

American National Standard for Ladders — Wood Safety Requirements



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American National Standard for Ladders – Wood Safety Requirements

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American National Standard

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Foreword

(This Foreword is not a part of American National Standard A14.1-1994.)

This standard is a revision of American National Standard Safety Requirements for Portable Wood Ladders, ANSI A14.1-2007. It is one of a series of many standards prepared under the supervision of American National Standards Committee on Safety in the Construction, Care, and Use of Ladders, A14. All of the standards have been developed by subcommittees reporting to American National Standards Committee A14. The subcommittees are: A14.1, Portable Wood Ladders; A14.2, Portable Metal Ladders; A14.3, Fixed Ladders; A14.4, Job-Made Ladders; A14.5, Portable Reinforced Plastic Ladders; and A14.9, Ceiling Mounted Disappearing Climbing Systems.

All standards, with the exception of A14.7-1991, Mobile Ladder Stands, derive from the original American National Standard Safety Code for Construction, Care, and Use of Ladders, A14, which was first approved in 1923. Revisions were approved in 1935, 1948, and 1952.

The earlier editions contained some treatment of metal and fixed ladders. Requirements for these types of ladders were removed from the 1948 revision because rapid development in the metal ladder field warranted special consideration and treatment of metal ladders and fixed ladders (usually metal) in separate standards. In 1948, the code was revised and its title and designation changed to American National Standard Code for Wood Ladders, A14.1. In 1952, it was again revised and retitled American National Standard Safety Code for Portable Wood Ladders. It was further revised in 1959, 1968, 1980, and 1982.

Responding to a Consumer Product Safety Commission challenge in August 1975, the A14 Committee mounted a three-prong attack to upgrade the portable ladder standards within the consensus framework of developing standards. Three Task Forces — Anthropometric, Testing, and Labeling — were established in October 1975.

Without question, the most massive and technically difficult task, which included a significant amount of human-factors work, was carried out by the Testing Task Force. Over 100 known ladder experts were solicited to join this task force and provide their technical expertise. The work involved 50 meetings, over 400 test documents, and the use of numerous test ladders over a period of nearly two years. The cost of the project has been conservatively estimated at over \$300,000.

At the August 11, 1977, joint meeting of the Testing Task Force and the A14 Advisory Committee, 23 procedures were presented. These procedures, with an accompanying rationale based upon statistical and human-factors data, were distributed to the three portable-ladder subcommittees for review and incorporation into the standards. Recommendations for nomenclature and for care and use of ladders have been included in the Appendixes, had been previously balloted in order that this more technical material from the Testing Task Force receive the full attention of the three subcommittees.

Test procedures were developed for three different applications; namely, design verification, quality control, and in-service testing. Design verification tests would generally be conducted on a one-time basis during the original design development of the product and would usually be destructive tests. Quality control tests would be conducted by the manufacturer on an on-going basis; some of the tests would be destructive and some would be nondestructive. In-service tests would be conducted by the user on a periodic basis and would be nondestructive in nature.

The A14 Committee adopted June 4, 1982*, as the effective date of ANSI A14.1-1981. This was to allow the manufacturers the necessary lead time to evaluate their products for conformance to the 1981 edition of the three portable-ladder standards, to redesign and test their products where applicable, to design and build the required manufacturing tooling and machinery, and to convert their manufacturing operations to produce the revised products.

In 1981, experience by some of the manufacturers indicated that the inclined load test was not practical when applied to all available lengths of extension ladders. Also, recommendations were received for clarifications in test procedure descriptions.

In the course of resolving these questions, evidence was produced to warrant modifications in the label test requirements. As a result, it became necessary to postpone the effective date of these standards from June 4, 1982, to October 4, 1982, to allow investigations which brought about needed changes in label test specifications.

In September 1991, an errata sheet was added to allow an extension beyond November 10, 1991, of 90 days to use existing stocks of labels.

On November 17, 1994, the A14 committee agreed to specify residential non-waxed vinyl sheet floor covering for test surfaces as needed.

In the 1994 revision, two new sections on double front ladders were added along with two new labels/markings for these ladders.

The 2007 standard contains editorial changes which align the presentation with ANSI A14.2 and A14.5 standards for metal and plastic ladders, respectively.

This 2017 edition is a largely a reissue of the 2007 standard with some changes to reflect the introduction of new test protocols shared with A14.2 and A14.5 as well as some minor updates on material properties.

Suggestions for improvement of this standard will be welcomed. They should be sent to the American Ladder Institute.

The standard was processed and approved for submittal to ANSI by American National Standards Committee on Safety in the Construction, Care, and Use of Ladders, A14. Committee approval of the standard does not necessarily imply that all the committee members voted for its approval. At the time it approved this standard, the A14 Committee had the following members:

* The original effective date was March 4, 1982.

At the time it approved this standard, the A14 Committee had the following members:

Organization Represented	Name of Representative
American Insurance Association	George Earhart
American Ladder Institute	Ron Schwartz
	Marc McConnell (Alt)
American Society of Safety Engineers	Michael Lorenzo
	Tim Fisher (Alt)
Associated General Contractors of America	Charles E. Bird
	Tim Fischer (Alt)
Canadian Standards Association	Dave Shanahan
Cosco Home and Office Products	Eric Kruse
	Larry Voris (Alt)
Cotterman Company	Don Gibson
	Pete Catlos (Alt)
Ellis Fall Safety Solutions, LLC Div. of DSC	J. Nigel Ellis
	Cody Snyder (Alt)
Grainger Industrial Supply	Richard Martin
	John Foston (Alt)
International Brotherhood of Electrical Workers	Christian Duva
International Union of Painters and Allied Trades	Greg Renne
	Dan Penski (Alt)
International Union of Bricklayers & Allied Craftworkers	Gerald Scarano
	Mike Kassman (Alt)
Little Giant Ladder Systems	Ben Cook
Louisville Ladder, Inc.	Tom Schmitt
National Association of Home Builders	Jerry Passman
	Robert Matuga (Alt)
National Frame Builders Association	Stan Virkler
NIOSH	Peter Simeonov, Ph. D
	Hongwei Hsiao, Ph. D (Alt)
Precision Ladders	Don McKinney
	Steve Richey (Alt)
Risk Retention Services	Paul B. Junius
	Robert G. Stuligross (Alt)
Scaffold Access Industry Association	Alan D. Kline
State University of New York	George H. Kyanka
Steel Plate Fabricators Association	Ken Wade
Switalski Engineering, Inc.	William Switalski
Technology Associates, LLC	Irving U. Ojalvo
	Kristopher Selgua (Alt)
Tri-Arc Manufacturing Co., Inc.	Ron Schwartz
	Eric Pucek (Alt)
U.S. Consumer Product Safety Commission	Thomas Caton*
	Mark E. Kumagai* (Alt)
Ver Halen Engineering, P.C.	Jon Ver Halen
Werner Ladder	Brett Latimer
	Dale King (Alt)

World/General Window Cleaning Companies (formerly Illinois Association of Building Maintenance Contractors)	Carl Pedersen Noa W. Pedersen (Alt)
Independent Specialists.	Dr. Donald Bloswick Dr. George H. Kyanka Dr. Irving Ojalvo

*non-voting advisory member

Subcommittee A14-1, which developed this standard, had the following members:

George H. Kyanka, Chairman
A.L. DeBonis
Alan Kline
Tom Harrison
Dale King

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American National Standard for Ladders – Wood Safety Requirements

1. Scope and Purpose

1.1 Scope

This standard prescribes rules and establishes minimum requirements for the construction, testing, care, and use of the common types of portable wood ladders described herein in order to ensure safety under normal conditions of usage. Ladder Types included are:

Duty Rating	Ladder Type	Working Load (pounds)
Extra Heavy-Duty	IA	300
Heavy-Duty	I	250
Medium-Duty	II	225
Light-Duty	III	200

It does not cover ladder accessories, including, but not limited to, ladder shoes, ladder levelers, ladder stabilizers or standoff devices, ladder jacks, or ladder straps and hooks, that may be installed on or used in conjunction with ladders.

Note: While ladder type stools are covered by A14.1, it is recognized that a step stool standard is under development. When the step stool standard is approved, A14.1 will no longer cover ladder type step stools under 48 inches in height. The new standard will be A14.11.

These requirements are also intended to prescribe rules and criteria for labeling/marketing of the kinds of portable ladders cited in this standard, but exclusive of furniture type step stools and special purpose ladders. These labeling/marketing requirements do not apply to those situations where training, supervision, or documented safety procedures would be in conflict, or serve in lieu of, these labeling/marketing requirements.

1.2 Purpose

The purpose of this standard is to provide reasonable safety for life, limb, and property. In order to develop an effective safety program, the standard may serve also as a basis for purchase requirements and for instructions in personnel training. It may also assist in the preparation of motivational/instructional material such as safety practices, manuals, posters, and the like. This standard is also intended to provide the manufacturer, purchaser, and user of wood ladders with a set of specifications and requirements against which a ladder may be compared.

It is not the purpose of this standard to specify all the details of construction of portable wood ladders. The limitations imposed are for the purpose of providing adequate general requirements and testing methods needed for consistency.

2. General

2.1 Rationale

A rationale has been developed covering the specifications and performance requirements of this standard.¹

2.2 Application

This standard is intended for voluntary use by establishments that use, manufacture, or evaluate ladders. It is also designed to serve as a guide for federal and state authorities or other regulatory bodies in the formulation of laws or regulations.

The methods employed to ensure the proper regulatory or administrative authority should determine compliance with this standard.

2.3 Interpretation

To secure uniform application of this standard, it is recommended that suggestions involving changes in the requirements or disputes over its interpretation shall be referred to the A14 Administrative Secretariat.

If it is determined that your inquiry requires an interpretation of the standard, the inquiry must be submitted in writing and the Secretariat will forward the inquiry to the appropriate Subcommittee Chairman for committee response.

In view of the many different kinds of ladders and the many different conditions under which they are used, this standard should be liberally construed considering the rationale (see 2.1). In cases of practical difficulty or under special-service conditions, it is expected that the administrative authority will grant exceptions to the literal requirements of this standard or will permit the use of alternate designs or features, but only if equivalent safety is thereby secured.

2.4 Mandatory and Advisory Provisions

The word “shall” is to be understood as denoting a mandatory requirement. The word “should” is to be understood as denoting a recommendation.

2.5 Equivalent

The word “equivalent” in this standard means a construction, connection, or material providing equal performance.

2.6 Effective Date

The requirements of this standard shall become effective 1 year after the revised A14.1 standard is approved by ANSI.

3. Related Standards

This standard is intended for use in conjunction with the following American National Standards or latest revision (see Section 10):

American National Standard Safety Requirements for Scaffolding, ANSI A10.8-2008

American National Standard for Ladders — Portable Metal — Safety Requirements, ANSI A14.2-2017

American National Standard for Ladders — Portable Reinforced Plastic — Safety Requirements, ANSI A14.5-2017

American National Standard Nomenclature of Domestic Hardwoods and Softwoods, ANSI/ASTM D1165-13

American National Standard Methods for Establishing Clear-Wood Strength Value, ANSI/ASTM D2555-16

National Fire Protection Association Standard for Manufacturers Design of Fire Department Ground Ladders
NFPA 1931-15

¹The rationale is on file with the Secretariat, American Ladder Institute, 330 N. Wabash Avenue, Chicago, IL 60611.

4. Definitions and Nomenclature

Angle of inclination. The preferred pitch for portable non-self-supporting ladders.

Back leg (rear rail). The support members of a self-supporting portable ladder back section. Rungs, bars, rear braces or other bracing to form the back section joins the back legs.

Combination ladder. A portable ladder capable of being used either as a stepladder or as a single or extension ladder. It may also be capable of being used as a trestle ladder or a stairwell ladder. Its components may be used as single ladders.

Double front ladder. A self-supporting portable ladder, non-adjustable in length, consisting of two sections with steps for climbing designed to be able to be climbed by two (2) individuals simultaneously, one (1) per side, and hinged at the top to form angles with the base.

Duty rating. The combination of factors, including, but not limited to, ladder type and design features, which imply service capability.

Engineered Wood. Composite wood structural products such as laminated veneer lumber and parallel strand lumber that are strength and durability rated by recognized agencies (APA/EWS & AITC). American Plywood Association/Engineered Wood Society – American Institute for Timber Construction

Extension ladder. A non-self-supporting portable ladder adjustable in length. It consists of two or more sections traveling in guides or brackets or the equivalent and so arranged as to permit length adjustment.

Extension trestle ladder. A self-supporting portable ladder, adjustable in length, consisting of a trestle ladder base and a vertically adjustable extension section, with a suitable means for locking the ladders together.

Highest Standing Level. The vertical distance, expressed in feet and inches, from the uppermost rung or step the climber is advised to use to the horizontal plane of the ladder base support, with the ladder in the preferred climbing position.

Inside clear width. The distance between the inside flanges or faces of the side rails of a ladder.

Ladder. A device incorporating or employing steps, rungs, or cleats on which a person may step to ascend or descend.

Ladder foot, shoe² or slip -resistant bearing surface. That component of ladder support that is in contact with the lower supporting surface.

Ladder Type. The designation that identifies the working load.

Marking. Any sign, label, stencil, or plate of a primary hazard or informational character, or both, affixed, painted, burned, stamped or embossed on a ladder surface. (See Appendixes A and B.)

Maximum extended length or maximum working length. The total length of the extension ladder when the middle or intermediate and top or fly sections are fully extended (maintaining the required overlap).

Nail. A steel nail, unless otherwise designated.

Permanent deformation (set). That deformation remaining in any part of a ladder after all loads have been removed.

Pitch. The included (acute) angle between the horizontal and the ladder, which is measured on the side of the ladder opposite the climbing side. It is usually expressed as the ratio H/L, which is the horizontal distance H from the base of the ladder to the supporting surface divided by the working length L of the ladder.

Plastic top cap. Molded thermoset or thermoplastic uppermost horizontal member of a portable stepladder.

Platform. A landing surface that is used as a working or standing location.

Platform ladder. A self-supporting portable ladder of fixed size with a platform provided at the intended highest standing level.

Plywood Test Surface. The test surface shall be Russian (Baltic) or Finnish Birch throughout plywood (100% Birch veneers through the full thickness of the plywood sheet) between 1/2 and 3/4 inch total thickness, with a face grade of BB or better (including face grades B,S and BB) and shall be void free. The maximum thickness of the veneers shall be 0.1 inch, regardless of total sheet thickness.

² An optional accessory from the manufacturer.

Portable ladder. A ladder that can readily be moved or carried, usually consisting of side rails joined at intervals by steps, rungs, cleats, or rear braces.

Rail. The side members joined at intervals by either rungs, steps, cleats, or rear braces.

Rear Braces. Crosspieces or diagonals (in the back section of a self-supporting ladder), not intended for climbing, which may be spaced at any interval.

Rungs, steps, or cleats. Ladder crosspieces that are intended for use by a person in ascending or descending.

Scaffold. A temporary elevated platform and its supporting structure used for supporting worker(s) or materials or both.

Section

(1) **bottom or base section.** The lowest section of a non-self-supporting portable ladder.

(2) **top or fly section.** The uppermost section of a non-self-supporting portable ladder.

(3) **middle or intermediate section.** The section between the top (fly) and bottom (base) sections of a non-self-supporting portable ladder.

Sectional ladder. A non-self-supporting portable ladder, nonadjustable in length, consisting of two or more sections, and so constructed that the sections may be combined to function as a single ladder.

Single ladder. A non-self-supporting portable ladder, nonadjustable in length, consisting of one section.

Size. The quantitative description of the length of the ladder. Methods of defining size are presented in the individual standards.

Special-purpose ladder. A portable ladder that is either an experimentally designed ladder or a modification or assemblage of A14 approved requirements for design testing or construction features of one of the general-purpose ladders defined elsewhere in this section, in order to adapt the ladder for special or specific climbing uses.

Standoff. A means by which a ladder may be erected at some horizontal distance away from its upper support point.

Stepladder. A self-supporting portable ladder, nonadjustable in length, with flat steps and hinged back.

Step stool (ladder type). A self-supporting, foldable, portable ladder, nonadjustable in length, 32 inches or less in overall size, with flat steps and without a pail shelf, designed so that the ladder top cap as well as all steps can be climbed on. The side rails may continue above the top cap.

Step surfaces. The clear portion of steps, rungs, or cleats on which a person may step while ascending or descending a ladder.

Test failure. Damage, deformation, or visible weakening of the ladder structure or a component, except where otherwise defined by the test protocol.

Test load. The applied load used to demonstrate compliance with performance test requirements.

Top cap. The uppermost horizontal member of a portable stepladder or step stool.

Top step. The first step below the top cap of a portable stepladder or step stool. Where a ladder is constructed without a top cap, the top step is the first step below the top of the rails.

Trestle (double front) ladder. A self-supporting portable ladder, non-adjustable in length, consisting of two sections with rungs or bars for climbing designed to be able to be climbed on by two (2) individuals simultaneously, one (1) per side, and hinged at the top to form angles with the base.

Ultimate failure. The collapse of the ladder structure or, where applicable, a component thereof.

Visual damage. Damage evident by visual inspection.

Visual inspection. Inspection by the eye without recourse to any optical devices except prescription eyeglasses.

Wood characteristics. Distinguishing features, the extent and number of which determine the quality of a piece of wood.

Wood characteristics. Natural growth related or machining related characteristics in or on the wood that may lower its durability, strength, or utility.

- (1) **Bark pocket.** An opening between annual growth rings that contain bark. Bark pockets appear as dark streaks on radial surfaces and as rounded areas on tangential surfaces.
- (2) **Check.** A separation of the wood along the fiber direction that usually extends across the rings of annual growth, commonly resulting from stresses set up in the wood during seasoning.
- (3) **Compression failure.** A deformation (buckling) of the fibers due to excessive compression along the grain. This deformation may appear as a wrinkle across the surface. In some cases, compression failures may be present but not visible as wrinkles; in such cases, they are often indicated by “fiber breakage” on end grain surfaces.
- (4) **Compression wood.** An aberrant, highly variable type of wood structure with abnormal cells occurring in many softwood species.
- (5) **Cross grain (slope of grain).** A deviation of the fiber direction from a line parallel to the sides of the piece. Cross grain may be diagonal or spiral, or both.
- (6) **Decay.** The disintegration of wood due to the action of wood-destroying fungi; also known as wood rot.
- (7) **Knot.** A portion of a branch or limb, embedded in the tree and cut through in the process of lumber manufacture. It is classified according to size, quality, occurrence, and location in the cross section of a piece. The size of the knot is determined by its average diameter on the surface of the piece.
- (8) **Low-density wood.** Wood that is exceptionally light in weight and usually deficient in strength properties for the species. In softwood species, low density is frequently indicated by exceptionally wide, or sometimes by extremely narrow, rings, and generally a low proportion of latewood. On the other hand, low-density hardwood, at least in ring-porous species, is most commonly indicated by excessively narrow annual rings in which the earlywood portion predominates.
- (9) **Pitch pocket.** An opening extending parallel to the annual growth rings that contains, or that has contained, either solid or liquid pitch.
- (10) **Shake.** A separation along the grain, occurring most often between the rings of annual growth.
- (11) **Split.** A separation of the wood parallel to the fiber direction due to tearing apart of the wood fibers, normally caused by external forces.
- (12) **Wane.** Bark, or lack of wood, on the corner of a piece.

Working length. The length of a non-self-supporting portable ladder measured along the rails from the base support point of the ladder to the point of bearing at the top.

Working load. The maximum applied load, including the weight of the user, materials, and tools that the ladder is to support for the intended use.

5. Materials

5.1 Requirements for Wood Parts

5.1.1 Requirements Applicable to All Wood Parts.

5.1.1.1 General Requirements. All wood parts of the species specified in Table 1 shall be seasoned at the time of manufacture to a moisture content of not more than 15 percent; smoothly machined and dressed on all sides; free from sharp edges and splinters; and sound and free by accepted procedures of visual inspection from shake, wane, compression failures, decay, or other irregularities except as hereinafter provided. Low-density wood shall not be used.

To allow for normal variations in width and thickness which occur in surfacing lumber, on up to five percent of the length of a part, the depth and thickness may be undersized a maximum of 1/64” when measured at a moisture content of 15 percent. Permissible irregularities as provided for in this standard are based on minimum dimensions. When oversized parts are used some deviations from those irregularities may be allowable.

5.1.1.2 Compression Wood. Compression wood is found mostly in softwoods. Compression wood commonly has a density somewhat higher than that of normal wood but has somewhat lower stiffness and tensile strength for equivalent weight. Compression wood has high longitudinal shrinkage that frequently causes warping of long,

slender structural members such as ladder rails. This variant type of wood structure, when of a damaging nature, can be readily identified, by competent and conscientious visual examination during the grading and manufacturing process, by its relatively wide annual rings and large proportion of latewood, which is darker and often reddish in color and commonly has a dull lifeless surface appearance. Moreover, the dark latewood merges slowly with the earlywood of the same annual rings rather than being more sharply delineated. The extent of compression wood's effect on strength and warping varies with the proportion of compression wood in a cross section. For example, wide streaks of readily identifiable compression wood comprising the larger part of the annual rings in a piece of lumber are associated with more seriously adverse properties than narrow streaks involving only a few annual rings, particularly when the latewood comprises one-third or less of the ring widths in narrow streaks.

The presence of microscopic levels of compression wood is not uncommon in softwoods. The use of magnifying equipment to search for such small areas is not necessary. These small regions have no measurable effect on strength.

5.1.1.3 Cross Grain. Cross grain is limited in terms of its slope, which is defined as the distance along the sides of the piece in which a deviation of the grain of 1 inch occurs. For example, cross grain with a slope of one in 12 means that in a distance of 12 inches, the grain deviates one inch from the edge of the piece. The slope of grain shall be measured over a distance that will ensure that the determination of the general slope of the grain is consistent and is not influenced by short local deviations which do not pass from surface to surface on either the wide or narrow faces.

When the grain direction differs between opposite faces on edges, averaging is appropriate. A slope of one in twenty shall be used for any surface having that value or less.

Local deviations of the grain from the general slope in the piece are usually associated with a knot or other irregularity that may or may not be present in the piece. In addition to the limits on general slope of grain, it is also desirable, in pieces of small cross section such as occur in ladder parts, to limit the occurrence of local deviations, except for those which are associated with otherwise permitted irregularities appearing in the piece.

5.1.1.4 Limited Irregularities. Black streaks in western hemlock shall not be considered an irregularity. However, openings or chambers associated with black streaks, when present in the part, shall be limited as specified for pitch and bark pockets.

5.1.2 Permissible Irregularities in Side Rails and Back Legs.

5.1.2.1 Cross Grain. The general slope of the grain in side rails and back legs shall not be steeper than one in 12, except for ladders under 10 feet in length and having flat steps for treads, in which the general slope of the grain shall not be steeper than one in 10. The slope of the grain in areas of local grain deviation shall be limited as above when occurring on the narrow face or in the outer one-fourth of the width of the wide face. Local areas of grain deviation within the center half of the width of the wide face may be permitted to contain a grain slope as steep as one in eight. Local deviations of grain associated with otherwise permissible irregularities shall be permitted.

5.1.2.2 Knots. Knots shall not appear in a narrow face of a side rail or back leg. Knots, if tight and sound and less than 1/2 inch in diameter, shall be permitted on the wide face provided no part of the knot is within 1/2 inch from either edge and knots are not more frequent than one in any three feet of length.

5.1.2.3 Pitch and Bark Pockets. Pitch and bark pockets in side rails and back legs shall be permitted provided that there is not more than one that is 1/8 inch in width, two inches in length, and 1/2 inch in depth, or the equivalent of smaller pockets, on the basis of exposed area and depth, per each three feet of length.

5.1.2.4 Checks. Checks that are not more than six inches in length or 1/2 inches in depth shall be permitted in side rails or back legs.

5.1.2.5 Splits. Splits that are not more than two inches in length shall be permitted in side rails and back legs.

5.1.2.6 Compression Wood. Occurrences of compression wood, in relatively small amounts and positively identified by competent and conscientious visual inspection during the grading and manufacturing process of side rails and back legs shall be permitted provided that no single streak exceeds 1/2 inch in width and that the aggregate of streaks does not exceed in width 1/4 of the wide face of the side rail. No streak of compression wood shall be allowed on the narrow face of the rail. Borderline forms of compression wood not positively identified by competent and conscientious visual inspection during the grading and manufacturing process shall be permitted. Those parts containing bow or crook that would interfere with the operation of the ladder shall not be used. No streaks of compression wood shall be within 1/2 inch of the edge of the rail.

5.1.3. *Permissible Irregularities in Flat Steps, Rungs, and other Ladder Parts.*

5.1.3.1 Cross Grain in Parts Other Than Rungs. The general slope of grain shall not be steeper than one in 12 in pieces for ladders 10 feet and greater in length and not steeper than one in 10 in pieces for ladders less than 10 feet in length. The slope of the grain in areas of local deviation shall be limited as is the general slope of the grain. For all ladders, cross grain not steeper than 1 in 10 may be permitted in lieu of one in 12 provided the size of the part is increased to afford at least 15 percent greater calculated strength than in ladders built to minimum dimensions. Local deviations of grain associated with otherwise permissible irregularities shall be permitted.

5.1.3.2 Cross Grain in Rungs. The general slope of the grain and the slope in areas of local deviation shall not be steeper than one in 15. For all ladders, cross grain not steeper than one in 12 may be permitted in lieu of one in 15 provided the size of the part is increased to afford at least 15 percent greater calculated strength than in ladders built to minimum dimensions. Local deviations of grain associated with otherwise permissible irregularities shall be permitted.

5.1.3.3 Knots. Permissible knots shall be sound and tight. Knots over 1/8 inch in diameter shall not appear in rungs. Knots shall not appear in the narrow faces of flat steps. Knots appearing in the wide faces of flat steps shall not exceed 1/4 inch in diameter. Knots in other ladder parts shall comply with the requirements of 5.1.2.2.

5.1.3.4 Pitch and Bark Pockets. Pitch and bark pockets shall be permitted provided that there is not more than one that is 1/8 inch in width, two inches in length, and 1/2 inch in depth, or the equivalent of smaller pockets on the basis of exposed area and depth, per each three feet of length.

5.1.3.5 Checks. Seasoning checks shall be permitted at the time of manufacture provided that the checks are not more than six inches in length or 1/2 inch in depth.

5.1.3.6 Splits. Splits shall be permitted at time of manufacture provided that they are not more than two inches in length.

5.1.3.7 Compression Wood. Occurrences of compression wood, positively identified by competent and conscientious visual inspection during the grading and manufacturing process, shall be permitted provided that no single streak exceeds 1/2 inch in width and that the aggregate of streaks does not exceed in width 1/4 of the wide face. No streak of compression wood shall be allowed on the narrow face. Borderline forms of compression wood not positively identified by competent and conscientious visual inspection during the grading and manufacturing process shall be permitted. Parts containing bow or crook that would interfere with the operation of the ladder shall not be used.

5.2 Classification of Species of Wood

Table 1 gives a list of native woods, divided into five groups on the basis of their mechanical properties, considered from the viewpoint of use for ladder construction.

5.2.1 Side Rails and Flat Steps. All minimum dimensions and specifications set forth hereinafter for side rails and flat steps shall be followed, except that wood from species of Group E may be substituted for wood from group D when the former is used in sizes that provide equivalent strength. (See Note 6 of Table 1 for suggested methods of size adjustment.)

5.2.2 Rungs. All minimum dimensions and specifications set forth hereinafter for rungs are based on the species of wood listed in Group A of Table 1.

5.3 Hardware

Hardware shall be made of aluminum, steel, wrought iron, malleable iron, or other material that is adequate in strength for the purpose intended and free from sharp edges and from sharp projections in excess of 1/64 inch. The materials shall be corrosion and weather resistant.

5.4 Fasteners

Fasteners shall be applied in a tight and secure manner and remain so with normal use and care, or be such that they can be field tightened. Rivets shall be peened or set over the hardware or a washer. The washers shall be standard riveting burrs; that is, 3/16 inch diameter rivets shall use a minimum 1/2 inch diameter burr, and 1/4 inch diameter rivets shall use a minimum 5/8 inch diameter burr. The head of the rivet, when used against wood, shall be a wagon box, truss, or similar type head to afford adequate bearing against the wood. Holes drilled in wood parts for fasteners shall not exceed the diameter of the fastener by more than 1/32 inch.

5.5 Alternate Materials

When a wood ladder is manufactured with a part or parts made of some other material (aluminum or steel steps, top cap, or rungs), or species not herein specified, these parts shall meet the requirements of this and other applicable American National Standards for ladders. A component part made of other wood-based material may be substituted if it has strength, stiffness, durability, performance, and weathering characteristics at least equal to or exceeding the solid lumber component specified in this standard. Engineered wood components available from APA/EWS or AITC certified suppliers are specific options.

6. Construction Requirements

6.1 Basis of Requirements

6.1.1 Types of Ladders.

6.1.1.1 Type IA. Type IA is an extra heavy-duty industrial ladder with a 300-pound duty rating. These ladders are for frequent extra heavy-duty applications, such as industry, utilities, contractors, and the like.

6.1.1.2 Type I. Type I is a heavy-duty industrial ladder with a 250-pound duty rating. These ladders are for applications such as industry, utilities, contractors, and the like.

6.1.1.3 Type II. Type II is a medium-duty commercial ladder with a 225-pound duty rating. It is for applications such as offices, light maintenance, and the like.

6.1.1.4 Type III. Type III is a light-duty household ladder with a 200-pound duty rating. These ladders are for light household use.

6.1.2 General. The dimensions specified hereinafter for wood ladders are the minimum dressed cross-sectional dimensions (subject to manufacturing variations allowed in second paragraph of 5.1.1.1) for the type of ladders herein designated, based on the species of wood specified in 5.2, at a moisture content of 15 percent. The dimensions for side rails are based on a mortise or groove as specified herein for the various types of ladders for step or rung attachments. Where the strength of the side rails or back legs is reduced by a greater mortise or groove than specified, or where it is desired to use for any wood part a cross section either dimension of which is less than specified, the required dimensions may be found as indicated in 6.1.3.

6.1.3 Formula for Determining Dimensions.

6.1.3.1 For the side rails of single, extension, and sectional ladders, the proposed section shall develop an actual stress per square inch not greater than 2000 pounds per square inch (psi) for Group A and B woods, 1875 psi for Group C woods, 1600 psi for Group D woods, or 1375 psi for Group E woods when computed by the following formula applying to rectangular sections, with a maximum tolerance of five percent over these stresses:

$$f_b = \frac{1.5LD(P + W/16)}{B(D^3 - d^3)}$$

(Eq. 1)

where

P = one-eighth of the duty rating, which is the normal component of the applied load to each rail at the center of the ladder, when the foot of the ladder is moved out of the perpendicular by one-quarter of its length. P is 37.5 pounds for Type IA, 31.25 pounds for Type I, and 28.125 pounds for Type II, and 25 pounds for Type III

f_b = stress in extreme fiber in pounds per square inch

W = weight of ladder in pounds (see first footnote of Table 1)

L = maximum working length of ladder in inches (size of ladder less minimum overlap for two-section extension ladder, less 12 inches or 6-inch overhang at each support point)

B = net thickness of each side rail in inches

D = depth of side rail in inches

d = diameter of hole bored for rung (d3 shall be taken as not less than 0.67in3; this adjustment is for loss of strength in rail from boring of rung hole of 7/8-inch diameter)

Equation 1 is a simplified formula for determining rail sizes.

6.1.3.2 Adjustment of sizes for wood parts of stepladders and other ladder types covered in this standard may be made as follows:

(1) The dimensions throughout this standard for parts having rectangular cross sections generally represent only one of a number of possible combinations of thickness and width that could satisfy the requirements for strength and stiffness. Depending upon the material sizes available, manufacturing practices, and other such variable factors, parts produced by a particular manufacturer may or may not agree exactly with the sizes given subsequently. The rest of 6.1.3.2 provides means for determining equality of load-carrying capacity of parts of different sizes, or for determining the sizes needed to provide equality.

(2) Any changes in dimensions made in accordance with 6.1.3.2(3) shall result in a change in the width-thickness ratio for side rails or back legs not greater than 25 percent from the ratio now specified in this standard for a corresponding ladder unless new dimensions provide a cross section that has a greater modulus (or equivalent strength and safety).

(3) Where both dimensions are different from those specified, the load-carrying capacity in bending of a part will be equal to or greater than that of a part of specified dimensions if the changed section modulus equals or exceeds the specified one; that is:

$$B_2 D_2^2 \geq B_1 D_1^2$$

(Eq. 2)

where

B = dimension of the part at right angles to the direction of load (width of a step, thickness of a side rail or back leg)

D = dimension of the part parallel to the direction of load (thickness of a step, width of a side rail or back leg)

B1, D1 = dimensions as specified herein

B2, D2 = dimensions of part being considered

The dimensions to be used in the computation are net dimensions. For example, in the case of a stepladder side rail, dimension B shall be taken as the gross thickness of the rail minus the depth of the gain for the steps. Where there is a rung hole at the center of depth of a rail, a somewhat more accurate comparison may be made by the use of the adjusted section modulus; that is

$$\frac{B_2 (D_2^3 - d_2^3)}{D_2} \geq \frac{B_1 (D_1^3 - d_1^3)}{D_1}$$

(Eq. 3)

where the symbols have the same meanings as before, and d is the diameter of the hold for the rung tenon. In most instances the difference in results calculated by equations 2 and 3 is slight.

6.2 Portable Stepladders

Stepladders, as hereinafter specified, shall have lengths as follows:

- (1) Type IA and Type I – 3 to 20 feet
- (2) Type II – 3 to 12 feet
- (3) Type III – 3 to 6 feet

The overall length measured along the front edge of the side rails, not including the top cap shall determine the size.

6.2.1 General Requirements.

6.2.1.1 Slope. Slope is the angle of side rails or back legs with respect to the vertical and is expressed as the horizontal deviation from the vertical per unit length of the member. Stepladders shall be constructed so that when they are in the open position, the slope of the front section is not less than 3-1/2 inches and the slope of the back section is not less than 2 inches, for each 12-inch length of side rail.

6.2.1.2 Step Spacing. The uniform step spacing measured along the rail shall be 12 inches $\pm 1/4$ inch. Steps shall be parallel and level within $\pm 2^\circ$ relative to the lower support surface when the ladder is in position for use.

Note: Stepladders with the top step 18 inches below the top cap and the bottom step six inches above the base support are permitted as an alternate means of construction, and in this case the top step may be used for stepping purposes. When the top step is 18 inches below the top cap, provision should be made to warn against and/or to restrict inadvertent stepping into the opening.

6.2.1.3 Width and Spread. The minimum inside clear width at the top step shall be 12 inches. From top to bottom the spread between the side rails shall increase a minimum of 1-1/4 inches per foot of side rail length.

6.2.1.4 Step Attachment. When side rails of minimum thickness are used, steps shall be closely fitted into the grooves in the side rails; the grooves shall be 1/8 inch in depth with a tolerance of $\pm 1/32$ inch and shall be firmly secured as hereinafter described. Alternatively, steps shall be closely fitted into metal brackets of an equivalent strength, which in turn shall be firmly secured to the side rails. The depth of groove specified herein may be increased in proportion to the thickness of side rails as provided in 6.2.2.1, 6.2.3.1, and 6.2.4.1.

6.2.1.5 Top Cap. All stepladders shall have a top cap. Wood top caps with metal attachment brackets, or molded top caps are permissible.

Wood top caps shall use metal brackets on fittings to connect the top caps with the side rails. The brackets shall be tightly secured to the top, and the front rails, or the rear rails, or both, to allow free swinging of the back section without excessive play or wear at the joints. Rivet spacing shall be no less than 1-1/4 inches. On Type IA and Type I stepladders there shall be a minimum of three 3/16-inch-diameter or two 1/4-inch-diameter rivets, or equivalent fasteners, to attach each metal bracket to each front rail, if metal brackets are used to provide the top hinging of the back section.

For molded top caps, specification of the particular resin, filler and additives are the responsibility of the molder, who shall give consideration that certain requirements are achieved. All filled thermoplastics shall have the appropriate coupling agent and adequate ultraviolet inhibitors should be incorporated*.

The assembled part shall be designed to exhibit satisfactory corrosion resistance, outdoor weathering, thermal stability, and structural integrity under the stipulated thermal conditions outlined in the standard. Rivet sizes and spacing shall comply with those outlined above for wood tops.

*One acceptable system is a minimum of 0.25% by weight of HALS (Hindered Amino Light Stabilizer) and 0.12% antioxidant.

6.2.1.6 Spreaders. A spreader or locking device of sufficient size and strength to securely hold the front and back sections in the open position shall be a component part of each stepladder. The spreader shall not be more than 6-1/2 feet above the lower support surface and shall have all sharp points or edges covered or removed to protect the user. For ladders using double sets of spreaders, the foregoing height limitation applies only to the lower set. For the Type III ladder the pail shelf and spreader may be combined in a unit (the so-called shelf-lock ladder). When spreader hooks are used in lieu of the lower spreader, they shall be installed at sufficient heights so that they can be folded downward and secured when the ladder is folded.

6.2.1.7 Length Tolerance. When measured along the front edge of the side rails, all stepladders shall measure within two inches of the specified length.

6.2.1.8 Bucket (Pail) Shelves. Where bucket shelves are an integral part of the stepladder, they shall be so fastened that they can be folded up within the ladder when the ladder is closed. On ladders eight feet or less in length, the shelf shall be designed so that it must be folded before the ladder can be closed, or during the closing of the ladder the shelf shall fold and the bucket shelf arms shall not project beyond the front rail frame surfaces facing the user.

6.2.1.9 Hardware. All hardware and fittings shall be securely attached by means of rivets, bolts, screws, or equivalent means.

6.2.1.10 Shoes. When shoes or other means are needed to meet the performance requirements of any of the tests in Section 7, they shall be securely bolted, nailed, or riveted, or attached by equivalent methods, with the exception of elastic boot-types that are properly fitted.

6.2.1.11 Step Width. Step width shall be as required in other sections of this standard, but in no case be less than three inches.

6.2.2 Type IA and Type I — Industrial Stepladders.

6.2.2.1 Dimensions. The minimum dimensions of the parts of Type IA and Type I stepladders shall be as given in Table 2 when these parts are made of Group A, B, C, or D woods.

The minimum thickness of the side rails provides for the cutting of a groove 1/8 inch in depth with the tolerance indicated in 6.2.1.4 and shall be increased when grooves of greater depth are used. The minimum thickness of the steps provides for the cutting of tread grooves in the top surface not exceeding 1/8 inch in width and 1/16 inch in depth and a rod-lock groove in the underside of the step not exceeding 9/32 inch in width and 9/32 inch in depth.

Note: The upper eleven steps on 14- through 20-foot Type IA and Type I stepladders may be dimensioned as those for Type IA and Type I 12-foot stepladders.

6.2.2.2 Flat Steps. Steps shall be secured from front-to-back lateral movement with at least two 6d nails (minimum dimensions: 0.086 inch in diameter and 1-7/8 inches long) at each end, or the equivalent thereof such as rod-lock construction. When nails are used, they shall be located at least 3/8 inch from the rail edge. Steps less than 30 inches long shall be reinforced by a steel rod not less than 0.160 inch in diameter, with standard commercial tolerances. Steps 30 inches in lengths and longer shall be reinforced by a steel rod not less than 0.180 inch in diameter, with standard commercial tolerances. These rods shall pass through flat metal washers of minimum 18-gage thickness and at least one-inch diameter or through formed steel washers of 24-gage minimum thickness on each end to prevent them from excessive pressing into the side rails. A truss block shall be fitted between the rod and the center of each step. An alternative construction may be provided by a metal angle brace on each end, firmly secured during the grading and manufacturing process to the step and the side rails, or by other construction of equivalent strength.

When rod-reinforced construction is used, the end of the rod shall be peened, and the bottom step shall also be provided with a metal angle brace on each side, or the equivalent, which shall be securely fastened to the bottom step and side rails. In addition, all steps 3-5/8- to 4-1/4-inches wide and 27 inches or more in overall length and all steps 4-1/4 inches or wider in width and 32 inches or more in overall length shall be provided with a metal angle brace at each end, securely riveted to the step and side rail, or shall have construction of equivalent strength. The maximum projection on the leading edge of a step shall not exceed 3/4 inch at the top of the step.

6.2.2.3 Bracing of Back Section. The back section shall be braced by one of the methods outlined in 6.2.2.3.1 and 6.2.2.3.2.

6.2.2.3.1 The back legs shall be braced with 1-1/8 inch diameter dowels made of Group A woods (see Table 1), or material of equivalent strength, having 7/8-inch diameter tenons or oval, square or rectangular wood cross pieces of equivalent strength, spaced not more than 24 inches apart. The back legs shall be bored with holes extending either through the legs or to within 1/8 inch of the outside face of the legs, and the size of the hole shall be such as to ensure a tight fit for the cross piece. The minimum length of the tenon shall be 9/16 inch; the shoulder of the cross piece shall be forced firmly against the leg, and the tenon shall be secured in place with a 0.080-inch-diameter nail, or the equivalent thereof, to prevent turning of the cross piece. At a minimum, the length of the fastener shall be sufficient to pass through the tenon and at least 1/8 inch beyond into the back leg.

The back legs shall be braced by a metal angle brace on each side securely riveted to the cross piece and the back legs; one cross piece shall be braced for each four feet of length or fraction thereof on ladders more than four feet in length, with braces required only on the bottom cross piece for ladders that are four feet or shorter. The bottom cross piece shall be braced with a metal angle brace on each side, and the spacing between the braces shall not be more than four feet. Where cross pieces between the back legs are more than 28 inches in length, they shall be provided with center bearing consisting of a wood bar not less than

3/4 x 2 inches in cross section securely nailed to each cross piece, passing through the cross piece, and long enough to include each cross piece longer than 28 inches. Where there is only one such cross piece, supported by metal braces, the center bearing is not required.

6.2.2.3.2 The back legs shall be braced with horizontal wood bars made of Group A, B, C, or D woods (see Table 1), not less than 3/4 x 2-1/2 inches in cross section, and spaced not more than 24 inches apart. The ends of the bars shall fit into metal sockets of not less than 24-gage (Manufacturer's Standard) steel, or other material of equivalent strength, or into mortises of not less than 1/8 inch $\pm$ 1/32 inch in depth in the back legs. A steel rod not less than 0.160 inch in diameter, with standard commercial tolerances, shall pass through the back legs and the bar, and at each end through flat metal washers at least one inch in diameter and of minimum 20-gage thickness or formed steel washers of 24-gage minimum thickness to prevent the rod from excessively pressing into the back legs. The back legs shall also be braced by a metal angle brace on each side, securely riveted to the bar and to the legs; one bar shall be so braced for at least each four feet of length or fraction thereof, with braces required only on bottom bars for ladders that are four feet or shorter. Metal sockets, when used, shall be attached to the back legs by rivets, by means of a rod running through the socket, or by equivalent means.

6.2.2.4 Antisplit Devices. Where a separate hinge is not used, the back legs shall be reinforced by a rivet through the depth of the leg above the top hinge or pivot point, by metal plates or collars at the hinge point, or by other means suitable for preventing splitting of the back leg from the hinge pin to the top.

6.2.3 Type II — Commercial Stepladder.

6.2.3.1 Dimensions. The minimum dimensions of the parts of the Type II stepladders shall be as given in Table 3 when these parts are made of Group A, B, C, or D woods. The minimum thickness of the side rails provides for the cutting of a groove 1/8 inch in depth with the tolerance indicated in 6.2.1.4 and shall be increased when grooves of greater depth are used. The minimum thickness of the steps provides for the cutting of tread grooves in the top surface not exceeding 1/8 inch in width and 1/16 inch in depth and a rod-lock groove in the underside of the step not exceeding 9/32 inch in width and 9/32 inch in depth.

6.2.3.2 Flat Steps. Steps shall be secured from front-to-back lateral movement with at least two 6d nails (minimum dimensions: 0.086 inch in diameter and 1-7/8 inches long) at each end, or the equivalent thereof such as rod-lock construction. When nails are used, they shall be located at least 3/8 inch from the rail edge.

Each step shall be reinforced by a steel rod not less than 0.160 inch in diameter. The rod should have standard commercial tolerances which shall pass through flat metal washers of minimum 20-gage thickness and at least one-inch diameter or through formed steel washers of 24-gage minimum thickness on each end to prevent the rod from excessively pressing into the side rails.

A truss block shall be fitted between the steel rod and the center of each step. Alternative construction may be provided by a metal angle brace on each end, firmly riveted to the step and side rail, or by other construction of equivalent strength.

Where rod reinforced construction is used, the end of the rod shall be peened, and the bottom step shall also be provided with a metal angle brace on each side, or the equivalent, which shall be securely fastened to the bottom step and side rails. In addition, all steps 27 inches or more in overall length shall be provided with a metal angle brace at each end, securely riveted to the step and side rails, or shall have construction of equivalent strength. The maximum projection on the leading edge of a step shall not exceed 3/4 inch at the top of the step.

6.2.3.3 Bracing of Back Section. The back section shall be braced by one of the methods given in 6.2.3.3.1 through 6.2.3.3.3.

6.2.3.3.1 The back legs shall be braced with cross pieces consisting of 7/8-inch-diameter dowels made of group A woods (see Table 1), or other materials of equivalent strength, having 5/8-inch-diameter tenons firmly secured in the back legs and spaced not more than 12 inches apart. The back legs shall be bored with holes extending either through the legs or to within 1/8 inch of the outside face of the legs, and the size of the hole shall be such as to ensure a tight fit for the dowel. The minimum length of the tenon shall be 9/16 inch. The shoulder of the dowel shall be forced firmly against the leg, and the tenon shall be secured in place with a 0.080-inch-diameter nail, or the equivalent thereof, to prevent turning of the dowel. At a minimum, the length of the fastener shall be sufficient to pass through the tenon and at least 1/8 inch beyond into the back leg.

A bar connecting two or more of the dowels shall be provided on all ladders of six-foot length or more. The cross-sectional dimensions of the bar shall be the same as the cross-sectional dimensions of the back legs, and the dowels shall pass through holes at the centerline of the bar. The bar shall be attached at the center of the length of the lower two dowels on a six-foot ladder and shall extend upward one dowel for each additional two feet of length.

6.2.3.3.2 The back legs shall be braced with wood dowels as set forth in 6.2.3.3.1 plus an inverted V bracing of 3/4 x 1-1/2 inch material through which the dowels extend; the length of the V shall extend two-thirds of the way up the back.

6.2.3.3.3 The back legs shall be braced with horizontal wood bars made up of group A, B, C, D, or E woods (see Table 1) not less than 3/4 x 2 inches in cross section, the ends of which shall fit into metal sockets of not less than 24-gage (Manufacturer's Standard) steel, or other material of equivalent strength, or into mortises in the back legs not less than 1/8 inch $\pm$ 1/32 inch in depth. The bars shall be reinforced by steel rods not less than 0.160 inch in diameter, with standard commercial tolerances, which shall pass through the back legs and the bar, and at each end through flat metal washers at least one inch in diameter and 20-gage minimum thickness, or through formed steel washers of 24-gage minimum thickness, to prevent the rods from excessively pressing into the back legs. The spacing of such bars shall not exceed three feet, and there shall be at least one bar on three- and four-foot ladders, two bars on five- and six-foot ladders, three bars on seven- and eight-foot ladders, and four bars on 10-foot ladders. The bottom bar shall be not more than 18 inches from the bottom of the ladder, and where only one bar is used, it shall be braced by a metal angle brace on each end and securely riveted to the bar and the back leg, or by construction of equivalent strength.

6.2.3.4. Antisplit Devices. Where a separate hinge is not used, each back leg shall be reinforced by a rivet through the depth of the leg above the top hinge or pivot point, by metal plates or collars at the hinge point, or by other means suitable for preventing splitting of the back leg from the hinge pin to the top.

6.2.4. Type III — Household Stepladder.

6.2.4.1 Dimensions. The minimum dimensions of the parts of the Type III stepladder shall be as given in Table 4 when these parts are made of Group A, B, C, or D woods.

The minimum thickness of the side rails provides for the cutting of a groove 1/8 inch in depth with the tolerance indicated in 6.2.1.4 and shall be increased when grooves of greater depth are used. The minimum thickness of the steps provides for the cutting of tread grooves in the top surface not exceeding 1/8 inch in width and 1/16 inch in depth and a rod-lock groove in the underside of the step not exceeding 1/4 inch in width and 1/4 inch in depth.

6.2.4.2 Flat Steps. Steps shall be secured from front-to-back lateral movement with at least one 6d nail (minimum dimensions: 0.0858 inch in diameter and 1-7/8 inches long) at each end, or the equivalent thereof such as rod-lock construction. When nails are used, they shall be located at least 3/8 inch from the rail edge. Each step shall be reinforced by a steel rod not less than 0.160 inch in diameter, with standard commercial tolerances, which shall pass through flat metal washers of a minimum 20-gage thickness or formed steel washers of a minimum 24-gage minimum thickness and at least one inch in diameter on each end to prevent the rod from excessively pressing into the side rails. Alternate construction may be provided by a metal brace at each end securely riveted to the step and side rail, or by other construction of equivalent strength.

Where rod reinforced construction is used, the end of the rod shall be peened, and the bottom step shall be provided further with a metal angle brace on each end, or the equivalent, which shall be securely fastened to the bottom step and side rails. The maximum projection on the leading edge of a step shall not exceed 3/4 inch measured at the top of the step.

6.2.4.3 Bracing of Back Section. The back section shall be braced by one of the methods given in 6.2.4.3.1 and 6.2.4.3.2, or by construction of equivalent strength.

6.2.4.3.1 Back legs shall be braced by diagonal slats made of Group A, B, C, D, or E woods (see Table 1) not less than 3/8 x 1-15/16 inches, securely fastened to the back legs by screws (minimum length 1 inch), or the equivalent thereof. Diagonal slats shall be joined at the point of intersection with a clinched nail, or the equivalent thereof. Six-foot ladders shall also include a horizontal slat of 3/8 x 1-15/16 inches, located no higher than one-third the length of the back legs from the lower support surface.

6.2.4.3.2 Back legs shall be braced with horizontal wood bars made of Group A, B, C, D, or E woods (see Table 1) not less than 5/8 x 1-5/8 inches in cross section, the ends of which shall fit into metal sockets of not less than 24-gage (Manufacturer's Standard) steel, or other material of equivalent strength, or into mortises in the back legs not less than 1/8 inch $\pm$ 1/32 inch in depth. The bars shall be reinforced by steel rods not less than 0.160 inch in diameter, with standard commercial tolerances, which shall pass through the back legs and the bar, and at each end through flat metal washers at least one inch in diameter and 20-gage minimum thickness or formed steel washers of 24-gage minimum thickness to prevent the rods from excessively pressing into the legs. The spacing of such bars shall not exceed three feet, and there shall be at least one bar on three- or four-foot ladders and two bars on five- and six-foot ladders. The bottom bar shall be not more than 18 inches from the bottom of the ladder and where only one bar is used, it shall be braced by a metal angle brace on each end securely riveted to the bar and the back leg or by construction of equivalent strength.

6.3 Portable Rung Ladders

Portable rung ladders as herein specified shall be of four kinds: (1) single ladder, (2) two-section extension ladder, (3) sectional ladder, and (4) trestle and extension trestle ladders.

6.3.1 General Requirements.

6.3.1.1 Base. The bottom or lower portion of a ladder may be designed with parallel side rails, with side rails varying uniformly in separation along the length (tapered), or with side rails flaring at the base.

6.3.1.2 Rung Spacing. Rungs shall be parallel, level, and uniformly spaced. The rung spacing shall be on 12 inch $\pm$ 1/4 inch centers, except for trestle and extension trestle ladders. (See 6.3.5.7)

6.3.1.3 Rung Joint. All holes for wood rungs shall either extend through the side rails or be bored so as to give at least a 7/8 inch length of bearing to the rung tenon. In through-bored construction, the rungs shall extend so that they are at least flush with the outside rail surface. All holes shall be located on the centerline of the wide face of the side rails and shall be of such size as to ensure a tight fit for the rung. The shoulder of the rung shall be forced firmly against the side rails and the tenon secured in place so as to maintain the rung position in the side rail and prevent it from turning. The minimum length of the fastener shall be sufficient to pass completely through the diameter of the tenon and at least 1/8 inch beyond into the side rail. The fastener shall be a common nail of at least 0.080 inch diameter or one of equivalent holding power.

6.3.1.4 Rung Dimensions. Round rungs shall be made of Group A woods (see Table 1). The dimensions shall be as follows:

Rung Length	Minimum Diameter
Up to 24 inches	1-1/8 inches
24-28 inches	1-3/16 inches
Over 28 inches	1-1/4 inches

A 1-1/8 inch diameter rung may be substituted for a 1-3/16-inch diameter rung if it is reinforced with a steel rod having a minimum diameter of 0.160 inch, rung braces, or center bearing. 1-3/16-inch diameter rungs may be substituted for 1-1/4 inch diameter rungs on the same basis.

All rungs shall have tenons with a minimum diameter of 7/8 inch. Rungs of equivalent strength and bearing may be provided. All rungs more than 28 inches in length between rails shall, in addition, be provided with center bearing or equivalent support.

6.3.1.5 Oval Rungs. Oval rungs or rungs of any other cross section may be used provided they are secured by a nail at each end as described in 6.3.1.3, or the equivalent thereof, and have at least the same strength and bearing as round rungs of the same length.

6.3.1.6 Hardware. All hardware and fittings shall be securely attached by means of rivets, bolts, screws, or equivalent means.

6.3.1.7 Movable Parts. The construction and assembly of movable parts shall be such that they shall operate freely and securely without binding or unnecessary play.