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BSR E1.1-202x
Entertainment Technology—Construction and Use of Wire Rope Ladders

Approved by the ANSI Board of Standards Review on _____

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The Entertainment Services and Technology Association's Technical Standards Program

The ESTA Technical Standards Program was created to serve the ESTA 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 benefit of our members, and improving communications and safety within the industry. ESTA works closely with the technical standards efforts of other organizations within our industry including USITT and VPLT as well as representing the interests of ESTA members to ANSI, UL and the NFPA. The Technical Standards Program is accredited by the American National Standards Institute.

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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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Voting members:**Observer (non-voting) members:****Interest category codes:**

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

ANSI E1.1 – 2018 Entertainment Technology—Construction and Use of Wire Rope Ladders

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1 Scope

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

The entertainment industry includes, but is not limited to, live events, 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, but not limited to 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 Authorities Having Jurisdiction (AHJ) in the development and enforcement of the appropriate safety directives concerning wire rope ladders in entertainment venues.

3 New and Existing Installations

- (a) **New Installations.** Construction, installation, inspection, testing, maintenance, and operation of equipment manufactured after the date of this standard must conform with the mandatory requirements of this volume.
- (b) **Existing Installations.** Inspection, testing, maintenance, and operation of equipment manufactured prior to the date of this standard must 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 must be reviewed relative to the current Standard. If the performance differs substantially, the need to meet the current requirements must be evaluated by a competent person selected by the owner (or user).

4 Definitions

4.1 Anchorage: A secure point of attachment to which the wire rope ladder is connected.

4.2 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.

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

4.4 Designated person: A person selected or assigned by the owner or user as being competent to perform specific duties.

- 4.5 Design factor:** The ratio between the working load limit and the ultimate strength of a product.
- 4.6 Equivalent:** To demonstrably provide an equal or greater degree of safety.
- 4.7 Event:** Any assembly, indoor or outdoor which, includes the preparation for and dismantling (load in, load out) of the event.
- 4.8 Eye:** A loop formed in the end of a wire rope for the purpose of connecting the wire rope to something else.
- 4.9 Live Event:** See 4.7 Event.
- 4.10 Must:** Denotes a mandatory requirement.
- 4.11 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.
- 4.12 Rail:** The vertical strength member of the ladder that supports the rungs.
- 4.13 Rungs:** Ladder crosspieces that are intended for use by a person in ascending or descending.
- 4.14 Should:** Denotes a recommendation.
- 4.15 Thimble:** A grooved metal fitting installed into an eye for the purpose of abrasion protection.
- 4.16 Ultimate strength:** The maximum load that can be applied without a failure occurring.
- 4.17 Vertical spacing:** The elevation difference between adjacent rungs.
- 4.18 Wire rope:** Strands of one or more carbon or nickel steel wires wrapped in a helical fashion to form the finished product.
- 4.19 Wire rope ladder, climber:** Person or persons that physically ascend and/or descend a wire rope ladder.
- 4.20 Wire rope ladder, owner:** The person or entity who has legal title to the wire rope ladder.
- 4.21 Wire rope ladder, user:** The person or entity who, either by ownership, lease, or other arrangement, controls the use and installation of the wire rope ladder.
- 4.22 Working load limit:** The maximum load allowable as established by the product manufacturer.

5 References

ANSI/ASSE Z359 Fall Protection Code (most current version)

ANSI E1.39 – 2021 – Selection and Use of Personal Fall Arrest Systems on Portable Structures Used in the Entertainment Industry

CFR - 1910.132 – Personal Protective Equipment

CFR - 1926.501 – Duty to Have Fall Protection

CFR - 1926.251 – OSHA Requirements Addressing Fall Protection Equipment

OSHA – NEP Directive Number: CPL 03-00-025

WIRE ROPE LADDER

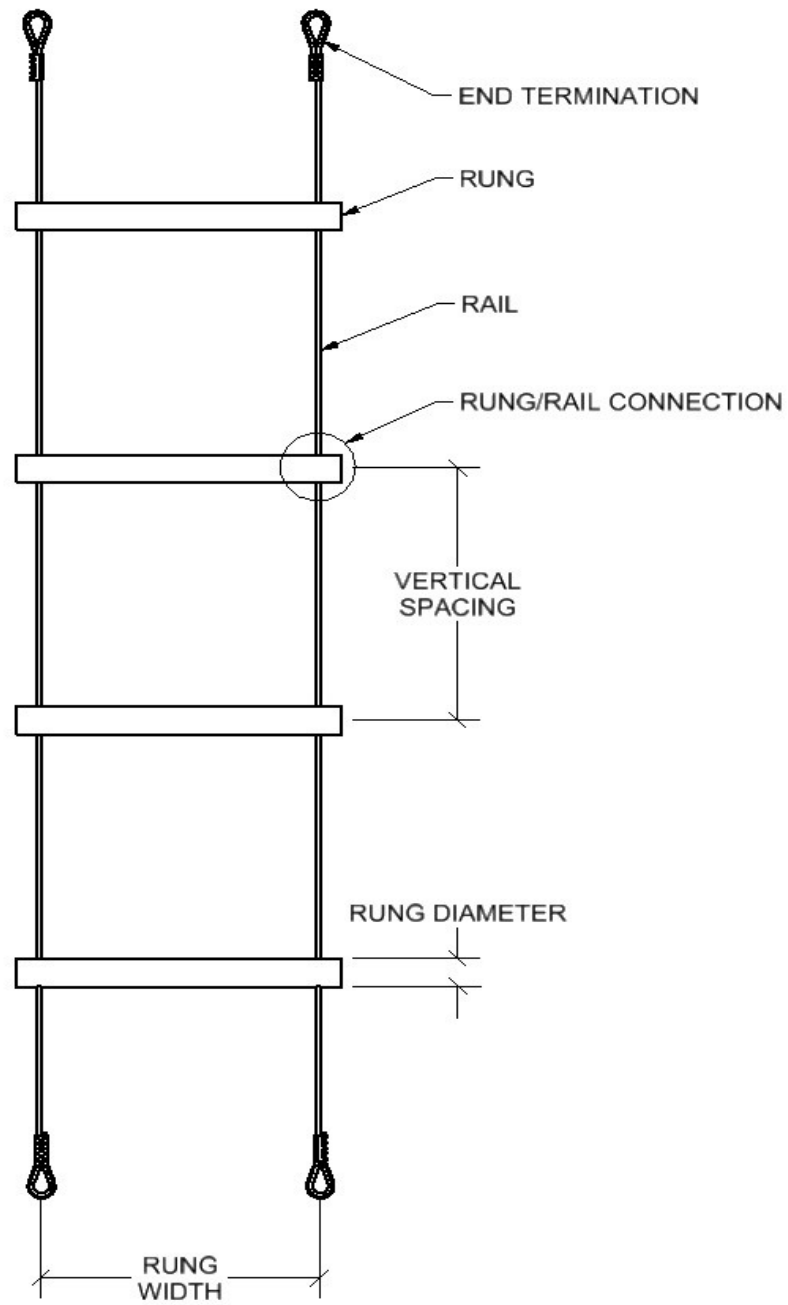


Figure 1 - Wire Rope Ladder

6 Wire Rope Ladder Requirements

6.1 Components

6.1.1 Ladder Rungs

Material

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

Finish

Neither the rungs nor the rung/rail connections must 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 must be wire rope. The rails must each be one continuous section of material. No in-line splicing, mechanical or otherwise must be allowed. The wire rope with fittings must support a load not less than that specified in the paragraph below.

End Fittings

The end fittings on the rails must 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 must have an ultimate strength of not less than 1,550 lbs (6.89 kN). All eyes must have heavy pattern thimbles installed.

6.1.3 Connecting Hardware

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

6.1.4 Ladder Anchorage

The anchorage must have a minimum ultimate strength of 2,480 lbs (11.03 kN) 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 must be 9,920 lbs (44.13 kN).

6.1.5 Ladder Identification

An identification tag must be attached to each ladder. The tag must 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 must read: "one person only – 310 lbs (140 kg) max". The tag may also refer to the fact that the ladder conforms to this standard. If a statement of conformance to this standard is made, then the manufacturer must warrant that the ladder conforms to all requirements set forth in this standard. The identification tag and its means of attachment must be as permanent as is practical.

6.2 Ladder Geometry

6.2.1 Rung Width

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

6.2.2 Rung Vertical Spacing

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

7 Ladder Installation

Prior to installation the ladder must be inspected in accordance with section 10.

The anchorage must be selected in accordance with section 6.1.4. The rails of the ladder must not be used as an anchorage sling. All slings and connecting hardware must meet the requirements of section 6.1.3.

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

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

A retractable lifeline or equivalent must be installed adjacent to the ladder as a part of a Personal Fall Arrest System. The system must conform to ANSI/ASSE Z359 FALL PROTECTION CODE (most current version). The installation of this system must be accomplished under the supervision of a competent person.

The bottom of the ladder must be stabilized by applying a downward force within 24 inches (61 cm) 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 must not exceed 222 N (the force provided by a 23 kg weight, 50 lbs). This stabilization must not be achieved by securing the bottom of the ladder to a solid structure.

The completed installation must then be inspected by a competent person prior to being used by a climber.

8 Ladder Use

Only one climber at a time must be allowed on the ladder.

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

9 Training

A wire rope ladder climber must be trained by a competent person 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 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.
4. Proper ladder installation.
5. Climber training and use of the mandatory fall arrest system.

A designated person at the location of use must be trained in inspecting all the components of the wire rope ladder system including the fall protection components.

10 Inspection

The wire rope ladder must be inspected prior to each installation by a competent or designated person in accordance with manufacturer's recommendations. The inspection must include, but not be limited to, the following criteria:

Broken wires
Excessive kinking
Slippage of button stops or swage fittings
Cracked or bent rungs
Sharp, exposed edges on rungs
Missing identification tag
Cracked or deformed swage fittings

2. Inspection of the Personal Fall Arrest System to be used with the ladder must be in accordance with manufacturers specifications.
3. If any of the above ladder inspection items are observed, the ladder must not be installed
4. If any part of the fall protection system fails inspection, it must not be installed.
5. If after installation any item is noticed which would cause removal from service during the pre-installation inspection, the system must be removed from service until the affected item has been replaced.