ASME A120.1-2008
(Revision of ASME A120.1-2006)

Safety Requirements for Powered Platforms and Traveling Ladders and Gantries for Building Maintenance

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

ASME
SETTING THE STANDARD

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Date of Issuance: September 5, 2008

The next edition of this Standard is scheduled for publication in 2011. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME website under the Committee Pages at http://cstools.asme.org as they are issued.

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

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FOREWORD

This Standard provides for the safe design of powered platforms for building maintenance, where window cleaning and related services are accomplished by means of suspended equipment at heights in excess of 35 ft (11 m) above a safe surface, e.g., grade, street, floor, or roof level.

The provisions of the Standard are intended to apply to all known systems used to support suspended maintenance equipment as well as the suspended equipment itself (either permanently installed or transportable equipment). Guidelines are also included for a building's structural support areas as well as the building surfaces that actually interface with the equipment.

The Standard does not apply to other suspended powered platforms used for remedial renovations or modifications to buildings. The safe use of these types of scaffolds is addressed by American National Standard ANSI A10.8. The A120.1 Standard also does not relate to any service performed by persons supported by equipment covered by any of the ANSI A92 standards.

The purpose of this Standard is to ensure the protection of all powered platform users as well as persons potentially exposed to use of the equipment. In developing this Standard, safety has been held as the primary consideration. The Standard requires that permanently installed or transportable equipment be properly designed by a qualified professional engineer, taking into account specific building features rather than attempting to accommodate the system to a building's structure and facade features that may not be suitable for its safe operation. In addition, care has been taken so as not to exclude or render obsolete any existing product or equipment.

This Standard reflects the evolution of a project begun in 1962 by the American National Standards Committee on Window Cleaning Safety, A39. At that time, the Committee recognized that a new method was being developed for cleaning fixed sash windows by means of a special scaffolding. In order to deal expertly with this new development, a new project was established, separate from that handled by the A39 Committee. Following a general conference, the American National Standards Committee on Powered Platforms, ANSI A120, was formed, with the National Safety Council acknowledged as sponsor. In 1965, The American Society of Mechanical Engineers was approved as cosponsor. In 1984, the Building Owners and Managers Association International was approved as Secretariat.

A previous edition of the Standard, A120.1-1970, was administratively withdrawn in 1989. This Standard had established safety requirements for the design, construction, installation, inspection, and use of power-operated platforms for exterior building maintenance. The Standard did not apply to temporary equipment used for construction work or to devices raised and lowered manually.

A120.1-1992 was the result of joint action by participating organizations under the auspices of the American National Standards Institute. That Standard was approved through two votes of the ANSI A120 Committee, at a meeting in New York City (October 17, 1991) and by letter ballot (dated December 30, 1991).

In 1995, ASME again assumed sponsorship of the Standard. ASME A120.1-1996 was approved by ANSI on April 17, 1996. ASME A120.1-2001 was approved by ANSI on July 3, 2001. ASME A120.1-2006 was approved by ANSI on September 20, 2006.

This revision was approved by the American National Standards Institute on July 16, 2008.

ASME A120 COMMITTEE
Safety Requirements for Powered Platforms for Building Maintenance

(The following is the roster of the Committee at the time of approval of this Standard.)

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General. ASME codes and standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, and attending Committee meetings. Correspondence should be addressed to:

Secretary, A120 Standards Committee
The American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes which appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal including any pertinent documentation.

Interpretations. On request, the A120 Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the A120 Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit the request in the following format:

Subject:	Cite the applicable paragraph number(s) and provide a concise description.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation.

Requests which are not in this format may be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information which might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Attending Committee Meetings. The A120 Standards Committee regularly holds meetings which are open to the public. Persons wishing to attend any meeting should contact the Secretary of the A120 Standards Committee.

ASME A120.1-2008
SUMMARY OF CHANGES

Following approval by the ASME A120 Committee and ASME, and after public review, ASME A120.1-2008 was approved by the American National Standards Institute on July 16, 2008.

ASME A120.1-2008 includes editorial changes, revisions, and corrections identified on the pages by a margin note, **(08)**, placed next to the affected area.

Page	*Location*	*Change*
1	1	New para. 1.4 added and former paras. 1.4, 1.4.1, and 1.5 redesignated as 1.5, 1.5.1, and 1.6, respectively
2–4	1.6	Definitions of *bird cage*; *core*; *kink*; *lay;* and *strand* added
6	2.3.4.1	Added
8, 9	3.2.2	Last paragraph added
	3.2.4(a)	First paragraph revised
	3.2.8	Added
10	3.3.4(c)	Revised
14	3.7.5.5(a)	Second sentence added
17	3.10.3.1	New subpara. (a) added and subsequent subparagraphs redesignated

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SAFETY REQUIREMENTS FOR POWERED PLATFORMS AND TRAVELING LADDERS AND GANTRIES FOR BUILDING MAINTENANCE

(08) 1 GENERAL RECOMMENDATIONS AND DEFINITIONS

1.1 Scope

This Standard establishes safety requirements for powered platforms (scaffolds) for buildings where window cleaning and related services are accomplished by means of suspended equipment at heights in excess of 35 ft (11 m) above a safe surface (e.g., grade, street, floor, or roof level). Additionally, this Standard establishes safety requirements for permanent traveling ladders and gantries (TLG).

It pertains to either permanently installed or transportable equipment meeting the requirements of this Standard.

Powered platforms and TLGs may be used or operated by one or more persons engaged in services such as normal building maintenance. The equipment may also be used for tasks such as caulking, metal polishing, reglazing, or other building repairs.

This Standard does not apply to other suspended powered platforms used for remedial renovations or modifications to buildings. The safe use of these scaffolds is included in ANSI A10.8-2001, Safety Requirements for Scaffolding.

This Standard does not relate to any service performed by persons supported by equipment covered by any of the ANSI A92 standards.

1.2 Purpose

The purpose of this Standard is to ensure the protection of powered platform users and traveling ladder and gantry users, and persons exposed to equipment used with the previously described maintenance of buildings.

It is also intended for use by architects, engineers, designers, manufacturers, inspectors, purchasers, building owners, and others associated with the installation of powered platforms and traveling ladders and gantries.

Additionally, it is recommended for use by enforcement agencies having jurisdiction over the installation of powered platforms and traveling ladders and gantries to ensure that the platforms meet the safety provisions of this Standard.

1.3 Application of This Standard

1.3.1 Applications. This Standard applies to the installation of all powered platforms and traveling ladders and gantries.

1.3.2 Deviations. Deviations from the requirements of this Standard may be granted by the enforcing authority if it is determined that a specific requirement creates practical difficulty or excessive hardship, or where the specific requirement prevents the use of a novel design, only when equivalent safety is provided.

1.3.3 Alterations

(a) Any existing building being serviced may continue to be serviced until the building is altered, requiring a modification of the installation. Alteration of the building and equipment modification shall then be made to comply with the applicable parts of this Standard.

(b) If the authority having jurisdiction believes that hazards exist to warrant a change in an existing installation, the authority may require compliance with any part of this Standard. If a qualified person deems that a hazard exists, the hazard shall be corrected, and the correction shall be in compliance with this Standard.

(c) Once a building permit is issued or modified, the current version of the Standard shall apply.

1.4 Applicable Units (08)

This edition of the Standard uses U.S. Customary units with acceptable metric (SI) units shown in parentheses.

NOTE: The metric values stated may not be exact equivalents to the U.S. Customary units.

Information on the usage of SI units and their conversion from U.S. Customary units is contained in the IEEE/ASTM SI 10-1997, Standard for the Use of the International System of Units (SI): The Modern Metric System; or ASME Guide SI-1, Orientation and Guide for Use of SI (Metric) Units.

1.5 References (08)

When a nationally recognized standard, other than that specifically referred to in para. 1.1, is referred to and is superseded by a revision, the edition current at the time of acceptance of this Standard shall apply.

Aluminum Construction Manual
Specifications for Aluminum Structures
Aluminum Standards and Data

Publisher: Aluminum Association, Inc. (AA), 1525 Wilson Boulevard, Arlington, VA 22209

ANSI A10.8-2001, Safety Requirements for Scaffolding

Publisher: American National Standards Institute, Inc. (ANSI), 25 West 43rd Street, New York, NY 10036

ANSI/ASSE A10.32-2004, Fall Protection Systems for Construction and Demolitions

Publisher: The American Society of Safety Engineers (ASSE), 1800 East Oakton Street, Des Plaines, IL 60018

Federal Specification (FS)
RR-W-410-C for Wire Rope

Publisher: Superintendent of Documents, U.S. Government Printing Office (GPO), 732 N. Capitol Street, NW, Washington, DC 20401

National Electrical Code

Publisher: National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471

1.5.1 Listed below are additional nationally recognized standards-promulgating organizations.

American Gear Manufacturers Association (AGMA), 500 Montgomery Street, Alexandria, VA 22314-1581

American Institute of Steel Construction, Inc. (AISC), One East Wacker Drive, Chicago, IL 60601-2001

ASTM International (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

American Society of Civil Engineers (ASCE), 1801 Alexander Bell Drive, Reston, VA 20191-4400

The American Society of Mechanical Engineers (ASME), Three Park Avenue, New York, NY 10016-5990

American Welding Society, (AWS), 550 NW Le Jeune Road, Miami, FL 33126

National Electrical Manufacturers Association (NEMA), 1300 North 17th Street, Rosslyn, VA 22209

(08) 1.6 Terms and Definitions

accepted: accepted by the enforcing agency having jurisdiction.

allowable stresses: the working stress limitations imposed by a nationally recognized standards-promulgating organization.

angulated roping: a means of stabilization where the upper point of suspension is inboard from the attachments on the suspended unit, causing the suspended unit to bear against the face of the building.

bird cage: the appearance of a wire rope where the outer strands displace, forming a cage appearing as an increase in the overall rope diameter.

brake, primary: a brake designed to be automatically applied whenever power to the prime mover is interrupted or discontinued.

brake, secondary: a brake designed to prevent the descent of the suspended or supported equipment in the event of an overspeed condition.

brake types

disc: a brake in which the holding effect is obtained by frictional resistance between faces of rotating discs or shoes.

self-energizing band: a unidirectional brake in which the braking action is obtained by frictional resistance between a stationary flexible brake band and a rotating drum, whereby the friction force increases the holding force or pressure on the friction surfaces.

shoe brake: a brake in which the holding effect is obtained by applying pressure on two or more stationary segmental friction elements against a rotating cylindrical wheel or drum.

wire rope engaging: a brake that grips onto a wire rope, without damage to the rope, to prevent the descent of a suspended unit.

building: a structure wherein people may live, work, or otherwise make use of the facilities offered within the structure.

building face roller: a guide roller designed to ride on the face of the building wall to prevent the suspended or supported equipment from abrading the face of the building.

building maintenance: exterior or interior operations such as window cleaning, caulking, metal polishing, reglazing, and general light maintenance or repairs on building surfaces.

cable: a conductor, or group of conductors, enclosed in a weatherproof sheath, which may be used to supply electrical power or control currents for equipment and to provide voice communication circuits.

carriage: a wheeled vehicle used normally for the horizontal movements and support of equipment.

catalog strength: the rated strength of any product or material as designated by its manufacturer or vendor, based on standard testing procedures or acceptable engineering design practices.

certified: accepted by design, evaluation, or inspection by a registered professional engineer.

combination cable: ropes having both steel structural members for support of the equipment and copper or other electrical conductors insulated from each other and the structural members by nonconductive barriers.

continuous pressure: the requirement for a constant manual actuation of an operating control or device.

control: a mechanism used to regulate or guide the operation of the equipment.

core: the axial member of a wire rope about which the strands are laid.

davit: a device for suspending a powered platform. Unlike outriggers, a davit reacts its operating moment load into a single pedestal, socket, carriage attachment, or other connection.

dropline: a vertical line from a fixed anchorage, independent of the work platform and its rigging, to which a lanyard is affixed. Droplines are also variously called lifelines, safety lines, ratlines, scarelines, etc.

dynamic load: loading induced by masses undergoing changes in velocity and loads varying with time. In application, a simulated static load surcharge may be assumed to be equivalent to dynamic effects.

electrical ground: a conducting connection between an electrical circuit of the equipment and the earth, or a conducting body that serves in place of the earth.

equipment tie-in: a positive-type connection provided to secure a working platform or suspension rope to the building.

failure: a deficiency of a structural element that makes it unable to continue the load-bearing function for which it was originally designed.

fairlead: the uppermost guide for the suspension wire rope.

fairlead roller: a roller provided to allow a minor change in the direction of travel of a suspension rope.

four-rope suspended platform: a platform suspended by four load carrying wire ropes arranged such that the failure of any one support rope or its fastenings will not cause the platform to upset (substantially alter the normal position). (Also known as four rope, four line, and *multi-rope*. See *two-rope suspended platform*.)

ground rigging: a method of suspending a self-powered working platform from a safe horizontal surface to an acceptable point of suspension above the safe surface.

guide roller: a rotating cylindrical member, operating separately or as a part of a guide assembly, that provides continuous engagement between the suspended or supported equipment and the building guides.

guide shoe: equivalent to guide rollers, except shoes provide a sliding contact between the building guides and the shoe.

hoisting machine: a device intended to raise and lower a suspended or supported unit.

installation: the total affected parts of a building and the equipment associated with the intended operation.

interlock: a device to ensure operations or motions in proper sequence.

intermittent stabilization: a means to stabilize a suspended unit by securing the suspension rope(s) to vertically spaced building anchors.

kink: a deformation of a wire rope caused by a loop of the rope being pulled down tight.

lanyard: a flexible line used to secure a wearer of a safety belt or harness to a dropline, lifeline, or fixed anchorage.

lay:

(a) the manner in which the wires in a strand or the strands of a rope are helically laid, or

(b) the length, parallel to the longitudinal axis, in which a wire makes one complete turn about the axis of a strand or a strand makes one complete turn about the axis of a rope.

lifeline: see *dropline*.

live load (static): the total static weight of personnel, tools, parts, and supplies that the equipment is designed to support.

multiple wrap (layer) drum hoist: a type of hoisting machine that accumulates the suspension wire rope in more than one successive layer on the surface of the drum of the hoist.

nondestructive tests: those tests required to ensure the reliability or soundness of a product but which do not have a detrimental effect on the product.

obstruction detector: a device that will stop the suspended or supported unit in the direction of travel if an obstruction is encountered and will allow the unit to move only in a direction away from the obstruction.

operating device: a device actuated manually to activate a control.

outrigger: a device for suspending a powered platform. Unlike a davit, an outrigger reacts its operating moment load into at least two opposing vertical components acting into two or more distinct reaction points and/or attachments.

powered boatswain's chair: a powered seat for one person suspended by a single line that is designed to be raised and lowered by the user.

powered platform: suspended or supported manned equipment that provides access to the face of a building for the purpose of maintenance.

prime mover: the source of mechanical power for a machine.

qualified person: a person with training and experience in the use, service, and repair of specific equipment. Training may be provided by the equipment manufacturer.

rated load: as assigned by the manufacturer, the total load permitted on a hoist. The load includes the static weight

of the suspended or supported unit plus the weight of the live load imposed on the hoist.

registered professional engineer: a person who has been duly registered and licensed by an authority within the United States to practice the profession of engineering.

remedial work: restoration, renovation, or modifications employing crafts associated with the construction industry, such as masonry, glazing, caulking, and carpentry.

remote powered platform and equipment: a powered platform or suspended equipment where the means of raising and lowering the suspended unit is located at an elevation or location other than on the platform or suspended unit.

reverse bend: a reverse bend in a wire rope is one where a rope bends around one sheave followed by bending around a second sheave in the opposite direction.

rope lay length: the length, parallel to the longitudinal axis, in which a wire makes one complete turn about the axis of the strand or a strand about the axis of a rope. In this connection it is also referred to as lay length or *pitch.*

safe surface: a horizontal surface intended to be occupied by personnel, which is so protected that it can be reasonably assured that said occupants will be protected against injury or from falling.

self-powered platform: a powered platform where the hoist(s) is located on the platform.

shall: mandatory.

should: advisory.

single wrap (layer) drum hoist: a type of winding drum hoist that accumulates the suspension wire rope in a single layer on the surface of the hoisting drum.

speed reducer: a positive-type speed-reducing machine.

stability factor: the ratio of the stabilizing moment to the overturning moment.

strain relief anchor: a positive device used for the mechanical anchorage of cable to prevent undue strain on the cable connectors.

strand: a symmetrically arranged and helically-wound assembly of wires.

supported equipment: any building maintenance equipment that is held or moved to its working position by means of attachment directly to the building or extensions of the building being maintained.

suspended equipment (suspended scaffold): any building maintenance equipment that is suspended or moved to its working position by means of ropes or combination cables attached to some anchorage above the equipment.

tail line: the nonsupporting end of a suspension wire rope.

tie-in-device: the portion of a suspended unit that positively engages the building tie-in-guides.

tie-in-guides: the portion of a building that provides continuous positive engagement between the building and a suspended unit during its vertical travel of the face of the building.

traction or sheave hoist: a type of hoisting machine that does not accumulate the suspension wire rope, but is designed to raise and lower a suspended load by the application of friction forces between the suspension wire rope and the hoist's drum.

transfer drum: a drum incorporated within a hoist to transfer wire rope from one traction drum groove to an adjacent groove.

transportable equipment: ground-rigged powered platforms or supported equipment brought to a building site for the purpose of maintenance, as covered by this Standard.

transportable outriggers and davits: outriggers and davits designed to be moved from one work location to another.

traveling cable: a cable intended to contain electrical power, control, or communication conductors from the power or communication source to a suspended or supported unit or between the source and a carriage.

traveling ladders and gantries (TLG): site-specific permanently installed traveling ladders or gantries used to service surfaces of a building such as an atrium roof, skylight, or building facade.

trolleyline/dogline: a horizontal lifeline secured to the guardrail and structural portions of a platform (see para. 3.7.5.10).

trolley system: a track-mounted carriage suspended from an overhead structure.

two-rope suspended platform

(a) a platform suspended by two load-carrying wire ropes

(b) a platform suspended by two load-carrying wire ropes and with two secondary wire ropes such that the failure of any one support rope or its fastenings will not cause the platform to upset (substantially alter the normal position). Also known as *two rope, two line*, and *dial-rope*. See *four-rope suspended platform*.)

weatherproof: equipment or component protection constructed so that exposure to adverse weather conditions will not affect or interfere with the proper use or functions of the equipment or component.

winding-drum hoist: a type of hoisting machine that accumulates the suspension wire rope on the drum of the hoist.

working platform: a suspended or supported platform arranged to provide access to the building.

wrap: one complete turn of the suspension wire rope around the surface of a hoist drum.

2 BUILDING DESIGN REQUIREMENTS

2.1 General

All buildings with wall surfaces requiring cleaning or buildings not provided with operable windows shall be designed relative to the use of the equipment covered by this Standard.

All buildings shall be designed to safely accommodate powered platforms and traveling ladders and gantries to be used for remedial work.

The design shall incorporate all features needed to provide the degree of safety required for users of the equipment and those exposed to use of the equipment.

All equipment and anchorages designed in accordance with this Standard shall be used only as herein described. Variations in use or modifications of its designed anchorages shall be approved, prior to use, by a registered professional engineer experienced in the design and installation of such equipment.

All loads and structural attachments to the building shall be approved by a registered architect or a registered professional engineer.

2.1.1 Installation Owner. When the equipment is to be continuously used at a specific location, the registered professional engineer for the building shall provide to the owner of each installation the following materials constituting the installation design record:

(a) architectural and structural drawings of those portions of the building contacted by the equipment or supporting the equipment

(b) engineering drawings of the equipment anchorages and their means of attachment or support

(c) calculations or test reports to verify compliance of the design with this Standard

(d) a certification by a registered professional engineer that the equipment has been initially installed in compliance with this Standard and that the equipment is compatible with the building

2.2 Design Requirements

The design requirements for each installation shall be based on the limitations (stresses, deflections, etc.) established by nationally recognized standards promulgated by the agencies listed in para. 1.4, or by equivalent Standards found acceptable to the agency having jurisdiction. The design standards used shall be recorded in the installation design record.

2.3 Specific Building Design Requirements

2.3.1 General Requirements. All buildings on which or in which equipment will be installed for window cleaning and related services shall be designed and constructed to sustain all the loads imposed on the building by the equipment, with stresses or deflections not to exceed those permitted by nationally recognized standards referred to in this Standard.

2.3.2 Safety Requirements. All buildings shall be designed and constructed to allow the equipment to be installed and used in a safe manner and to provide safe access to and egress from the equipment and areas used for maintenance of the equipment.

2.3.3 Tie-in-Guides

(a) The exteriors of all buildings shall be designed with guides to provide a positive and continuous means of engagement between the suspended or supported portion of the equipment and the building during full vertical travel of the suspended or supported unit on the face of the building.

(b) A method shall be provided to separate the guide shoes from the platform without the use of tools, in case of an emergency.

2.3.3.1 Exceptions

(a) Where the building exterior prohibits the installation of building tie-in-guides at the uppermost elevation of the building, they may be omitted for not more than 50 ft (15 m) of the uppermost elevation. When angulated roping is employed, the allowable unguided distance may be increased to 75 ft (23 m), provided a stabilizing force of at least 10 lb (44.5 N) is maintained under all conditions of loading.

(b) Continuous tie-in-guides may be eliminated on the exterior of buildings where either

(1) the building is provided with an intermittent stabilization system (equipment tie-in-devices) in accordance with para. 2.3.3.3; or

(2) the equipment installation utilizes angulated roping, a stabilizing force of at least 10 lb (4.5 kg) is maintained under all conditions of loading, and only where the rise of the suspended portion of the equipment does not exceed 130 ft (40 m).

(c) Continuous tie-in-guides, angulated roping, and workstation tie-in-devices are not required for interior building maintenance equipment.

2.3.3.2 Minimum Tie-in-Guide Dimensions. The continuous tie-in-guides shall be one of the following types:

(a) Internal Track (Restricted Opening). Such guides are imbedded in other building members with only the opening exposed. The minimum opening shall be $\frac{3}{4}$ in. (19 mm), and the interior shall provide a $\frac{3}{4}$ in. (19 mm) minimum clear width each side of the opening and a minimum clear depth of $1\frac{1}{4}$ in. (32 mm). Track design shall incorporate a method for unencumbered insertion and removal of the engagement device.

(b) External Tracks. These guides are installed external to the other building members and are fully or partially exposed. For this type of installation

(1) square or rectangular guides shall have vertical openings and dimensions in accordance with para. 2.3.3.2(a)

(2) flanged beam or angle shapes (H- or L-shapes) shall be large enough to allow free passage for at least one roller or guide shoe of 1½ in. (38 mm) diameter, and provide a clear contact surface width of ¾ in. (19 mm)

(3) round or oval shaped guides shall have a minimum diameter of 2 in. (50 mm)

(c) Platform-Mounted Tracks (Button Guide System). This guide system, as opposed to para. 2.3.3.2(b), has the external tracks attached to the platform. The tracks engage vertical rows of buttons (anchors) on the facade as the platform is raised or lowered. The building anchors shall be located such that as the platform is raised or lowered, each platform track will engage at least two building anchors maintaining the platform to the facade in a smooth uniform manner. Platform tracks shall not exceed 13 ft (396 cm) in length and shall comply with the minimum guide track dimensions in para. 2.3.3.2(a).

NOTE: Joints in building tie-in-guides shall be mechanically aligned to prevent interference with the proper functioning of the equipment's guide assemblies. Joint openings should be limited to ¾ in. (19 mm) maximum.

2.3.3.3 Intermittent Stabilization Systems. Intermittent stabilization systems shall conform to the following standards:

(a) The system shall keep the equipment in continuous contact with the building facade and shall prevent sudden horizontal movement of the platform. The system may be used together with continuous positive building guide systems using tie-in-guides on the same building, provided the requirements for each system are met.

(b) The maximum vertical interval between building anchors shall be three floors or 50 ft (15.3 m), whichever is less.

(c) The anchors shall be positioned horizontally on the building face so as to be symmetrical about the platform suspension ropes, either inboard of the suspension ropes or outboard.

(d) Building anchors shall be easily visible to workers and shall allow a stabilizer tie attachment for each of the platform suspension ropes at each vertical interval. If more than two suspension ropes are used on a platform, only the two building-side suspension ropes shall require a stabilizer attachment.

(e) Building anchors that extend beyond the face of the building shall be free of sharp edges or points.

(f) Building anchors shall be capable of sustaining without failure at least four times the maximum anticipated load to be applied or transmitted to the anchors. The ultimate design load for each anchor shall be a minimum of 600 lb (270 kg; 4:1 safety factor), applied laterally or perpendicularly, but not simultaneously.

2.3.3.4 Standing (Static) Line. Standing (static) line scaffold stabilization systems shall be prohibited. A *standing (static) line* is a vertical rope used to stabilize the platform during its travel and/or positioning.

2.3.4 Perimeter Guarding of Elevated Areas. Elevated working areas over 4 ft (1 219 mm) above an adjacent working area on all buildings or structures shall be provided with perimeter protection consisting of a parapet or guardrail system, or a combination of both.

Where building parapet heights exceed 6 ft (1.8 m), special provisions shall be employed to provide a safe means of access to the facade for rigging purposes if such access is necessary for performance of the work. Rolling scaffolds or ladders shall not be used unless they are compatible with and dedicated to the roof and exterior maintenance systems they are to service.

The top of the perimeter protection shall be at least 42 in. (1 067 mm) above the working area on which equipment is installed or which provides access to or egress from the equipment. Where workers approach the face of the building, the inboard edge protection of the elevated working area shall not be more than 18 in. (457 mm) inboard from the building or structure's facade.

Special architectural features such as building cornices, eyebrows, and sunscreens shall be reviewed on an individual basis.

2.3.4.1 Rigging, Accessing, and Servicing Platforms. Rolling scaffolds or ladders shall not be used for accessing, rigging, or servicing powered platforms unless they are dedicated to the roof and the platform system they are designed to service. Accessing and servicing platforms shall comply with the requirements of the standards that pertain to them. (08)

2.3.5 Equipment Structural Support. When welding is employed for making structural connections for the equipment installation, the welding shall be done by welders qualified under American Welding Society standards. All welds shall be visually inspected, and welds specified by the registered professional engineer shall undergo nondestructive testing. A report of inspection, together with any test reports, shall be made part of the installation design record.

When used, imbedded tie-down anchors shall be of noncorrosive metal. The anchor installation shall be inspected for compliance with design requirements by a registered professional engineer. The report of inspection shall be included in the installation design record. Anchors should be tested at the discretion of the inspecting engineer.

2.3.6 Electrical Requirements. The electrical design shall be in accordance with the following:

(a) General design shall be in accordance with the applicable requirements of the National Electrical Code edition in effect at the time of making the design, e.g.,

grounding, wire sizes, motors, controls and control wiring, and enclosures.

(b) When full load is applied to the circuit, building conductors shall be of such capacity that not more than a 3% voltage drop from nominal equipment requirements shall occur at each building outlet.

(c) Communications and power connections shall be weatherproof and provided with locking type connectors. They shall be protected from damage and abrasion.

(d) Each communication and power outlet shall be provided with an adjacent strain relief anchor to prevent force from being applied to the outlet or to the conduit leading to the outlet by movement of the equipment.

(e) The equipment power supply shall be from an independent electrical circuit that shall remain separate from all other equipment within or on the building, except hand tools used in conjunction with the equipment. If the building is provided with an emergency power system, the equipment circuit may be designed so it may be connected to the emergency circuit.

(f) The power circuit shall be provided with a cutoff switch that can be locked in the "OFF" position. To allow the equipment operators access to the switch, it shall be conveniently located relative to the primary operating area of the equipment.

(g) Power and communication outlets shall be located at the approximate elevation of the primary equipment operating area. The outlets should be located so that no more than 100 ft (30.38 m) of supply cable need be used for the horizontal area being traversed.

(h) The power circuit shall contain a separate equipment electrical grounding conductor.

(i) Carriage track systems shall be electrically connected to an earth ground.

(j) Communication Facilities. A two-way voice communication system shall be provided between the equipment operators and a manned station while the working platform is in use. The communication facility shall be operable and manned at all times when the equipment is being used.

2.3.7 Miscellaneous Requirements

(a) Cable Stabilization, Other Than for Suspension Wire Ropes. For equipment installations where the vertical travel of a manned platform exceeds approximately 200 ft (61 m), a means shall be provided to stabilize separate hanging lifelines, and all cables not in tension, to restrict their displacement by wind or any other force. Stabilization means shall be provided for each 200 ft (61 m) of vertical travel of the platforms. The means of stabilization may be independent of the building face being serviced.

For equipment installations where constant tension is maintained in the suspended cables, and the vertical travel of a suspended manned platform exceeds approximately 600 ft (183 m), means shall be provided to stabilize the cables at intervals of approximately 600 ft (183 m) or less.

(b) Emergency Recovery Requirements. Procedures shall be provided for the safe emergency recovery of persons working from suspended equipment, or other types of installations, in the event of power failure, equipment failure, or disability of any nature. Emergency procedures shall be included in the operating and maintenance instructions for the installation.

(c) Building Requirements. All repairs or major maintenance required on those portions of the building that provide primary support for the equipment shall be performed under the direction of a registered professional engineer. Upon completion of repairs or maintenance, the engineer shall provide the building owner with certification that the repair or maintenance has been properly accomplished and that the building has been restored to meet the requirements of this Standard.

3 EQUIPMENT DESIGN AND CONSTRUCTION REQUIREMENTS

3.1 General

The design, construction, and installation of equipment under this Standard shall be governed by the requirements imposed for its use and by the environmental factors to which the equipment will be exposed.

3.1.1 General Design Requirements. The design of the equipment shall incorporate all features necessary to provide the degree of safety required by this Standard. In accordance with sound engineering and design practice, materials and components shall have essential properties needed to meet all requirements imposed by the purpose they are to fulfill.

Domestically produced equipment shall be designed by or under the direction of a registered professional engineer. The design of foreign produced equipment, including materials, welds, and accessories, shall be verified and tested by or under the direction of a registered professional engineer.

The design requirements for each equipment installation, excluding wire ropes used for suspension, shall be based on the limitations (stresses, deflections, etc.) established by nationally recognized standards promulgated by the agencies listed in para. 1.4, or by equivalent standards acceptable to the enforcing agency. The design standards used shall be recorded in the equipment design record. A copy of the record shall be provided to the installation owner.

3.1.2 Climatic Conditions. For exterior installation in locations where freezing weather or other adverse climatic conditions exist, precautions shall be taken to minimize the hazards of such conditions that may affect the installation.

3.1.3 Material Requirements

(a) Structural and mechanical components shall be fabricated from structural materials that will withstand anticipated conditions including dynamic forces and climatic extremes.

(b) Unless filled with foam, the use of pneumatic tires to transport equipment is prohibited.

3.1.4 Construction Requirements. Bolted connections shall be of a secured type, i.e., each bolt and/or nut shall be either self-locking or shall be secured by other means to prevent loosening by vibration.

For domestically manufactured equipment, when welding is employed for structural connections, the welding shall be done in strict conformance with American Welding Society standards.

For foreign manufactured equipment, when welding is employed for structural connections, the registered professional engineer shall ascertain that weld designs employ weld configurations, materials, sizes, and processes that are listed by the American Welding Society. Foreign materials are acceptable for welding when subjected to criteria applying to ASTM designated materials with equivalent properties for strength and welding. In addition, the registered professional engineer shall secure certified written proofs from the manufacturer that welders have been tested and found qualified and that quality control measures have been employed that satisfy the intent of American Welding Society standards.

All structural welds shall be visually inspected for compliance with design requirements and shall be subjected to nondestructive testing. Inspection and test records shall be maintained by the equipment manufacturer for domestically manufactured equipment and by the engineer for foreign manufactured equipment.

3.1.5 Installation Documentation. The owner of the equipment or installation shall initially be provided by the equipment supplier with the following documentation constituting the equipment design record:

(a) sufficient engineering data, consisting of dimensions, loading, and operation parameters, to generally delineate the equipment and its contact with the building

(b) operating instructions (see Mandatory Appendix I for the minimum requirements in an operating manual)

(c) maintenance instructions

(d) certification by the manufacturer that the equipment has been designed, manufactured, and tested in accordance with this Standard, and certification by a registered professional engineer that the equipment has been installed and tested in compliance with this Standard

All installation documentation shall be kept on file on site by the installation owner and shall be made available to users of the installation and regulatory agencies.

3.1.6 Identification Components. Components of the installation shall be permanently and visibly numbered or otherwise identified. All numbers or letter markings shall be not less than $\frac{1}{2}$ in. (12.7 mm) in height. The application of the identification shall not compromise the corrosion resistance of the item. Specifically excluded are intermittent stabilization anchors and guide tracks. Components include, where applicable

(a) roof carriage
(b) davit
(c) socket
(d) each module of a platform
(e) pedestal/base
(f) TLG
(g) outrigger
(h) trolley
(i) roof tieback anchor

3.2 Specific Design Requirements

3.2.1 Design Loads. Design loads shall include static and dynamic loads, the load of the suspended or supported portion of the equipment, wind forces defined in paras. 3.2.4 and 3.2.5, and forces due to adverse conditions.

NOTE: Design load information shall be transmitted to the architect or engineer responsible for the design of the building and equipment supporting structures.

3.2.1.1 Dynamic Load. A dynamic load, equal to at least one-half the static load, shall be considered as the impact load to be included in the resultant load of the suspended or supported equipment as required by para. 3.2.1. In the event an installation could be subjected to a larger dynamic load, the larger value shall be considered.

3.2.1.2 Wind Loads (Exterior Installations). Wind forces, established in para. 3.2.4, shall be used for consideration of stability and stresses during operation and storage of the equipment. Wind forces shall be applied in the least favorable direction in each calculation in which wind forces are considered.

3.2.1.3 Additive Loads. The resultant design load shall be the summation of the static and the dynamic loads or the static and the wind loads, whichever results in a larger value or produces the more adverse condition.

3.2.2 Live Load and Allowable Stresses. The minimum live load for each occupant of a suspended or supported platform shall be 250 lb (113.4 kg). Platforms may be designed and rated for a capacity larger than that required for the minimum number of occupants. (08)

Allowable stresses in all structural components shall not exceed those permitted in para. 3.1.1 under the worst possible combination of operating and wind loads.

Stress increase shall be permitted only for out-of-service equipment exposed to storm winds.

Additionally, there shall be special consideration for installations in hurricane areas that may have supplementary wind and debris and/or seismic building code jurisdictional requirements.

3.2.3 Allowable Deflections. The deflections of all structural components and connections shall be limited so as not to adversely affect the safe operation of any portion of the equipment and shall not exceed those specified in the standards referred to in para. 3.1.1.

The calculated deflection of any structure or component shall not induce stresses greater than permitted by this Standard.

3.2.4 Wind Loads. Suspended or supported units, carriages, supporting structures, and operating mechanisms shall be designed and constructed to withstand the following wind loads applied in the least favorable direction:

(08) *(a)* Those parts of the equipment and installation that remain in place, exposed to the wind when not in service, shall be designed for forces produced by storm winds. Wind velocity shall be taken as not less than 75 mph (33.6 m/s) at 30 ft (9.1 m) above grade and shall be adjusted for the height of the equipment and for local conditions including seismic and wind loads as determined by the local building code jurisdiction. There shall be special consideration for installations in hurricane areas that may have additional wind and debris building requirements.

Velocity pressures shall be corrected for member shape and shielding effects. In lieu of exact analysis, the equipment and installation may be designed for a wind pressure of 40 psf (1 915 Pa) for the first 200 ft (61 m) of elevation plus 3.5 psf (167.6 Pa) for each additional 100 ft (30.5 m) above 200 ft (61 m) applied to the projected area.

(b) All parts of the equipment and installation exposed to wind during operation shall be designed for wind forces produced by winds of 50 mph (22 m/s) for all elevations. Velocity pressures shall be corrected for member shape and shielding effects. In lieu of exact analysis, the equipment and installation may be designed for a wind pressure of 10 psf (480 Pa) applied to the projected area for all elevations.

(c) All values specified are minimum and shall be adjusted upward, when necessary, to meet local conditions.

3.2.5 Projected Exposed Area (Exterior Installations). The exposed area subjected to wind pressure shall be the total area of all portions of the equipment exposed to wind pressure. These areas shall be projected on a plane perpendicular to the direction of the wind. No shielding effect of one element by another shall be considered where the distance between the elements exceeds four times the smaller projected dimension of the windward element.

3.2.6 Acceptable Means of Suspension. The following are the acceptable means to be used for the suspension of equipment:

(a) carriage as specified in para. 3.3

(b) outriggers as specified in para. 3.4

(c) trolley system supported from a permanent overhead structure as specified in para. 3.3.9

(d) davits as specified in para. 3.5

(e) equivalent systems that meet the technical and safety requirements of this Standard

3.2.7 Height Restriction. Buildings with vertical platform travel exceeding 490 ft (150 m) shall employ powered equipment with the hoists located at the roof level.

3.2.8 Movement and Positioning. The manual effort required to move, assemble, or operate equipment shall not exceed 70 lb (33 kg) per person, except as otherwise stated in the Standard. (08)

3.3 Carriage

Unless employing a suspension system listed in para. 3.2.6(b), (c), or (d), a carriage or equivalent shall be provided, regardless of the elevation of the point of suspension or support, whenever it is necessary to traverse the suspended or supported portion of the equipment horizontally to a working or storage location or when access to or egress from the equipment is at approximately the elevation of the point of suspension.

3.3.1 Movement and Positioning. The horizontal movement of a carriage shall be controlled so as to ensure safe movement and accurate positioning.

Powered carriages shall not exceed a traversing speed of 50 ft/min (0.25 m/s). Manually propelled carriages shall not require a horizontal force in excess of 100 lb (445 N) per person to initiate a traversing movement.

3.3.2 Restriction of Movement. Structural stops or curbs shall be provided to prevent the traversing of the carriage beyond its designed limits of travel. Such stops shall be capable of withstanding the inertia force of the moving mass.

3.3.3 Operating Controls for Powered Roof Carriage

(a) Traversing controls shall be of a continuous-pressure weatherproof type. Multiple controls when provided shall be arranged to permit operation from only one control station at a time.

(b) In the case of suspended equipment, the operating control(s) shall be so connected that traversing of a carriage is not possible until

(1) the suspended portion of the equipment is located at its uppermost designed position for traversing and is free of contact with the face of the building or building guides, except as noted in para. 3.8

(2) all protective devices and interlocks are in the proper position to allow traversing of the carriage

3.3.4 Stability. The stability factor of each system shall be calculated or 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's stability may be obtained by gravity, by an attachment to a structural support, or by a combination thereof.

(a) For horizontal traversing, considering a 10 psf (480 Pa) wind load applied to the traversing unit, the stability factor shall not be less than 2, including the effects of impact.

(b) For the operational mode, considering the wind load defined in para. 3.2.4(b), the stability factor shall be 4.

NOTES:

(1) At no time shall the rated load be able to be placed in its most outboard position without a system stability factor of 4 against overturning.

(2) When imbedded tie-down anchors are used to obtain the required system's stability, the anchors shall meet the requirements of para. 2.3.5.

(08) *(c)* When the equipment is in a nonuse or stored position, it shall be capable of withstanding the highest wind velocities expected for the specific area, as noted in para. 3.2.4(a).

3.3.5 Required Features

(a) An automatically applied braking or locking system shall be provided to prevent unintentional traversing of power traversed carriages.

(b) A manual or automatic braking or locking system shall be provided to prevent unintentional traversing of manually propelled carriages.

(c) A means to lock out the power supply shall be provided on the carriage to prevent its unauthorized use.

(d) Enclosures or guards shall be provided to prevent accidental contact by personnel with moving parts or pinch points.

3.3.6 Access and Egress. Safe access to and egress from the carriage shall be provided from a safe-boarding area. If the carriage traverses an elevated exposed area, any operating areas on the carriage shall be protected by a guardrail system in compliance with para. 2.3.4. Any access gate provided shall be self-closing and self-latching or provided with an interlock.

3.3.7 Maintenance and Storage. A maintenance and storage area in compliance with para. 2.3.4 shall be provided.

3.3.8 Workstation Identification. Each carriage workstation position shall be identified by location markings or position indicators as required by the equipment design.

3.3.9 Trolley System. A track-mounted trolley system, supported from an overhead structure, may be used as a means of suspension, under the definition of a carriage, provided that the installation complies with the requirements of this Standard and with the following specific requirements:

(a) Each installation shall be provided with a means for safe egress of personnel in the event of a loss of power to the equipment.

(b) A maintenance area shall be provided to permit safe access to the trolley(s).

(c) Means shall be provided to prevent the equipment from unintentionally traversing in a horizontal direction.

(d) Manually propelled trolleys shall require a maximum of 40 lb of pull to move the trolley along its track.

3.4 Outriggers (Beam Type)

Outriggers may be used on buildings to support ground-rigged self-powered platforms where the point of suspension does not exceed 130 ft (39.6 m) above a safe surface unless a continuous means of engagement is provided on the face of the building where the maximum rise of the platform shall be limited to 300 ft (92 m).

The initial installation shall be designed by, or under the direction of, a registered professional engineer to comply with the following safety requirements:

(a) Platforms shall be required to be disengaged from the outriggers after each day's use or the platforms shall be secured and stored at grade with the power supply disconnected. All suspension wire ropes shall be attached to their outriggers with forged double-locking snap hooks or equivalent devices.

(b) All outriggers shall be secured to a certified anchorage on the building during the entire period of use. The anchorages shall provide a stability factor of 4 against overturning or upsetting. Each outrigger, when installed on buildings erected prior to the effective date of this Standard, may be stabilized by rigid counterweights secured to its inboard ends. It shall also be tied back to a certified anchorage on the building with a minimum of $\frac{5}{16}$ in. (8.0 mm) wire rope. The counterweights shall provide a stability factor of 4 against overturning or upsetting of the outrigger. Each counterweight shall be permanently identified as to its weight.

(c) Access and egress shall be from a safe surface such as grade or a roof surface below the elevation of suspension. The installation shall be designed to prevent access to or egress from the platform at the elevation of suspension.

(d) Each outrigger shall be designed for lateral stability to prevent rollover.

(e) Each outrigger shall be designed to support an ultimate load of four times the rated capacity of the hoist to be used with the outrigger.

(f) Each outrigger shall be so located that the suspension wire ropes for two-point suspended platforms are hung parallel to each other.

3.5 Davits and Rotatable Outriggers

Each installation shall be designed by, or under the direction of, a registered professional engineer and shall comply with the following requirements.

3.5.1 Types of Installations

(a) Davit Installation. The scaffold platform can be raised above the building face being serviced and translated inboard for storage, rigging, and access to or egress from the scaffold platform. For this type of installation

(1) access to and egress from the platform shall be from a safe surface. Access or egress shall not require persons to climb over a building's parapet or guard railing.

(2) the scaffold platform and davits shall be provided with wheels, casters, or a carriage for traversing horizontally to workstations or storage positions.

(3) the davits shall be high enough to prevent a suspended scaffold from striking any building components.

(4) davits shall be provided with bearings that allow the davits to be readily rotated.

(b) Rotatable Outrigger Installation. The scaffold platform cannot be raised above the building face being serviced for storage, rigging, and access to or egress from the working platform. For this type of installation

(1) the point of suspension shall not be more than 130 ft (40 m) above a safe surface unless a continuous means of engagement is provided. In the latter case, the maximum rise of the platform shall be limited to 300 ft (92 m).

(2) access and egress shall only be from an area such as grade floor or a roof surface below the point of suspension and shall preclude persons climbing over a building's parapet or guard railing for access to or egress from a scaffold.

(c) Davit and Rotatable Outrigger Installations Requiring Relocation of Davits or Outriggers to Other Work Locations on Same Elevation. For this type of installation

(1) the davits or outriggers shall be inserted into sockets secured and rigged with the suspension ropes before being raised to their vertical position

(2) the davit and outrigger sockets shall be positioned to prevent their being raised at less than 7 deg in respect to the facade being serviced

(3) davits shall be provided with wheels or a cart to assist in traversing

(d) For all davit and rotatable outrigger installations

(1) the sockets shall be made from structural steel hot-dipped galvanized or other corrosion-resistant material

(2) all bolts, nuts, and pins shall be made from stainless steel

(e) High-Profile Davits. [See para. 3.5.1(a) for characteristics] Davits that are not permanently dedicated to one specific socket or base location shall have a maximum reach of 8 ft 6 in. (2 600 mm).

(f) Davits that are not permanently dedicated to one specific socket or base location shall have a maximum, fully assembled weight of 300 lb (135 kg).

3.5.2 Design Consideration. Each davit or rotatable outrigger installation shall be designed and installed to ensure that it has a stability factor of 4 against failure based on the rated capacity of the hoist being used.

The following shall be considered in the design calculation of stability:

(a) the rated load considered with the platform in its most outboard position with respect to the davit or outrigger anchorage

(b) the inclusion of moments due to appropriate wind forces for exterior installations, as defined in paras. 3.2.4 and 3.2.5

(c) dynamic loads that need not be considered concurrently with wind loads

(d) deflection of the davit(s) due to the foregoing

3.6 Hoisting Machines

A hoisting machine shall be provided for all installations where a suspended or supported portion of the equipment is required to be raised and lowered.

Each hoisting machine shall require the application of a motivating force to raise and lower its suspended or supported load and shall be designed and constructed to arrest any overspeed descent of the load.

To be acceptable, hoisting machines shall meet the specific design requirements described in paras. 3.6.1 through 3.6.8.

3.6.1 Prime Mover. Each hoisting machine shall be provided with a source of power sufficient to raise and lower 125% of the hoist's rated load.

No hoisting machine shall be capable of exerting power sufficient to exceed three quarters of the system moment resisting overturning or one-third of the catalog strength of the support ropes.

(a) Electric Motors. Electric motors, used as the prime mover for a hoist, shall be protected with a current overload device or a circuit protected by a current overload device located on the hoist or on the carriage. Motors shall be of weatherproof design for exterior installations. Each motor shall be provided with the manufacturer's nameplate listing all pertinent characteristics.

(b) Air, Liquid Propane, Diesel, and Hydraulic Motors, or Manual Force. These power sources may be used as the motivating power for installations provided that the application complies with all requirements of this Standard.

(c) Gasoline Motors. Gasoline motors shall not be used as the prime mover for any hoist or placed on any platform.

3.6.2 Speed Reducers. Speed reducers shall be of a positive type. Friction-type speed reducers shall not be used with any hoist.

(a) Speed reducers shall be directly connected to the drum or elevating mechanism of the hoisting machine. They shall not be connected by means of chains, belts, clutches, shear pins, or friction-type devices.

(b) Speed reducers of the gear-reduction type shall conform to the standards established by the American Gear Manufacturers Association. Each shall have a service factor of not less than 1.2.

3.6.3 Gearing. The rating, strength, and surface durability characteristics of gearing shall be in conformance with good engineering practice and shall comply with applicable standards of the American Gear Manufacturers Association.

3.6.4 Lubrication Provisions. Each component of each hoisting machine shall be provided with an adequate means of lubrication to ensure that all moving parts are lubricated.

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

All oil-lubricated gear boxes shall be provided with means for determining that the proper quantity of lubricant is contained in the gearbox.

3.6.5 Guards. All moving parts shall be so enclosed or guarded as to adequately reduce the likelihood of injury to persons who may accidentally contact the parts.

3.6.6 Shafts, Fillets, Keys, and Splines. Fillets shall be provided as points of change in the diameter of hoisting machinery shafts and sheave shafts to prevent excessive stress concentration in the shafts. Fitted keys, splines, bolts, or machine screws shall be used in all connections subject to torque. All threaded fasteners shall have an antiloosening device. Threaded areas of bolts and screws shall not be subjected to shear loads. Set screws shall not be used to transmit torque.

3.6.7 Drums and Sheaves. Hoisting drums and sheaves shall be designed for use with wire ropes of not less than $\frac{5}{16}$ in. (7.94 mm) diameter.

(a) Winding Drums. Each winding drum shall be provided with a positive means of attaching the wire rope to the drum. The drum portion of the attachment shall be capable of developing at least 4 times the rated capacity of the hoist. The wire rope portion of the attachment shall develop at least 80% of the wire rope catalog strength.

(1) Each drum shall be provided with a means to level wind the suspension wire rope.

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

(3) On drums where the suspension wire rope is not maintained under tension at all times, a means shall be provided to prevent the rope from moving off the drum ends or causing a loose wrap on the drum. A loose wrap detector shall be provided which, if actuated, will shut off power to the hoist and actuate the hoist's primary brake. All hoists shall be provided with a means to maintain tension in the wire rope during rerigging.

(4) Hoist drums shall have a pitch diameter at least 10 times the diameter of the suspension wire rope.

(b) Traction Hoists. Each traction drum or sheave hoist shall be constructed to depend on a continuous force from the suspension wire rope to ensure reliable friction contact between the rope and the drum or sheave under all conditions.

Tail line counterweights are not acceptable as a means of obtaining traction. Further, each traction hoist shall be designed and constructed so that the suspension wire rope cannot be unintentionally disengaged from the hoist.

(c) Traction Drum Hoists

(1) Each traction drum shall be provided with grooves, or equivalent means, to ensure that a wearing surface on the drum will not have a detrimental effect on the suspension wire rope.

(2) Each drum shall have a pitch diameter not less than 18 times the diameter of the wire rope used.

(3) Transfer drums, used to transfer the wire rope from one drum groove to an adjacent drum groove, shall have a pitch diameter not less than 10 times the diameter of the suspension wire rope used.

(d) Traction Sheave Hoists. Each traction sheave (single groove) shall have a pitch diameter not less than 22 times the diameter of the wire rope used.

(e) Sheaves. Sheaves that change the direction of the suspension rope shall have a pitch diameter not less than 10 times the diameter of the rope. Sheaves used with combination cables shall have a pitch diameter at least 22 times the rope diameter.

(f) Fairlead Rollers. Fairlead rollers that change the direction of the wire rope less than 10 deg shall be at least 3 times the nominal rope diameter.

3.6.8 Brakes. All hoisting machines shall be provided with at least two independent brakes, which shall comply with the following:

(a) Primary Brake

(1) All hoists shall be provided with a primary brake that automatically engages whenever power to its prime mover is interrupted.

(2) The primary brake shall be rated to stop and hold not less than 125% of the rated load of the hoist but in no case less than the maximum lifting capacity of the hoist.

(3) Each primary brake shall be directly connected to the drive train of the hoist and shall not be connected

to the drive train by belts, shear pins, clutches, roller chains, or friction devices.

(b) Secondary Brake

(1) Each hoist shall be provided with an automatic secondary brake that will stop and hold at least 125% of the rated load under an accelerating or overspeed condition. When the secondary brake is actuated, it shall stop and hold the platform within a vertical distance of 24 in. (610 mm).

(2) The secondary brake shall act directly on the suspension wire rope on a traction hoist. On a winding drum type hoist, the secondary brake shall act either on the suspension wire rope or on the drum or drum extension. Failure of the hoist drive train shall not prevent operation of the secondary brake. The actuating mechanism of a secondary brake may be separate from the brake.

(3) The secondary brake shall not be used to stop the hoist except under overspeed or abnormal conditions. It shall not be bypassed or prevented from operating by any other device (during overspeed conditions). In normal operation, the secondary brake shall not engage before the hoist is stopped by the primary brake.

(4) Every secondary brake shall be periodically tested according to the manufacturer's recommendations and in accordance with para. 5.1.4.

(5) The design and installation of every secondary brake shall be such that the triggering mechanism is enclosed.

(c) Overload Protection. Overload protection shall be provided in the hoisting or suspension system to protect against the equipment operating in the up direction with a load in excess of the capacity of the hoist braking systems.

(d) Braking Loads. Dynamic loads induced by activation of primary or secondary braking systems shall be accounted for in the design and installation of the equipment.

(e) Braking Actuation Results. Actuation of the secondary brake shall not

(1) damage the suspension wire rope

(2) impose an overturning moment in excess of 75% of the system's stability

(3) impose stresses in structural members in excess of 75% of their yield strength

(f) Secondary Brake Test. Prior to use on an installation, a secondary brake shall be dynamically tested. (The test on a prototype unit will be deemed as compliance with this requirement.)

3.7 Suspended Equipment

3.7.1 General Requirements. The design shall comply with the provisions set forth in para. 3.1.1.

3.7.2 Load-Rating Identification. Each suspended unit of an equipment installation shall be provided with a load-rating plate, conspicuously located, stating the weight of the unit and live load rating of the suspended unit. The load-rating plate shall be of a noncorrosive, permanent-type, compatible material and securely fastened to the unit. All letters and figures on the plate shall be made by printing, stamping, or etching, or shall be cast on the surface of the plate. The letters and figures shall be not less than ¼ in. (6.35 mm), with the load indicated in ½ in. (13 mm) high figures. The letters and figures shall be maintained in a legible condition.

3.7.3 Suspended Unit Stabilization Requirements. When the suspension points on a suspended unit are not at the unit ends, the unit shall be designed to be continuously stable with a factor of 1½ to 1 against upsetting under all conditions of use.

3.7.4 Building Contact Members

3.7.4.1 General. Guide rollers, guide shoes, or building face rollers shall be incorporated on the suspended unit of all installations. Guide rollers and guide shoes shall be designed to compensate for normal variations in building dimensions and to permit horizontal leveling of the suspended unit.

All rollers and shoes for vertical travel in guides shall be of the positive engaging type so as to minimize horizontal displacement of the suspended unit longitudinally or away from the building face being serviced.

All suspended units shall be provided with face rollers to prevent the unit from abrading the face of the building when there is a possibility of the unit contacting the face.

3.7.4.2 Entrance of Guide Rollers or Shoes Into or Onto Building Guides. When guide extensions or other mechanical means are used to align the suspended unit with the building guides prior to descent or ascent, the equipment shall be operated at its lowest descent or ascent speed for making the engagement with the building guides.

3.7.5 Manned Suspended Equipment (Working Platform)

3.7.5.1 Enclosures. All suspended working platforms shall be provided with a guardrail system on all sides, capable of sustaining a 200 lb point load applied horizontally at any point along the top guardrail. The system shall consist of a 42 in. (1 067 mm) high enclosure on the ends and outboard side. The inboard side shall not be less than 36 in. (914 mm) high. The enclosures shall consist of a top guardrail, a midrail, and a 4 in. (102 mm) high toeboard. The areas between the guardrail and toeboard on the ends and outboard side, and the area between the midrail and toeboard on the inboard sides, shall be closed with a material capable of withstanding a load of 100 lb (45.36 kg) applied horizontally over any area 12 in.^{2} (305 mm^2). The material shall contain no opening large enough to allow the passage of a ball 2 in. (51 mm) in diameter. All connections

used in fabricating the guardrail system shall be of the positive type. Set screws and friction connections are unacceptable.

3.7.5.2 Platform Construction. The working platform shall be constructed of a structural grade material.

It shall not be less than 24 in. (610 mm) wide and shall be provided with a minimum of a 12 in. (305 mm) wide passage at or past any obstruction on the platform.

The flooring shall be of a slip-resistant type and shall contain no opening that would allow the passage of a 1 in. (25 mm) diameter ball. If larger openings are provided, they shall be protected by placing a screen under the opening. The screen shall have holes that will reject a 1 in. (25 mm) diameter ball.

The working platform shall be provided with a means of suspension that will restrict the platform's inboard to outboard roll about its longitudinal axis to a maximum of 15 deg from a horizontal plane when moving the live load from the inboard to the outboard side of the platform.

3.7.5.3 Cable Storage. Any power, control, or communication cable suspended from above the platform shall be provided with a means of storage to prevent accumulation of the cable on the floor of the platform.

3.7.5.4 Cable Stabilization. A means shall be provided for the stabilization of all suspended cables and lines, other than the suspension wire ropes, at intervals not to exceed 200 ft (61 m) for nontensioned cables and 600 ft (183 m) for cable under tension from an external load.

3.7.5.5 Controls for Vertical Movement

(08) *(a)* All operating controls for the vertical travel of a platform shall be located on the platform and shall be of the constant-pressure type. Foot pedals or treadles, if used, shall have a protective guard in place to prevent inadvertent activation.

(b) Every manned platform shall be provided with an emergency means of interrupting the power supply at the operating stations on the platform.

(c) The maximum rated speed shall be compatible with the equipment provided and with the building guides, but in no case shall exceed 50 ft/min (0.254 m/s) with single speed hoists, or 75 ft/min (0.381 m/s) with multispeed hoists. In the latter case, the starting speed shall not exceed 50 ft/min (0.254 m/s).

3.7.5.6 Communications Requirements. A two-way radio or a two-way telephone system shall be provided for every manned platform. Communications shall be between the manned platform and a station that is manned at all times while the working platform is in use.

3.7.5.7 Provisions for Tools and Items. Tools, water tanks, and other items shall be secured to prevent their movement or accumulation on the floor of the platform.

3.7.5.8 Fire Protection. A manually operated approved Type B-C portable fire extinguisher shall be securely attached on all manned platforms. Each extinguisher shall be properly maintained and provided with a durable maintenance inspection tag.

3.7.5.9 Access and Egress. Suitable runways, ladders, stairs, or platforms shall be provided for safe access to and egress from all manned scaffold platforms except for those that land directly on a safe horizontal surface. Any such means of access or egress, at an elevation of 30 in. (762 mm) or more above a safe horizontal surface, shall be provided with a guardrail system or handrails.

3.7.5.10 Fall Protection. All persons shall be provided with and shall use a personal fall protection system complying with ANSI Z359.1-1992 (R1999), Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components, or ANSI/ASSE A10.32-2004, Fall Protection Systems for Construction and Demolitions. Fall protection systems shall be engaged whenever a worker is exposed to the risk of a fall greater than 6 ft (1.6 m).

An independent vertical lifeline is required for each worker on suspended equipment where a failure of any support wire or its fastenings allows the suspended equipment to upset. Suspended equipment that does not upset as a result of failure of a support wire rope or its fastenings may incorporate a trolleyline complying with the following requirements:

(a) Trolleylines shall be designed to provide fall protection for workers.

(b) The trolleyline shall be not less than $\frac{5}{16}$ in. (8 mm) in diameter galvanized or stainless steel wire rope.

(c) The trolleyline, the platform members it is attached to, and its fastenings shall be designed to maintain a minimum safety factor of 2.

Separate hanging lifelines shall not be used when a powered platform has an overhead structure that would restrict emergency egress of the occupants. In such cases, the suspended equipment shall be designed such that the failure of any support wire rope shall not allow the suspended equipment to upset or fall. The occupants in such cases shall be secured to the suspended equipment by fall protection system equipment.

3.7.5.11 Single Point Suspended Working Platform. Single point suspended working platforms and powered boatswain's chairs shall comply with the following requirements:

(a) Each single point suspended system shall be equipped with a secondary wire rope separate from the suspension rope, which will not permit the working platform or chair to fall should there be a failure of the primary means of support.

(b) The operator(s) shall be secured to the work platform by a safety belt/harness and lanyard.

(c) The platform shall be stable. The design shall limit the maximum tilt by the movement of the operator to 15 deg.

(d) The platform shall be continuously engaged to a building guide(s), or intermittently secured as noted in para. 2.3.3.1(b)(1), during its total vertical travel on the face of the building.

3.7.5.12 Ground-Rigged Suspended Scaffold Platforms. Ground-rigged suspended scaffold platforms shall comply with all the requirements of para. 3.2.6 and the height limitations of paras. 3.4 and 3.7.5.

Ground-rigged suspended platforms shall be secured at the end of each day's use by one of the following methods:

(a) shall be disengaged from suspension points after each day's use

(b) shall be secured and stored at grade and disconnected from the power supply from within the building being serviced to prevent use by unauthorized persons

3.7.5.13 Powered Boatswain's Chairs. Powered boatswain's chairs shall not be used on buildings for window cleaning at elevations higher than 75 ft (22.86 m) above grade or another safe surface unless they are continuously stabilized.

3.7.6 Unmanned Suspended Equipment (Automatic Equipment — Unmanned Platform)

3.7.6.1 Enclosures. All suspended unmanned units shall be provided with a screened or solid enclosure to prevent any loose object on the unit from falling during use of the equipment.

3.7.6.2 Construction. The structural portion of the suspended unit shall be constructed of structural grade materials compatible with the conditions and service to be rendered by the equipment.

3.7.6.3 Cable Stabilization. A means shall be provided for the stabilization of all suspended cable, other than suspension wire ropes, at intervals not to exceed 200 ft (61 m) for nontensioned cable and 600 ft (183 m) for cable under tension.

3.7.6.4 Controls for Vertical Movement

(a) Operating Controls. All operating controls for the vertical travel of the suspended unit shall be located on the structural or carriage assembly from which the unit is suspended.

(b) Emergency Controls. Each unmanned suspended unit shall be provided with an accessible overriding emergency control at each operating station on the structural or carriage assembly from which the unit is suspended. The activation of said control shall prevent any further powered ascent or descent of the suspended unit. The emergency control shall be red and shall be labeled "EMERGENCY STOP."

(c) Obstruction Control. When a building on which the subject equipment is installed presents a hazard in the form of outsets, offsets, or projections in the normal path of vertical travel of the suspended unit, the unit shall be provided with an obstruction detection system.

3.7.6.5 Maximum Rated Speed. The maximum rated speed of vertical travel of any unmanned suspended unit shall be compatible with the equipment provided and the positive building guide system installed on the building, but in no case faster than 120 ft/min (0.6096 m/s).

3.7.6.6 Communication Requirements. Two-way voice communication equipment shall be provided at the operating area from which the unmanned unit is suspended. The communication equipment shall provide communication between the operating area and a station within the building, which shall be manned at all times when the equipment is in use.

3.7.6.7 Fire Protection. A manually operated approved Type B-C portable fire extinguisher shall be provided on the carriage assembly from which the unmanned unit is suspended. Every extinguisher shall be properly maintained and provided with a durable maintenance inspection tag.

3.7.6.8 Access and Egress

(a) Suitable access to and egress from all unmanned suspended equipment shall be provided for the operation, maintenance, and repair of the equipment. This shall include runways, ladders, or platforms that may be a part of the building.

(b) Every building that is provided with unmanned suspended equipment shall have provisions for the installation of manned equipment to be used for maintenance not performed by the unmanned equipment.

3.7.6.9 Upper Travel Limit Switches. Upper travel limit switches and/or detectors shall be provided to prevent the travel of a suspended unit beyond the normal upper limit of travel.

3.8 Remote Traversing Units

When necessary because of building design, equipment may be used that is designed to permit remotely controlled traversing of the roof carriage from the platform, with the platform at elevations on the building other than its uppermost position. Each installation of this type shall incorporate at least the following safety features:

(a) The roof carriage must move by power and be guided by tracks attached to the roof structure.

(b) When the platform is suspended more than 130 ft (30 m), it must move horizontally by a powerized platform drive, which must have enough traction to resist wind forces parallel to the building wall.

(c) The control system for the horizontal travel shall incorporate devices that automatically ensure that the position of the platform is maintained in proper relationship with the roof carriage.

(d) Limits to horizontal travel shall be provided by electrical or mechanical limit stops so that movement at any working position be no farther than required to accomplish the specified maintenance cycle.

(e) The horizontal control circuit shall contain the same degree of protection and redundancy as is required of a vertical control circuit.

(f) The normal traversing control station at the roof carriage must automatically be inoperative when the platform is not in its uppermost position.

(g) All requirements for continuous tie-in or stabilization of the platform must be met as the roof car and platform are traversed.

(h) Provision must be made to ensure proper automatic handling of the power cable.

(i) If horizontal guide members are used, provision must be made to prevent vertical loads from being imposed on them.

3.9 Supported Equipment

3.9.1 General Requirements. All supported equipment shall be adequate to support its rated load under any condition or position of loading, and shall comply with the provisions set forth in para. 3.1.

3.9.2 Unit Load Rating Identification. Each supported unit of an equipment installation shall be provided with a load-rating plate, conspicuously located, stating the unit weight and live load rating of the supported equipment.

The load-rating plate shall be made of a noncorrosive, permanent-type, compatible material and securely fastened to the unit. All letters and figures on the plate shall be made by printing, stamping, or etching, or shall be cast on the surface of the plate. The letters and figures shall be not less than ¼ in. (6.35 mm), with the load indicated in ½ in. (13 mm) high figures.

The letters and figures shall be maintained in a legible condition.

3.9.3 Building Contact Members

3.9.3.1 General. Friction wheels, cog wheels, or other means shall be incorporated to provide climbing traction between the supported equipment and the building guides. Additional guide wheels or shoes shall be incorporated as may be required to ensure that the drive wheels are continuously held in positive engagement with the building guides.

3.9.3.2 Entrance of Guide Shoes or Wheels Into Building Guides. At the point where the machine's guides enter the building guides, they shall be properly aligned by means of launch guide mullions indexed to the building guides and retained in alignment with the building guides.

3.9.3.3 Manned Equipment

(a) All the provisions of para. 3.7.5 shall apply to manned platforms on supported equipment.

(b) Manned supported equipment shall not be dependent upon friction to maintain its vertical position relative to the face of the building.

3.9.3.4 Unmanned Equipment. All the provisions of para. 3.7.6 shall apply to unmanned equipment.

3.10 Suspension Wire Ropes and Rope Connections

The specifications for the suspension wire ropes and connections recommended by the hoisting machine manufacturer shall be used for each specific installation.

3.10.1 Wire Rope Classifications. Preformed or nonpreformed, consisting of the following typical, but not necessarily all inclusive, wire rope classifications: 6 × 19, 7 × 19, 6 × 37, or 8 × 19.

NOTE: The first number of the identity refers to the number of strands contained in the rope. The second number of the identity refers to the general category of the number of wires contained in each strand.

A 19 wire strand may have 15 through 26 wires per strand, but not more than 12 outer wires in each strand. A 37 wire strand may have 27 through 49 wires per strand, but not more than 18 outer wires in each strand.

The strength member of a combination cable may be one of the following configurations:

(a) two or more layers of contrahelical galvanized armor wires

(b) wire rope strands as described above

(c) 12 × 19 combination cable

3.10.1.1 Grade of Wire Rope

(a) Carbon Steel. The minimum grade of wire rope permitted shall be improved plow steel.

Ropes shall be fabricated of either drawn galvanized or bright wire. Drawn galvanized wire rope shall be fabricated of individual wires on which the zinc coating has been applied to an intermediate size. The wire will then be drawn to finished size and to the same tolerances and with the same mechanical properties as uncoated wire of equal grade.

(b) Stainless Steel. Stainless steel of types 302/304, 316, or equivalent may be used as a means of suspension, but only when specified by the equipment manufacturer. The fatigue life of stainless steel may be less than carbon steel. Therefore, a more frequent routine inspection is required to determine the condition of any stainless steel rope used.

3.10.1.2 Rope Cores. Rope cores shall be fiber, independent wire rope, wire strand, or coated electrical conductors. Wire strand core shall be permitted in wire

ropes $\frac{3}{8}$ in. (10 mm) in diameter and smaller, but shall not be used in eight strand ropes.

Coated electrical conductors may be used as cores when specified by the equipment manufacturer and found acceptable by the wire rope manufacturer.

3.10.1.3 Rope Lubrication. The wire rope and the fiber core shall be lubricated at the time of manufacture. The lubrication on traction hoisting ropes shall be suitable for such service.

3.10.1.4 Design Factor. The minimum design factor of safety F shall be 10, and shall be calculated by the following equation:

$$F = SN/W$$

where

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

3.10.1.5 Minimum Diameter of Suspension Wire Ropes. Suspension ropes shall be sized to conform with the required factor of safety, but in no case shall the size be less than $\frac{5}{16}$ in. (8 mm) in diameter.

3.10.2 Limitations

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

3.10.2.2 Angular Displacement (Fleet Angle). The angular displacement (fleet angle) between any suspension wire rope and a hoist's drum shall not deviate more than 2 deg from perpendicular to the axis of the drum at the point of contact of the rope with the drum.

3.10.3 Rope Tag Data

(08) **3.10.3.1 Initial Rope Tag.** When suspension wire rope is used at a specific location and will remain in that location, a corrosion-resistant data tag shall be securely attached to one of the wire rope fastenings or to a substantial component of the suspended unit, readily visible to interested persons. This data tag shall bear the following wire rope data:

(a) length, ft (m)
(b) diameter including units, in. (mm)
(c) construction classification
(d) whether nonpreformed or preformed
(e) grade of material used
(f) manufacturer's catalog strength
(g) name of the manufacturer of the rope
(h) month and year the ropes were installed
(i) name of the person or firm who installed the ropes

3.10.3.2 Type of Tag. A corrosion-resistant data tag shall be used. The minimum height of the letters, stamped or etched, shall be $\frac{1}{16}$ in. (1.6 mm).

3.10.3.3 Rope Renewal Tag. A new tag shall be installed at each rope renewal. When ropes are resocketed, the original tag shall be retained and a supplemental tag showing the date of resocketing and the name of the person or firm who resocketed the ropes shall be provided.

3.10.4 Securing of Suspension Wire Ropes

3.10.4.1 Winding Drum Hoists

(a) Drum Ends. The drum ends of suspension wire ropes in winding drum machines shall be secured to the drum by specially designed clamps or one of the methods described in para. 3.6.7.

(b) Nondrum Ends. The nondrum ends of suspension wire ropes 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 nonswiveling or nonrotating type.

3.10.4.2 Traction Drum or Sheave Hoists

(a) Suspension Point. The 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 nonswiveling or nonrotating type.

(b) Tail Line

(1) Provisions shall be made to accumulate the tail line to prevent it from hanging below the platform.

(2) The free end of the tail line shall be provided with a fitting to ensure that the tail line cannot pass through the hoisting machine after the hoist has been reeved.

3.10.5 Types of Suspension Wire Rope Fastenings.

Fastenings shall be of the type and size specified by the hoisting machine manufacturer, shall be capable of developing not less than 80% of the rope manufacturer's rated catalog strength, and shall be one of the following types:

(a) individual tapered babbitted sockets
(b) zinced fastenings for wire rope $\frac{1}{2}$ in. (13 mm) diameter and larger
(c) swaged fittings
(d) other types of fastenings substantiated by tensile and fatigue tests conducted by a qualified laboratory
(e) forged "J" type rope clips, installed by a qualified person

NOTES:
(1) Types (a), (b), (c), and (d) shall be attached to the rope by the wire rope manufacturer, hoisting machine manufacturer, or another authorized representative.
(2) U-type wire rope clips shall not be used for fastening at the point of suspension.

3.10.6 Minimum Number of Wraps or Length of Suspension Wire Ropes

(a) Winding Drum Type Hoists. Each drum shall contain at least three wraps of the suspension wire rope

when the suspended unit has reached the lowest possible point of its vertical travel.

(b) Traction Drum and Sheave Type Hoists. Each such hoist shall be provided with a wire rope of sufficient length to reach the lowest point of vertical travel of the suspended unit with an excess length of at least 4 ft (1.21 m) more than that needed for the maximum vertical travel of the unit.

3.10.7 Lengthening or Repairing of Suspension Wire Ropes. The lengthening or repairing of suspension wire ropes by the joining of two or more lengths is prohibited.

3.10.8 Adjustable Shackle Rods (When Used). The nondrum ends of the suspension wire ropes, if required by the equipment design, shall be provided with individual shackle rods, or equivalent, that will permit individual adjustment of the lengths of the ropes.

3.11 Control, Power Circuits, and Components

Power and control circuits shall operate by hydraulic, pneumatic, electrical, or other suitable means that provide at least the minimum safety requirements as set forth in this Standard.

3.11.1 Electrical Grounding. All exposed noncurrent-carrying metal parts shall be grounded. The equipment grounding shall be done by means of a grounding conductor included in the power cable used for connecting the equipment to the supply. The grounding conductor shall be bonded to the equipment metal frame at one end and terminated in the grounding contact of an approved grounding-type attachment plug at the supply end. All exposed noncurrent-carrying metal parts of the equipment shall be considered grounded if secured to and in metal contact with the grounded equipment frame. Suspended equipment, if not directly connected to the supply, shall either be grounded by a grounding conductor in the cable used to carry control or power and communications between the suspended equipment and the carriage, may be grounded by the steel support ropes, provided that the steel ropes are properly bonded to both the suspended equipment and the grounded carriage to ensure a good grounding connection.

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

3.11.2 Electrical Wiring and Components

3.11.2.1 General Requirements. Electrical wiring and components shall conform to the requirements of the standards adopted by the National Fire Protection Association (National Electrical Code) or the JIC Electrical Standards for General Purpose Machine Tools (EGP 1-67), except as modified by this Standard.

3.11.2.2 Circuit Protection. The building power supply for the equipment shall be an independent circuit provided with a disconnect switch.

3.11.2.3 Guarding of Electrical Parts. An uninsulated live part that is a shock hazard shall be located or enclosed so that protection will be provided during normal operation.

3.11.2.4 Circuit Potential Limitations

(a) Circuit potential installed on a roof or other exterior location for service to the equipment shall not exceed 600 V, except when located at street or grade elevations, in which case the potential shall be limited to 230 V.

(b) Circuit potential to electrical components on manned platforms shall not exceed a nominal voltage of 480 single or polyphase.

(c) Circuit potential permitted for operating devices, limit switches, and electrical interlocks shall not exceed a nominal voltage of 230 single phase.

(d) Circuit potential limitations for hand power tools used on a working platform shall not exceed a nominal voltage of 230 single phase, which may be included in the equipment's power circuit.

3.11.2.5 Equipment Electrical Service System

(a) Receptacle and Cable System (Power). Provisions for electrical grounding shall be included with the power supply system. All supply receptacles shall be of a weatherproof type and shall be installed in accordance with para. 2.3.6.

(b) Runway Conductor System. Electrical runway conductor systems shall be of a type designed for use in exterior locations and shall be located so they are not subject to contact with accumulated snow or water. The conductors, collectors, and disconnecting means shall be in accordance with the applicable requirements of the National Electrical Code, as stated in para. 2.3.6.

(c) Power Supply for Maintenance Tools. Electrical power may be provided to outlets on the carriage and on the suspended or supported unit for operation of maintenance tools.

3.11.2.6 Traveling Cable

(a) Traveling Cable Provisions. Conductors for control, power, communication, signal circuits, and grounding connection may be run in the same traveling cable, provided that all conductors are insulated for not less than 600 V and all live parts of the equipment are insulated from ground for this voltage.

(b) Protection of Traveling Cable. Means shall be provided so that the traveling cable is protected against damage from striking the building or structure, overtensioning, or other causes (see paras. 2.3.6 and 3.7.6.3).

(c) Storage of Traveling Cable

(1) On manned platforms, cable shall be wound on drums designed for that purpose or placed in a container outside of the working area.

(2) On ground-rigged manned platforms, cable may be wound on drums at the boarding elevation or contained as described above.