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Standard Specification 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 stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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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.

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] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.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.

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.

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.

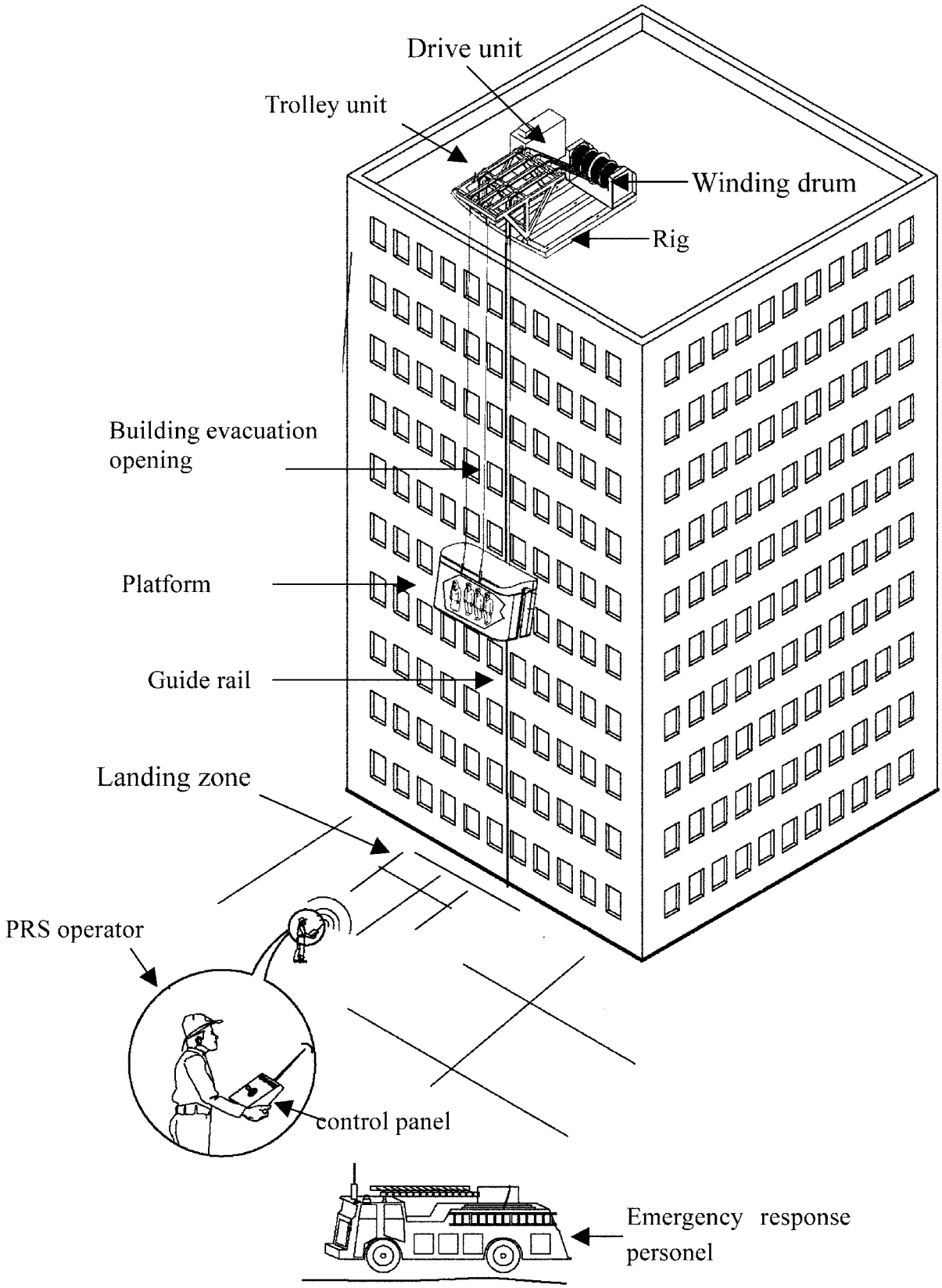


FIG. 1 PRS Overview

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.

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

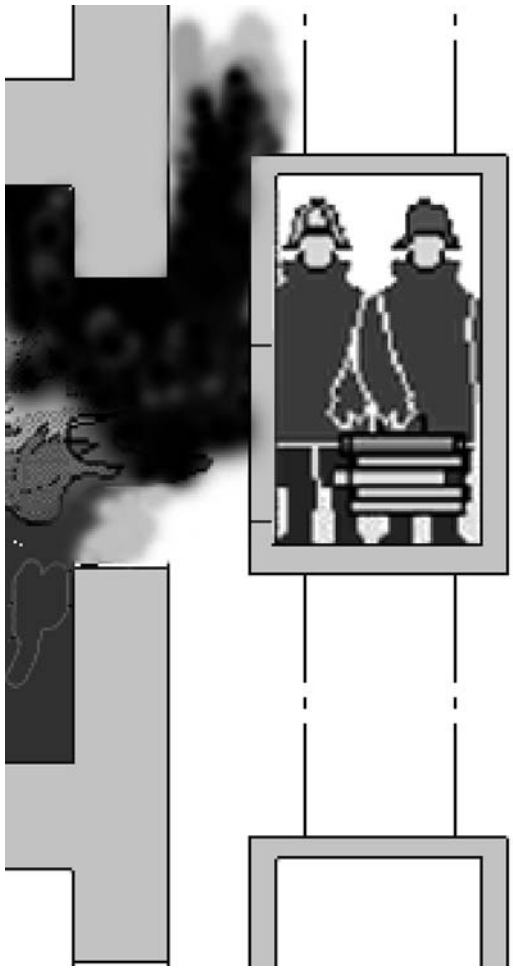


FIG. 3 Illustration of Platform(s) Passing Through Heated Zone

(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.

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.

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.

[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/.

9.1.9 *Guardrails:*

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.

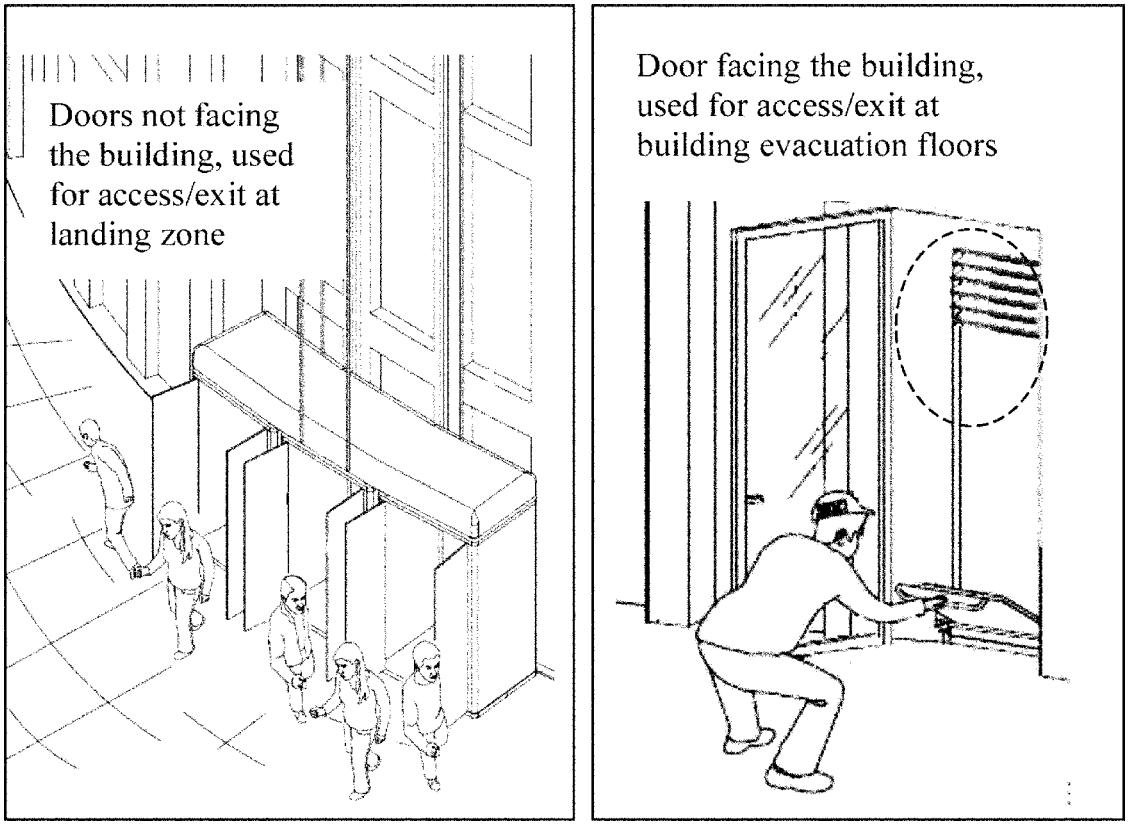


FIG. 4 Illustration of Access Doors

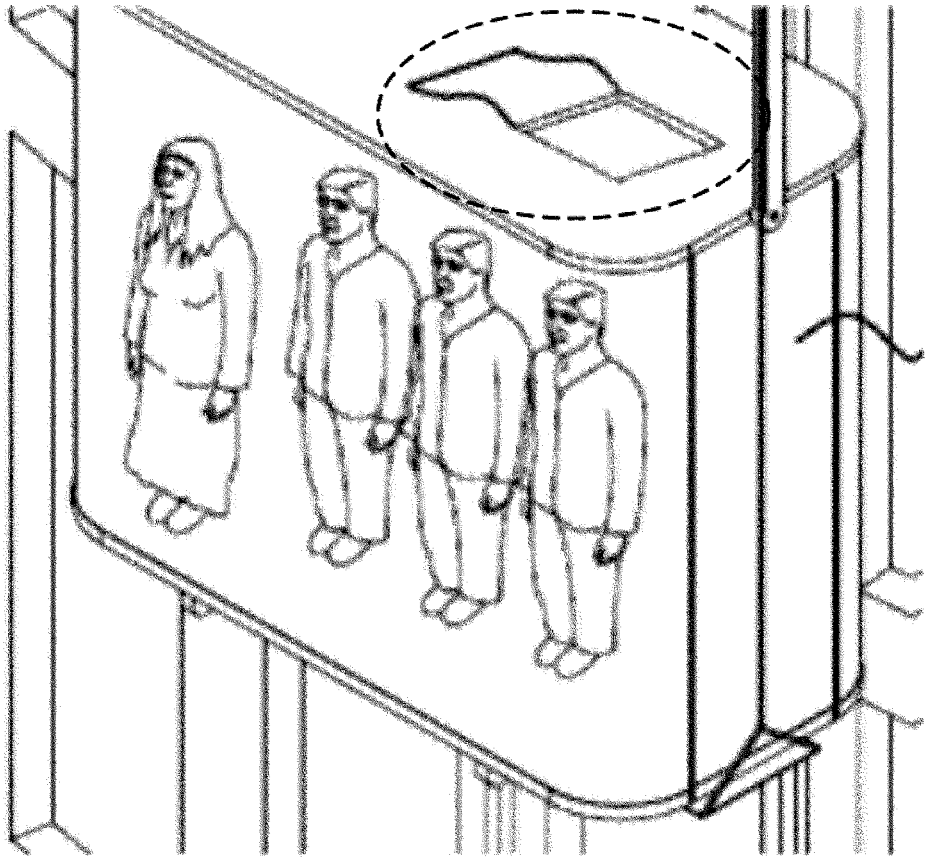


FIG. 5 Illustration of Trap Door

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

9.2.7.1 Locking of the doors in the closed position shall be done by a locking device or tongue that engages by a minimum length of 7 mm.

9.2.7.2 Locking elements shall be resistant to shock, and be made or reinforced with metal.

9.2.7.3 Engagement of the locking elements shall be achieved in such a way that a force of 300 N in the opening direction of the door does not diminish the effectiveness of locking.

9.2.7.4 Locks shall resist, without permanent deformation the following minimum forces applied at the level of the lock and in the direction of opening of the door:

(1) 1000 N in the case of sliding doors;

(2) 3000 N on the locking pin, in the case of hinged doors.

9.2.7.5 Locking action may be caused either by gravity, or by a spring force.

9.2.7.6 Locking devices shall be enclosed to minimize exposure to dust accumulation.

9.2.7.7 Construction of working parts of the locking device shall allow easy inspection.

9.2.7.8 The locking device shall be a normally closed type, so that it will not remain unlocked when the door is closed.

9.2.7.9 *Emergency Unlocking*—Each platform door shall enable unlocking from any side during abnormal conditions.

9.2.8 *Trap Door* (see Fig. 5):

9.2.8.1 Shall enable exiting the platform during abnormal conditions.

9.2.8.2 Shall be provided in each platform at the ceiling with area not less than 0.3 m^2, measure not less than 500 mm on any side. The hatch shall open upwards.

9.3 *Platform Enclosure:*

9.3.1 The enclosure, linings, decorative panels, light fixtures, suspended ceilings, and other apparatus or equipment attached within the platform enclosure shall be securely fastened and supported, so they will not loosen or become displaced in normal operation or abnormal conditions.

9.3.2 The enclosure shall be constructed so that removable portions cannot be dismantled from within the platform, without a special tool.

9.3.3 The enclosure shall include a vision panel facing the building. The panel shall withstand a force of 30 kgf applied perpendicular to the center of the panel.

NOTE 13—The vision panel purpose is to enable the Platform Operator to see the building facade and openings.

9.4 *Platform Ceiling:*

9.4.1 Shall be able to support at any position the mass of three persons, each counting for 1000 N on an area of 0.25 by 0.25 m, without permanent deformation.

9.4.2 Shall have at one point a clear area for standing of at least 0.12 m^2, the lesser dimension at least 0.25 m.

9.5 *Drawbridge (see Fig. 6):*

9.5.1 If clearance between building facade and platform is greater than 12 cm, the platform shall be fitted with a drawbridge which extends the width of the building evacuation opening it faces.

9.5.2 Drawbridge shall:

9.5.2.1 Have a nonskid surface.

9.5.2.2 Withstand a vertical load of 80 kg × number of persons it is designed to carry, or 150 kg, the higher of the values.

9.5.2.3 Remain connected in case of vertical deviation between the platform and the building evacuation opening within the range of ±15 cm.

9.5.2.4 Be fitted with guardrails and toeguards if clearance between building facade and platform is greater then 25 cm. The guardrail height shall be not less than 1000 mm measured from the upper side of the rail to the surface of the platform floor.

9.5.2.5 Not obstruct the PRS travel.

9.6 *Apron (see Fig. 7):*

9.6.1 Shall be fitted to each platform if drawbridge is not fitted.

9.6.2 Shall extend the width of the building evacuation opening it faces.

9.6.3 Height of the apron vertical section shall be at least 15 cm.

9.6.4 The vertical section shall be extended downwards by a chamfer whose angle with the horizontal plane shall be greater than 60° and the projection of this chamfer shall be not less than 20 mm.

9.7 *Platform Egress Accessory:*

9.7.1 If the vertical rise between platform(s) floor and landing zone is greater than 30 cm, PRS shall include a ramp or stairs to allow rapid egress from the platform(s) to the landing zone.

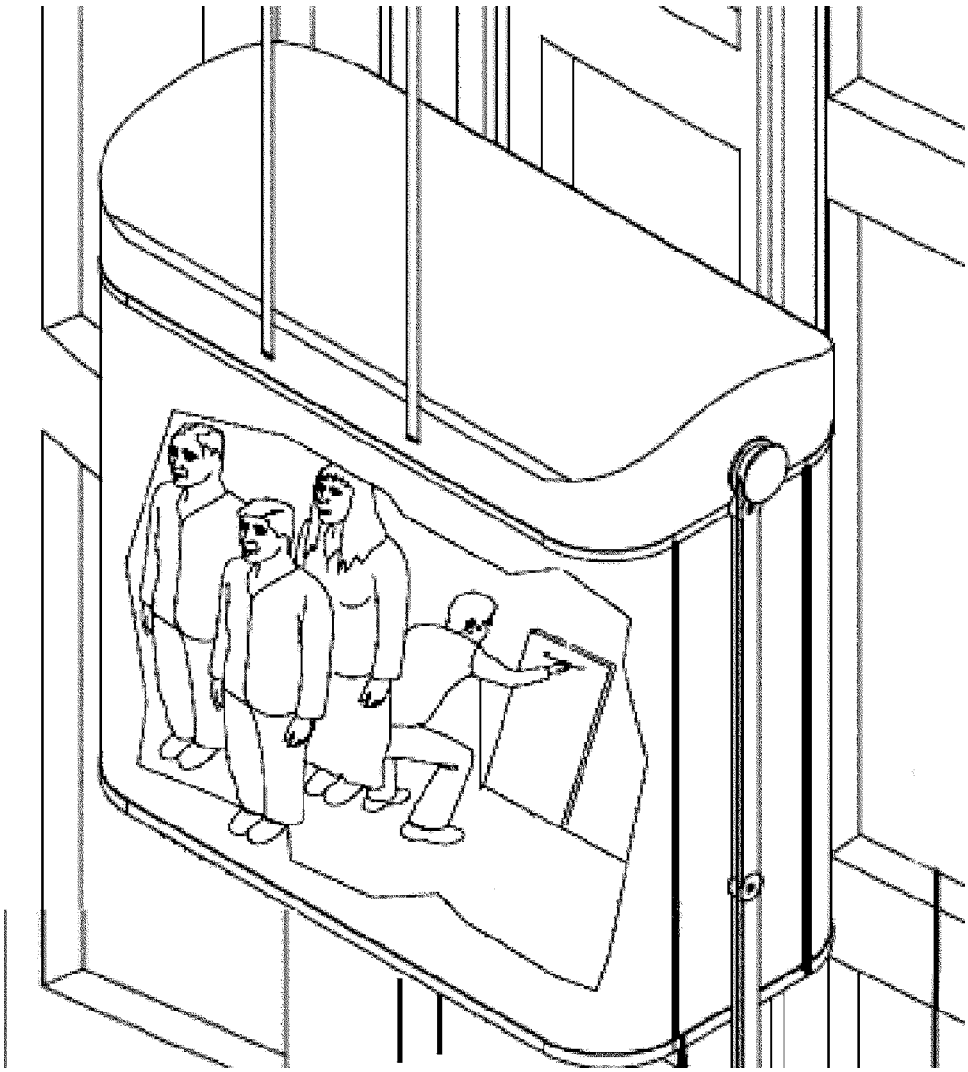


FIG. 6 Illustration of Drawbridge

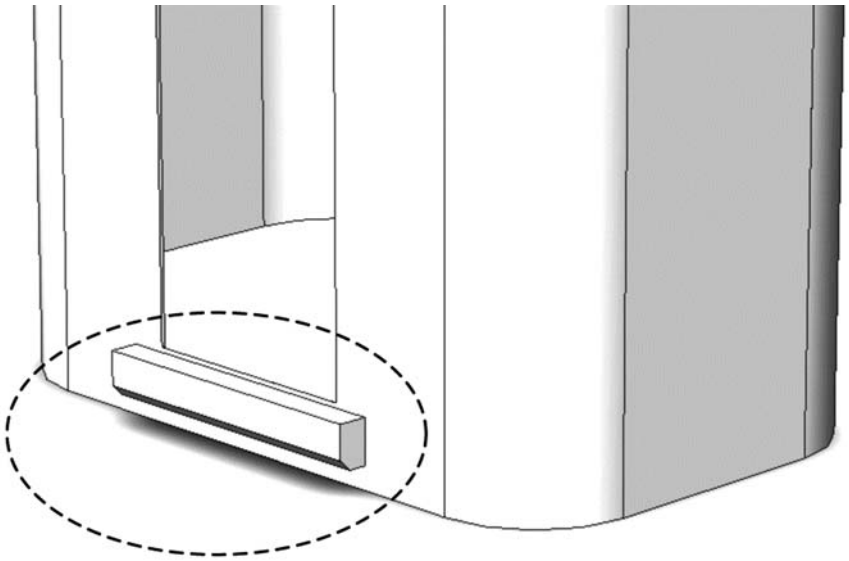


FIG. 7 Illustration of Apron

9.7.2 Egress from platform(s) shall take into consideration the limitations of people with disabilities, elderly persons and young children.

9.8 Continuous lighting shall be provided, ensuring a light intensity of a minimum of 10 lux at landing zone, platform(s) interior, and platform access door(s) exterior area.

10. Buffers and Guides

10.1 *Buffers* shall:

10.1.1 Be located symmetrically with reference to the vertical centerline of the platform(s) frame.

10.1.2 Fulfill the requirements according to ANSI/ASSE A10.4.

10.1.3 Be designed for platform(s) speed:

10.1.3.1 Equal to the operating speed in bypass mode, or

10.1.3.2 When the slowdown of the platform(s) in the landing zone vicinity is reduced using a speed limitation device the platform(s) reduced speed may be used.

10.1.4 Use spring or oil buffers or equivalent for rated speed up to 1.5 m/s; or oil buffers shall be used for rated speeds above 1.5 m/s.

10.2 *Guide Rails and Restraint System:*

10.2.1 Joints and attachments shall be designed to bear the loads and forces during normal operation and during abnormal conditions.

10.2.2 Guide rails shall be capable of holding the platform(s) in cases where safety gear is in operation. Loads shall be according to load case 3 (see 8.2).

10.2.3 Guide rails and restraint systems without safety gear shall be capable of preventing lateral movements which exceed the allowed loads and forces due to wind loads and other loads specified in 8.2. Loads shall be according to load case 1.

10.2.4 Manufacturer/installer shall ensure that the restraint assemblies do not come out of the guides at the lowest level or top level.

10.2.5 Guides shall be designed so that the restraint assemblies may be attached on site.

10.2.6 Restraint assemblies shall be designed so no damage will be caused to the suspension wire ropes.

10.2.7 In case the PRS does not rely on existing rails in the building, but includes a new design and fixing of the guide rails to their brackets and to the building, it shall permit compensation, either automatically or by simple adjustment, of effects due to normal settling of the building or shrinkage of concrete.

10.2.8 A rotation of the guide rail attachment by which the guide rail could be released shall be prevented.

11. Suspension Wire Rope and Wire Rope Connections

11.1 *Suspension Methods*—Only steel wire ropes having the specifications recommended by wire rope manufacturers for hoists shall be used to suspend the platform(s).

11.2 The design factor of safety shall be in accordance with 8.5.

11.3 *Reverse Bends*—Only one reverse bend within a length of seven times the wire rope lay is permitted.

11.4 *Angular Displacement (Fleet Angle)*—The angular displacement between any suspension wire rope and a hoist's drum shall not deviate more than 4 degrees from perpendicular to the axis of the drum at the point of contact of the rope with the drum.

11.5 *Distribution of Load Between the Ropes:*

11.5.1 When two ropes or more suspend the platform(s) from a single point, an automatic equalizing device with an anti-tilt detection device shall be provided for equalizing the tension of suspension ropes.

11.5.2 If springs are used to equalize the tension, they shall work on compression.

11.5.3 Devices for adjusting the length of ropes shall be made in such a way that these devices cannot work themselves loose after adjustment.

11.6 *Fastening of Suspension Ropes:*

11.6.1 Drum ends of suspension wire ropes in winding drum machines shall be fastened to the drum in accordance with 12.9.4.

11.6.2 Wire ropes, at the point of suspension, shall be fastened in such a manner that all portions of the rope shall be readily visible, except that portion inside a rope socket when used. Such fastenings shall be of the non-swiveling or non-rotating type.

11.7 Lengthening or repairing of suspension wire ropes by the joining of two or more lengths is not permitted.

11.8 *Type of Rope Fastening:*

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

11.8.2 Platform wire ropes shall be attached by approved means in accordance with known standards.

11.8.3 Babbitted rope sockets shall not be used.

11.9 Inspection and replacement of wire ropes shall be performed in accordance with 20.2 and 20.3, respectively.

12. Hoisting Machines and Pulleys

12.1 *General Provisions*—Each PRS shall have at least one hoist driving machine. Hoist driving machines shall be powered by:

12.1.1 Electric motors, or

12.1.2 Hydraulic motors (electrically driven), or

12.1.3 If other methods are used, redundancy is required.

12.2 *Prime Mover and Speed Reducer:*

12.2.1 The power source shall be sufficient to raise or lower 125 % of the upward or downward PRS rated load.

12.2.2 All Electric motors, used as the prime mover for a hoist, shall be protected with a current overload device.

12.3 *Hydraulic Drive System:*

12.3.1 Shall consist of an oil storage tank, a hydraulic pump and a hydraulic brake motor, and shall conform to the requirements in 12.12.

12.3.2 An interlock shall be provided to prevent the start or movement of the hoist unless the pump operates at the normal operating pressure, in accordance with 12.11.6.2.

12.3.3 Motors operated by diesel oil may be used as power sources provided that the application complies with all requirements of this standard.

12.3.4 Gasoline motors shall not be used as the power source for any hoist or placed on any platform.

12.3.5 *Speed Reducers:*

12.3.5.1 Shall be of a positive type.

12.3.5.2 Shall not be friction-type.

12.3.5.3 Speed reducers of the gear-reduction type shall conform to standards established by the American Gear Manufacturers Association (AGMA), or equivalent.

12.3.6 Speed reducers and control descent device(s) shall be directly connected to the drum or elevating mechanism. They shall not be connected by means of chains, belts, clutches, shear pins, or friction-type devices.

12.4 *Speed:*

12.4.1 Maximum rated speed of vertical travel of the PRS shall not exceed 3 m/s.

12.4.2 Downward speed of the fully loaded PRS, excluding all acceleration and retardation periods, shall not exceed the rated speed by more than 10 %.

12.5 *Descent Control Device:*

12.5.1 Components may use hydraulic, pneumatic, electromagnetic, aerodynamic, friction, other mechanisms or combinations to control the descent. Manufacturers shall specify these mechanisms to comply with the performance capability necessary to satisfy the requirements of this standard.

12.5.2 Shall be capable of dissipating the total descent energy created during the PRS descent, in accordance with its duty cycle based on mass and rated height without affecting performance or safety. Verification shall be made by testing in accordance with A1.3.3 and A2.9.

12.6 Hoisting machine components requiring lubrication shall be provided with a means of ensuring all moving parts are lubricated:

12.6.1 Self-sealed, self-lubricating, or dry bearings of a suitable design may be used.

12.6.2 Oil lubricated gearboxes shall be provided with a method of determining whether or not the gearbox contains the proper quantity of lubricant.

12.7 All moving parts shall be enclosed or guarded to reduce the potential of inadvertent contact by persons.

12.8 *Shafts, Fillets, Keys and Splines:*

12.8.1 Fillets shall be provided at points of change in the diameter of hoisting machinery shafts and sheave shafts to prevent excessive stress concentration in the shafts.

12.8.2 Fitted keys, splines, bolts, or machine screws shall be used in all connections subject to torque.

12.8.3 All threaded fasteners shall have an anti-loosening device.

12.8.4 Threaded areas of bolts and screws shall not be subjected to shear loads.

12.9 *Winding-Drum Machines:*

12.9.1 Grooves shall be machine-finished and of the helical or parallel type.

12.9.1.1 If helical grooving, only one layer of rope is permitted on the drum.

12.9.1.2 If parallel grooving, more than one layer of rope is permitted on the drum.

12.9.2 Driving sheaves and drums shall have a pitch diameter of not less than 28 times the diameter of the hoisting wire rope.

12.9.3 Hoisting drums and sheaves shall be designed for use with wire ropes of not less than 12.5 mm diameter.

12.9.4 Winding drums shall be provided with a positive means of fastening the wire rope to the drum.

12.9.4.1 Drum portion of the fastening shall be able to bear at least 4 times the rated capacity of the hoist.

12.9.4.2 Wire rope portion of the fastening shall be able to bear at least 80 % of the wire rope allowed strength.

12.9.4.3 Each drum shall have a minimum of three complete turns of rope on the drum at all times when in use.

12.9.4.4 On drums where the suspension wire rope is not maintained under tension at all times, means shall be provided to prevent the rope from moving off the drum ends or causing a loose wrap on the drum.

12.10 Chain drives are not permitted.

12.11 *Brakes*—All hoists shall be provided with a service brake, in accordance with the following, and secondary brake, in accordance with 13.2.1.

12.11.1 Brake shall be spring applied, electrically or hydraulically released and will apply automatically in the event of loss of electric power or hydraulic pressure.

12.11.2 Band brakes are not permitted.

12.11.3 The service brake shall be rated to stop and hold not less than 125 % of the rated load at the hoist rated speed, but in no case less than the maximum lifting capacity of the hoist.

12.11.4 When the electric motor of the hoist functions as a generator, it shall not be used for the electric devices that operate the brake.

12.11.5 The action of the brake shall be exerted by compression springs. The springs shall be supported and not be stressed in excess of 80 % of the torsional elastic limit of the material.

12.11.6 *Hydraulic Mechanical Service Brakes:*

12.11.6.1 Shall be designed in a way that prevents unintentional lowering of the platform and the open position is not reached until the motor provides sufficient torque to hold the platform.

12.11.6.2 Shall remain in the applied position until the pump operates at the normal operating pressure and the movement of the hoist is initiated.

12.12 *Hydraulics and Pneumatics:*

12.12.1 *Cylinders:*

12.12.1.1 Telescoping sections shall be designed in such a way that the pistons cannot leave the cylinders. Mechanical end stops shall be provided for this purpose.

12.12.1.2 Load holding cylinders shall be equipped with a pilot-operated valve so that, in the case of a pipe failure or failure of a compensating pipe, it prevents fluid leaving the cylinder until the valve is opened by an external force.

12.12.1.3 If pilot-operated valves are fitted as a secondary device they shall be:

(1) An integral part of the cylinder; or

(2) Directly and rigidly flange-mounted; or

(3) Placed close to the cylinder and connected to it by means of short rigid pipes, having welded, flanged or threaded connections.

12.12.2 The Hydraulic system shall be provided with a pressure relief valve fitted between the power source and the first control valve.

12.12.2.1 If different maximum pressures are used in the fluid system a pressure relief valve shall be provided in each pressure section.

12.12.2.2 Relief valve(s) shall be installed in a bypass connection so the valve cannot be shut off from the hydraulic system.

12.12.2.3 Relief valve(s) shall be preset to open at a pressure not greater than 125 % of the working pressure at the pump.

12.12.3 Pneumatic systems shall be designed so that ice formation in the system will be prevented.

12.12.4 Piping and fittings shall not be subjected to working pressures exceeding those recommended by the manufacturer for the type of service in which they are used. Piping shall be supported to eliminate undue stresses at joints and fittings, and particularly at any section of the line subject to vibration.

12.12.5 *Flexible Hose and Connections:*

12.12.5.1 Connections installed in high-pressure lines shall have rupture strength of not less than four times the working pressure. Flexible joints may be used in hydraulic lines connecting control or check valves to the motor, provided the failure of the flexible sealing element will not cause separation of the parts connected.

12.12.5.2 Flexible hose shall be marked in accordance with 17.3.7.

12.12.5.3 Flexible hose shall be fixed with a bending radius of not less than that indicated by the hose manufacturer.

12.12.6 Rigid pipes and fittings shall be designed such that the forces resulting from a pressure equal to 2.3 times the full load pressure allow a safety factor of at least 1.7 based on the yield stress. In thickness calculations a value shall be added of 1.0 mm for the connection between the cylinder and the rupture valve, if any, and 0.5 mm for the other rigid pipes.

12.12.7 Hydraulic fluid tank(s) shall be designed and constructed for easy:

12.12.7.1 Checking of hydraulic fluid level in the tank;

12.12.7.2 Filling and draining.

12.12.8 Filters or similar devices installed in the hydraulic circuit shall be accessible for inspection and maintenance.

12.12.9 Pressure gauge(s) shall be provided and connected to the hydraulic circuit with a gauge shut-off valve provided between the main circuit and the connection for the pressure gauge.

12.12.10 A high oil temperature safety device shall be connected to the hydraulic circuit and to the oil tank as protection against overheating of the hydraulic fluid (refer to 15.5.3.3 and Table 3 for its application).

12.13 *Bypass Mode of Operation*—The hoist shall have a manually operated system which allows controlled descent of the platform(s) in case of power failure or system failure. Descent shall be to a landing zone where passengers can exit platform(s).

12.13.1 Manual operation shall be possible from the landing zone and from the machine room.

12.13.2 Manual descent shall have “hold-to-run” action.

12.13.3 Manual operation mechanism shall be operated in the case of loss of power, elongation or disconnections of members and pipes.

12.13.4 In order to control the speed, a centrifugal governor may be used during no-power descent. The controlled descent speed shall be lower than the triggering speed of the secondary device.

12.13.5 If the no-power descent system utilizes a manual crank, provision shall be made to prevent any part of the body

from being trapped or struck (for example, solid hand wheel, electrical interlock, power cut-off if manual crank in use).

12.13.6 Manual operation mechanism shall have capacity to lower the PRS speed of at least 0.1 m/s.

12.13.7 Platform(s) speed during manual operation shall not exceed 0.3 m/s.

12.14 *Trolley Unit:*

12.14.1 *General:*

12.14.1.1 May move either on rail(s) or on a specially made track.

12.14.1.2 Shall be provided with guide rollers or flanged wheels which ensure the trolley unit's position on the track.

12.14.1.3 If there is a deviation from the track or a wheel assembly fails, a device or means shall be provided to prevent the unit from overturning.

12.14.1.4 Suitably positioned mechanical end stops positively connected to the rails/tracks with connections that do not rely on friction shall be provided to stop the unit before leaving the track.

12.14.2 *Powered Traversing:*

12.14.2.1 Nominal traversing speed shall not exceed 0.3 m/s measured at the trolley unit and on the platform(s).

12.14.2.2 Service brake shall stop the trolley and maintain it in a stationary position taking into account the wind force both in service and in the parked position. If necessary, a clamp or similar device shall be provided to attach the unit to the track in its parked position.

12.14.2.3 During traversing of the unit, an audible signal shall warn persons at the roof level that the unit is moving.

12.14.2.4 Protection bars shall be attached to the wheel units to prevent feet from being trapped. The distance between the bars and the trolley rail must not exceed 2 cm.

12.14.3 *Jibs*—Where jibs change position by lifting or telescoping, the platform(s) must not move faster than 0.3 m/s in any direction.

12.14.4 *Slewing*—The service brake shall stop the jib and maintain it in the stationary position taking into account the wind force during use and in the parked position. If necessary, a device or means shall be provided to attach the jib to the frame of the PRS or to the track in its parked position.

12.14.5 *Counterweights,* when used to achieve stability of a trolley unit, shall be permanently attached to the structure.

12.14.6 *Covering and Guarding:*

12.14.6.1 Machinery (for example, hoist) of the unit shall be enclosed by lockable and removable maintenance access covers designed to prevent inadvertent access by persons to the equipment and moving parts.

12.14.6.2 When open, covers shall not conceal any danger signs, warnings, instructions or other notices.

12.14.6.3 Machinery of the unit shall be designed and assembled so it can be maintained safely.

12.14.6.4 It shall be possible to gain access to the controls and equipment in abnormal conditions in whatever position the unit is situated.

13. Means to Prevent Falling of the Platform(s)

13.1 *General:*

13.1.1 Wire-rope suspension systems and secondary devices (see 13.2) shall be installed to overcome the hazard of the platform(s) falling.

13.1.2 Where the platform(s) are suspended by 3 wire ropes, or more, a secondary brake is required. In case of failure of one wire rope, the other ropes shall be capable of holding the platform(s). In case of failure of the hoist system, the secondary brake shall be capable of stopping and holding the platform(s).

13.1.3 In cases where the platform(s) are suspended by 2 wire ropes, a safety gear operated by speed governor shall be used (see 13.2.2). The safety gear shall be able to hold the platform(s) in case of failure of all the suspension wire ropes and/or and failure of the hoist.

13.2 Secondary device can be one of the following:

13.2.1 *Secondary Brake:*

13.2.1.1 Each hoist shall be provided with an automatic secondary brake that will stop and hold the platform(s) with at least 125 % of the rated load under an accelerating or over-speed condition.

13.2.1.2 When the secondary brake is actuated, it shall stop and hold the platform(s) within a maximum 0.5 g average deceleration and maximum vertical distance of 1200 mm.

13.2.1.3 The secondary brake shall act directly on a traction hoist.

13.2.1.4 On a winding drum type hoist, the secondary brake shall act either on the drum or drum extension.

13.2.1.5 Failure of the hoist drive train shall not prevent operation of the secondary brake.

13.2.1.6 The secondary brake shall not be used to stop the hoist except under over-speed conditions.

13.2.1.7 It shall not be bypassed or prevented from operating by any other device.

13.2.1.8 In normal operation, the secondary brake shall not engage before the hoist is stopped by the service brake.

13.2.1.9 Every secondary brake shall be periodically tested according to the manufacturer's recommendations and in accordance with A1.3.5.3.

13.2.1.10 Design and installation of every secondary brake shall be such that the triggering mechanism is enclosed.

13.2.1.11 The secondary brake is a safety device (see 15.5).

NOTE 14—The actuating mechanism of a secondary brake may be separate from the brake.

13.2.2 *Safety Gear:*

13.2.2.1 Shall be capable of operating in the downward direction and capable of stopping the platform(s) carrying the rated load, at the tripping speed of the over-speed governor, even if the suspension devices break, by gripping the guide rails, and holding the platform(s) in place.

NOTE 15—Safety gear shall preferably be located at the lower part of the platform(s).

13.2.2.2 Is a safety device, see 15.5.

13.2.2.3 Conditions of use for different types of safety gear:

(1) Platform(s) safety gear shall be of the progressive type if the rated speed of the PRS exceeds 0.63 m/s and of the instantaneous type with buffered effect, if the rated speed does not exceed 0.63 m/s.

(2) If the platform(s) carries several safety gears they shall all be of the progressive type.

13.2.2.4 *Methods of Tripping:*

(1) Safety gears shall be tripped by over-speed devices in accordance with 14.2.3.

(2) Safety gears shall not be tripped by devices, which operate electrically, hydraulically or pneumatically. If electrical devices are used, redundancy is required.

(3) Retardation—For progressive safety gears the average retardation in the case of free fall with rated load in the platform(s) shall lie between 0.2 and 1.5 g.

(4) Release:

(a) When a safety gear has tripped, its release shall require the intervention of a competent person.

(b) Release and automatic reset of a safety gear shall only be possible by raising the platform(s).

13.2.2.5 *Construction Related Conditions:*

(1) Jaws or blocks of safety gears shall not be used as guide shoes.

(2) If safety gear is adjustable, the final setting shall be sealed.

13.2.2.6 When platform safety gear operates, the platform floor with or without the load uniformly distributed shall not incline more than 10 % from its normal position.

13.2.2.7 When the platform(s) safety gear is engaged, an electric safety device shall initiate the stopping of the hoist before or simultaneously with the safety gear operation.

13.2.3 *Over-Speed Governor*—Tripping of the over-speed governor shall occur at a speed in the range 125 to 150 % of the rated speed.

NOTE 16—If the rated speed exceeds 1 m/s, it is recommended to choose a tripping speed of 125 % of the rated speed.

14. Electrical Power Requirements

14.1 *Power Supplies:*

14.1.1 The PRS shall have primary and secondary (stand-by or alternative) supplies.

14.1.2 Both supplies shall be installed in fire protected route(s).

14.1.3 Both supplies shall be independent of the building power supply (see 4.7.4).

14.1.4 Changeover shall be possible from primary to secondary supply while the PRS is in operation.

14.1.5 Secondary (stand-by) power shall be used in the event of failure of the primary power supply.

14.1.6 Minimum size of the secondary power supply shall be sufficient to run the PRS at rated load.

14.1.7 After re-establishment of the power supply, the control system shall indicate the PRS position and be available for service immediately. Correction-run (operation of the PRS without position indication) of not more than two floors is allowed for the system to recognize its location.

14.1.8 Any command, received from the control panel, before the changeover of power supply shall be cancelled.

14.1.9 The main power supply must be protected by over current protective devices and by a residual current device.

14.2 Wire ropes with integrated electrical conductors shall:

14.2.1 Be not less than 0.5 mm^2 in cross-sectional area.

14.2.2 Be adequately insulated and protected.

14.2.3 Not exceed the local allowed voltages (that is, 120/240V).

14.3 *Degrees of Protection*—All electrical equipment shall comply with NEMA 250 or EN 60529 and when exposed to open air shall have a protection degree of not less than IP 54 (NEMA 250).

14.4 *Electrical Grounding:*

14.4.1 All exposed non-current-carrying metal parts shall be grounded by means of a grounding conductor included in the power cable used for connecting the equipment to the supply.

14.4.2 Conductor and fastening shall conform to the requirements of ANSI/NFPA 70.

14.4.3 Any track system used in conjunction with traversing of equipment shall be grounded.

14.5 Electrical safety wiring and components shall conform to requirements of ANSI/NFPA 70 or equivalent, except as modified by this standard.

14.6 *Voltages Permitted in Power Supply and Control System*—The maximum system or circuit potential permitted on any equipment in the machine room or on the platform(s) shall be not more than 600 volts (nominal). Where the potential exceeds 120 volts (nominal), either a grounding conductor shall be incorporated in the traveling cable or a separate grounding conductor shall be installed.

14.7 *Suppression of Radio and Television Interference*—Design of the electric motor, contact devices and control devices shall comply with EN 12015 and EN 12016 for the suppression of electromagnetic interference. Components necessary to give an adequate degree of suppression shall not be in any part of the circuit where failure may occur.

14.8 *Motors Supplied Directly from AC or DC Mains*—The supply shall be interrupted by two independent contactors, the contacts of which shall be in series in the supply circuit. If, while the PRS is stationary, one of the contactors has not opened the main contacts, further movement of the platform(s) shall be prevented at the latest at the next change in the direction of motion.

14.9 *Drive Using a "Ward-Leonard" System:*

14.9.1 Excitation of the generator supplied by classical elements, two independent contactors shall interrupt, either:

14.9.1.1 The motor generator loop; or

14.9.1.2 The excitation of the generator; or

14.9.1.3 One, the loop and the other, the excitation of the generator.

14.9.2 If, while the PRS is stationary, one of the contactors has not opened the main contacts, further movement of the platform(s) shall be prevented, at the latest at the next change in direction of motion.

14.9.3 In cases 14.9.1.2 and 14.9.1.3 effective precautions shall be taken to prevent the rotation of the motor in the case of a residual field, if any, in the generator (for example, suicide circuit).

14.10 *Absorption of Regenerated Power*—Where a power source is used that, in itself, is incapable of absorbing the energy generated by the overhauling load, means of absorbing sufficient energy shall be provided on the load side of the disconnecting means for each PRS power-supply line to prevent the PRS from attaining governor-tripping speed or a speed in excess of 125 % of rated speed, whichever is less.

14.11 *Measures to Monitor Three Phase Systems*—Means shall be provided to ensure that incorrect phase rotation of the power supply cannot result in an incorrect starting of the hoist motor if:

14.11.1 Phase rotation is in the wrong direction; or

14.11.2 There is a failure of any phase. This protection shall be considered to be adequately provided by a generator-field control having ac motor-generator driving motors, provided a reversal of phase will not cause the hoist driving-machine motor to operate in the wrong direction.

15. Operation, Control and Communication

15.1 *PRS General:*

15.1.1 Operational procedures are an essential and integral part of system use and shall comply with the requirements of Annex A4.

15.1.2 Each PRS shall function independently from all others in a multiple PRS installation.

15.1.3 Operation shall not be initiated automatically by smoke or fire detectors or similar devices.

15.1.4 Each shall be fully operable using a Control Panel, without need to access the machine room or storage unit.

15.1.5 Operation shall be available from the landing zone and from a platform using control panels in accordance with 15.2.

15.2 PRS Control Panel types are the following:

15.2.1 *Control Panel in Station (CPS):*

15.2.1.1 CPS shall have a wired communication port from the landing zone.

NOTE 17—CPS may have a second means of operation by wireless communication.

15.2.1.2 CPS shall have the following functions:

(1) Platform(s) up/down movement.

(2) Emergency stop button.

(3) System data and information related to safety status.

(4) Bypass mode of operation at no power conditions or abnormal conditions.

(5) Voice communication with platform(s), or alternatively the operators will carry communication devices.

(6) an override manual button in accordance with 15.2.3.1 that enables overriding the CPP.

(7) Initiation/completion, in accordance with 15.3.2.

15.2.2 *Control Panel in Platform (CPP):*

15.2.2.1 CPP shall support operation from within the platform(s).

15.2.2.2 CPP shall have the followings functions:

(1) Platform manual up/down movement.

(2) Emergency stop button.

(3) Ready run button.

(4) Voice communication with the CPS, or alternatively the platform operator will carry communication devices.

15.2.2.3 In multi-platform PRS, at least one platform shall have a CPP as required in 15.2.2.2. The other platforms shall have CPPs with the following functions:

(1) Emergency stop button.

(2) Ready run button.

(3) Voice communication with the CPS, or alternatively platform operators will carry communication devices.

15.2.3 *Control Panels Prioritization:*

15.2.3.1 Activation of the “Override” manual button in the CPS shall set the highest priority to any function in the CPS.

15.2.3.2 Otherwise, emergency stop button of any control panel shall have the highest priority.

15.3 *Phases of Operation:*

15.3.1 *Phase 1*—Standby mode: PRS is in the storage unit, not operating, but under power, and ready to activate on command.

15.3.2 *Phase 2*—PRS activation and operation completion.

15.3.2.1 PRS activation shall invoke procedures in which the PRS arrives from the storage unit to the landing zone in no more then 10 minutes.

15.3.2.2 Operation completion shall invoke procedures in which the PRS goes from the landing zone to a stand-by position in the storage unit.

15.3.3 *Phase 3*—PRS normal operation.

15.3.3.1 After PRS has arrived at the landing zone, control of the PRS shall be available to the CPS and CPP

15.3.3.2 While the platform(s) is (are) in motion it shall be possible for the PRS to receive a command from the CPS. The previous order will be canceled, and the platform(s) will travel to the new destination.

15.3.3.3 Position of the platform(s) shall be shown in the CPS at all times while the PRS is available for use, whether the platform(s) is in motion or stationary.

15.3.3.4 PRS shall remain in its position until further command is received.

15.3.3.5 There shall be a minimum delay of 3 seconds between the command to move and platform movement. Vocal and visual alarms shall be provided during the delay and the movement time.

15.3.4 *Phase 4*—Operation using secondary power supply shall be available from the landing zone, in accordance with 14.1.

15.3.5 *Phase 5*—Bypass mode operation shall be available from the landing zone, as described in 12.13.

15.3.6 *Phase 6*—Rescue of trapped PRS occupants back to the building: in case of failure that prevents proper operation of the PRS in one of its modes, including the bypass mode of operation, PRS occupants shall have the possibility to return back to the building using the access or the trap doors.

NOTE 18—All phases of PRS operation can be conducted from the CPS.

15.4 *Electrical Equipment Redundancy*—Any single fault listed hereby in the electric equipment shall not, on its own, be the cause of a dangerous malfunction of the PRS. Faults envisaged:

15.4.1 Absence of voltage;

15.4.2 Voltage drop;

15.4.3 Loss of continuity of a conductor;

15.4.4 Insulation fault in relation to the metalwork or the earth;

15.4.5 Short circuit or open circuit, change of value or function in an electrical component such as: resistor, capacitor, transistor, lamp, and so forth;

15.4.6 Non-attraction or incomplete attraction of the moving armature of a contactor or relay;

15.4.7 Non-separation of the moving armature of a contactor or relay;

15.4.8 Non-opening of a contact;

15.4.9 Non-closing of a contact;

15.4.10 Phase reversal;

15.4.11 Loss of wireless communication.

15.5 *Safety Device:*

15.5.1 *General*—Safety devices, as listed in Table 3, for example, secondary device, over-speed governors, limit switches, shall be located and installed to prevent them from being damaged or rendered inoperative during any foreseeable operating conditions. They shall only be adjustable using tools and shall be accessible for inspection purposes.

15.5.2 Components actuating the safety devices shall be able to function properly under the mechanical stresses resulting from operation.

TABLE 3 Safety Devices and Safety Contacts Parts Classification

Safety Related Parts	Type	Function
Emergency stop button/device	B	See 15.5.4.8
Ready run button	C	See 15.5.4.9
Overload detection device	B	Ascending prevented, descending allowed with alarm; see 15.5.4.1
Descending limit switch	B	Descending prevented, ascending allowed; see 15.5.4.5
Ascending limit switch	B	Ascending prevented, descending allowed; see 15.5.4.4
Ultimate ascending limit switch	A	See 15.5.4.6
Terminal speed-limiting devices	B	See 15.5.4.7
No load device	B	Descending prevented, ascending allowed; see 15.5.4.2
Anti-tilt detecting device	C	Indication of longitudinal leveling of platform
Anti-collision device	B	Prevent lowering if obstacle encountered on descending; see 15.5.4.3
Loss of wireless control	B	In case wireless communication is used
Speed governor over speed switch	A	Preventing PRS over-speed; see 13.2.3
Secondary brake	A	See 13.2
Three phase monitoring for direct moving	A	See 14.11
High oil temperature or high brake temperature	B	In accordance with 12.12.10
Battery level sensor	C	Indication of battery level

15.5.3 *Safety Device Classification:*

15.5.3.1 Safety devices are classified on the basis of performance characteristics and function. There are three types: A, B and C, based on their application on the PRS control system as described in Table 3.

15.5.3.2 *Type A*—Operation of a safety contact Type A shall cut off the main power to the hoist and the brakes and cannot be overridden in any way except for manual operation (Bypass mode).

15.5.3.3 *Type B*—Operation of a safety contact Type B shall stop the motions of the PRS and can be overridden manually by the CPS override function.

15.5.3.4 *Type C*—Operation of a safety contact Type C can limit the function of the system and cause only indication (visual signal and alarm) and can be overridden by any CP.

15.5.4 *Safety Devices Description:*

15.5.4.1 *Overload Protection*— shall be provided in the hoisting or suspension system or by software to protect the equipment operating during ascending when the suspended load exceeds its permissible limits.

15.5.4.2 *No Load Device*—PRS shall be provided with devices or by software which stops the platform as soon as an empty suspended load applies on the hoist.

15.5.4.3 *Anti-Collision Device*—PRS shall be provided with anti-collision devices or by software which stops the platform when an obstruction is encountered

15.5.4.4 *Ascending Limit Switch*—PRS shall be provided with ascending limit switch to stop the platform automatically at the highest level; PRS stopping shall occur before contact with the ultimate lifting limit switches.

15.5.4.5 *Descending Limit Switch*—PRS shall be provided with a switch to stop the platform automatically at the lowest level. If the lowest level is ground level, an anti-collision device is regarded as a descending limit switch.

15.5.4.6 *Ultimate Ascending Limit Switch*—PRS shall be provided with a switch so that the platform will come to a complete stop before reaching the top of the suspension rig. After triggering, no ascending or descending shall be possible until corrective action has been taken by a competent person.

15.5.4.7 *Terminal Speed-Limiting Devices* shall be installed when reduced-stroke oil buffers are used or the PRS rated speed exceeds 0.3 m/s and shall:

(1) Operate independently of the normal terminal stopping device if the latter fail to slow the platform(s) at the terminal as intended.

(2) Provide a retardation of not more than 1.5 g.

(3) Be designed and installed so a single short circuit caused by a combination of grounds or by other conditions will not prevent their functioning.

15.5.4.8 *Emergency Stop Button* shall be designed and supplied in accordance with 15.6 and located at each operator control panel and other places where an emergency stop button may be required. All emergency stop buttons shall be operative irrespective of the control station in operation, and have the following characteristics:

(1) Cause electric power to be removed from the hoist driving machine motor and brake.

(2) Manually opened and closed type.

(3) Red operating handles or buttons.

(4) Conspicuously and permanently marked "stop".

(5) Positively opened mechanically and their opening shall not be solely dependent on springs.

(6) A reversible type, meaning: disengagement of the emergency stop button shall restore the PRS power supply and operational availability.

15.5.4.9 *Ready Run Button* shall be designed and located at each CPP, be operative irrespective of the CPS operation and have the following characteristics:

(1) Green operating handles, buttons and indicators;

(2) Indicates to the CPS that the platform is ready for motion;

(3) When the PRS is in motion, shall be reset automatically.

15.6 *Control Devices:*

15.6.1 Shall be designed and constructed to provide the minimum safety requirements as set forth in other portions of Section 15, and in all phases of operation and environmental conditions (see Section 5).

15.6.2 Shall not generate (including associated electrical/electronic circuitry) false signals that influence the functioning of the PRS in all phases of operation.

15.6.3 Shall not be functionally influenced in operation by short circuit, earth fault or bridging of the associated electrical/electronic circuitry.

15.6.4 Shall be of the enclosed electric type.

15.6.5 At the control panel:

15.6.5.1 Direction and movement shall be clearly indicated on or near the control by words or symbols.

15.6.5.2 Minimum diameter of buttons shall be 10 mm.

15.6.5.3 Controls of following types are permitted:

(1) Continuous-pressure operation.

(2) Automatic floor-stop operation.

15.6.5.4 Continuous-pressure operation controls shall:

(1) Return to the stop position automatically when the operators hand is removed from the control.

(2) Lever-type handles shall be recessed or protected from inadvertent actuation.

15.7 *Wireless Communication:*

15.7.1 Shall be designed to prevent movement of its designated PRS except in response to actuation of its control devices, and only then when all safety circuits are closed.

15.7.2 Shall be designed so as to be no less safe than a wired control system in the event of component failure.

15.7.3 The wireless link shall remain effective throughout the platform travel.

15.7.4 Shall comply with ANSI/ASSE A10.4, Section 24.1.5.

15.8 *Voice Communications:*

15.8.1 A suitable system shall enable the PRS operator to communicate with the Platform Operator(s) and with the PRS occupants at all times. May rely on platform operator(s) communication system.

16. Accompanying Documents

16.1 An instruction handbook shall be provided with the PRS.

16.2 Content of the handbook shall include the following:

16.2.1 *General:*

16.2.1.1 Information about any exclusions;

16.2.1.2 Limitations on the use by operators (see 16.2.5);

16.2.1.3 A risk analysis, in accordance with Section 4;

16.2.1.4 Information about regular inspection;

16.2.1.5 Information about weather conditions: maximum wind speed, range of temperature, lightning;

16.2.1.6 Information about checking and operating the PRS after a seismic event;

16.2.1.7 Advice about checking for obstructions along the PRS pathway before activation;

16.2.2 Information relating to transport and handling:

16.2.2.1 Total mass of the equipment and of the main parts which can be dismantled for transport;

16.2.2.2 Instructions for handling (for example, drawings indicating points for hoisting equipment).

16.2.3 Information relating to installation, assembly, and commissioning of the equipment:

16.2.3.1 Maximum load imposed by suspension rig on the building;

16.2.3.2 Rail fixing/anchoring requirements;

16.2.3.3 Information to prevent assembling components inappropriately;

16.2.3.4 Space requirements for use and maintenance of the PRS;

16.2.3.5 Instructions regarding the power supply;

16.2.3.6 Wire rope instructions;

16.2.3.7 Instructions for verification by a certifying organization before use;

16.2.4 Information relating to the PRS itself:

16.2.4.1 Limitations of use, for example, height, wind speed in service and out of service, and temperature range;

16.2.4.2 Detailed description of the equipment and its safety devices. Text illustrated with pictures or sketches;

16.2.4.3 Comprehensive range of examples of applications for which the equipment is intended, including prohibited usages if any, and foreseeable misuse;

16.2.4.4 Schematic representation of safety functions;

16.2.4.5 Documents confirming that the equipment complies with the present standard.

16.2.5 Information regarding use of the equipment:

16.2.5.1 Operational procedures in accordance with Annex A4;

16.2.5.2 Description of manual controls;

16.2.5.3 Means for stopping (including emergency stop);

16.2.5.4 Operating instructions for stopping the system and notifying the PRS commander in case of faults, damage or other circumstances that may jeopardize safety;

16.2.5.5 Description of how to operate the no-power descent;

16.2.5.6 Operating instructions in case the secondary device is activated;

16.2.5.7 Information about means of communication between the platform(s) and the PRS commander;

16.2.5.8 Instructions for fault identification and location, for correction and for re-starting after intervention, in table form comprising three columns (fault, foreseeable cause, remedy);

16.2.5.9 Where necessary, instructions on personal protective equipment to be used;

16.2.5.10 Information about the residual risks which cannot be eliminated by design and information on safety measures to be taken by the operators;

16.2.5.11 Instructions on periodic (daily, weekly, monthly, etc.) inspections;

16.2.6 Instructions to maintain a logbook with provisions for the following:

16.2.6.1 Name of the competent person in charge of the PRS;

16.2.6.2 Date and name of operator(s) allowed to operate the PRS;

16.2.6.3 Serial number of hoist(s) and secondary device(s);

16.2.6.4 Number of hours in service (operational, maintenance, tests, drills and other);

16.2.6.5 Specification of wire rope;

16.2.6.6 Number of hours wire rope in use;

16.2.6.7 Record of any incident and action taken;

16.2.6.8 Dates of periodic inspections, routine tests and maintenance and record of outcome.

16.2.7 Information for maintenance regarding components of PRS and accessories necessary to keep it in working order and instructions for safe maintenance:

16.2.7.1 Maintenance to be carried out by a competent person;

16.2.7.2 Recommendations by manufacturer concerning the nature and frequency of inspections for each component;

16.2.7.3 Drawings and diagrams enabling maintenance personnel to carry out their task;

16.2.7.4 Wire rope specification prescribed by the manufacturer;

16.2.7.5 Maintaining certificates of wire ropes;

16.2.7.6 Warnings regarding the dismantling of spring loaded devices or winders;

16.2.7.7 Information about replacement criteria for wire ropes and all components subject to wear;

16.2.7.8 Checks on the integrity of the seal on the setting element of the overload or secondary device.

16.2.7.9 Describe hazards during maintenance including:

(1) Special personal protective equipment (harnesses, lanyards, hardhat, eye protection, gloves) needed to perform the tasks;

(2) Ergonomic hazards;

(3) Weight of heavy components and a "two person lift" or "lifting aid required" labels shall be included where appropriate.

16.2.8 Include hazard information in a safety section at the front of the handbook and at specific locations in the handbook where a hazard or hazardous activities are discussed.

17. Markings, Warnings and Operating Instructions

17.1 *General Provisions*—All labels, notices, markings and operating instructions, aided where necessary by sign or symbols, shall be indelible, legible and readily understandable.

17.1.1 On-product safety warnings should follow the format of ANSI Z535.4 or equivalent.

17.2 *Platforms* shall display the following:

17.2.1 The Rated load shall be indicated in kilograms, pounds as well as the number of persons as follows: "…KG …POUNDS …PERSONS".

17.2.2 Manufacturer's name and the PRS identification number.

17.2.3 The control device of the emergency stop switch (where fitted) shall be red in color and identified by the word "EMERGENCY STOP", so placed that there can be no risk of error as to the emergency stop position.

17.2.4 The red color shall not be used for other buttons.

17.2.5 Control devices shall be clearly identified by reference to their function.

17.2.6 Instructions for operation of the platform doors (including trap doors), and the service key (service key, see 9.2.5.2).

17.2.7 Instructions for operation of the communication system.

17.2.8 *Platform Roof*—Instructions to ensure safe use of trap doors.

17.3 *Machine Room* shall display:

17.3.1 Notice bearing the following minimum inscription shall be fixed to the outside of doors giving access to the machines and pulleys:

"PRS Machine – Danger – Authorized Personnel Only"

17.3.2 The following Notice shall be prominently posted in the Machine Room:

"Before servicing power off and lock out"

17.3.3 Notices shall be posted to permit easy identification of the main switch(es) and light switch(es). If circuitry permits portions of the equipment to be energized after the Main switch has been locked out, a procedure for total lock out must be provided, and all switches must be labeled and provided with a lockout capability.

17.3.4 The maximum permissible load shall be indicated on the lifting beam and hooks.

17.3.5 *Over-Speed Governor*—A data plate shall be fixed indicating:

17.3.5.1 Name of the manufacturer of the over-speed governor;

17.3.5.2 Type examination and its references;

17.3.5.3 Actual tripping speed for which it has been adjusted.

17.3.6 Each motor shall be provided with the manufacturer's nameplate listing all pertinent characteristics.

17.3.7 The hydraulic flexible hose shall be marked in an indelible manner with:

17.3.7.1 Name of the manufacturer or the trade mark;

17.3.7.2 Test pressure;

17.3.7.3 Date of the test.

17.4 *Buffers*—On other than energy accumulating type buffers, there shall be a data plate showing:

17.4.1 Name of the manufacturer of the buffer;

17.4.2 Type examination sign and its references.

17.5 *Rope Tag Data:*

17.5.1 A corrosion-resistant initial data tag shall be used and securely attached to one of the wire rope fastenings or to a

substantial component of the suspended unit. Data tag shall bear the requirements according ANSI/ASSE A10.4.

17.5.2 A new tag shall be installed at each rope renewal. When ropes are re-socketed, the original tag shall be retained and a supplemental tag showing the date of re-socketing shall be installed.

17.6 *Service Key* (see 9.2.5.2) shall have a label attached, drawing attention to the danger which may be involved in using this key and the need to make sure that the door is locked after it has been closed.

17.7 *Secondary Device*—A data plate shall be fixed indicating:

17.7.1 Name of the manufacturer;

17.7.2 Type examination and its references.

17.8 *Building Signage:*

17.8.1 Building evacuation openings shall be marked by approved signs.

17.8.2 Clear marking of the floor level number shall be visible from the PRS interior through the vision panel.

18. Verification of Safety Requirements

18.1 Acceptance verifications shall include:

18.1.1 Verification before launching series production, in accordance with 18.2.

18.1.2 Verification before first use (after installation or following major alterations), in accordance with 18.3.

18.1.3 Periodic inspections and tests shall be performed during service, in accordance with 18.4.

18.2 Verification before launching series production shall be performed by a certifying organization and consist of a design check (18.2.1), manufacturing check (18.2.2) and type tests (18.2.3).

18.2.1 Design check that the PRS is designed in accordance with this standard including the following documents:

18.2.1.1 Mechanical drawings and calculation.

18.2.1.2 Description of the PRS with information about its capabilities.

18.2.1.3 Information about the materials used.

18.2.1.4 Diagrams of electrical, hydraulic and pneumatic circuits.

18.2.1.5 Operating instructions.

18.2.2 Manufacturing check shall be fulfilled where the manufacturer has achieved ISO 9002 certification or other equivalent recognized standard; otherwise the manufacturing check shall verify that the PRS is manufactured in accordance with the design documents and this standard:

18.2.2.1 Components are in accordance with the drawings;

18.2.2.2 Test certificates are available for each type of rope, (including their terminations) and hydraulic or pneumatic hose and that these certificates indicate the minimum breaking load or bursting pressure as appropriate;

18.2.2.3 Welding has been performed by qualified welders in accordance with the relevant welding procedures and standards;

18.2.2.4 Construction and installation of safety devices are in accordance with this standard.

18.2.3 Type tests shall be made to check that the PRS is stable, and all functions work correctly in accordance with this standard.

18.2.3.1 It shall be carried out on PRS components (one or several representative samples), in the case of modular equipment on the most unfavorable configuration.

18.2.3.2 It shall be performed in accordance with Annex A1 and made either in the manufacturer's plant, in a testing laboratory, or in a completed installation.

18.2.3.3 If safety components are available on the market as separate components, they shall be tested separately.

18.3 Verification before first use:

18.3.1 Requires a static and dynamic load test, to check that the equipment is correctly assembled and that the safety devices operate as designed.

18.3.2 Is done on the complete installation in its configuration for use, by a certifying organization or registered engineer:

18.3.2.1 Visual examination of the application of the rules of good construction of components for which this standard has no special requirements;

18.3.2.2 Comparison of details given in the verification of conformity for the safety components with characteristics of the PRS;

18.3.2.3 Tests and verifications in accordance with Annex A2.

18.4 Periodic tests and verifications shall be performed by a competent person to ensure the integrity of the safety functions, in accordance with Annex A3.

19. Quality Assurance

19.1 Manufacturers of the PRS, subsystems or components shall:

19.1.1 For consistency and traceability, operate a quality management system which complies with national and local regulations in force at the time.

19.1.2 Maintain a system of quality control that is ISO 9000 or equivalently certified.

19.1.3 Document methods that track quality assurance, inspection and testing of the PRS, by serial number during the manufacturing and test process.

19.2 Workmanship, finish and appearance shall be in compliance with this standard and in accordance with the manufacturers design and documented production requirements. Verification shall be by inspection and review of the manufacturer's documents.

20. Maintenance

20.1 *General*—PRS maintenance shall be done according to ASME 120.1, Section 4.3.1, maintenance.

20.2 *Wire Ropes Inspection:*

20.2.1 A competent person shall conduct the required hoist inspections and keep written records of rope condition in a Hoist Operations Log.

20.2.2 Method of inspection shall be made in accordance of ANSI/ASSE A10.4, Section 26.

20.2.3 Periodic inspections shall be established for each PRS hoist, with the frequency of inspection determined by the

type of installation, and the manufacturer's recommendations. It is recommended that a visual inspection will be made every 3 months and a complete inspection of all ropes will be made at least once a year.

20.2.4 A routine periodic check is required by a competent person to ensure the integrity of the safety devices.

20.3 *Removal and Replacement of Wire Ropes*—Wire ropes with one or more of defects such as: corrosion, broken wires, abrasion, kinking, crushing, heat: evidence, reduction of rope diameter and others as described in ANSI/ASSE A10.4 Section 25.11 shall be removed or replaced immediately. If one wire rope of a set requires replacement, the entire set of ropes shall be replaced.

21. Keywords

21.1 evacuation; external evacuation; high-rise building; multi-platform; multi-story building; platform; platform rescue system

ANNEXES

(Mandatory Information)

A1. TYPE TESTS

A1.1 General Provisions

A1.1.1 Dispatch of samples for tests shall be made by agreement between the certifying organization and manufacturer.

A1.1.2 Precision of the instruments shall allow, unless particularly specified, measurements to be made within the following tolerances:

A1.1.2.1 ±2 % mass, force, distance, speed;

A1.1.2.2 ±5 % acceleration, retardation;

A1.1.2.3 ±5 % voltage, current;

A1.1.2.4 ±5°C temperature;

A1.1.2.5 Test recording equipment shall be capable of detecting signals, which vary in time of ±0.02 seconds.

A1.1.3 When system testing is complete, non-destructive tests shall be performed on critical system parts to verify that there are no cracks or other damage.

A1.2 Platform tests shall reflect the actual load configurations used to test the ultimate strength.

A1.2.1 *Residual Deflection Test:*

A1.2.1.1 Platform is to be supported directly underneath the stirrup.

A1.2.1.2 Floor of the platform is subjected to a load equal to the RL distributed over the total width of platform for 15 minutes; see Fig. A1.1.

A1.2.1.3 The load is then removed and reapplied (A1.2.1.2) for another 15 minutes.

A1.2.1.4 Deflection induced by the load shall be measured and recorded.

A1.2.1.5 After removing the load, the residual deflection shall be checked after a period of 3 minutes. The value b of the residual deflection must not exceed: $b \leq L/1000$.

A1.2.1.6 When the platform raw material is not steel, different values shall be considered.

A1.2.2 *Static Test:*

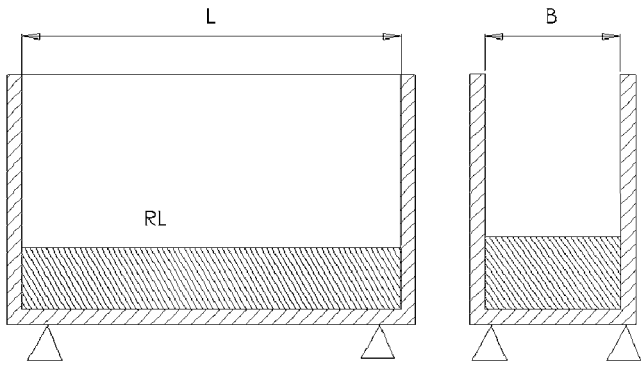
A1.2.2.1 *Horizontal Test:*

(1) Platform shall be suspended by its mounting points, in a horizontal position and the floor subjected to a load equal to 1.5 RL.

(2) Load is applied gradually in the most unfavorable position as illustrated in Fig. A1.2.

(3) Load is distributed along the length T according to the following equation:

$$T = RL/(B \times RF)$$



b = measured deflection
L = maximum length or width of the platform

FIG. A1.1 RL Distribution on Platform

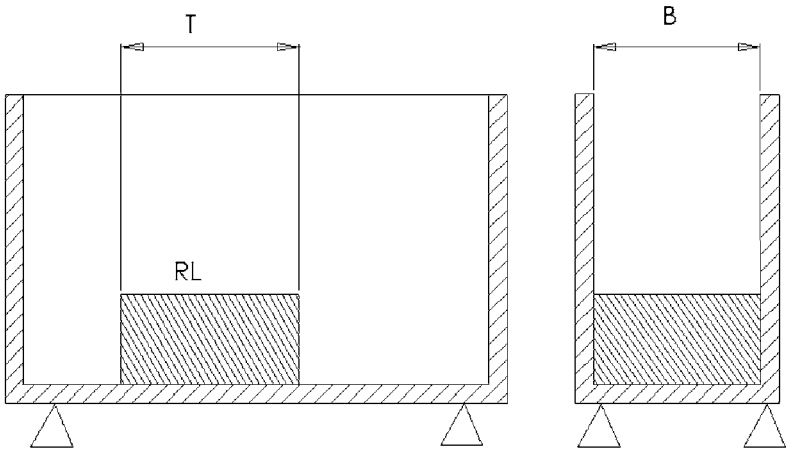


FIG. A1.2 RL Distribution on Platform

where:

RL = platform rated load,
B = platform width, and
RF = minimum platform floor capacity (kg/m^2).

(4) The load is applied for 15 minutes.

(5) The platform is considered satisfactory, if the static test causes no failure or visible damage to the structure, and the residual deflection *b*, does not exceed $b \leq L/1000$.

(6) When the platform raw material is not steel, different values shall be considered.

A1.2.2.2 *Sloped Test:*

(1) Platform shall be suspended by its stirrups in a horizontal position and the stirrup at one end shall be raised so that the platform is at an incline of 14° to the horizontal; see Fig. A1.3 and the load distribution is identical to the test in A1.2.1.

(2) Platform is considered satisfactory, if the static test causes no failure or visible damage to the structure, and the residual deflection *b*, does not exceed $b \leq L/1000$.

(3) When the platform raw material is not steel, different values shall be considered.

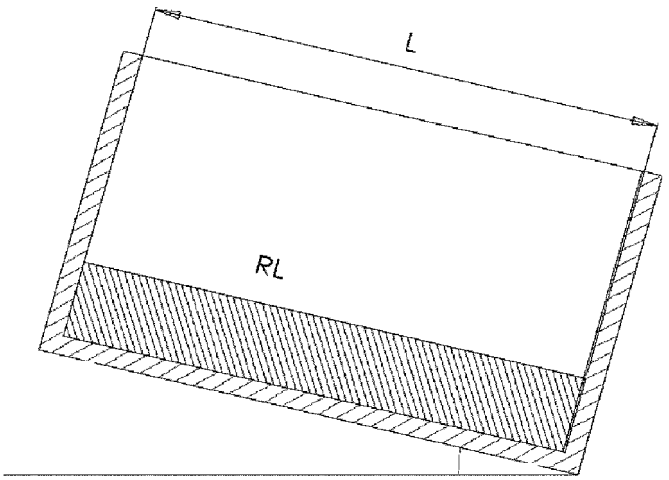


FIG. A1.3 Sloped Test

A1.2.3 *Dynamic Test:*

A1.2.3.1 Platform is attached to the wire ropes and both lifted and lowered at the rated speed of the hoist.

A1.2.3.2 Platform floor is subjected to a load equal to 1.25 RL, applied gradually along the length *T* in accordance with A1.2.2.1 *(2)* and A1.2.2.1 *(3)*.

A1.2.3.3 Conducted for 30 cycles and the minimum lifting height is 1 m.

A1.2.3.4 Test is considered satisfactory if there is no failure or visible damage to the platform structure.

A1.2.4 *Strength Test of Platform Floor:*

A1.2.4.1 Floor strength shall be tested with the platform in a horizontal position, supported at each end.

A1.2.4.2 Platform floor shall withstand, without breaking, a load of 300 kg, distributed over an area of 0.2 by 0.2 m; see Fig. A1.4.

A1.2.4.3 Load is placed centrally between the two adjacent cross-members that support the floor.

A1.2.5 *Ultimate Load Type Tests :*

A1.2.5.1 *Single Platform PRS:*

(1) Platform shall be suspended by its stirrups, in a horizontal position with the floor subjected to a load equal to 2.5 × RL applied gradually along the length *T* in accordance with A1.2.2.1 *(2)* and A1.2.2.1 *(3)*.

(2) Application time: 1 hour.

(3) Strength of the platform is considered adequate if load bearing and non-load bearing parts suffer elastic or permanent deformation, but do not break.

A1.2.5.2 *Multi-Platform PRS:*

(1) Each platform shall be suspended by its stirrups in a horizontal position.

(2) Floor of each platform is subjected to a load equal to 2.5 × RL applied gradually along the length *T* in accordance with A1.2.2.1 *(2)* and A1.2.2.1 *(3)*.

(3) Application time: 1 hour.

(4) Strength of the platforms is considered adequate if load bearing and non-load bearing parts of the platforms suffer elastic or permanent deformation, but do not break.

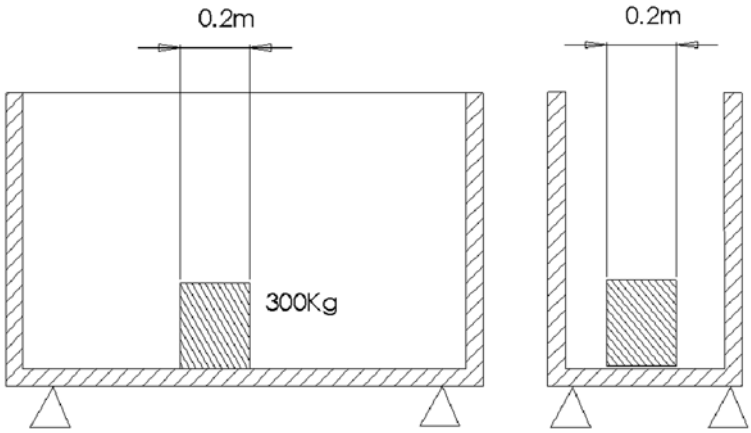


FIG. A1.4 Floor Strength Test

A1.2.6 *Collision Test:*

A1.2.6.1 *Single Platform PRS:*

(1) Platform floor shall be tested at 1.25 RL applied gradually along the length *T* in accordance with A1.2.2.1 *(2)* and A1.2.2.1 *(3)*.

(2) Platform shall be lowered by the wire-ropes at the maximum speed allowed by the system speed-monitoring device, until impact occurs between the platform and the ground surface.

(3) Speed shall be recorded for the last meter before impact.

(4) The acceleration shall be determined as a function of time throughout the movement of the platform.

(5) The test recording equipment shall be able to measure force with the tolerances of ±2 %, in a frequency bandwidth of at least 50 Hz.

(6) Time pulses of duration of 0.01 seconds shall be recorded and measured with the tolerances of ±2 %.

(7) Test shall be conducted 3 times.

(8) Platform is considered satisfactory if the collision test causes no failure or visible damage to the platform structure.

(9) Average retardation shall not exceed 1.5 g evaluated taking into account the time between the first two absolute minima of the retardation. Peaks of retardation with more than 2.5 g shall not be longer than 0.04 seconds.

A1.2.6.2 *Multi-platform PRS:*

(1) Upper platform shall be loaded with 1.25 RL applied gradually along the length *T* in accordance with A1.2.2.1 *(2)* and A1.2.2.1 *(3)*.

(2) Upper platform shall descend and impact the rest of the platform(s) located below, in a speed equal to either 1.1 of the maximum speed allowed by the system speed monitoring device or 1.1 of the design speed in the landing zone.

(3) Test procedure shall be performed in accordance with A1.2.6.1 *(3)–(6)*.

(4) Strength of the platforms is considered adequate if load bearing and non-load bearing parts of the platforms suffer elastic or permanent deformation, but do not break.

(5) The average retardation shall not exceed 1.5 g and will be evaluated taking into account the time between the first two absolute minima of the retardation. Peaks of retardation with more than 2.5 g shall not be longer than 0.04 seconds.

A1.3 Hoist and Secondary Device Tests

A1.3.1 *Static Test:*

A1.3.1.1 Hoist machine shall be statically loaded for 15 minutes to 1.5 × its WLL.

A1.3.1.2 Hoist machine shall not show any signs of the wire rope slipping or creeping through the traction sheave. The wire rope shall be lubricated in accordance with the manufacturer's instructions.

A1.3.1.3 Service brake shall hold the load without slipping or creeping.

A1.3.1.4 No load-bearing component of the hoist machine shall fail, deform or weaken and the load shall be held in position.

A1.3.1.5 After the load is released, the hoist machine shall operate in accordance with the manufacturer's instructions.

A1.3.2 *Dynamic Test:*

A1.3.2.1 Hoist machine carrying 1.25 × its WLL in a suspended position shall lift and lower for 30 cycles.

A1.3.2.2 Service brake shall stop the descent of a hoist within a distance of $v^2/2a$, where v is velocity and a is deceleration, and shall hold the load without slippage.

A1.3.2.3 Drum hoists are tested with the maximum number of layers of wire rope specified by the manufacturer wrapped around the drum.

A1.3.3 *Descent Energy, Temperature Rise and Endurance Test:*

A1.3.3.1 Shall be conducted using methods and parameters of EN 341: (E), 5.7, performed using the PRS manufacturer specified test height and rated load in accordance with the requirements of this Standard.

A1.3.3.2 Number of test descents shall be 20 from the rated height. These tests shall be performed continuously. The temperature rise shall not exceed the oil manufacturer's recommendation.

A1.3.3.3 Shall be conducted from the specific rated height, or from lower heights employing an increased number of operating cycles to produce the total descent energy required.

A1.3.3.4 Test may be accomplished using a mechanical simulator, fixture or special device, that is based on and consistent with the requirements of EN 341: (E), 5.7 and Annex A, (Informative), of that standard.

A1.3.3.5 When the testing is completed, the hoist shall be inspected and there shall be no signs of breakage, malfunction, cracks or wear in critical system parts including pulleys.

A1.3.3.6 After testing the system should be run and operated at its rated load, and speed.

A1.3.3.7 Rated speed should be measured, with an allowed rated speed tolerance: 10 %.

A1.3.4 *Strength Test:*

A1.3.4.1 Hoist machine shall be statically loaded for 15 minutes to 2.5 × its WLL.

A1.3.4.2 Test shall be carried out in such a way that no slippage of the wire rope in the traction system occurs, with the prime mover mechanically locked.

A1.3.4.3 Brakes shall be disengaged.

A1.3.4.4 No load bearing component of the hoist shall fail with the load held in position.

A1.3.4.5 After the above tests, the traction sheave or drum shall be rotated 90° and the test repeated until the traction sheave or drum has been rotated 360°.

A1.3.5 *Testing the Operation of the Secondary Device:*

A1.3.5.1 Safety gear test method and procedure shall be according to EN 81.1 F3.1 and EN 81.1 F3.3.

A1.3.5.2 Over speed governor test method and procedure shall be according to EN 81.1 F4.

A1.3.5.3 *Secondary Brake Test:*

(1) Maximum traction force T_m in the wire ropes is expressed as:

$$T_m = S_d \times TSL/N_r$$

where:

TSL = total suspended load,
S_d = shock load coefficient, and
N_r = number of steel wire ropes when the platform(s) is completely lowered.

(2) Secondary brake is part of the hoist machine and the test shall be conducted with the secondary brake built into the total system, if testing of the total system is not feasible the secondary brake will be tested by itself in a test rig.

(3) Typical test rig for secondary brake according to EN 1808 Annex B, except as modified in this section.

(4) Fall of the load is caused by releasing the drop test device.

(5) Force variations in the wire ropes are recorded and the distance of drop is measured.

(6) Secondary brake is considered satisfactory if:

(a) It withstands three falls without failure;

(b) Shock load coefficient (S_d) is less than or equal to 3;

(c) Distance of drop is in accordance with ANSI/ASSE A10.4, Section 19, Table 4;

(d) No cracks were created.

A1.4 Endurance Test

A1.4.1 Hoist shall operate in its nominal operational condition for 20 cycles while the platform engages the guide rail carrying the rated load.

A1.4.2 No repairs shall be allowed during this test but adjustment of the brake is permitted.

A1.4.3 Rate of cycling shall be adjusted to prevent overheating of the prime mover.

A1.4.4 When test cycles are completed, the hoist shall be inspected indicating no signs of breakage, malfunction, cracks and wear in critical system parts including pulleys.

A1.4.5 System shall be operated at its rated load and speed for 3 cycles and the rated speed measured.

A1.4.6 Allowed velocity tolerance: 10 %.

A1.5 *End of Rope Test*—Each of the wire rope endings shall be tested with a load equal to 2.5 × calculated wire rope load.

A1.6 No-Power and Bypass Modes Test

A1.6.1 Platforms shall be descended 6 times in No-power mode and 6 times in Bypass mode bearing the following:

A1.6.1.1 Rated load in 3 cycles, and

A1.6.1.2 Zero-load in 3 cycles.

A1.6.2 Rated speed shall be measured.

A1.6.3 Allowed velocity tolerance is 10 % for each mode.

A1.7 *Detection Device/Software Test*—Tripping limit performances are tested according to the following procedure:

A1.7.1 Platform is placed on the ground;

A1.7.2 Hoist is loaded with 1.25 × its WLL;

A1.7.3 Platform is then raised above the ground; raising the platform a maximum of 10 cm above the test surface shall trigger the overload device;

A1.7.4 Platform is unloaded until the overload device resets automatically;

A1.7.5 Platform is then reloaded as before;

A1.7.6 Raising shall not be possible when the overload device is triggered;

A1.7.7 Once the overload device(s) is triggered, it shall continuously prevent all movement except lowering;

A1.7.8 Overload indicator shall continuously warn the operator;

A1.7.9 Once, the platform is placed to the ground, the overload device shall reset automatically;

A1.7.10 Once, the hoist is loaded with the WLL; Lifting and lowering shall be possible, without any cut off.

A1.8 Electric Tests

A1.8.1 *EMC Compliance Criteria :*

A1.8.1.1 Compliance with EMC requirements of 5.3 shall be checked by a completed system test.

A1.8.1.2 If testing of the completed system is not reasonably practicable due to the size of the machinery, the manufacturer shall verify that all appropriate equipment and sub-assemblies comply with the requirements.

A1.8.1.3 Manufacturer shall verify that all sub-assemblies are suitably installed and wired, to minimize the effects of disturbances on the equipment, and generated disturbances, in accordance with any recommendation of sub-assembly suppliers.

A1.9 Suspension Rigs

A1.9.1 Suspension rigs which are installed in conjunction with a platform mounted hoist, that is, roof suspension beam, parapet clamp, fixed davit and monorail, shall be tested to the following:

A1.9.1.1 Vertical force, $Fv = 2.5 \times$ WLL;

A1.9.1.2 Horizontal force, $Fh = 0.15 \times$ WLL acting in the most unfavorable direction.

A1.9.1.3 Suspension rig is considered satisfactory if it:

(1) Withstands the static load test without breakage or any permanent deformation of the structure;

(2) Remains stable;

(3) Remains stationary while supporting the static test load.

A1.10 Environmental Conditions Test

A1.10.1 Sun radiation/Ultraviolet light and water exposure tests in accordance with UL 1523, Section 10.2, P8.

A1.10.2 Samples of the non-metallic material of the platform enclosure are to be exposed to ultraviolet light and water in accordance with Method I of the Standard Practice of Operating Light Exposure Apparatus (Carbon Arc Type) With or Without Water for Exposure of Nonmetallic Materials, Practice G153, using apparatus designated Type D or DH in Practice G153.

A1.10.3 During each operating cycle of the apparatus (20 minutes), each specimen is to be exposed to ultraviolet light from the carbon arcs for 17 minutes and to ultraviolet light and water spray for 3 minutes. The apparatus is to operate continuously for 1000 hours.

A1.11 Abnormal Operation Test

A1.11.1 When tested for 2 cycles of operation under applicable abnormal conditions specified in the following sections:

A1.11.1.1 All tests should be performed with nominal loads and speeds.

A1.11.1.2 At the end of each test the system should be run and operated in its rated load and speed, 5 cycles.

A1.11.1.3 Velocities should be measured. Allowed rated speed tolerance: 10 %.

A1.11.2 *Oil Leakage Test*—Hydraulically operated systems: one half of the hydraulic fluid from the reservoir is to be removed.

A1.11.2.1 *Over-Load Test*—A load equal to 1.5 WLL is to be applied.

A2. TESTS AND VERIFICATIONS BEFORE FIRST USE

A2.1 *Locking Devices at the Building Evacuation Openings and in Platform(s) Doors*—Functional test.

A2.2 *Electric Safety Devices*—Verification.

A2.3 *Suspension Elements and Their Attachments*—Verification.

A2.4 *Braking System*—The test shall be conducted while the platform(s) are descending at rated speed with 125 % of rated load and interrupting the power to the motor and the brake.

A2.5 Measurements of current or power and speed verification.

A2.6 *Electric Wiring*—Measurement of the insulation resistance of the major circuits.

NOTE A2.1—Measurement all the electronic components can be tested separately from the system.

A2.7 Verification of electrical continuity of the connection between the earth terminal of the machine room and the different parts of the PRS with potential to be made live accidentally.

A2.8 *Final Limit Switches*—Functional test.

A2.9 Descent Energy Test

A2.9.1 Rate of descent with the maximum and minimum rated loads shall not exceed the manufacturer specified limit.

A2.9.2 Test shall be performed, using the test height and weight in accordance with the requirements of installation and rated energy specified by the PRS manufacturer.

A2.9.3 Number of test descents shall be 30 cycles from the rated height. These tests shall be performed continuously.

A2.9.4 Temperature rise shall not exceed temperature specified by the PRS manufacturer.

A2.9.5 Descent energy testing shall be conducted from the specific rated height, or from lower heights employing an increased number of operating cycles to produce the total descent energy required.

A2.10 Endurance Test

A2.10.1 Hoist shall operate in its nominal operational conditions for 20 cycles while the platform engages the guide rail carrying the rated load including folding and unfolding of platforms in the case of multi-platforms PRS.

A2.10.2 No repairs shall be allowed during this test but adjustment of the brake is permitted.

A2.11 Speed Limitation Device Test

A2.11.1 Operating speed shall be checked in the up and down direction.

A2.11.2 Operation of safety gear and stopping control shall be checked in descent direction.

A2.11.3 Speed shall be measured and recorded before and after the secondary device engagement.

A2.12 Secondary Device—Secondary Brake or Safety Gear Test

A2.12.1 Maximum energy absorbed by the secondary brake during engagement will be verified in accordance with A1.3.5.

A2.12.2 Check correct mounting and setting and the soundness of the complete assembly, comprising platform(s), hoist machine and attachment to the building.

A2.12.3 The test shall be made while the platform(s) are descending, with the required load uniformly distributed over the platform area, with the machine running until the ropes slip or become slack, and under the following conditions:

A2.12.3.1 Platform(s) should be loaded with 125 % of the rated load, and travel at rated speed or lower.

A2.12.3.2 When the test is made with lower than rated speed and/or load, the manufacturer shall provide curves to illustrate the behavior of the type tested progressive safety gear when dynamically tested with the suspensions attached.

A2.12.3.3 After test, it shall be ascertained that no deterioration, which could adversely affect the normal use of the PRS has occurred, if necessary, friction components may be replaced.

NOTE A2.2—Visual check is considered sufficient.

A2.13 *Over Speed Governor Test* —Tripping speed and operation of the safety gear and stopping control shall be checked in descent direction.

A2.14 Buffers

A2.14.1 *Energy Accumulation Type Test*—Test shall be carried out as follows:

A2.14.1.1 Platform with its rated load shall be placed on the buffer(s),

A2.14.1.2 Ropes shall be made slack.

A2.14.1.3 Check that the compression corresponds to the manufacturer specified limits.

A2.14.2 *Energy Type*—With buffered return movement and energy:

A2.14.2.1 The platform(s) with its rated load shall be brought into contact with the buffers at the rated speed or at the speed for which the stroke of the buffers has been calculated, in the case of the use of reduced stroke buffers with verification of the retardation.

A2.14.2.2 After test, it shall be ascertained that no deterioration, which could adversely affect the normal use of the PRS has occurred.

NOTE A2.3—Visual check is considered sufficient.

A2.15 *Full Load Hydraulic Pressure* —Measure hydraulic pressure when PRS is fully loaded and compare with manufacturer specified limits.

A2.16 *Pressure Relief Valve*—Visual check for correct setting.

A2.17 *Creep Test*—The platform(s) movement shall not exceed 10 mm downwards within 10 minute time period, when the platform(s) bear the rated load and are located at the lowest level above the landing zone.

A2.18 *Descent of the Platform(s) in No-Power Mode and Bypass Mode*—System shall descend the platform(s) under rated load in both modes, for 10 m height.

A2.19 *Functional Test*—Control and communication systems of the PRS will be tested by activating each of the safety devices (see 15.5 and Table 3) and shall be considered satisfactory if all safety devices are operating in accordance with 15.5.

A2.20 *Ascending Platform(s) Over Speed Protection Devices*(if ascending over speed is possible in the PRS design). This test shall be made while the empty platform is ascending at not less than rated speed, using only the buffer for braking.

A3. PERIODIC VERIFICATIONS

A3.1 Shall be carried out a minimum of every 12 months or in accordance with manufacturer instructions if a shorter time interval is recommended.

A3.2 Methods

A3.2.1 *Visual Check*—Establish if system operation is impaired by placement of materials atop PRS components or sub-system, or in its pathway.

A3.2.2 *Functional Test*—To establish, in an unloaded working operation, normal cycle or part of cycle that the machine, including all safety devices, works as intended and all functions comply with the requirements of this standard.

A3.2.3 Periodic tests and verifications may be performed under platform self (dead) weight.

A3.3 Tests and Verifications

A3.3.1 *Locking Devices at Floor Exits and on Platform Doors*—Visual check and functional test.

A3.3.2 *Safety Contacts*—Visual check and functional test.

A3.3.3 *Suspension Elements and Their Attachments*—Visual check.

A3.3.4 *Braking System*—Visual check and functional test shall be carried out while the platform is descending at rated speed with rated load and the brake engaged by interruption of the motor and the brake supply.

A3.3.5 *Rate of Descent*—Functional test under zero and maximum rated loads shall not exceed the specified limit in the standard and the speed shall be recorded.

A3.3.6 *Descent Energy*—Visual check and functional test shall be performed for 10 cycles using the rated height and load in accordance with the PRS manufacturer specifications. The temperature rise shall not exceed the limit as specified by the PRS manufacturer.

A3.3.7 *Endurance Test*——Visual check and functional test; hoist shall operate in its nominal operational conditions for 10 cycles.

A3.3.8 *Speed Functional Test*—PRS operating speed shall be verified while platform ascending and descending.

A3.3.9 *Secondary Device (Secondary Brake or Safety Gear)*—Visual check and functional test.

A3.3.9.1 Shall be engaged while the PRS descends at rated speed and load.

A3.3.9.2 Lower speed or load, or both, are allowed in the case where the manufacturer provides verification procedures and curves that are in accordance with A1.3.5.1 and A1.3.5.3.

A3.3.9.3 After the test, in a visual check, it shall be ascertained that no deterioration, which could adversely affect the normal use of the PRS has occurred.

A3.3.10 *Over Speed Governor*—Visual check and functional test. Tripping speed of the over speed governor shall be checked during the PRS descending cycle.

A3.3.11 *Buffers*—Visual check to ascertain that no deterioration, which could adversely affect the normal use of the PRS has occurred.

A3.3.12 *Hydraulics*—Visual check and functional test to determine No-leaking in hydraulic system and pressure relief valves and verify correct adjustments.

A3.3.13 *Creep Test*—Visual check and functional test. PRS movement shall not exceed 10 mm downwards within 10 minute time period, when the platform is located at the lowest level above the landing zone under rated load.

A3.3.14 *No Power and By-Pass Modes of Operation*—Visual check and functional test. The PRS correct operation in No-power mode and in by-pass mode shall be verified and the average speed shall be recorded during descent of at least 10 meters.

A3.3.15 *Guide Rail*—Visual check and functional test to ascertain that no deterioration, which could adversely affect the normal use of the PRS has occurred.

A3.3.16 *Platform Frame*—Visual check to ascertain that no deterioration, which could adversely affect the normal use of the PRS has occurred.

A3.3.17 *Structural Check and Inspection of, Jig, Davits, and Anchorage Points*—Visual check to ascertain that no deterioration, which could adversely affect the normal use of the PRS has occurred.

A4. PRS UTILIZATION PROCEDURES

A4.1 *Operational Conditions*—A PRS shall be designed to operate in multi-story buildings where there is fire in parts of the building, as long as there is no fire in its path, or fire exposures that preclude safe use of the PRS.

A4.2 PRS Operation

A4.2.1 Shall be in accordance with predefined Operation procedures with participating agencies, if needed.

A4.2.2 Operation procedures shall be integrated and in harmony with the building fire safety plan, and the building evacuation strategy.

A4.2.3 Building occupants shall be advised and informed during an emergency, to discourage panic or stress during adverse circumstances.

A4.3 Operational Situations

A4.3.1 Operation procedures shall address at a minimum the following situations:

A4.3.1.1 Trapped occupants due to fire or smoke conditions within the building.

A4.3.1.2 Evacuation of occupant is needed from a building under circumstances where no other means of evacuation exist.

A4.3.1.3 Entrance of emergency response personnel to the building under circumstances where assistance/first aid is required and no other means of access exist.

A4.4 *Operational Procedures*shall be developed to address specifically the various types of situations that might be experienced on the system (see A4.3) and risks during the operation including, but not be limited to, the following:

A4.4.1 Identification of situations envisioned;

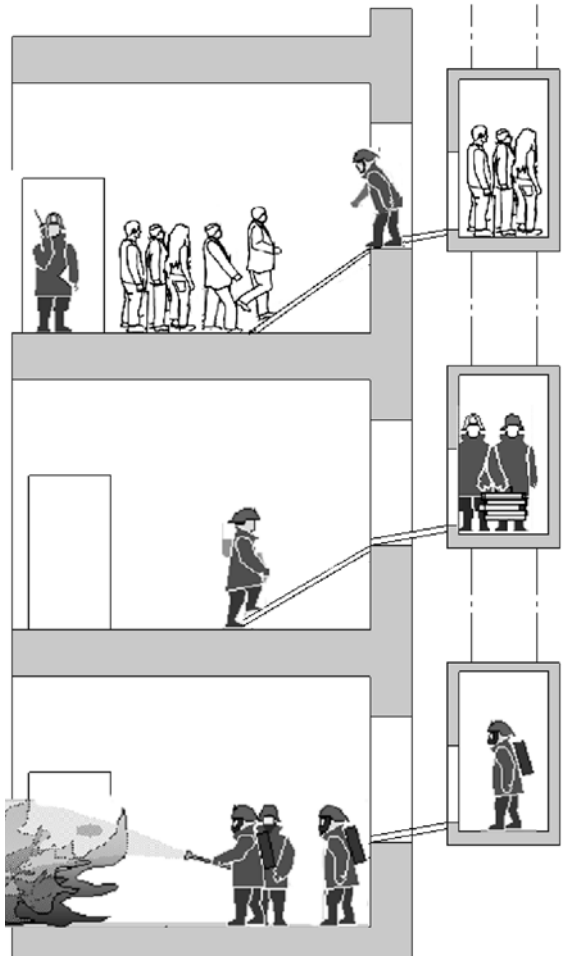
A4.4.2 Safety procedures to be implemented specific to each situation;

A4.4.3 Objects and areas that need to be observed continuously and clearly, by at least one PRS operator, during operation, such as:

A4.4.3.1 Landing zone;

A4.4.3.2 Platforms;

A4.4.3.3 PRS pathway on the building.



NOTE 1—In addition, evacuees enter the platforms through the same openings.

FIG. A4.1 Illustration of Emergency Response Personnel Entering the Building from a Multi-Platform PRS

A4.4.4 PRS operators and commander(s) purposes as applicable.

A4.4.5 Communications, categories available, procedures to maintain safe operation, and equipment to interface with responding agencies.

A4.4.6 Fire and smoke emergency information and procedures to be provided, to PRS commander including the following:

A4.4.6.1 Location of fire in the building;

A4.4.6.2 Fire detection systems/zones in building;

A4.4.6.3 Building evacuation opening locations;

A4.4.6.4 PRS pathway location;

A4.4.6.5 Agency(ies) to be notified and phone numbers (for example, fire department);

A4.4.6.6 Any other information or data that participating agencies determine to be necessary to provide effective response.

A4.4.7 Requirement that during an emergency at least one operator shall attend and operate the platform and in case of multiple platform PRS, each platform shall be attended and operated by a designated operator.

A4.5 PRS Operators

A4.5.1 The direct operation of the PRS shall be done by the PRS operators and each platform operator shall be capable of activating directly and instantaneously a control panel.

A4.5.2 PRS commander is a PRS operator, who is in charge of supervising and commanding the platform operators.

A4.5.3 Operational procedures shall be accessible for the PRS commander.

A4.5.4 PRS commander may operate the PRS using the CPP or the CPS.

A4.5.5 Operational personnel (including emergency response personnel, PRS operators, PRS commanders, platform operators) training shall be kept current through periodic drills and review courses.

APPENDIX

(Nonmandatory Information)

X1. RATIONALE STATEMENT

X1.1 Multi-story and High-rise buildings are an ever-growing phenomenon in skylines of cities world-wide. Constructing them in a manner that makes them absolutely safe in case of major fire, explosion, terror attack, earthquake, or other natural and human-created disaster is extremely difficult, if not impossible.

X1.2 Disastrous events bring into focus the vulnerability of multi-storied buildings. The NIST report on the World Trade Center disaster recommends numerous Code changes and policy initiatives to address this vulnerability. Modifications of stairwell design have been recommended by the World Trade Center Building Code Task Force in New York City, and have been adopted by the National Fire Protection Association in the Life Safety Code 101 and Building Code 5000; however, such Code modifications will not resolve these issues completely, and in any case will not affect shortfalls in thousands of existing buildings, with millions of exposed tenants. Policy bodies, occupants, owners, and employers of occupants of these buildings now seek redundancy and added capacity in ways to evacuate and access tall buildings. Issues and problems brought to attention with respect to egress and access include the:

X1.2.1 Capacity of stairs for occupant egress, especially for full-building evacuation;

X1.2.2 Capacity of stairs for emergency responder access during an occupant evacuation;

X1.2.3 Lack of redundancy when a single event compromises all stairs and elevators; and

X1.2.4 Inherent limitations of evacuating children and persons with mobility impairments. Evacuation from high floors (numerous flights of stairs), very difficult even for healthy individuals, can be impossible for people with physical limitations. Many buildings incorporate ‘areas of refuge’, yet provide little for ready evacuation of these persons to a safe zone, or within the building to other safe floors.

X1.3 The marketplace is responding to the public’s concern with innovative devices to aid in emergency escape and evacuation, including parachutes, controlled descent devices, powered platforms, chutes and even vertical take-off and landing craft (VTOLs). Some may be suitable in the right situation, while others are ineffective or downright dangerous. If emergency escape device use is to be sanctioned, standards of criteria for acceptability and application of such equipment must be established.

X1.4 Recognizing that appropriate standards are in the best interest of public safety, ASTM Subcommittee E06.77 was established (2004) to consider devices designed for external evacuation from multi-story buildings, which will aid building owners, occupants, authorities and emergency responders to better define and evaluate device suitability. These currently include Platform Rescue Systems (PRS) and two other families of devices: Controlled Descent Devices (CDD) and Chutes.

X1.5 Platform Rescue Systems (PRS) covered by this standard are for use only in emergency situations, and are designed to maximize the number of occupants that can be safely evacuated. It should be noted, nothing in this standard changes currently required means of egress. Rather, the intention is to provide building occupants with an alternate escape route if the primary and secondary routes are determined to be unavailable, or if additional exit capacity is desired. In addition, some of these systems support emergency forces by carrying personnel and equipment up to building upper floors.

X1.6 The standard draws on and refers to existing standards, but due to the new nature of these devices, developing the standard required innovative thinking, and hybrid applications of existing standards. These unique devices meet stringent strength and reliability requirements for the device itself and give substantive consideration to user safety, taking into account the emergency situations in which they would be utilized.

X1.7 Recognizably, they do not have the redundancy of safety features found in equipment performing with great frequency, that is, essentially constantly in use or periodically used for facility maintenance. These devices may be used 2–4 events a year, for testing and drills, and hopefully never in an emergency. Also, their intended use in often extreme situations, where command decision-making may be the key to safety, dictates an approach that substitutes a person in the loop and his/her judgment for the automatic and mechanical safety devices we have become accustomed to in other kinds of equipment (and which, in the situations envisioned, may actually reduce safety).

X1.8 The PRS standard addresses reliability of equipment under adverse weather conditions, exposure to fire, structural loading, human behavior under evacuation conditions during system use, communications during evacuation, and capability of transporting small children and disabled persons. This territory is new and requires a rather new approach to standardization, different from existing standards, but relying on much good and time-proven work, definitions and requirements within them, that is, standards for elevators, scaffolds, powered platforms, cranes, cableways and fire-resistant fabrics and materials.