



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

Rig/2004-2029r4

A revision of ANSI E1.1 - 2006

[blank page]



worldwide standards for the entertainment industries

ANSI E1.1 – 2012
Entertainment Technology Construction and
Use of Wire Rope Ladders
A revision of ANSI E1.1 - 2006

Copyright 2012 PLASA North America.
All rights reserved.
Rig/2004-2029r4

Approved as an American National Standard by the ANSI Board of Standards Review on
19 June 2012.

NOTICE and DISCLAIMER

PLASA does not approve, inspect, or certify any installations, procedures, equipment or materials for compliance with codes, recommended practices or standards. Compliance with a PLASA standard or an American National Standard developed by PLASA is the sole and exclusive responsibility of the manufacturer or provider and is entirely within their control and discretion. Any markings, identification or other claims of compliance do not constitute certification or approval of any type or nature whatsoever by PLASA.

PLASA neither guarantees nor warrants the accuracy or completeness of any information published herein and disclaims liability for any personal injury, property or other damage or injury of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this document. In issuing and distributing this document.

In issuing this document, PLASA does not either (a) undertake to render professional or other services for or on behalf of any person or entity, or (b) undertake any duty to any person or entity with respect to this document or its contents. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstance.

Published by:

PLASA North America
630 Ninth Avenue, Suite 609
New York, NY 10036
USA
Phone: 1-212-244-1505
Fax: 1-212-244-1502
Email: standards.na@plasa.org

For additional copies of this document contact:

The ESTA Foundation
630 Ninth Avenue, Suite 609
New York, NY 10036
USA
Phone: 1-212-244-1505
Fax: 1-212-244-1502
<http://www.estafoundation.org>

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.

Contact Information

Technical Standards Manager

Karl G. Ruling
PLASA North America
630 Ninth Avenue, Suite 609
New York, NY 10036
USA
1-212-244-1505
karl.ruling@plasa.org

Technical Standards Council Chairperson

Mike Garl
President and General Manager
Tomcat USA
2160 Commerce Drive
PO Box 550
Midland, TX 79703-7504
USA
1-432-694-7070
mike.garl@tomcatusa.com

Rigging Working Group Chairperson

Bill Sapsis
Sapsis Rigging, Inc.
233 North Lansdowne Ave.
Lansdowne, PA 19050
USA
1-215-228-0888 x206
bill@sapsis-rigging.com

Acknowledgments

The Rigging Working Group members when this document was approved by the working group on 21 December 2011 are shown below.

Voting members:

Mark Ager; Stage Technologies Group; CP
 Tray Allen; James Thomas Engineering, Inc.; MP
 Dana Bartholomew; Fisher Technical Services, Inc.; CP
 William Beautyman; Limelight Productions, Inc.; DR
 Keith Bohn; Vitec Group plc; MP
 Ron Bonner; PLASA EU; G
 William Bradburn; Aerial Arts, Inc.; U
 Spencer Brown; Oasis Stage Werks; DR
 Vincent J. Cannavale; Motion Laboratories; CP
 Joseph Champelli; ZFX Flying Inc.; CP
 William Conner; Amer. Society of Theatre Consultants; DE
 Kimberly Corbett; Schuler Shook; DE
 Stu Cox; ZFX Flying Inc.; CP
 Dan Culhane; SECOA; CP
 Bruce Darden; Rigging Innovators, Inc.; CP
 Don Dimitroff; Vitec Group plc; MP
 Brad Dittmer; Stage Labor of the Ozarks; U
 Scott Fisher; Fisher Technical Services, Inc.; CP
 Adrian Forbes-Black; Total Structures Inc.; MP
 Howard Forryan; Harting KGAA; G
 Eric Foster; Hall Associates Flying Effects; CP
 Mike Garl; James Thomas Engineering, Inc.; MP
 Ed Garstkiewicz; Harting KGAA; G
 Ethan William Gilson; Advanced Lighting and Production Services; U
 William B. Gorlin; M.G. McLaren, P.C.; G
 Jerry Gorrell; Theatre Safety Programs; G
 Pat Grenfell; PjDeZyNeS; DE
 Joshua Grossman; Schuler Shook; DE
 Joel A. Guerra; Texas Scenic Company; DR
 Donald Halchak; Mountain Productions Inc.; DR
 Rod Haney; IATSE Local 891; U
 Tim Hansen; Oasis Stage Werks; DR
 Pete Happe; Walt Disney Company; U
 Greg Hareld; Kleege Industries; U
 Herb Hart; Columbus McKinnon Corp.; MP
 Peter Herrmann; Motion Laboratories; CP
 David Herrmann; Motion Laboratories; CP
 Donald Hoffend III; Avista Designs, LLC; G
 Donald A. Hoffend Jr.; Avista Designs, LLC; G
 Wendy Holt; Alliance of Motion Picture and Television Producers; G
 Rodney F. Kaiser; Wenger Corp.; CP
 Christine L. Kaiser; Syracuse Scenery & Stage Lighting Co., Inc.; DR
 Theresa Kelley; Total Structures Inc.; MP
 Jerald Kraft; SECOA; CP
 Edwin S. Kramer; I.A.T.S.E. Local 1; U
 Kyle Kusmer; Steven Schaefer Associates; G
 Roger Lattin; I.A.T.S.E. Local 728; U
 Michael Lichter; Electronic Theatre Controls, Inc.; MP

Dan Lisowski; University of Wisconsin - Madison; U
Joseph McGeough; Foy Invention Enterprises, Inc.; CP
Orestes Mihaly; Production Resource Group; DR
John (Jack) Miller; I Weiss; CP
Rick Montgomery; R&M Materials Handling; MP
Reid Neslage; H & H Specialties Inc.; MP
Mark Newlin; Xtreme Structures and Fabrication; MP
James Niesel; Arup; DE
Richard J. Nix; Steven Schaefer Associates; G
Shawn Nolan; Production Resource Group; DR
Tracy Nunnally; Hall Associates Flying Effects; CP
Edward A. (Ted) Paget; Daktronics Inc. CP
Miriam Paschetto; Geiger Engineers; G
Rocky Paulson; Freeman Companies; DR
Troy Post; R&M Materials Handling; MP
Woody Pyeatt; A V Pro, Inc.; DR
John Ringelman; Freeman Companies; DR
Rick Rosas; Texas Scenic Company; DR
Shawn Sack; Columbus McKinnon Corp.; MP
Bill Sapsis; Sapsis Rigging, Inc.; U
Stephen G. Surratt; Texas Scenic Company; DR
Peter V. Svitavsky; Wenger Corp.; CP
Harvey Sweet; Electronic Theatre Controls, Inc.; MP
Will Todd; Vitec Group plc; MP
Elmer Veith; Total Structures, Inc.; MP
Steve Walker; Steve A. Walker & Associates; G
Charlie Weiner; U
Michael Wells; Xtreme Structures and Fabrication; MP
Marty Westrom; Mountain Productions Inc.; DR
Jeff Wilkowski; Thern, Inc.; MP
Frank Willard; Syracuse Scenery & Stage Lighting Co., Inc.; DR
R. Duane Wilson; Amer. Society of Theatre Consultants; DE
Thomas S. Young; Wenger Corp.; CP
Robert Young; Arup; DE
Art Zobal; Columbus McKinnon Corp.; MP

Observer (non-voting) members: Brent Armstrong; U
William Ian Auld; Auld Entertainment; U
Warren A. Bacon; U
Rinus Bakker; Rhino Rigs B.V.; G
Robert Barbagallo; Solotech Inc.; DR
Roger Barrett; Star Events Group Ltd.; DR
F. Robert Bauer; F.R. Bauer & Associates, LLC; G
Maria Bement; MGM Grand; U
Roy Bickel; Roy Bickel; G
Lee J. Bloch; Bloch Design Group, Inc.; G
Louis Bradfield; Louis Bradfield; U
Buddy Braile; Bestek Lighting & Staging; U
Barry Brazell; Barry Brazell; U
André Broucke; André Broucke; G
David M. Campbell; Geiger Engineers; G
Michael J. Carnaby; Mikan Theatricals; DR
Daniel J. Clark; Clark-Reder Engineering, Inc.; G
Ian Coles; Total Structures, Inc.; MP
Gregory C. Collis; I.A.T.S.E. Local 16; G

Randall W. A. Davidson; Risk International & Associates, Inc.; U
Robert Dean; ZFX Flying Inc.; DR
François Deffarges; Nexo; MP
Cristina Delboni; Feeling Structures; MP
Noga Eilon-Bahar; Eilon Engineering Industrial Weighing Systems; MP
James B. Evans; Mountain Productions Inc.; DR
Philip Fleming; PSAV Presentation Services; DR
Tim Franklin; Theta-Consulting; G
Jay O. Glerum; Jay O. Glerum & Associates, Inc. U
Rand Goddard; W.E. Palmer Co.; CP
Reuben Goldberg; Technic Services; U
Thomas M. Granucci; San Diego State University; U
Robert A. Grenier Jr.; Ocean State Rigging Systems Inc.; DR
Sean Harding; High Output, Inc.; G
Dean Hart; Freeman Companies; U
Ben Hayes; Freedom Flying; G
Marc Hendriks; Prolyte; MP
Ted Hickey; OAP Audio Products; MP
Chris Higgs; Total Solutions Group; G
Daniel Lynn Houser; Real Rigging Solutions, LLC; U
Wes Jenkins; Down Stage Right Industries; CP
Joseph Jeremy; Niscon Inc.; CP
Peter Johns; Total Structures, Inc.; MP
Ted Jones; Chicago Spotlight, Inc.; U
Kent H. Jorgensen; IATSE Local 80; G
Gary Justesen; Oasis Stage Werks; DR
John Kaes; U
JoAnna Kamorin-Lloyd; Vincent Lighting Systems; U
Nevin Kleege; Kleege Industries; U
Ken Lager; Pook, Diemont & Ohl, Inc.; DR
Jon Lagerquist; South Coast Repertory; U
Eugene Leitermann; Theatre Projects Consultants, Inc.; G
Jon Lenard; Applied Electronics; MP
Mylan Lester; Creation Logics Ltd.; U
Baer Long; Act 1 Rigging Inc.; G
Dennis J. Lopez; Automatic Devices Co.; MP
Darren Lucier; North Guard Fall protection Inc.; U
Aleksandrs Lupinskis; Real Rigging Solutions, LLC; U
Gary Mardling; Kish Rigging; DR
Chuck McClelland; Jeamar Winches Inc.; MP
Richard C. Mecke; Texas Scenic Company; DR
Hank Miller; W.E. Palmer Co.; CP
Shaun Millington; SEW-Eurodrive, Inc.; MP
Timothy Mills; Geiger Engineers; G
Scott Mohr; R&R Cases and Cabinets; G
Derek Moon; Wenger Corp.; CP
Martin Moore; G
John "Andrew" Munro; animaenagerie; U
Bob Murphy; Occams Razor Technical Services; G
Steve Nelson; Educational Theatre Association; U
Rikki Newman; Rikki Newman; U
Michael Patterson; Pook Diemont & Ohl, Inc.; CP
G. Anthony Phillips; I.A.T.S.E. Local 16; U
Michael Powers; Central Lighting & Equipment, Inc.; DR
Kurt Pragman; Pragman Associates, LLC; G

Michael Reed; Reed Rigging, Inc.; DR
Mark Riddlesperger; LA ProPoint, Inc.; CP
Jean-Philippe Robitaille; Show Distribution Group, Inc.; DR
Michael L. Savage, Sr.; Middle Dept. Inspection Agency, Inc.; G
Peter A. Scheu; Scheu Consulting Services, Inc.; G
Peter "Punch" Christian Schmidtke Hollywood Lighting, Inc.; DR
Monica Skjonberg; Skjonberg Controls, Inc.; CP
Knut Skjonberg; Skjonberg Controls, Inc.; CP
John C. Snook; Thermotex Industries Inc.; CP
Rob Stevenson; SEW-Eurodrive, Inc.; MP
Joachim Stoecker; CAMCO GmbH; MP
Andy Sutton; AFX UK Ltd.; U
Katherine Tharp; LA ProPoint, Inc.; CP
John Van Lennep; Theatrix Inc.; DR
Stephen Vanciel; Stephen Vanciel; U
Bill Waters; Conductix-Wampfler; MP
Michael G. Wiener; Aerial Rigging & Leasing, Inc.; U
Jiantong Wu; Beijing Special Engineering Design & Research Institute; G

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 – 2012
Entertainment Technology Construction and Use of Wire Rope Ladders

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

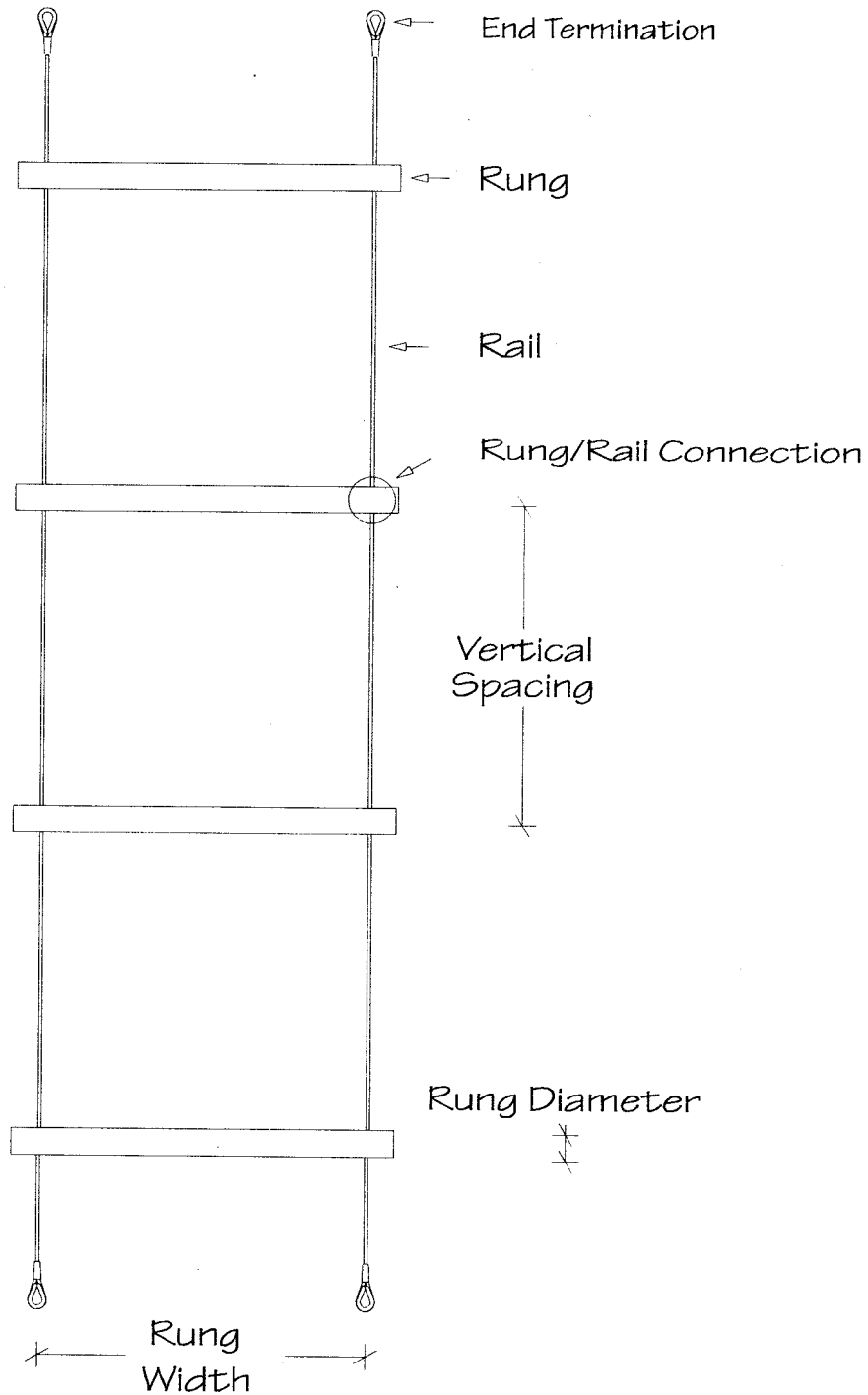


Figure 1 - Wire Rope Ladder

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.