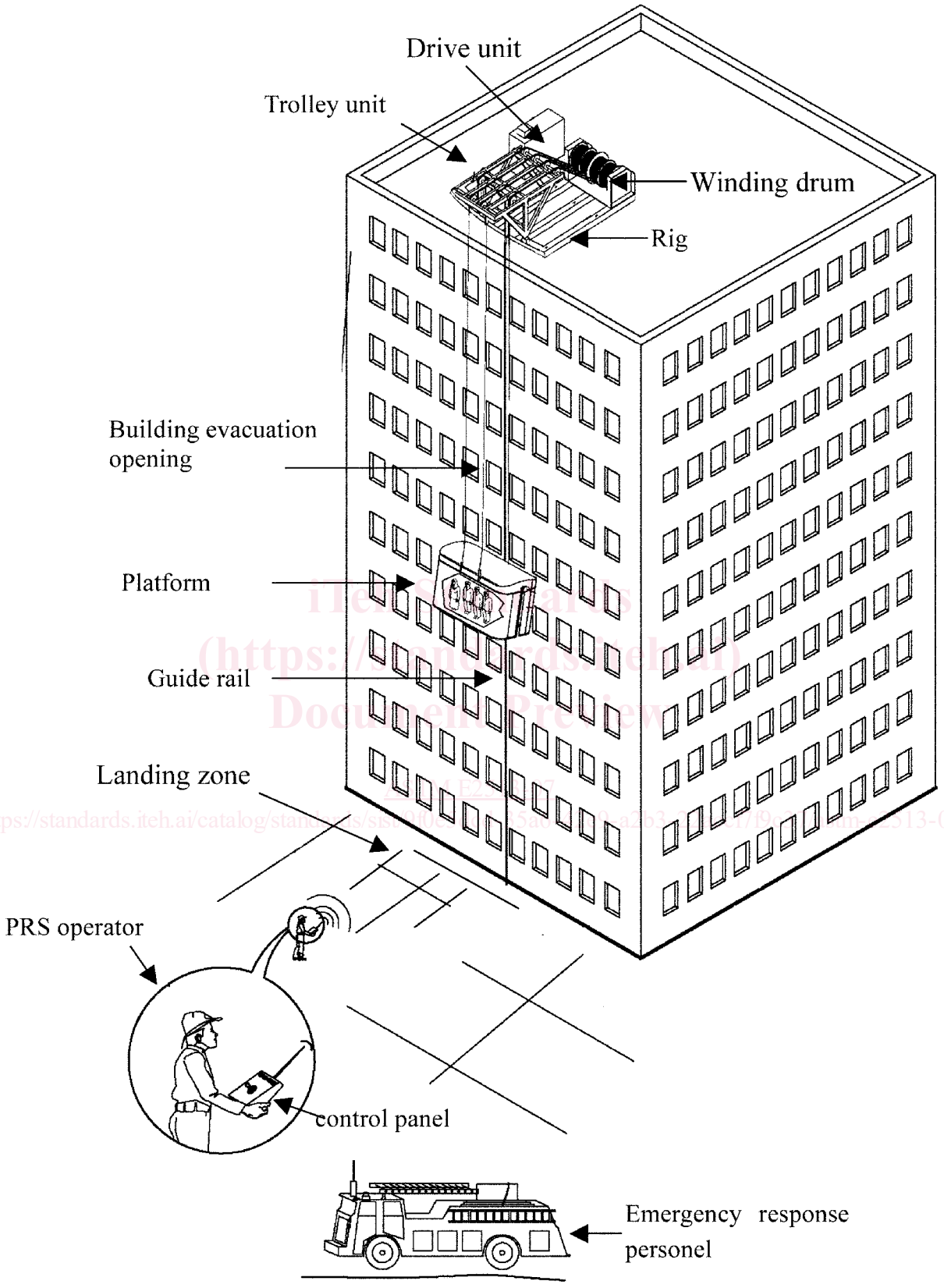

FIG. 1 PRS Overview

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4.3 *Risk Assessment:*

4.3.1 PRS manufacturer shall accomplish a hazard analysis and risk assessment for the site-specific PRS installation. The risk assessment shall cover all aspects of the building interfaces with the PRS during its entire life cycle (installation, operation, maintenance).

4.3.2 The risk assessment shall consider every mode of operation envisaged. The aim is also to ensure that the installation design and configuration shall consider the local surroundings and the most adverse situations in order to ensure that an acceptable level of risk is attained.

4.3.3 The hazard analysis and risk assessment shall be provided to the purchaser and local authorities.

4.3.4 For risk assessment methodology refer to ISO 14798, ISO 14121 or equivalent.

4.3.5 Risk reduction measures shall be applied to reduce the risk, where relevant.

4.3.6 The risk assessment shall at a minimum take into account:

4.3.6.1 Location of PRS on the building, relative to the escape routes;

4.3.6.2 Accessibility of building evacuation openings;

4.3.6.3 Interference with the PRS pathway by suspending devices, balconies, setbacks, and so forth;

4.3.6.4 Human error that may interfere with the correct operation of the PRS, for example, opening of windows within the PRS pathway.

4.3.6.5 Extreme environmental conditions.

4.4 *Load Capability*—Building shall have the capacity to sustain all loads imposed by the PRS, during any mode of operation. The design requirements for each installation shall be based on the limitations (stresses, deflections, and so forth.) established by nationally recognized standards or by equivalent standards found acceptable to the Authority Having Jurisdiction.

4.5 *Landing Zone* shall be designed:

4.5.1 To withstand all forces imparted by the PRS during all modes of operation including impact force.

4.5.2 With dimensions and clearances necessary for safe operation.

4.6 *Access:*

4.6.1 PRS as installed shall enable easy and safe access to machine room and component subsystems that require periodic inspection, testing, maintenance or repair. This shall include permanent electric light fixture(s) runways, ladders, or platforms that may be a part of the building.

4.6.2 Building evacuation openings shall:

4.6.2.1 Be modified if necessary to allow safe access and entrance from the building to platform(s) and from platform(s) to the building (see Fig. 2);

4.6.2.2 Be no less than: 800 mm in width, and 1200 mm in height;

4.6.2.3 Take into consideration access to platform(s) for people with physical limitations (for example, people with disabilities, elderly persons and young children);

NOTE 9—Even with the access accommodations, it should be assumed that these people will be assisted by others.

4.6.2.4 Contain an access ramp or stairs, if needed, to allow safe access to the platform(s);

4.6.2.5 Be closed with a door or window that shall:

(1) Be provided with a means of locking which permits opening from the PRS;

(2) Be opened from the building only by special tools or service key installed in accordance with AHJ requirements;

(3) Be constructed to return automatically to the closed and locked position;

(4) Include a vision panel, to enable seeing the platform(s) arrive; and

(5) Not open into the PRS pathway.

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FIG. 2 Illustration of Building Evacuation Opening

4.7 *Electrical Requirements* shall be in accordance with the following:

4.7.1 General design shall comply the applicable requirements of the National Electrical Code edition in effect at the time of PRS manufacture, for example, grounding, wire sizes, motors, controls, wiring, and enclosures;

4.7.2 Communications and power connections shall be weatherproof and protected from damage and abrasion;

4.7.3 If connectors are used, each communication and power outlet shall be provided with an adjacent strain relief anchor to prevent force movement of the equipment from applying a force to the outlet or conduit leading to the outlet;

4.7.4 PRS electrical power (see Section 14) shall be from an independent source and independent circuit, such that a failure in the building's power system cannot, by itself, cause loss of power in the PRS.

4.7.4.1 *Exceptions:*

(1) If the building emergency power system is independent from the building main power and has capacity to add the PRS power requirements, it may be used as the PRS secondary power supply (required in 14.1.1).

(2) PRS sub-systems that require continuous power supply while the PRS is in standby position, such as the control system or other battery charges subsystems, may be connected to the building power supply.

4.7.5 The power circuit shall be provided with a cutoff switch that can be locked in the "OFF" position. The switch shall be conveniently located in the machine room, to allow putting the PRS out-of service for maintenance or repair purposes.

5. Environmental Conditions

5.1 *General:*

5.1.1 The PRS, including all of its subsystems and components, shall be designed to withstand the environmental conditions during storage and operation as described in 5.2-5.11.

5.1.2 Verification shall be accomplished by the PRS manufacturer's analysis or by review of components vendor tests and certification documents.

5.2 *Ambient Temperature Range:*

5.2.1 *Non-Operating:*

Low temperature: -35°C (-31°F)
High temperature: +50°C (122°F)

5.2.2 *Operating:*

Low temperature: -20°C (-4°F)
High temperature: +42°C (108°F)

5.3 *Electromagnetic Compatibility (EMC):*

5.3.1 Disturbances generated by the control system, control device, electric motor and contact devices shall not exceed the levels specified in generic emission standard EN 61000-6-3.

5.3.2 The power driving PRS equipment and its control system shall have sufficient immunity to electromagnetic disturbances to enable it to operate as intended when exposed to levels and types of disturbance as specified in EN 61000-6-2.

5.3.3 The manufacturer of the PRS shall design, install and wire the equipment and sub-assemblies, taking into account the recommendations of the supplier(s) of the sub-assemblies, to ensure that effects of electromagnetic disturbances thereon shall not lead to unintended operation.

5.4 *Humidity and Rain*—System parts, mechanisms, electrical cabinets and cabinets containing electronic components shall be rated as follows:

5.4.1 *Protected Areas*—IP 55 or Enclosures type 12 (NEMA 250).

5.4.2 *Unprotected Areas,,* for example, platform(s), control panel(s)—IP 55 or Enclosures type 4X (NEMA 250).

5.5 *Ice and Snow*—System shall be designed so that operation is not impaired in conditions of ice or snow, or both (see also 8.3.6).

5.6 *Winds*—All components and parts of PRS that mount on the outside of buildings shall be regarded as being affected by wind loads in accordance with 8.3.5.

5.7 *Electrical Storms*—System parts shall be connected to the building lightning protection system.

5.8 *Smoke:*

5.8.1 System parts that may be exposed to smoke shall be designed to operate without failure in smoke conditions.

5.8.2 If the machine room is filled with smoke, the PRS shall continue to function without failure for at least 1 hour.

5.9 *Sun Radiation/Ultraviolet Light and Water Exposure*—All system parts that are non-metallic and exposed to sun radiation shall be tested according to A1.10.

5.10 *Mildew*—The system shall be protected against mildew and other fungi during storage conditions. The manufacturer shall design and install the equipment and sub-assemblies, taking into account recommendations of the supplier(s) of sub-assemblies, to ensure that mildew effects are eliminated.

5.11 *Rodents and Other Pests*—The system shall be protected against rodents during storage conditions.

6. Fire and Smoke Protection

6.1 *General*—The PRS shall be designed, constructed and maintained to protect PRS occupants from fire, heat and smoke emerging from the building during a descending cycle in accordance with 6.2-6.5.

6.2 *Platform Material*—Platform(s) material shall meet requirements specified in 7.6.

6.3 *PRS Occupants Tenability Conditions:*

6.3.1 PRS occupants shall not be exposed to instantaneous or cumulative untenable conditions, as specified in BSI-PD 7974-6, Annex G; Tables G-2, G-3.

6.3.2 The manufacturer shall conduct analysis to ensure that PRS occupants are kept within tenable conditions during a descending cycle, in case fire erupts from one window within the PRS pathway. (See Fig. 3.)

6.3.2.1 The analysis shall assume:

(1) Fire heat release rate of 5 MW;

(2) Fire source is a closed office, 10 m^2 area (with one open window as an oxygen source);

(3) Window area is 2.2 m^2, standard shape;

(4) Natural heat dissipation (zero-wind conditions); and

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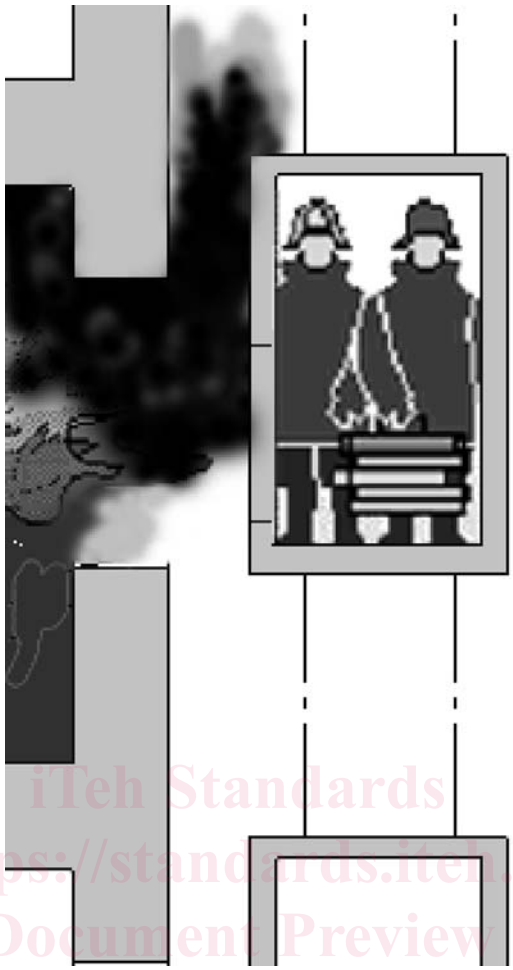

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FIG. 3 Illustration of Platform(s) Passing Through Heated Zone

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(5) Maximum temperature in the surrounding of the fire is 600°C.

6.4 *Analysis Method and Documentation* shall be:

6.4.1 Performed using recognized and accepted methods (for example, computational fluid dynamics).

6.4.2 In a report and include all results, data, scenarios, methodologies, tests, material certifications, models and assumptions that support the analysis results.

6.5 *Mechanical Failure Verification*—All elements that can fail in the conditions specified in 6.3.2.1, and therefore endanger the PRS occupant's life shall be tested (for example, hoist wire-ropes). During this test the elements shall be exposed to the same heat conditions as specified in 6.3.2.1, for the relevant period of time, and their correct operation shall be verified.

7. Material Requirements

7.1 *Materials and Connections*—All PRS structural components shall be suitable for the application, free from obvious defects, of required strength and quality, and in compliance with any additional material requirements specified in this standard.

7.2 *Welding Material and Welded Connections* shall comply with requirements of ANSI/AWS D1.1 or ANSI/AWS D14.4, as applicable.

7.3 *Fastener Materials for PRS Structural Components* shall conform to Specification A36/A36M specifications or equivalent. The fastener finish and tolerances shall be suitable for the type of connection in which it is employed.

7.4 *Bolted Connections* shall be of a secured type, that is, each bolt and/or nut shall be either self-locking or secured by other means to prevent loosening due to vibration.

7.5 *Mechanical Properties*—Base materials for components shall be structural steel and conform to Specification A36/A36M specifications or equivalent.

7.6 *Platform(s) Material:*

7.6.1 Platform structural components and frame shall be noncombustible in accordance with Test Method E136 test.

7.6.2 Platform enclosure material shall:

7.6.2.1 Not exceed flame spread index 0–25 by NFPA 255, Test Method E84 or UL 723.

7.6.2.2 Not exceed smoke development index of 0–450 by NFPA 255, Test Method E84 or UL 723.

7.6.2.3 Conform to an average Thermal Protective Performance rating of 35 by NFPA 1971.

8. Structural, Mechanical and Stability Calculations

8.1 *General*—Calculations in Section 8 shall take into account:

8.1.1 The PRS is stored most of the time and is rarely in operation.

8.1.2 When in operation, the PRS may be exposed to extreme environmental conditions.

8.2 *Specific Design Requirements:*

8.2.1 *Safety Margins Allowed Within the Calculation:*

8.2.1.1 Calculations shall be carried out in accordance with good engineering practices including, if necessary, the effect of elastic deformations.

8.2.1.2 All failure modes of the material shall be considered, including fatigue and wear.

8.2.1.3 Design calculations shall be carried out in accordance with the permissible stress deflection method.

8.2.2 *Calculating the Stresses in Structures:*

8.2.2.1 For the three load cases defined in Table 1, calculation of the different members is set out, allowing a safety margin for the critical stresses, taking the following two failure modes into account:

(1) Yield strength exceeded.

(2) Critical load for buckling exceeded.

8.2.2.2 The ratio between the elastic yield limit σ_E and the breaking limit σ_R shall be less than or equal to 0.7. Alternatively, if the result is higher than 0.7, special considerations shall be taken regarding safety factors, design analysis material elongations and ultimate stress. ν_E = factor of safety compared to yield limit.

Load case 1	In service conditions, PRS with rated load, affected by wind.
Load case 2	Under occasional conditions, for example, static and dynamic tests, dynamic force caused by collision of platform(s) or tripping of overload detection device.
Load case 3	Under extreme conditions, for example, operation of the secondary device, storm wind, extreme weather conditions or fire.

8.2.3 *Calculating the Stress in Mechanisms:*

8.2.3.1 Mechanical parts are designed by checking that they have a sufficient safety margin (see Tables 1 and 2) compared to the failure modes arising from breaking, buckling, fatigue and wear.

8.2.3.2 The calculated stress for mechanism parts must not exceed the allowable stress σa obtained by dividing σ_E by a coefficient depending on the load cases set out in Table 2 except as otherwise indicated in the standard.

8.2.4 *Check Against Fracture:*

8.2.4.1 Verification of mechanical parts against fracture is carried out by verifying that the calculated stress does not exceed the allowable stress, taking into account the ultimate tensile strength of the material used.

TABLE 1 Elastic Factor of Safety

	Load Case 1	Load Case 2	Load Case 3
Value of ν_E	1.8	1.5	1.1
Allowable stress σ_a	$\sigma_E/1.8$	$\sigma_E/1.5$	$\sigma_E/1.1$

TABLE 2 Parameters for Checking Against Fracture

	Load Case 1	Load Case 2	Load Case 3
Value of ν_R	4	2.2	1.5
Allowable stress	$\sigma_R/4$	$\sigma_R/2.2$	$\sigma_R/1.5$

8.2.4.2 The value of the allowable stress σ_a is given in the following formula:

$$\sigma_a = \sigma_R/\nu_R \quad (1)$$

where:

σ_a = allowed stress,
σ_R = ultimate tensile strength, and
ν_R = factor of safety compared to breaking limit.

NOTE 10—See 8.2.2.2 for load cases.

8.3 *Design Loads and Forces* shall include static and dynamic loads, the load of the suspended or supported portion of the equipment, wind forces and forces due to adverse conditions as specified in Section 5.

8.3.1 *Total Suspended Load* shall be calculated as the sum of:

8.3.1.1 Platforms weight (dead load);

8.3.1.2 Suspension equipment weight (including cable weight, lifting accessories and connections); and

8.3.1.3 Platform rated load multiplied by the number of platforms.

8.3.2 *Rated Load and Number of Persons in the Platform*—To prevent overloading of a platform by persons, the available area of the platform shall be limited by the relationship between rated load and maximum available area is given in the following formulas:

PRL = Platform Rated load [kg] = N*80 [kg]
N = Number of passengers = A/0.115
A = Maximum available platform area, [m^2]

8.3.3 *Dynamic Load* equal to at least one half of the static loads shall be considered as the impact load to be included in the resultant load of the suspended or supported equipment. The impact factor value will be determined by the manufacturer with respect to the actual installation. In the event an installation is subjected to a larger dynamic load, the larger value shall be considered (for example, impact factor for different types of secondary device or collisions).

8.3.4 *Forces Exerted by Persons:*

8.3.4.1 Nominal weight of a person: 80 kg.

8.3.4.2 Nominal weight of a rescue person, including personal gear: 115 kg.

8.3.4.3 Minimum value for the forces exerted by persons on the platform wall or guardrails, top edge of a rigid side is assumed to be 150 N for each of the first 10 persons on the platform and 100 N for each additional person acting in the horizontal direction.

8.3.4.4 The guardrail or top edge of a rigid side shall be able to resist without permanent deflection a vertical load of 2000 N located in the most unfavorable position.

8.3.4.5 Platform surrounding walls shall have a mechanical strength that withstands a normal force of 1000 N applied from inside to outside, at any location and being evenly distributed over an area of 5 cm^2 in a round or a square section.

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8.3.5 *Wind Load Calculations:*

8.3.5.1 Wind forces shall be calculated in accordance with ASME A120.1 Sections 3.2.1.2, 3.2.4 and 3.2.5 or ASCE 7-05[3]. Wind forces shall be used for consideration of stability and stresses during operation and storage of the system.

8.3.5.2 Wind forces shall be applied in the least favorable direction in each calculation in which wind forces are considered.

8.3.5.3 For Shape factors applied to areas exposed to wind refer to FEM 1.001[13] or ASCE 7-05[3] or equivalent.

8.3.6 *Snow and Ice Loads*—PRS to be installed where freezing conditions occur shall have the loads from accumulated snow and ice calculated during both storage and operating conditions.

8.3.7 *Earthquakes*—In order to minimize safety hazards caused by seismic events (when system is in storage position) PRS subassemblies and all devices used for anchoring shall be designed as follows:

8.3.7.1 Equipment shall withstand a horizontal loading of 30 % of the weight of the equipment.

8.3.7.2 Horizontal loads acting at the equipment center of mass shall be calculated independently on each of the X and Y axes, or on the axis that produces the largest loads on the anchorage points.

8.3.7.3 When calculating for overturning, a maximum value of 90 % of the weight of the equipment shall be used to resist the overturning moment.

8.4 *Platform Structural Strength* is to be proven by calculation for the load cases (defined in 8.2.2.2, Table 1) as expressed below:

Load case 1	1.25 × (PRL + SWP) + 1.25 × wind loads in operation + 1.25 × forces exerted by persons + 1.25 × forces exerted by ice and snow when relevant
Load case 2	1.5 × (PRL + SWP)
Load case 3	2.5 × (PRL + SWP)

PRL = Platform rated load (see 8.3.2)
SWP = Platform dead load

8.4.1 The load shall be placed in the least favorable position.

8.4.2 SWP shall take into account the mass of wire ropes winders if any.

8.5 *Calculation for Steel Wire Rope:*

8.5.1 *Factor of Safety*—Minimum design factor of safety, F, shall be 10 and shall be calculated by the following formula:

$$F = S \times N/W \quad (2)$$

where:

N = number of suspension ropes under load,
S = manufacturer's catalog strength of one suspension rope, and
W = maximum static load at any point of travel.

8.5.2 Rope terminations shall resist not less than 80 % of the minimum guaranteed breaking load of the rope.

[13] European Federation of Materials Handling and Storage Equipment publications, *FEM 1.001 Booklet 2: Rules for the Design of Hoisting Appliances—Classification and Loading on Structures and Mechanisms*; Available at http://www.fem-eur.com/.

8.6 *Suspension Rig, Davits, Trolley and Outriggers:*

8.6.1 Shall be designed and constructed to withstand the specified loads in the static and dynamic tests and any impact loads caused by a failure of the hoist or suspension wire rope, without breaking.

8.6.2 In addition to having adequate stability against overturning, the suspension rig shall have sufficient lateral strength or be adequately braced against the effect of lateral sway of the platform(s) parallel to the face of the building.

NOTE 11—The forces producing lateral sway may be caused by wind forces, movement of the platform(s) or surges caused by the starting and braking of the traversing system.

8.6.3 Stability factor of the PRS shall be calculated and proven by tests, considering the suspended or supported unit in its most outboard positions for traversing, operating, and storage attainable with positive mechanical or electrical interlocks. The system is regarded stable if the stability moment is equal or greater then the overturning moment in the case of stressing obtained by gravity, by an attachment to a structural support, or by a combination thereof.

8.6.3.1 For horizontal traversing, considering, a 480 Pascal wind load shall be applied to the traversing unit and the stability factor shall not be less than 2, including the effects of impact.

8.6.3.2 For the operational mode, with the rated load placed in its most outboard position and the wind load defined in 8.3.5, the stability factor shall be 4.

8.6.3.3 When the equipment is in a stored position, it shall be capable of withstanding the highest wind velocities expected for the specific area and location.

9. Mechanical and Physical Properties

9.1 *Platform Construction:*

9.1.1 The platform shall have a frame which may be an integral part of the platform.

9.1.2 The platform frame shall be guided on each guide member (guide rails section) by upper and lower guide shoes or rollers attached to the frame. In a suspended multi-platform PRS, guide members can be attached to either the upper or lower parts of the frame. The frame and its guide shoes or rollers shall be designed to withstand the forces resulting from the loading conditions for which the PRS is designed.

9.1.3 The platform shall be completely surrounded by the enclosure, floor and roof; the only permissible openings are in accordance with 9.2.

NOTE 12—Small openings at joint members are allowed.

9.1.4 Mechanical strength, see Section 8.

9.1.5 Fire resistance requirements, see Sections 6 and 7.

9.1.6 Dimensions of the floor area shall be sufficient for the number of persons allowed in the platform as defined in 8.3.2.

9.1.7 *Height of Platform:*

9.1.7.1 Interior height of the platform shall be at least 2 m.

9.1.7.2 Clear height of platform entrance(s) for normal access of users should all be 1.65 m or higher.

9.1.8 Platform floor shall have a nonskid surface.

9.1.9 *Guardrails:*

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9.1.9.1 Shall be fitted to the platform perimeter except for the sections where doors are located.

9.1.9.2 Height shall be 800 to 1200 mm measured from the upper side of the rail to the surface of the platform floor.

9.1.9.3 Components shall not have sharp edges or angles or protruding parts that may cause injury to persons.

9.1.10 *Multi-Platform Assembly:*

9.1.10.1 Distance between platforms shall:

(1) Correspond to the height of the building evacuation floors; and

(2) Remain positive during the platforms movement, to avoid collision.

9.1.10.2 Site assembled components be designed to ensure that:

(1) Incorrect assembly is not possible; and

(2) Once assembled, it is only possible to dismantle the connections by intentional intervention.

9.2 *Platform Doors*—Platform shall include at least a single access door for normal conditions operation (Fig. 4), and a single trap door for abnormal conditions operation (Fig. 5).

9.2.1 *Door Mechanism*—Access doors shall be constructed to return automatically to the closed and fastened position and shall be locked and fastened during the PRS travel.

9.2.2 *Type of Doors Allowed:*

9.2.2.1 Manually or automatically operated;

9.2.2.2 Horizontal or vertical or sliding biparting door;

9.2.2.3 Swing door.

9.2.3 Doors and their guides, guide shoes, tracks and hangers shall be:

9.2.3.1 Constructed of metal or fire-retardant reinforced material.

9.2.3.2 Guard the full width and height of the platform entrance opening.

9.2.3.3 Designed, constructed and installed so:

(1) When the fully closed door is subjected to a normal force of 30 kgf, applied on an area of 5 cm^2 approximately at the center of the door, the door shall resist without permanent deformation.

(2) During and after such a test the function of the door (open/close/lock) shall not be affected.

(3) In case multi-section doors are used, each section shall withstand the forces specified.

9.2.4 Suspension Members of vertically sliding platform doors shall have a factor of safety of not less than five.

9.2.5 *Platform Doors Opening Mechanism:*

9.2.5.1 Doors facing the building shall be designed so when the platform is stopped they can be opened by hand from inside and outside the platform.

9.2.5.2 Doors not facing the building shall be designed so when the platform is stopped they can be opened by hand from outside the platform. Opening from inside the platform shall be possible only by special tools or service key.

9.2.6 Platform doors shall be considered to be in the closed position when the clear open space between the edge of the door and the nearest fixed face does not exceed 3 cm.

9.2.7 *Locking*—Platform doors shall be provided with a locking mechanism that complies with the following:

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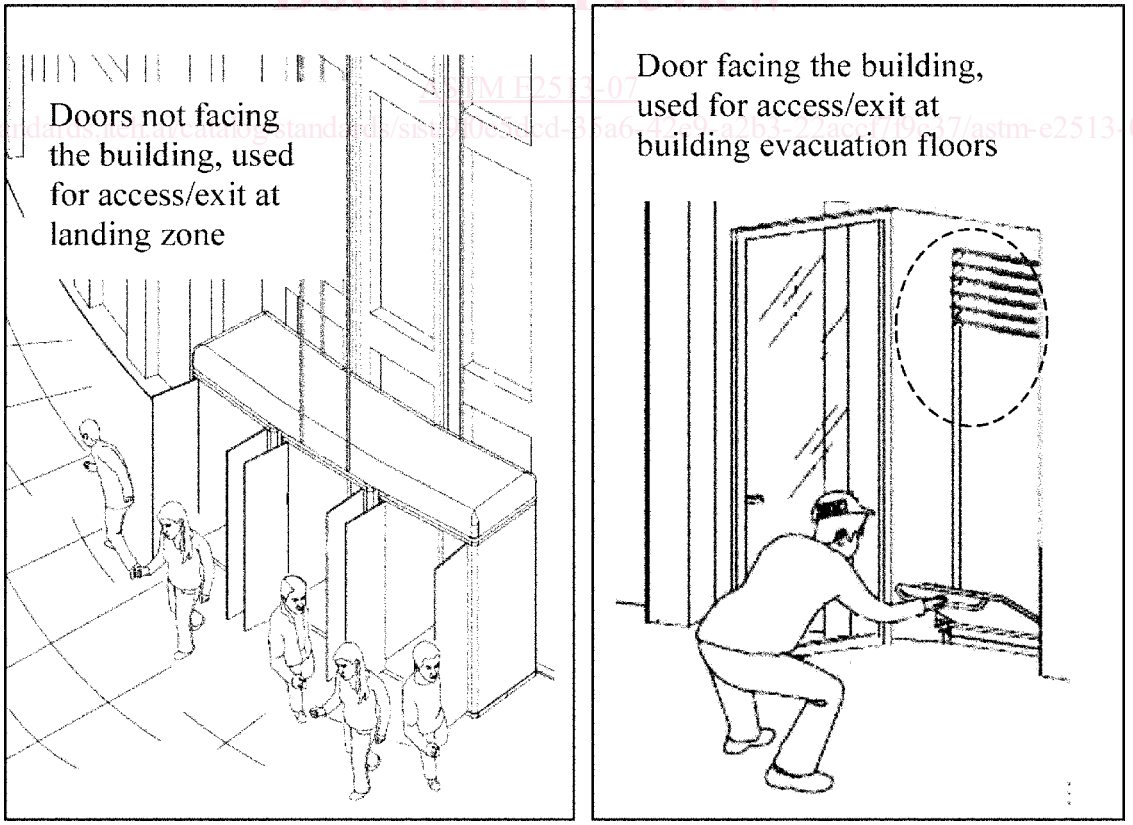

FIG. 4 Illustration of Access Doors