



ANSI E1.1 – 2012
Entertainment Technology Construction and
Use of Wire Rope Ladders

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A revision of ANSI E1.1 - 2006

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worldwide standards for the entertainment industries

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The PLASA Technical Standards Program

The PLASA Technical Standards Program was created to serve the PLASA membership and the entertainment industry in technical standards related matters. The goal of the Program is to take a leading role regarding technology within the entertainment industry by creating recommended practices and standards, monitoring standards issues around the world on behalf of our members, and improving communications and safety within the industry. PLASA works closely with the technical standards efforts of other organizations within our industry, including USITT and VPLT, as well as representing the interests of PLASA members to ANSI, UL, and the NFPA. The Technical Standards Program is accredited by the American National Standards Institute.

The Technical Standards Council (TSC) was established to oversee and coordinate the Technical Standards Program. Made up of individuals experienced in standards-making work from throughout our industry, the Council approves all projects undertaken and assigns them to the appropriate working group. The Technical Standards Council employs a Technical Standards Manager to coordinate the work of the Council and its working groups as well as maintain a “Standards Watch” on behalf of members. Working groups include: Control Protocols, Electrical Power, Floors, Fog and Smoke, Followspot Position, Photometrics, Rigging, and Stage Lifts.

PLASA encourages active participation in the Technical Standards Program. There are several ways to become involved. If you would like to become a member of an existing working group, as have over four hundred people, you must complete an application which is available from the PLASA office. Your application is subject to approval by the working group and you will be required to actively participate in the work of the group. This includes responding to letter ballots and attending meetings. Membership in PLASA is not a requirement. You can also become involved by requesting that the TSC develop a standard or a recommended practice in an area of concern to you.

The Rigging Working Group, which authored this Standard, consists of a cross section of entertainment industry professionals representing a diversity of interests. PLASA 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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Table of Contents

1	Scope	1
2	Purpose	1
3	New and Existing Installations.....	1
4	Mandatory and Advisory Rules.....	1
5	Definitions and References	2
5.1	Definitions	2
5.2	References to Other Codes and Standards.....	2
6	Wire Rope Ladder Requirements	4
6.1	Components.....	4
6.1.1	Ladder Rungs	4
6.1.2	Ladder Rails.....	4
6.1.3	Connecting Hardware.....	4
6.1.4	Ladder Anchorage.....	4
6.1.5	Ladder Identification.....	4
6.2	Ladder Geometry.....	4
6.2.1	Rung Width	4
6.2.2	Rung Vertical Spacing.....	5
7	Ladder Installation.....	5
8	Ladder Use	5
9	Worker Training	5
10	Inspection	5

1 Scope

This standard shall apply to the construction and use of wire rope ladders in the entertainment industry.

The entertainment industry includes, but is not strictly limited to, musical productions, live concerts, live theater, film production, video production, corporate events, trade shows, and broadcast production.

Wire rope ladders are distinguished from other ladders by having flexible rails, and are used in applications where ladders with rigid rails are impractical to use, or where a rigid ladder would pose a greater danger to the user or other workers in the area. Wire rope ladders are used for vertical access by personnel to lighting trusses, temporary follow spot platforms, and other areas of a temporary nature. Such areas cannot be practically served by rigid ladders because the floor underneath is not level or clear, the elevated work area is not rigidly fixed in place, or the ladder must coil for storage or to allow clear access beneath the elevated work area.

This standard does not address the construction or use of fixed or portable ladders with rigid rails.

2 Purpose

This standard is designed to:

- (a) prevent most injuries and to minimize the remaining injuries to workers by prescribing safety requirements;
- (b) provide direction to owners, employers, and any other individuals such as supervisors who are responsible for wire rope ladders; and
- (c) guide governments and other regulatory bodies in the development and enforcement of the appropriate safety directives concerning wire rope ladders in entertainment venues.

3 New and Existing Installations

- (a) **Effective Date.** The effective date of this standard for the purpose of defining new and existing installations shall be one year after its date of issuance.
- (b) **New Installations.** Construction, installation, inspection, testing, maintenance, and operation of equipment manufactured after the effective date of this standard shall conform with the mandatory requirements of this volume.
- (c) **Existing Installations.** Inspection, testing, maintenance, and operation of equipment manufactured prior to the effective date of this standard shall be done as applicable, in accordance with the requirements of this standard.

It is not the intent of this standard to require replacement of existing equipment. However, when an item is being modified, its performance requirements shall be reviewed relative to the current Standard. If the performance differs substantially, the need to meet the current requirements shall be evaluated by a competent person selected by the owner (or user). Recommended changes shall be made by the owner (or user) within one year of the evaluation.

4 Mandatory and Advisory Rules

Mandatory rules are characterized by the word “shall.” Advisory statements use the word “should.”

5 Definitions and References

5.1 Definitions

5.1.1 anchorage: A secure point of attachment to which the wire rope ladder is connected.

5.1.2 competent person: A person capable of identifying existing and predictable hazards in the surroundings or working conditions which are hazardous or dangerous to employees, and who is authorized to take prompt corrective measures to eliminate the hazards.

5.1.3 defect: Any characteristic or condition which tends to weaken or reduce the strength of the tool, object, or structure of which it is a part.

5.1.4 design factor: The ratio between the working load limit and the ultimate strength of a product.

5.1.5 equivalent: To demonstrably provide an equal or greater degree of safety.

5.1.6 eye: A loop formed in the end of a wire rope for the purpose of connecting the wire rope to something else.

5.1.7 permanent deformation: Any permanent measurable change in the shape of the object or any measurable slippage in the connection between two objects after the load has been released.

5.1.8 rail: The vertical strength member of the ladder that supports the rungs.

5.1.9 rungs: Ladder crosspieces that are intended for use by a person in ascending or descending.

5.1.10 thimble: A grooved metal fitting installed into an eye for the purpose of abrasion protection.

5.1.11 ultimate strength: The maximum load that can be applied without a failure occurring.

5.1.12 vertical spacing: The elevation difference between adjacent rungs.

5.1.13 wire rope: Strands of one or more carbon or nickel steel wires wrapped in a helical fashion to form the finished product.

5.1.14 working load limit: The maximum load allowable as established by the product manufacturer or, when not specified by the manufacturer, arrived at by a competent person by applying an appropriate design factor.

5.2 References to Other Codes and Standards

ANSI/ASSE Z359.1-2007, Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components

ASTM A 1023/A 1023M – 2002, STANDARD SPECIFICATION FOR STRANDED CARBON STEEL WIRE ROPES FOR GENERAL PURPOSES.

Wire Rope Ladder

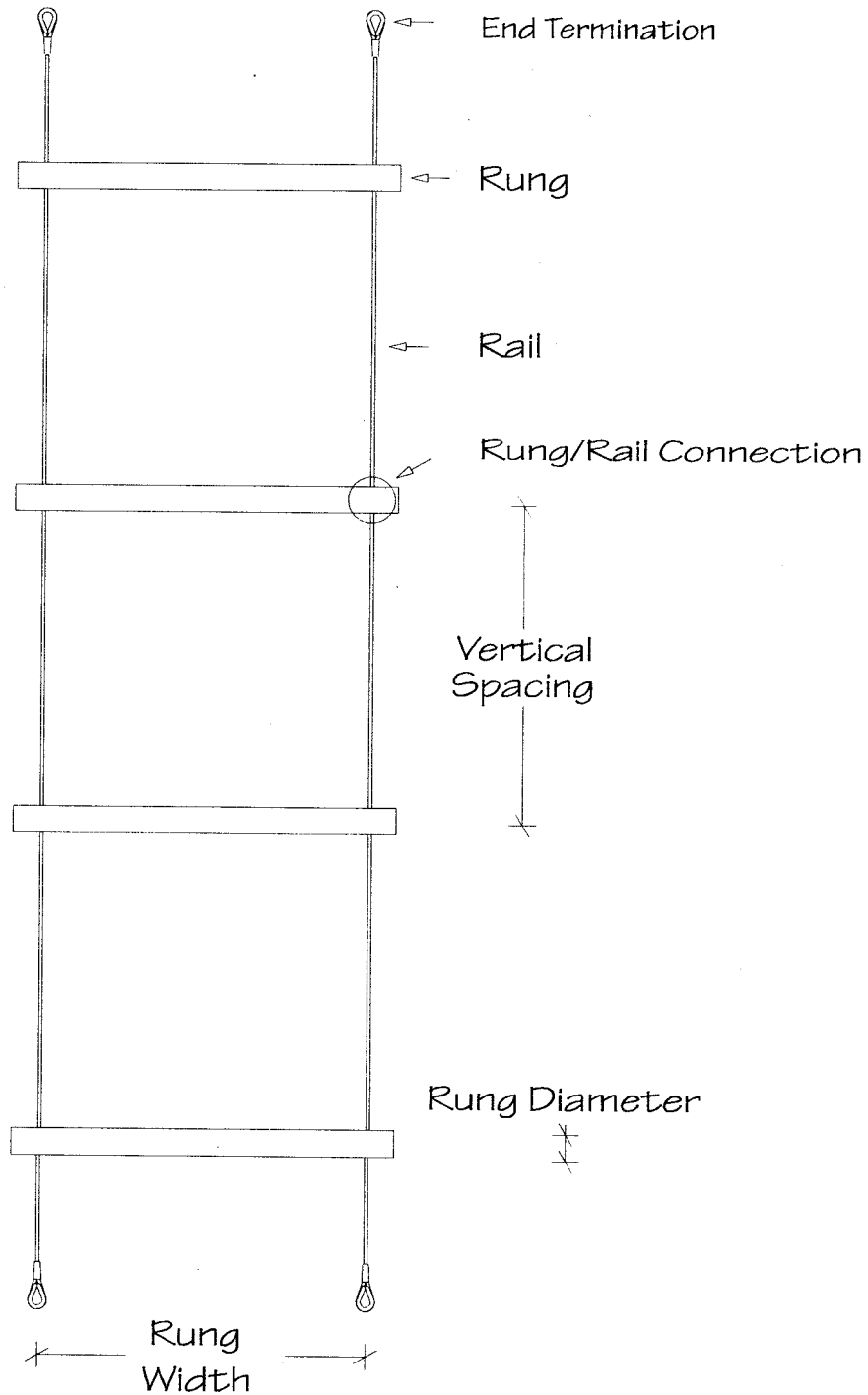


Figure 1 - Wire Rope Ladder

6 Wire Rope Ladder Requirements

6.1 Components

6.1.1 Ladder Rungs

Material

The rung material shall be such that a 7.6 cm (3 inches) wide load of 4.45 kN (1,000 lbs) applied to the center of the rung shall not cause permanent deformation of the rung. The rung outside diameter shall not be less than 2.5 cm (1 inch) nor larger than 5.1 cm (2 inches).

Finish

Neither the rungs nor the rung/rail connections shall have sharp or jagged edges that could cause injury during the use of the ladder. The stepping/gripping surface should have a slip resistant treatment that when gripped is neither painful to hands nor likely to cause injury.

6.1.2 Ladder Rails

Material

The rail material shall be wire rope. The rails shall each be one continuous section of material. No in-line splicing, mechanical or otherwise shall be allowed. The wire rope with fittings shall support a load not less than that specified in the paragraph below.

End Fittings

The end fittings on the rails shall be permanent. Swaging of fittings or ferrules and button stops, at rung securement, should be swaged consistent with the fitting, ferrule, or button stop manufacturer's recommended specifications. The end fittings shall have an ultimate strength of not less than 6.89kN (1,550 lbs). All eyes shall have heavy pattern thimbles installed.

6.1.3 Connecting Hardware

All connecting hardware shall be approved for fall protection or lifting and shall be stronger than the ladder rails. Slings used to connect the ladder to the anchorage (anchorage sling) shall be connected in such a fashion so as to have a minimum working load limit of 6.89 kN (1,550 lbs). If used, all hooks should be double locking.

6.1.4 Ladder Anchorage

The anchorage shall have a minimum ultimate strength of 11.03 kN (2,480 lbs) per rail connected to it. The anchorage for the ladder should be separate from the required fall protection anchor. If the same anchorage must be used the ultimate strength of the combined anchorage shall be 44.13 kN (9,920 lbs).

6.1.5 Ladder Identification

An identification tag shall be attached to each ladder. The tag shall contain the name of the ladder manufacturer, the date on which the ladder was made, a serial number, and a working load statement. The working load statement shall read: "one person only - 140 kg (310 lbs) max". The tag may also make reference to the fact that the ladder conforms to this standard. If a statement of conformance to this standard is made, then the manufacturer shall warrant that the ladder conforms to all requirements set forth in this standard. The identification tag and its means of attachment shall be as permanent as is practical.

6.2 Ladder Geometry

6.2.1 Rung Width

The minimum clear space between rails shall be 23 cm (9 inches). The maximum clear space between rails shall be 30 cm (12 inches).

6.2.2 Rung Vertical Spacing

The vertical spacing shall be not less than 25 cm (10 inches) and not more than 30 cm (12 inches). The vertical spacing tolerance shall be ± 6 mm (0.25 inch) along the entire length of the ladder. The maximum vertical spacing variance between adjacent rungs shall be 6 mm (0.25 inch).

7 Ladder Installation

Prior to installation the ladder shall be inspected in accordance with section 10. The completed installation shall then be inspected by a competent person prior to being used by a worker. The anchorage shall be selected in accordance with section 6.1.4. The rails of the ladder shall not be used as an anchorage sling. All slings and connecting hardware shall meet the requirements of section 6.1.3.

The ladder shall be installed such that the rails remain vertical through the entire length of the suspension. There shall be a minimum 46 cm (18") horizontal distance between the rungs and a wall or other obstacle that would impede the climber from ascending or descending the ladder.

The ladder shall be installed such that no climb is longer than 15.2 m (50'). When climbs of greater than 15.2 m (50') are necessary, other means of access and egress shall be provided.

A retractable lifeline or equivalent shall be installed adjacent to the ladder as a part of a Personal Fall Arrest System. The system shall conform to ANSI/ASSE Z359.1-2007, SAFETY REQUIREMENTS FOR PERSONAL FALL ARREST SYSTEMS, SUBSYSTEMS AND COMPONENTS. The installation of this system shall be accomplished under the supervision of a competent person.

The bottom of the ladder shall be stabilized by applying a downward force within 61 cm (24 inches) of the bottom to minimize swinging and therefore minimize the chance of the worker missing a rung during ascent or descent. The stabilization force applied should be at least 133 N (the force provided by 14 kg weight, 30 lbs) but shall not exceed 222 N (the force provided by a 23 kg weight, 50 lbs). This stabilization shall not be achieved by securing the bottom of the ladder to a solid structure.

8 Ladder Use

Only one worker at a time shall be allowed on the ladder.

Ladders should be properly rolled and placed in a suitable container for safe storage and transportation.

9 Worker Training

Workers using wire rope ladders shall be trained in the following:

1. Recognition of and preventative measures for the hazards associated with climbing wire rope ladders. These hazards should include but not necessarily be limited to fatigue hazards, falling hazards, slipping and tripping hazards, cuts and abrasion hazards, as well as hazards presented by the specific installation.
2. Inspection and correct use of the mandatory Personal Fall Arrest System to be used with the ladder.
3. Climbing techniques.

10 Inspection

Workers using wire rope ladders shall be trained in the following:

1. Risk assessment for the hazards associated with climbing wire rope ladders. These hazards should include but not necessarily be limited to fatigue, falling, slipping and tripping, cuts and abrasions, as well as hazards presented by the specific installation.

2. Inspection of the Personal Fall Arrest System to be used with the ladder in accordance with manufacturers specifications.
3. Inspecting all wire rope ladder components for proper working condition.