



**ANSI E1.15 – 2006 (R2016)
Entertainment Technology –
Recommended Practices and Guidelines for
the Assembly and Use of Theatrical Boom &
Base Assemblies**

A reaffirmation of ANSI E1.15 - 2006

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Rig/1998-2032r12

Reaffirmed as an American National Standard by the ANSI Board of Standards Review
on 23 September 2016.



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Published by:

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The Rigging Working Group, which authored this standard, consists of a cross section of entertainment industry professionals representing a diversity of interests. ESTA is committed to developing consensus-based standards and recommended practices in an open setting.

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Interest category codes:

CP = custom-market producer DE = designer
 DR = dealer rental company G = general interest
 MP = mass-market producer U = user

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Foreword

The theatre and entertainment industry uses boom and base assemblies for the temporary attachment of lighting fixtures and their associated accessories. The assemblies usually consist of an assembly of pipe or tubing, and other fittings, attached to a weighted base. Often, the weighted bases are manufactured and supplied to others, who typically add components of their own selection to fabricate a finished assembly.

Before the publication of this standard, there was no uniformly accepted guideline or recommended practice that offered users of these assemblies a reliable reference concerning their manufacture, assembly, and use. Accidents, resulting in either injury to persons, or damage to property, have occurred due to the lack of such information. These guidelines have been written in an effort to reduce the potential for such incidents.

1 Scope

1.1 General

This document shall apply to the assembly and use of ground-supported variable and fixed-height lighting fixture suspension devices. These devices normally consist of a floor base (having a low center of mass or large included floor contact area), vertical members (often multiple short sections, sleeved to accommodate or otherwise allow extension to greater heights) and horizontal members for attachment of lighting fixtures or accessories or both.

1.2 Annex note references

This document uses annex notes to provide additional reference information about certain specific section requirements, concepts, or intent. Subject matter with a corresponding annex note reference is identified by the asterisk (*) symbol, and the associated reference text is found in the Annex Notes, identified with the referring text section number – e.g. an Annex Note to section 3.2 will be identified in the Annex Notes as A.3.2.

1.3 Scope Exclusions

The following devices are not within the scope of this document:

- a. Towers, ground-support structures, lifts, and other devices that use winches (or similar mechanisms) to gain a mechanical lifting advantage;
- b. Tripod or other similar lightweight stands;
- c. Stands with bases using casters or other wheel assemblies as the primary load-supporting mechanism.
- d. Devices that are not ground-supported

1.4 Outdoor Use

This document shall apply to the use of boom & base assemblies in outdoor environments, but only in applications that have been evaluated and deemed acceptable by a qualified person.*

2 Intent

The intent of this document is to establish minimum acceptable standards, guidelines, and recommended procedures for the following:

- a. Manufacturing of the assembly components, but only to the general extent of maximizing safety and stability for assemblers and users;
- b. Safe assembly, installation, and use of the assembly in order to minimize injury to persons or to property;

- C. Guidance to governing, regulatory, or other authorities having jurisdiction in the development and enforcement of safety directives.

Another important goal of this document is to establish a distinction between manufacturers, assemblers, and users. More importantly, because the user often assumes responsibility and liability equal to that of an assembler or a manufacturer, this document provides information intended to assist in the evaluation and reduction of that risk.

Those engaged in the manufacture, assembly or use of any device in the Entertainment Industry have an obligation to provide - and obtain as applicable – complete instruction and training as may pertain to the safe application and use of such devices. Manufacturers are encouraged to support and promulgate the general intent, recommendations and guidelines described herein, particularly with respect to the enhancement of safety awareness among assemblers and users of the devices.

3 Definitions

Assembly (See also **Device**): The entire unit; all components fitted, or otherwise attached together to form a complete unit. For the purpose of this document, the terms “assembly” and “device” are used interchangeably, where required to maintain clarity of intent.

Assembler: An individual who attaches together components that are designed, selected, or specified by others, in accordance with instructions provided by others, into complete assemblies intended for use within the scope of this document.

Base: The part of the assembly that makes direct contact with the floor, walking or acting surface, and that serves as the primary stabilizing and supporting element for the entire, complete assembly.

Base vertical fitting: The fitting, coupling, or other component used to attach the vertical member to the base.

Base weight: Weight placed on, or affixed to, the base and used in addition to the weight of the base itself to provide additional stability to the system.

Competent person: A person who is capable of identifying existing and predictable hazards, and who is authorized to take prompt corrective measures to eliminate the hazards.

Design factor: A ratio of the working load limit to the ultimate breaking strength of a material or component.

Device (See also **Assembly**): The entire boom and base assembly, as intended for use in accordance with, and within the scope of, this document.

Dynamic load: A load applied to a device or assembly that changes with time, and is the result of motion or impact.

Fixture: Any equipment intended for attachment to the boom & base assembly.

Horizontal attachment fitting: The fitting, coupling, or other component used to attach the horizontal member to the vertical member.

Horizontal member: The part of the assembly that is mounted perpendicular to the vertical member in the horizontal plane, parallel to the floor, and to which equipment may be attached.

Manufacturer: Any qualified person, organization, or entity that either a) builds components from raw materials, or b) designs, selects, or specifies individual components, intended for assembly together into complete devices, and intended for the specific applications described herein.*

Qualified Person: A person who, by possession of a recognized degree or certification of professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter or work.

Shall: Indicates a mandatory and required action.

Should: Indicates a recommended action, not necessarily mandatory.

User: An individual who attaches loads to or otherwise uses the fully assembled devices described herein, but does not necessarily manufacture or assemble them.*

Vertical member: The specific part of the assembly that is fixed or fastened to the base, extending vertically, and that provides the primary vertical extension to the whole assembly. The term may refer to a single fixed length designed to provide a fixed height, or multiple sliding lengths designed to provide variable heights.

4 Purpose.1 Acceptable Uses

The following applications of the devices described herein shall be considered acceptable, and within the scope of this document:

- A. Mounting of single fixtures*, the weight of which does not exceed 35% of the total assembly weight, or
- B. Mounting of small quantities of fixtures, the total combined weight of which does not exceed 50% of the total assembly weight AND where the weights of which are as evenly distributed about the vertical member as is feasible.
- C. Attachment of loads under conditions other than that described in A or B above, when used in conjunction with supplemental stabilizing method(s), provided that such applications meet the minimum requirements set forth herein.
- D. Use of assemblies in applications that have been evaluated and deemed acceptable by a qualified person.

Use of assemblies in applications that have been evaluated, and deemed acceptable by a competent person in accordance with Section 4.2 below.

4.2 Usage Evaluation Methods

When assemblies, attached loads, or applications do not meet the requirements of Section 4.1 above, the procedures of Sections 4.2.1 and 4.2.2 shall be used to determine the stability of the assembly, and acceptability of the application. For the intent of evaluation, and except as otherwise permitted, the tested assembly, its attached loads, and the manner and orientation of loads shall be identical to that of the intended application.

4.2.1 Slope Test

The stability of the assembly shall be acceptable if the assembly remains upright when placed on a surface inclined 5-degrees off horizontal (refer to Figure 1). Where loads are unevenly distributed about the centerline of the vertical member, the assembly shall be oriented on the incline such that the greatest load is placed towards the lower side of the slope.

4.2.2 Horizontal Force Test

The stability of the assembly shall be acceptable if the assembly remains upright without toppling when placed on a level surface, and subjected to a horizontal force applied to the vertical member, and at any point above its

midpoint. The applied force shall be a gradually applied dynamic load, sufficient to tip the vertical member a minimum of 10-degrees off vertical without damaging the assembly, or dislodging its attachments.

4.2.3 Rotation due to Tipping Action

The tests described in Sections 4.2.1 and 4.2.2 above shall consider any rotation of the assembly that may result from tipping actions.* Any application in which a tipping action results in a foreseeable rotational shifting of the loads shall require further evaluation and approval by a qualified person. In applications not fully evaluated by a qualified person, supplemental stabilizing methods shall be used.

4.2.4 Remedies for Failed Tests

The following standard stabilizing methods shall be applied to any assembly failing the test procedures outlined above, and shall be applied (in any order or combination) until the assembly successfully passes the testing requirements, but shall not restrict the application of other remedies provided that the intent of this section is met:

- a. Attached loads shall be shifted to improve load distribution about the vertical member, or to lower the assembly's center of gravity;
- b. Attached loads shall be removed;

Any remedy that requires the use of supplementary stabilizing methods, as described in Section 6.5 below, shall also require evaluation and approval by a qualified person.

5 Assembly Guidelines

5.1 Personnel Requirements

The assembly of the portable boom and base devices shall be performed by competent persons who have read and understood the manufacturer's instructions referenced in Section 10 below. To ensure safe assembly of the device, where the device height exceeds 3 meters (10 feet) two or more persons shall complete the assembly.

5.2 Order of Assembly Guidelines

Device assemblers and users shall follow all manufacturer's order of assembly guidelines, as referenced in Section 10.

5.3 Safety Precautions

Device assemblers and users shall follow all manufacturer's safety precautions, recommendations, and requirements prior to, during, and after the assembly of the device. They shall also inspect all components for visible defects and damage. If not included in the manufacturer's precaution advisory information, assemblers and users shall observe the following mandatory precautions:

- a. Confirm the general stability of the assembly both before and after attachment of fixtures and/or other equipment, by ensuring that the base is firmly placed on, and/or secured to, the mounting surface.
- b. Unstable assemblies shall be remedied at once, as directed by a competent person.

5.4 Loading During Assembly

Boom and Base assemblies shall be designed such that, for all acceptable assembly and installation methods documented as required by Section 10, or as deemed acceptable by a qualified person, the system shall remain mechanically sound and intact with a design factor in stress-to-failure limits of not less than 2.5.

If the assembly is intended to be loaded prior to being placed in the upright position, the assembly guidelines shall contain limiting conditions for each acceptable assembly method.

6 Use

6.1 Mounting Surfaces

Assemblies shall be mounted on smooth, level, and stable surfaces. Placement of assemblies on any other surface, or on surfaces where transmission of dynamic forces might result in instability of the assembly shall be evaluated and approved by a qualified person prior to installation. Documentation of the evaluation shall be retained. In the event of an accident involving the evaluated application, the documentation shall be supplied to appropriate authorities.

6.2 Load Distribution

Fixtures to the assembly shall be made in a manner that allows even distribution of loads about the vertical member centerline.*

6.3 Supply Cable Routing

Power/data or other cables shall be routed only along the vertical and horizontal members, and shall be securely fastened at regular intervals along their length, in a manner that protects the integrity of the cables. Where cables attach to fixtures, they shall be secured to the assembly immediately adjacent to the fixture. *

6.4 Fixture Restrictions and Load Limits

6.4.1 Torsion load resistance

All anticipated fixture torsional loads shall be fully resisted.*

6.4.2 Attached Load Limits

Load limits shall not exceed those that allow assemblies and applications to meet the criteria of Section 4.1 or Section 4.2 above, unless specifically authorized by the manufacturer or other qualified person.

6.5 Supplementary Stabilizing Methods and Requirements

6.5.1 General Requirements

Supplementary stabilizing methods shall be used where deemed necessary by a qualified person, and shall be applied in the following order of preference*:

- a) Fastening of the base to the mounting surface;
- b) Addition of supplementary base weights;
- c) Application of a guy wire system

Supplementary stabilizing systems shall be applied in accordance with manufacturer's recommendations, where such recommendations exist. Stabilizing system components shall be sized and applied as directed by the specific component manufacturer's recommendations. They shall be sized and applied as directed by a qualified person, where the manufacturer's recommendations either do not exist, or do not apply to the specific component application.

Where supplementary stabilizing systems are specifically required by either manufacturer's recommendations, or by determination of a qualified person, the design and application of the supplemental stabilizing system(s) shall be documented, and the system designer shall retain the documentation.*

A competent person shall be permitted to apply any stabilizing method that has been defined in writing by either the manufacturer or a qualified person, and shall not deviate from the written instructions.

6.5.2 Bases

Where direct attachment of the assembly base to the mounting surface is required, the base shall contain a minimum of three holes, evenly distributed in a circular pattern that is concentric with the vertical member axis. The pattern shall be sized not less than $\frac{1}{2}$ the base radius. For non-circular bases, the base radius shall be defined by the smallest circle that can be circumscribed through the vertex points on the edge of the base, concentric about the vertical member axis. The manufacturer or qualified person shall specify the hole diameter and the method of attachment to the mounting surface.

6.5.3 Anchorages

In all applications where anchorages are used as part of the assembly stabilizing system, the anchorage method shall be designed for the highest anticipated load that may be applied under normal working conditions. Anchorage types, methods, and applied design factors shall be determined by the manufacturer or other qualified person. Documentation of said evaluation shall be included with the assembly documents as referenced in Section 10 below.

6.5.4 Guy Wires - General Methods

Guy wires shall be used to increase the stability of the assembly under any circumstance where a qualified person determines that they are necessary.*

6.5.5 Guy Wires – Placement and Orientation

Where guy wires are used, they shall be arranged so that lateral loads are resisted in all directions. The use of fewer than three (3) guy wires shall be acceptable where the specific use of the assembly, including the guy wiring method, has been fully evaluated and approved by a qualified person.

Guy wires shall extend from the top of the vertical member (where fixed-height verticals are used), or from the top of the fixed-height vertical (where variable height verticals are used), down to the mounting surface. Guy wires shall be permitted to attach to vertical members as described above, but travel to anchorage or attachment points that are either a) at the same elevation, or b) higher than the horizontal assembly, but only where such application has been evaluated and approved by a qualified person.

Under no circumstance shall guy wires be attached to horizontal members, or to variable height vertical members. Where guy wires extend from the vertical at an angle of less than 60 degrees below horizontal, or above the horizontal plane, the base shall be secured to the mounting surface by not less than three fasteners, in a manner that prevents accidental sliding of the base.*

6.6 Placement, Dressing, and Visibility

The requirements and recommendations of this section are intended to reduce tripping and other hazards related to the use of assemblies in areas accessible to performers, technical staff, or other persons. The requirements of this section are also intended to establish minimum safety criteria, when applied by competent persons according to the level of available public access control, as appropriate to any specific use application.*

6.6.1 Cables and Dressing

Cables that are attached to assemblies shall be fully dressed to the base and surrounding mounting surface, in a manner that reduces tripping hazards. All assembly components representing a potential trip or collision hazard shall be clearly marked in a manner visible to non-public personnel at the normal operating production lighting levels.

6.6.2 Visibility and Notification

When all or parts of assemblies are visible to the audience, any assembly surfaces not visible to the audience shall be clearly marked. In these circumstances, all personnel having access to the installation space during use shall be notified of the location, the size, and the markings of all such assemblies.* Surfaces visible to the audience shall be permitted to be dressed according to the requirements of the production or use environment.

When in direct control of a specific application, or when participating in applications where hazard notification is required, a regularly scheduled notification procedure shall be developed and administered by a competent person, in a manner that provides a minimum of one hazard notification for any individual anticipated in the hazard area(s).*

6.7 Supplementary Precautions

Where impossible or unfeasible to locate the assemblies out of traffic areas, the following precautions shall be observed:

- A. When located in public access areas or in areas where it is not possible to fully restrict public access, a method to prevent access within a minimum 1-meter (3 foot) perimeter shall be used to reduce the potential for tipping due to accidental bumping of the assembly. This may be in the form of barricades, security personnel, or any other method that meets the intent of this requirement.
- B. When located in performance areas where public access is restricted or controlled, performers and all relevant persons shall be notified of all foreseeable hazards relating to the placement and proximity of the assemblies.

7 Inspections

A competent person shall perform periodic inspections on each assembly to ensure consistent conformance to the minimum requirements set forth herein. Components not meeting the requirements of this document shall be removed from service, and shall be further evaluated to determine if repairs can be made in accordance with the intent of Section 8 - Repair. Inspections shall occur as often as recommended by the manufacturer or, in the absence of manufacturer recommendation, at time intervals and circumstances as determined by a competent person.

8 Repairs

8.1 Intent of Repairs

Repairs to components or assemblies shall be performed only if such repairs will restore the component or assembly to a condition that allows its use in accordance with the minimum requirements of this document, or to the manufacturer's specifications, whichever is more stringent.

8.2 Methods of Repairs

A competent person shall determine the acceptable manner of repair. A competent person shall perform and inspect all repairs made.

9 Removal from Use

Components and assemblies shall be immediately removed from service under any of the following conditions, as determined by a competent person:

- a. That any assembly or component thereof fails to meet the minimum requirements of this document;
- b. That any component is unsuitable for safe and proper assembly or use as described in this document;
- c. That any component requires repair, whether the repairs will restore the component to its original condition or not;
- d. That any repaired component fails to meet the minimum requirements of this document;
- e. That the assembly poses any risk deemed unacceptable in the given circumstances.

10 Instructions and Documentation

Manufacturers shall develop and maintain documentation relevant to the acceptable uses of boom and base assemblies.

Documentation shall include detailed information regarding both recommended, and required procedures for assembly, installation, and use of the assembly. This information shall include recommended working load limits, safety precautions, warnings, advisories, and any other information deemed relevant (by the document developer) to the assembly and its use.

The documentation shall include information regarding personnel assembly requirements, order-of-assembly instructions, safety guidelines and precautions.

The manufacturer shall determine and specify criteria for hazard classification, according to the degree of hazard associated with assembly or use.

10.1 Voluntary Assembler and End-User Compliance

Assemblers and users shall obtain, and comply with, manufacturer's published safety recommendations, guidelines, and requirements, unless otherwise determined by a qualified person.*

11 Labeling

Devices shall be labeled in conformance to ANSI Z535.3 and ANSI Z535.4. Labels shall correspond to the manufacturer's hazard classification.

11.1 Capacities and sizes

Where the manufacturer of the device or component determines that a component self-weight represents a foreseeable lifting hazard during assembly, the component label shall contain both the weight and a precautionary statement for the hazard.*

11.2 Safety Instructions

Bases and vertical members shall have a permanently affixed label instructing all persons to read and understand the manufacturer's safety documentation prior to assembly and use.

12 Figures

Figure 1: 5-degree Slope Quick-Test Example

The example shown below illustrates a close approximation of the 5-degree slope for stability quick test purposes:

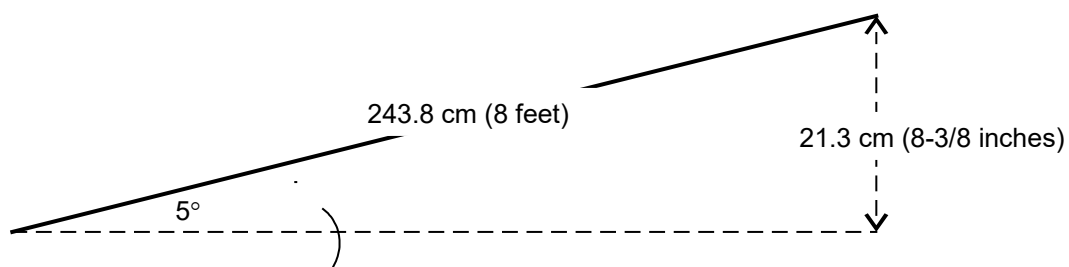
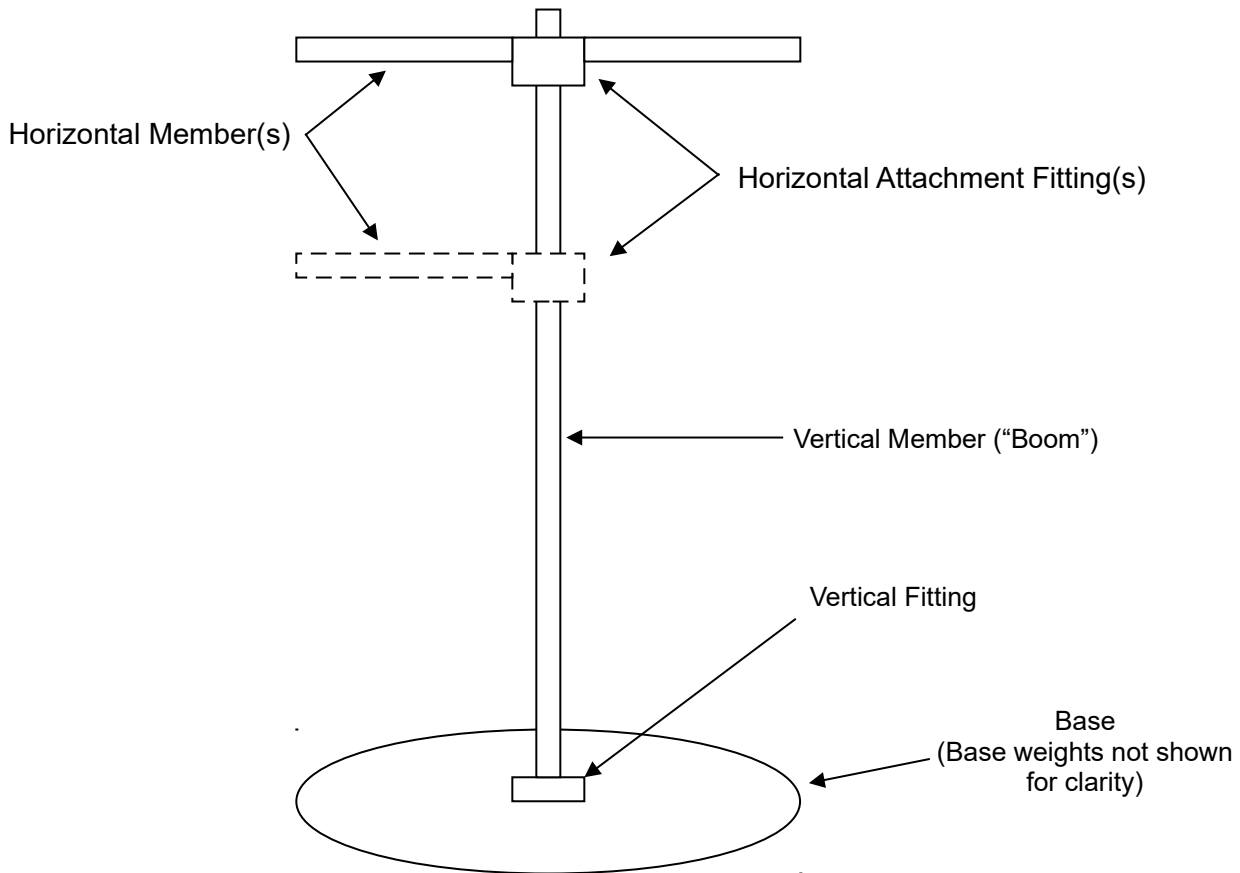


Figure 2: Reference Diagram Example

The example shown below is intended as a general illustration for the manufacturer or user to demonstrate the typical components and nomenclature of the Theatrical Boom & Base Assembly as described in this document.



Theatrical Boom & Base Assembly (Typical)

Annex Notes

A.1.4 Outdoor Use: Use in outdoor environments present additional concerns, such as wind loading, ground stability, etc. not otherwise applicable indoors. These concerns must be considered in any evaluation that assesses the safety of the application.

A.3 Definitions (manufacturer): The intent of the definition is to describe a single term that identifies the common essential responsibilities between persons or entities, which may be otherwise described in a mutually exclusive manner but, nonetheless, engage in similar and related actions. These actions essentially constitute an evaluation process, and the common responsibilities are a direct result of that process, which includes consideration and comparison of things such as material properties, component suitability, interoperability, and ultimate suitability to an intended task or function. The very action of making a preferential choice of one material, component, or method over another implies that there be justification and basis for the choice. This standard intends to require substantiation for those choices, in the form of quantitative analysis rather than qualitative preference.

In the case of a manufacturer, who (by common definition) “makes components from raw materials”; the manufactured components are developed and produced with a specific intent of use in one or more applications. That is to say, the manufacturing entity provides design input as to the composition, fit and finish of the final component, based upon its use in the intended application. Therefore, it is reasonable to expect that such entity should have the intellectual resources to provide such design input, specifically to the extent of a complete engineering analysis and, more specifically, to the extent of providing appropriate safety guidelines and usage criteria to assemblers and users. The action of selecting materials, as pertaining to a manufacturing process, requires a comparison and evaluation of material properties, and how they affect the manufactured component, its use in an assembly, and in the intended application.

Consistent with this, persons who design, specify, or select components, for assembly and use in a specific intended application, also provide a similar design input, inasmuch as they also perform a comparison and evaluation of the components, their material properties, and their subsequent suitability for the intended application. The act of specifying or selecting a particular component in preference over another supports this assumption, and it is reasonable to expect that acting in this manner should also require a similar justification for the action, performed with similar intellectual resources, and for the identical reasons of providing safety guidelines and acceptable usage criteria to the user or assembler.

Those who determine what is or is not acceptable, by virtue of a manufacturing, specification, or other selection process are classified under the scope of this standard as “manufacturers, and as such are subject to similar requirements hereunder.

A.3 Definitions (User): The intent of the definition is to distinguish the action of usage from the other actions of either manufacture or assembly, and is not intended to exclude the user from either action. For example, a person who assembles, and then uses, a boom-base device is considered both an assembler and a user in the context of this standard.

A.4.1 Acceptable Uses: Single load attachments do not require the use of a horizontal member, and are assumed to be located at the top of the vertical member (or directly attached thereto), in such a manner as to minimize the imposed moment as much as feasibly possible.

A.4.2.3 Rotation due to Tipping Action: This section intends to address the many different types of base shapes that are currently, and may possibly be used in boom and base assemblies. Regardless of whether the attached loads are evenly distributed or not, it is easy to recognize that certain configurations – such as a round base shape - may be more conducive to rotational translation of the loads when tipped. Conversely, base shapes having linear edges provide resistance to load translations under tipping conditions. Therefore, it is important to consider these factors when performing evaluations of the assemblies.

A.6.2 Load Distribution: When multiple loads are attached to the boom and base assembly, particularly when such loads are not equal in mass, care must be taken to ensure that the resulting moments are as equal as feasibly possible. Unevenly distributed loads are not recommended and should be avoided, as they contribute to instability of the assembly.

A.6.3 Supply Cable Routing: Heavier power supply cables should be fastened at shorter intervals than lighter cables. The intent is to keep the added weight of the cables as close to the boom base assembly as possible, by reducing the amount of loosely hanging slack cable, thereby maintaining better stability.

A.6.4.1 Torsion Load Resistance: A competent person can easily ensure that all such torsional loads are fully resisted, by simply applying an additional torsional force in a direction opposite the torsional resistance. For example, if a fixture applies a torsional load in the clockwise direction about an axis, the torsional resistance can be verified by applying an additional force in the same direction. The torsion force can be considered fully resisted if it neither causes rotation of the member (relative to its fitting or coupling), nor buckling of the member itself.

A.6.5.1 General stabilizing requirements: The order of preference for application of additional stabilizing methods is determined by that method that imparts the least amount of additional hazard. Since fastening of the base to its mounting surface does not generally or significantly increase the base height, and hence tripping hazards, this method is always preferred. However, it may be impractical or unfeasible to make such anchorages, so the addition of base weights is next favorable, since they generally present less of a trip hazard than guy wire systems. Guy wires systems add variables to the entire boom base assembly application, and thus require a greater degree of analysis. Therefore, and although they may represent the greatest stability (if properly applied), guy wire systems must be fully evaluated by qualified persons, and should be considered only as a last resort, and when such evaluation is possible.

A.6.5.1 General Stabilizing Requirements (design documentation): Supplementary stabilizing methods may be used as precautionary measures at any time, whether they are specifically required or not. Any time there is a specific requirement, for supplementary stabilizing methods, by a manufacturer or qualified person, the design criteria and evaluation requires appropriate documentation.

A.6.5.4 Guy Wires – General: When using guy wires, proper precautions must be taken to minimize excessive stress loading of the attachment to the mounting surface, and of the vertical height adjustment assembly.

A.6.5.5 Guy Wires – Placement and Orientation: In circumstances where the guy wire system must be applied in a manner wherein the base could potentially slide out from underneath, the requirement to fasten the base to the mounting surface may be an unnecessary redundancy, specifically where anchorages can be used as the primary (supplemental) stabilizing method. As indicated in other sections, the proper use of anchorages is preferred over the use of guy wire systems.

A.6.6 Placement, Dressing, and Visibility: Where possible, assemblies should be located out of high-traffic areas, and areas of uncontrolled access by the general public or non-working personnel.

A.6.6.2 Visibility and Notification: Working personnel who have been notified of a specific hazard shall not require multiple notifications of the same hazard, although a regular schedule and method of hazard notification is preferred.

A.10.1 Voluntary Assembler and End-user Compliance: Where manufacturer's information is not available, assemblers and users should develop similar assembly and usage policies consistent with the recommendations of this section, and as practical for the user-specific application(s). Such action is recommended in order to establish and maintain minimum safety policies, and reasonable standards of care consistent with those established by this document.

A.11.1. While ergonomic practices are generally important, there currently exist no ergonomic standards in the US. However, assembly instructions should also consider ergonomic practices, in order to minimize the risk of personal injury due to improper lifting techniques.

== END ==