WERNER

FIBERGLASS LADDER TECHNICAL MANUAL

INTRODUCTION

Fiberglass ladders were developed after years of design, testing and field use as a non-conductive tool. For the best performance and greatest life expectancy, fiberglass ladders must be maintained and handled with greater care than wood or aluminum ladders.

This manual outlines fiberglass' unique characteristics, test results, handling procedures, maintenance, and recommended modes of use.

While the test data is of greatest interest to the technically minded, it is important that all users understand the nature of fiberglass ladders and the proper maintenance procedures.

Recommendations for specialized use, maintenance, storage, transport, or other needs are available from Werner Co. upon request.

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The Effects of Weathering on Fiberglass Reinforced Plastic (FRP) Ladders

Fiberglass ladder rail will weather, as will most materials, when exposed to an outdoor environment. The degree of degradation of surface appearance will be accelerated by warm, moist climates; areas of high humidity; and high solar ultraviolet (U.V.) radiation. Humidity has the greatest effect on the degree of weathering.

VISUAL CHANGES THAT MAY OCCUR TO FIBERGLASS FROM WEATHERING ARE:

1. **Surface fiber appearance change** — The increase in fiber prominence due to resin erosion, fiber blooming, etc.
2. **Apparent color change** — The total effect in color change as a result of resin yellowing, pigment fading, fiber whitening, etc.
3. **Gloss loss** — The change in glossiness or light reflection of the sample.

Ultraviolet light will cause oxidation of the polyester resins generally used in Fiberglass Reinforced Plastic (FRP) ladders just as the oxidation of aluminum affects the metal's surface. The oxidation damage will result initially in loss of surface gloss and gradually in a chalky appearance. After a period of time, which will vary by heat, humidity and chemical atmosphere in the local environment, and without a surface veil (Werner ladders use a surface veil), the reinforcing fibers may become exposed to the surface, resulting in a condition commonly known as **"fiber bloom"**. Without a surface veil, this could occur in two to five years depending on the severity of conditions.

ULTRAVIOLET (U.V.) DAMAGE (FROM SUNLIGHT)

Ultraviolet light will attack the polyester resin of an FRP ladder and will definitely influence the aesthetic and, to a much lesser degree, the physical and electrical properties. The degree to which each of these characteristics is influenced should be a key consideration.

"Fiber bloom" is mainly an aesthetic condition — not a structural one. Exposed glass fibers due to UV damage do not reflect a significant loss in physical properties. Test programs instituted by producers to review structural property loss due to U.V. exposure as a function of time show only small losses of strength.

Surface weathering that occurs early in the life of a ladder can be a continuing phenomenon that may result in "fiber blooming". Should "fiber blooming" occur, the fiberglass will continue to show a worsening appearance until the end user takes some action to alleviate this condition. "Bloomed" fibers however, tend to shadow and protect the surface of fiberglass ladder rails against direct U.V. action to some degree.

If "fiber blooming" results from U.V. attack it can influence the **electrical properties** of an FRP ladder rail. The roughened surface of a ladder rail is now free to pick up contamination such as dirt or grease that can form an "electrical track". Furthermore, exposed fibers can now provide access for water or water vapor to penetrate the laminate. Absorbed water lowers the insulation resistance of the rail and hence its value as an insulator.

If "fiber blooming" occurs, it may also cause the user some discomfort if exposed fibers penetrate the skin. This is not serious, since it is only a temporary discomfort, but it is very annoying and the bloomed rail should be coated to eliminate the problem. Washing and applying skin lotion can relieve the discomfort, as long as repeated exposure is not encountered.

In an effort to combat resin degradation in the ladder rail, Werner Co. uses a U.V. inhibitor in the resin system to retard this weathering phenomenon. This inhibitor alone cannot eliminate "fiber bloom," but does extend the potential service life. Coating materials used on a ladder rail extend the period before fiber exposure is evident.

ULTRAVIOLET (U.V.) DAMAGE (FROM SUNLIGHT) (CONTINUED)

Werner Co. uses polyester fiber fabric surfacing materials (surface veils) on all its fiberglass ladder rail. These polyester fiber fabrics provide a barrier between the outer layer of glass mat and the surface of the rail.

These surface veils do not eliminate the weathering of the side rail from the ultraviolet rays of the sun. What they do is give a smooth, non-irritating outer surface to the rail, provide added resistance to UV degradation, and isolate the outermost glass layer which could irritate a user's skin once the resin becomes eroded. A fiberglass ladder with a surface veil can be comfortably used even after the resin has eroded without the itching sensation. The ladder can then be recoated with acrylic, polyurethane, or epoxy paint to restore the appearance and surface finish. (See page 4 for recommended coatings.)

STEPS THAT WERNER CO. HAS TAKEN TO IMPROVE OUTDOOR WEATHERING CHARACTERISTICS OF FRP LADDER RAIL INCLUDE:

1. Use of isophthalic polyester resin with superior weathering resistance.
2. Use of improved pigments with more resistant characteristics.
3. Use of improved monomer systems.
4. Use of U.V. inhibitor to reduce solar radiation effects.
5. Use of aluminum silicate filler.
6. Use of polyester surface veil to yield a higher resin rich surface.

For test purposes, several different types of accelerated artificial weathering devices are used such as:

1. Carbon Arc units such as the Atlas® Twin Carbon Arc[1], and Sunshine Carbon Arc (ASTM G23-90).
2. Xenon Arc type unit (ASTM G26-90).
3. Q-U-V®, Fluorescent, Ultraviolet, and Condensation unit[2] (ASTM G53-88).

For reference, 1000 hours at a cycle of 6 hours U.V. exposure at 130°F followed by 6 hours condensation at 100°F in the Q-U-V® accelerated weathering unit represents about one year of south Florida exposure; 2000 hours is about two years; and 3000 hours is about three years. This is based upon early development experience of other laboratories. An accelerated weathering test is only an approximation of real life weathering experience.

In all cases, a high humidity cycle is employed.

FACTORS AFFECTING THE SERVICE LIFE OF FRP LADDERS

An FRP ladder will be affected by:

1. Geographical location.
2. Type of handling given.
3. Whether or not a regular maintenance program is followed.

FOOTNOTES:

[1] Atlas Electric Devices Co.
4114 N. Ravenswood Avenue
Chicago, Illinois 60613

[2] Q-Lab
800 Canterbury Rd.
Cleveland, Ohio 44145

Geographical location: An FRP ladder in Miami (high solar, high humidity) will generally weather much faster than one in Chicago; and, therefore, requires a more frequent maintenance program.

Handling: Care should be taken to minimize impact loading to FRP ladders. Avoid dropping or stepping on ladders and dropping materials onto FRP ladder rails. Proper restraining of ladders during transit will prolong the useful life.

Maintenance: The maintenance cycle should be determined by local experience rather than by a national average. This requires the end user to use his/her best judgment in determining when an FRP ladder requires maintenance due to the effects of weathering.

MOISTURE ABSORPTION

FRP ladders are frequently exposed to moisture. FRP can absorb some moisture although it will never absorb as much moisture as wood. Wood is very porous by nature, which is not true of FRP since there is a bond between the reinforcement and polymer system.

A small amount of moisture can find its way into an FRP ladder by a wicking action at the surface through exposed fibers or at either end of the rails. This moisture reduces the insulation resistance of the ladder but does not reduce any physical properties.

Moisture is not visible in a laminate and requires an electrical confirmation test. Electrical tests such as a D.C. insulation resistance test can be used to determine the electrical safety of a ladder.

If there is reason to believe a ladder has absorbed considerable moisture, it should be placed in a circulating heat chamber at 120°F from four to twelve hours. Following this, the ladder should be coated with a highly pigmented polyurethane resin.

MAINTENANCE

The end user shall use his/her best judgment to determine when a ladder requires maintenance.

A good, general maintenance program should include the following:

1. All ladders should be cleaned of any build-up of dirt, grime, dust, grease, carbonaceous and other conductive materials. The cleaning effort ensures retention of the original electrical insulating characteristics and precludes a surface tracking condition. Regular washing and waxing will also greatly reduce the degree of surface degradation and potential fiber bloom. Wax slows down the entry of water but is invisible to U.V.
2. If the ladder is used indoors, there are fewer environmental concerns unless it is in a chemical environment. In that case, periodic inspection and possible coating may be warranted. Maintenance in a chemical environment requires specific consultation.
3. Ladders stored out-of-doors for extended periods of time can have the effect of weathering decreased by semi-annual waxing of the rails. Normally a good commercial non-slip paste wax, such as SC Johnson® Paste Wax[3], will reduce the possibility of glass fiber prominence.
4. Ladders employed in geographic locales with high U.V. ray exposure can have extended life and reduced potential for glass fiber prominence by periodic coating with certain acrylic lacquers, polyurethane coatings or similar materials. The U.V. additive employed in the resin formulation is gradually consumed during sunlight exposure. These subsequent coatings replace the U.V. screen or barrier.
5. A spot coating with a highly pigmented polyurethane resin is highly recommended when the ladder surface has been damaged by localized impact or abrasion. If there is any structural damage consult Werner Co. on repair or replacement or discard the ladder.
6. Ladders in service out-of-doors, where high humidity or high humidity coupled with intense U.V. ray exposure exists, may have their service life increased by applying a lacquer or paint coating and waxing.

FOOTNOTES:
[3] SC Johnson® Paste Wax
S. C. Johnson & Son, Inc.

CORROSION RESISTANCE GUIDE FOR FIBERGLASS

Chemical	75°F	150°F
Acetic Acid, 5%	R	R
Acetic Acid, 10%	R	NR
Aluminum Sulphate	R	R
Ammonium Hydroxide, 5%	R	NR
Aluminum Nitrate	R	R
Benzene Sulfonic Acid, 5%	R	R
Calcium Chloride	R	R
Chlorine Dioxide, 15%	R	NR
Chromic Acid, 5%	R	R
Copper Sulphate	R	R
Ethylene Chlorhydrin	R	R
Ethylene Glycol	R	R
Ferrous Sulphate	R	R
Fatty Acids, 100%	R	R
Fluosilicic Acid, 10%	NR	NR
Hydrochloric Acid, 1%-10%	R	R
Hydrochloric Acid, 37%	R	NR
Kerosene	R	R
Magnesium Chloride	R	R
Methyl Alcohol	R	NR
Naptha	R	R

Chemical	75°F	150°F
Nitric Acid, 5%	R	NR
Phosphoric Acid, to 85%	R	R
Sodium Bicarbonate	R	R
Sodium Bisulfate	R	R
Sodium Carbonate	R	NR
Sodium Chloride	R	R
Sodium Hydroxide, 5%	NR	NR
Sodium Hypochlorite, 5%	R	R
Sodium Nitrate	R	R
Sodium Silicate	R	NR
Sodium Sulfate	R	R
Sour Crude Oil	R	R
Sulfuric Acid, to 10%	R	R
Sulfuric Acid, 30—50%	R	NR
Trisodium Phosphate	R	NR
Xylene	R	NR

NOTE:
1) "R" is recommended
2) "NR" is not recommended

SOLVENTS NOT RECOMMENDED FOR IMMERSION

Acetone
Carbon Disulphide
Carbon Tetrachloride
Ethylether
Methyl Ethyl Ketone
Toluene

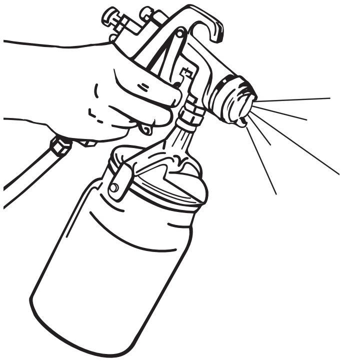
RECOMMENDED COATING METHODS AND MATERIALS FOR FIBERGLASS LADDERS

The following will enhance the life and appearance of FRP ladders which have weathered due to long term outdoor exposure:

RECOMMENDED METHOD OF PREPARATION

1. Sand the rails of the ladder smooth with a nonmetallic abrasive such as 3M™ Scotchbrite® or softback sanding sponge. Do not use ordinary sandpaper or emery cloth as it will leave atrace of abrasive grit embedded in the rail surface and may cause the surface to be an electrical conductor.
2. Wash the entire rail surface clean with denatured alcohol or an equivalent acceptable for health reasons and allow to air dry. Wash down a second time to ensure that no residue is left on the surface of the ladder.
3. Use a primer followed by one or two coats of either acrylic lacquer or polyurethane paint with U.V. additives for coating purposes. It is important to coat the sawed ends of the rails whenever possible. To restore color, apply a pigmented acrylic lacquer or polyurethane paint. Pigmented coating will screen out an even greater amount of U.V. while restricting moisture entry. Several acceptable coatings are on page five.
4. Contact Werner Co. for replacement labels.

NOTE: The use of all airborne chemical coatings must be done in accordance with federal, state and local laws.



ACCEPTABLE COATINGS

1. **Acrylic Lacquer**

   A high quality acrylic lacquer is recommended because of its wide availability. It may be found in paint stores, hardware stores or home improvement centers. Generally, two coats should be sufficient to remedy the severest condition of fiber prominence.

2. **Clear Acrylic Polyurethane***

   PPG - clear Deltron® DC3000
   PPG - hardener Deltron® DCH3085

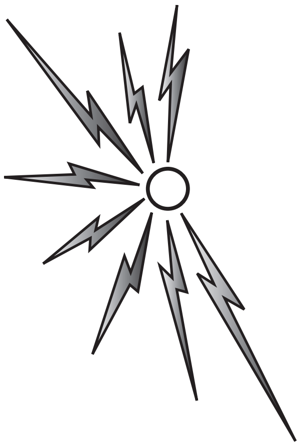
   Mix 4:1

   *Acrylic-based polyurethane is recommended over oil-based polyurethane.

3. **Rust-oleum® Universal Advanced Formula™**

   All surface paint is an excellent product choice because it is available in a wide variety of colors and is available at most home improvement centers and hardware stores.

INDEPENDENT ELECTRICAL LABORATORY TESTS



Electrical Testing Laboratories tested Werner Co. FRP ladders. Results from the test series are as follows:

FIBERGLASS BUTT LADDER	**FLASHOVER VOLTAGE** Before Immersion		After Immersion
Voltage Applied Between	45% R.H.	63% R.H.	52% R.H.
Rung 1 to Ground	6.0 KV	6.0 KV	5.5 KV
Rung 1 to Rung 2	94.0 KV	94.0 KV	64.0 KV
Rung 2 to Rung 3	95.0 KV	94.0 KV	66.0 KV
Rung 7 to Rung 8	95.0 KV	93.0 KV	81.0 KV
Rung 10 to Rung 11	83.0 KV	91.0 KV	84.0 KV
Rung 11 to Top (End cap to chain)	50.0 KV	53.0 KV	42.0 KV

	PRIOR FLASHOVER VOLTAGE TESTS Before Immersion	After Immersion
FIBERGLASS EXTENSION LADDER Rung to Rung (No R.H. Control)	90 KV	34.0 KV
WOOD EXTENSION LADDER Rung to Rung (No R.H. Control)	100 KV	Material Breakdown

Fiberglass Stepladder Voltage Applied Between	**FLASHOVER VOLTAGE** Before Immersion	After Immersion
Step 1 to Ground	29.5 KV	28.5 KV
Step 1 to 2	81.0 KV	75.0 KV
Step 4 to 5	82.0 KV	25.0 KV (Affected by Presence of label)
Step 5 to Top	100.4 KV	79.0 KV

The above products were immersed for 14 days, removed and permitted to air dry for two days, then tested.

ELECTRICAL TESTS

1. Electrical tests for DC leakage current requirements resulted in no more than 90 microamperes at 90 KV on a 10" electrode spacing. This test was run after 72 hours conditioning at 22°C and 80% relative humidity. For routine testing, conditioning at 60% Relative Humidity and 72ºF, is now utilized.

TEST RESULTS AT 80% RELATIVE HUMIDITY

Test Voltage	DC Leakage Current	Test Voltage	DC Leakage Current
20 KV	2.5 Microamperes (µA)	80 KV	8.2 µA
40 KV	3.2 µA	90 KV	---
60 KV	4.6 µA	100 KV	11.6 µA

Routine tests at 90 KV after conditioning at 72°F average 2 microamperes. The DC leakage current runs from less than 1 to as much as 8 microamperes with 60% of tests below 1 microampere.

2. AC Dielectric strength is measured parallel to the rail. The requirement is that a 1 inch length of ladder rail sustain 25 KV without electrical breakdown. Werner Ladder Co. fiberglass ladders averaged 65 to 70 KV on tests.
3. It is claimed that 1 milliampere (1000 microamperes) creates no sensation with 60 cycle AC while 5 milliamperes causes painful shock.
4. ANSI A14.5-1992 requires not over 90 microamperes at 90 KV DC with electrodes spaced 10 inches apart.
5. (Reference) — Electrical tests on other products used in electrical environments:

   a. Lineman's rubber gloves are available in five classes to meet ASTM F696 Specifications:

Ansi Class	Proof Test Voltage	Ansi Class	Proof Test Voltage
Class 0	5 KV (750 volt maximum use)	Class II	20 KV
		Class III	30 KV
Class I	10 KV	Class IV	40 KV

   b. **Insulated buckets and booms** must meet ANSI C92.2 using a portable current intensity detector. Test is run for 3 minutes and the leakage current can't increase 10% over initial value or exceed 1,000 microamperes at 69 KV (line-to-line AC) or 40 KV (line-to-ground AC).

SPECIAL ELECTRICAL TESTS

1. DC leakage current after water spraying sample for 5 minutes, wiped dry and tested. The electrodes were 50" apart.

Time	Applied Voltage		DC LEAKAGE CURRENT (MICROAMPERES)	
After Spray	Wood	Fiberglass	Wood	Fiberglass
10 minutes	5 KV	50 KV	1000	0.50
20 minutes	5 KV	50 KV	810	0.45
30 minutes	5 KV	50 KV	605	0.40
60 minutes	5 KV	50 KV	130	0.35
120 minutes	5 KV	50 KV	27	0.30
180 minutes	50 KV	50 KV	260	0.30
240 minutes	50 KV	50 KV	170	0.29
300 minutes	50 KV	50 KV	140	0.29

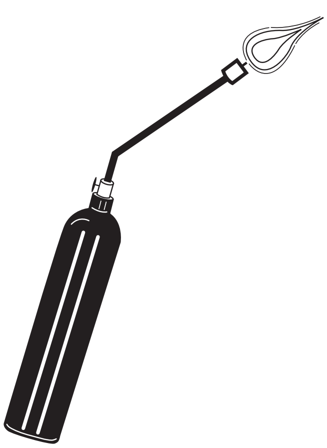
2. DC leakage current as related to conditioning for 10" electrode spacing, 80% relative humidity conditioned at 22° C.

	Applied Voltage		DC LEAKAGE CURRENT (MICROAMPERES)	
Time	Wood	Fiberglass	Wood	Fiberglass
As Received	90 KV	90 KV	7.0	1.0
24 hours	50 KV	90 KV	48.0	1.4
48 hours	50 KV	90 KV	67.0	1.9
72 hours	50 KV	90 KV	120.0	2.4

3. Fiberglass (FRP) ladder DC current leakage related to conditioning and electrical spacing 80% relative humidity, conditioned at 22° C.

		DC LEAKAGE CURRENT AT ELECTRODE SPACING OF: (MICROAMPERES)		
Time	Applied Voltage	20"	40"	60"
As Received	100 KV	0.75	0.65	0.55
24 hours	100 KV	1.10	0.80	0.75
48 hours	100 KV	1.50	1.10	1.00
72 hours	100 KV	2.10	1.40	1.20

FLAMMABILITY TESTS



A fire retardant resin is not employed in fiberglass ladder rails as its use would seriously reduce outdoor weathering qualities.

Two (2) tests are used to evaluate combustibility or flammability:

1. **Oxygen Index** *(ASTM D2863)* which is laboratory procedure. Bell Labs prefer materials whose index is 28% or better. Wood ladders test at 20.0% — 21.6% depending upon the species. Werner Co. fiberglass rails test at 20.5% minimum.
2. Werner Co. developed a **field propane burner test.** Craftsmen commonly use a propane torch on cable strand repair. The flame, for test purposes, was directed at the rails. The results were:
   a. At a 6" spacing, there was no char or discoloration up to 5 seconds.
   b. At a 3" spacing, the rail was exposed to the torch in separate locations for time periods ranging from 5 seconds through 2 minutes.
      1) 5 seconds created limited burning and char.
      2) The degree of burning and extent of char increases with time exposure. Flame extinguishes itself rapidly through 30 seconds exposure.
      3) At a 1 or 2 minute exposure, the flame and smoke fumes will continue for sometime but finally extinguishes itself.

When the flame or heat source was taken away, the ladder rail would not continue to burn.

ENVIRONMENTAL TEMPERATURE LOAD TESTING

An independent laboratory ran four series of temperature-load tests on single section fiberglass extension ladders to study the effect of temperature. ANSI A14.5 Horizontal Bending Test procedures were used with a 10 foot span and 250 lb. test load. In all but the Series IV tests, the 250 lb. test load was removed after each deflection reading was taken and then reapplied to the ladder when the listed temperature was attained. For the Series IV testing, the 250 lb. test load was maintained on the ladder for the entire 4 hour time period at the 125°F temperature listed. The load was then removed and reapplied for the 77°F reading. Separate ladders were involved in each test. Each ladder was preloaded to 180 - 185 lbs. in a horizontal position and then unloaded prior to starting each series of tests.

EFFECT OF MAXIMUM EXTREME TEMPERATURES ON DEFLECTION

Series	Temperature	Deflection	% of Room Temperature Deflection
I	80°F	1.141"	---
	-65°F	0.820"	72%
	75°F	1.020"	89%
	165°F	1.550"	136%
	80°F	1.161"	102%

EFFECT OF BELL SYSTEM TEMPERATURE LIMITS ON DEFLECTION

Series	Temperature	Deflection	% of Room Temperature Deflection
II	80°F	1.050"	---
	110°F	1.150"	110%
	140°F	1.255"	120%
	80°F	1.070"	102%

EFFECT OF EXTENDED TIME AT VARYING ELEVATED TEMPERATURES

Series	Temperature	Deflection	% of Room Temperature Deflection
III	80°F	1.075"	---
	165°F	1.355"	126%
	168°F†	1.380"	128%
	125°F	1.050"	98%
	80°F	1.045"	97%

This test is intended to simulate the condition of a ladder stored inside a van in the desert.

†The ladder was maintained @168°F for 16 hours & then retested.

EFFECT OF EXTENDED TIME AT A CONSTANT ELEVATED TEMPERATURE

Series	Duration	Temperature	Deflection	% of Room Temperature Deflection
IV	0	75°F	1.095"	---
	0	125°F	1.214"	111%
	1 hr.	125°F	1.298"	119%
	2 hrs.	125°F	1.310"	120%
	3 hrs.	125°F	1.318"	120%
	4 hrs.	125°F	1.322"	121%
		77°F	1.111"	101%

This test is intended to simulate a situation where a craftsman works on the ladder in the Southern U.S.A. heat.

TEST CONCLUSIONS

1. Low temperatures reduce deflection.
2. Elevated temperatures increase deflection.
3. Ladders will recover to about their initial deflection under load after being exposed to thermal cycling between -65°F and 165°F.
4. Deflection increases small amounts (the creep effect) when load is maintained at elevated temperature.

EFFECT OF TEMPERATURE ON IMPACT STRENGTH

Temperature	Izod Impact (Foot-Lbs./Inch Notch)	% Increase
Room	47.6	---
-65°F	82.0	172%

MISCELLANEOUS STRUCTURAL TESTS ON FIBERGLASS LADDERS

1. The Cyclic Horizontal Bending test is conducted to 100,000 cycles at the rated load for FRP composite ladder rail designs per ANSI A14.5 requirements. All FRP rail designs are then subjected to the Inclined Load Test requirements specified in ANSI A14.5.
2. A wide range of tests were performed at the bottom of a utility grade FRP extension ladder. The tests were run to demonstrate the degree of resistance to abuse. The results were:

Spur Shield System	Load Direction	Load at Failure
Design with internal rail shield and top rivet through the flange	Outward	715#
Design with internal rail shield with additional rivet through all components — this rivet at midpoint	Outward	900#

MATERIAL PROPERTIES — ELEVATED TEMPERATURE.

Web or flange specimens, as required, shall be maintained for a minimum of 1/2 hour at an elevated temperature of 150°F and then tested at that temperature.

The mechanical properties of the FRP rail at 150°F shall meet the values established in Table 1 and Table 2.

ANSI A14.5 FIBERGLASS LADDER STANDARD

(Selected Sections Abstracted from A14.5)

PHYSICAL PROPERTIES (TYPICAL)

- Density (in accordance with ANSI/ASTM D792-1991) 0.065 ± 10% lb/in
- Water absorption (in accordance with ASTM D229-91) 0.75% maximum

Density may vary with composite design. These are average values based upon the composite's cross section.

Material Properties — Dry. The composite shall meet the mechanical properties specified in Table 1 and Table 2.

Material Properties — Wet. Web specimens shall be immersed and maintained in boiling distilled water for a minimum of 2 hours, removed and immersed in distilled water maintained at room temperature, permitted to temperature stabilize, and tested wet.

The wet mechanical properties shall meet the values established in Table 1 and Table 2.

TABLE 1

Periodic Coupon Tests — Minimum Composite Properties*

Material Property	Testing Condition	Flange Lengthwise†	Web Lengthwise†	Web Crosswise‡
Flexural strength, psi	150°F	24,000	---	6,000
Flexural modulus, 10^6 psi	150°F	1.2	---	---
Tensile strength, psi	Condition A of ASTM D709-78*	45,000	30,000	---
Tensile modulus, 10^6 psi	Condition A of ASTM D709-78*	2.8	2.0	---
Comprehensive strength, psi	Wet	---	21,000	---
Comprehensive modulus, 10^6 psi	Wet	---	1.5	---

* This table is based on procedures outlined in ASTM D229-91, Testing Rigid Sheet and Plate Materials Used for Electrical Insulation.

† Lengthwise of pultrusion direction.
‡ Crosswise of pultrusion direction.

ANSI A14.5 FIBERGLASS LADDER STANDARD

(SELECTED SECTIONS ABSTRACTED FROM A14.5, Continued)

NOTE: Specimen sizes used for determining these properties shall be as follows:

(1) Flexural: based upon Method I, Procedure A, of Tests for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials, ASTM D780-91, with the outer surface of the composite down.

Preferred sizes are:

a. Flange lengthwise: 1/2-inch wide where thickness is greater than 1/8 inch; span-to-depth ratio approximately 36.5:1.
b, Web lengthwise: 1-inch wide where thickness is less than 3/16 inch; span-to-depth ratio approximately 36.5:1.
c. Web crosswise: 1-inch wide where thickness is less than 3/16 inch; span-to-depth ratio is approximately 16:1. Omit test when proper specimen length is not available.

(2) Tensile: Type I

(3) Compression: use support jig with dogbone-shaped specimens for all tests.

Preferred sizes are:

a. Flange lengthwise: 1/2-inch-wide neck.
b. Web lengthwise: 1/2-inch-wide neck.

TABLE 2

Qualification Coupon Tests — Minimum Composite Properties*
Testing Condition
Condition A of ASTM D709-78

Material Property	Flange Lengthwise†	Web Lengthwise†	Web Crosswise†	Web Lengthwise† Wet	Web Lengthwise† 150°F	Web Lengthwise† Weathering
Flexural Strength, psi	38,000	35,000	8,000	26,000	26,000	28,000
Flexural Modulus, 10^6 psi	2.0	1.8	0.70	1.4	1.4	1.4
Tensile Strength, psi	45,000	30,000	---	23,000	21,000	23,000
Tensile Modulus, 10^6 psi	2.8	2.0	---	1.5	1.4	1.5
Comprehensive Strength, psi	40,000	28,000	10,000	21,000	19,000	22,000
Comprehensive Modulus, 10^6 psi	2.8	2.0	---	1.5	1.4	1.6
Ultimate bearing strength, psi‡	---	30,000	---	---	---	---
Impact Izod (ASTM D256), Ft. lb. per inch of notch	---	20	---	---	---	---

*This table is based on procedures outlined in ASTM D229-91, Testing Rigid Sheet and Plate Materials Used for Electrical Insulation.

†Lengthwise or Crosswise of pultrusion direction.
‡See test for Bearing Strength of Plastics, ASTM D953-87.

NOTE: Specimen sizes used for determining these properties shall be as follows:

(1) Flexural: based upon Method I, Procedure A, of Tests for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials, ASTM D790-91, with the outer surface of the composite down.

Preferred sizes are:

a. Flange lengthwise: 1/2-inch wide where thickness is greater than 1/8 inch; span to depth ratio approximately 36.5:1.
b. Web lengthwise: 1-inch wide where thickness is less than 3/16 inch; span-to-depth ratio approximately 36.5:1.
c. Web crosswise: 1-inch wide where thickness is less than 3/16 inch; span-to-depth ratio is approximately 16:1. Omit test when proper specimen length is not available.

(2) Tensile: Type I

(3) Compression: use support jig with dogbone-shaped specimens for all tests except web crosswise, which are straight specimens.

Preferred sizes are:

a. Flange lengthwise: 1/2-inch-wide neck.
b. Web lengthwise: 1/2-inch-wide neck.
c. Web crosswise: 1/2-inch wide x 1-1/2 inches long, supported on both ends. Omit test when proper specimen length is not available.

7.9.5 Material Properties – Weathering. The mechanical properties of web coupon specimens prepared from the weathered samples shall meet the values established in Table 2 after 1000 hours of exposure to the weathering cycle. Further information concerning weathering is given in 7.9.5.1 through 7.9.5.3.

7.9.5.1 Accelerated Weathering Test Procedures. As a means of determining the weathering characteristics of newly manufactured fiberglass-reinforced plastic ladders, both outdoor and artificial weathering test may be employed. The different types of accelerated exposure devices used may include but are not limited to, the following:

(1) Fluorescent ultraviolet (UV) and condensation apparatus, as outlined in American National Standard Recommended Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials. ANSI/ASTM G53-94, to simulate the deterioration caused by sunlight and water as rain or dew. This tester is preferred, particularly if a cycle of 6 hours of ultraviolet exposure at 130°F followed by 6 hours of condensation at 100°F is used.

NOTE: For example, Q-U-V Cyclic Ultra-Violet Weathering Tester (available from the Q-Panel Company, 15610 Industrial Parkway, Cleveland, Ohio 44135), or the equivalent.

(2) Carbon-arc devices as outlined in ASTM G23-93, Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials, using distilled or ionized water in the water spray cycle; the requirements of American National Standard Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics, ANSI/ASTM D1499-92A, should also be met.

NOTE: For example, Sunshine or Twin Carbon Arc, or the equivalent.

(3) Xenon-arc-type devices as outlined in American National Standard Recommended Practice for Operating Xenon-Arc-Type (Water Cooled) Light- and Water-Exposure Apparatus for Exposure of Plastics, ANSI/ASTM D2565-92A, and American National Standard Recommended Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) with and without Water for Exposure of Nonmetallic Materials, ANSI/ASTMG26-94, using distilled or deionized water in the water spray cycle.

In either of the methods given in (2) and (3), the cycle should consist of the following: 102 minutes light only, black-panel temperature 145°F±9°F during light-only cycle; 18 minutes light and spray, relative humidity 50%±5%, black-panel temperature 100°F±10°F during light and spray; ozone, 5 parts per hundred million (optional).

(4) An accelerated device, utilizing an equatorial mount with mirrors for acceleration and water spray, may be used after correlation with one of the artificial weathering devices.

NOTE: For example, EMMAQUA Accelerated Outdoor Weathering Device (available from Desert Sunshine Exposure Test, Inc., Box 185, Black Canyon Stage, Phoenix, AZ 85020), or the equivalent.

7.10 Electrical Properties. The electrical properties of the reinforced plastic materials shall be determined at the time of manufacture.

NOTE: These tests do not reflect the electrical properties of reinforced plastic ladders owning to the wide variety of reinforced plastic composites, metals, and design possibilities employed in their construction. Consequently, these requirements refer only to the reinforced plastic rail. However, ladders constructed of reinforced plastic rails and metal rungs or steps are designed for use in certain electrical applications.

7.10.1 AC Dielectric Strength. A full section of 1-inch length of the rail material, as received, shall have a dielectric strength of at least 25,000 volts as determined by the short-time test method given in ASTM D149-94, Test for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials as Commercial Power Frequencies, and ASTM D229-91, which uses the parallel plane-to-plane method in oil, modified as follows: The full-section specimens with parallel ends shall be placed edgewise between parallel circular disc flat electrodes. These opposing cylinders should be at least 5 inches in diameter, 1 inch thick, with edges rounded to a 0.25-inch radius. The disc shall extend a minimum of 1/2 inch beyond the largest specimen dimension. Ten specimens shall be included in the average.

Special attention should be given to the cleanliness, dryness, and temperature of the transformer oil used. Dibutyl phthalate is a satisfactory substitute for transformer oil. Either material should be periodically evaluated using ASTM D1816-84A (1990). Test for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.

ANSI A14.5 FIBERGLASS LADDER STANDARD

(SELECTED SECTIONS ABSTRACTED FROM A14.5, Continued)

NOTE: The ac dielectric strength test is employed as a means of evaluating other characteristics of the composite.

7.10.2 DC Current Leakage. The dc current leakage shall not exceed 90 microamperes when a voltage of 90 kilovolts is applied to electrodes spaced 10 inches apart on a length of rail composite conditioned for 72 hours at 72°F and 60% relative humidity as follows:

(1) Affix a continuous length of metallic conductive tape completely around the specimen's surface at the two locations spaced 10 inches apart.
(2) Connect the tape to the power source.
(3) Slowly raise the voltage to the 90 kilovolt level and measure leakage current.
(4) If flashover occurs at a voltage lower than 90 kilovolts, report the voltage and flashover current level.

NOTE: The dc current leakage is affected by the surface condition, the presence of metallic or other electrical conductive materials, and even the adhesives used in labels.

CARE, USE, AND QUALITY CONTROL OF REINFORCED PLASTIC LADDERS

GENERAL

To obtain maximum serviceability and safety and to eliminate unnecessary damage to equipment, good safe practices in the use and care of ladder equipment must be employed by the users. While fiberglass ladders are designed for extended service, it may be necessary to perform additional periodic care in order to assure their continued use.

NOTE: The guidelines discussed do not constitute every possible proper or improper procedure for the care and use of ladders.

CARE OF LADDERS

Proper Handling. Ladders, like any tools, should be handled with care and not subjected to unnecessary dropping, jarring, or misuse. They are designed for a specific purpose or use; therefore, any variation from this use constitutes a mishandling of the equipment.

Storage. Ladders should be stored on racks designed to protect them when not in use. These racks should have sufficient supporting points to prevent any possibility of excessive sagging. At no time should material be placed on the ladder while it is in storage.

Transporting. Ladders transported on vehicles need to be properly supported. Overhang of the ladders beyond supporting points needs to be minimized. Contact points at supports need to be of a soft non-abrasive material, such as rubber or carpeting, to minimize the chafing and effects of road shock. Securing the ladder to each support point will minimize damage due to road shock and vibration.

Truck Racks. Ladders need to be tied down to the truck rack in order to avoid chafing caused by relative horizontal and vertical motion of the ladder with respect to the truck rack, the truck, and the individual ladder sections. Swivel type ladder shoes should be secured from pivoting while the vehicle is in motion. Points of contact on all ladder racks and carriers shall incorporate a shock absorbing material where contact is intended to be made by design while supporting the ladder. This material may consist of, but is not limited to, rubber and other elastomers, plastics and thermoplastics and textiles. In choosing a material for this purpose, care should be exercised to avoid the presence of abrasives such as glass reinforcements and certain mineral fillers in the cushioning materials which may cause wear of ladder components. The ladder truck rack needs to be designed to positively clamp the ladder into a fixed condition and to fit the particular ladder being fixed to the truck. If these conditions are not satisfied, excessive wear will occur in the ladder, which will cause premature retirement of the ladder from service. Improperly designed and used truck racks will damage the side rails, the rungs, the feet, and other ladder parts due to vehicle vibration and road shock.

Maintenance. Ladders should be maintained in good useable condition at all times. Hardware, fittings, and accessories should be checked frequently and kept in proper working condition. All pivoting connections should be lubricated with a light oil frequently and kept in good working order. All bolts are to be secure before using the ladder, and no ladder should be used if any fasteners are missing. Do not use a ladder if the padded feet are worn excessively. Make sure that enough pad remains so that the metal shoe body or fasteners will not contact the ground before the pad.

Geographical Location. The geographical location of the ladder and the amount of exposure to ultraviolet rays (sunlight) to which the ladder is subjected determines the frequency of periodic maintenance required. Follow the maintenance program specified on page three.

Ropes and Pulleys. Ropes or cables should be inspected frequently and replaced if they become damaged or worn.

Inspection. Complete a ladder inspection upon initial receipt and before each use. Check all working parts to see that they are functioning properly before using a ladder. Where structural damage is found, the ladder needs to be repaired by a competent repair center or returned to the manufacturer for repair.

Tip Over. If a portable FRP ladder has tipped over, inspect for the following damage:

Both self and non-self-supporting FRP ladders:

a. Cracks, fractures, splits, gouges, punctures or other structural damage to FRP side rails
b. Rivets that have been sheared, pulled through, uncurled or loosened
c. Components, such as braces that have been buckled, fractured, cracked or damaged

Non-self-supporting FRP ladders:

a. Bent locks, broken flippers on locks and flippers that don't pivot freely
b. Broken end caps and rail closures
c. Bent or dented rungs
d. Rungs that have loosened in their swages and move in or out when hand force is applied
e. Bent guide brackets or damaged guide bracket connections

Self Supporting FRP Ladders:

a. Cracks, fractures, punctures, or gouges to ladder tops
b. Bent, buckled steps
c. Bent spreaders or spreaders that do not open and close freely
d. Damage to the pail shelf

Check to make sure that extension ladder sections slide freely and engage the guide brackets properly. Stepladders shall open and close freely, and shall stand on a level floor without rocking.

Exposure to Fire. If ladders are exposed to excessive heat as in the case of fire, the strength may be reduced. After such exposure the ladder should be inspected visually for damage and tested for deflection and strength characteristics. In doubtful cases, refer to the manufacturer.

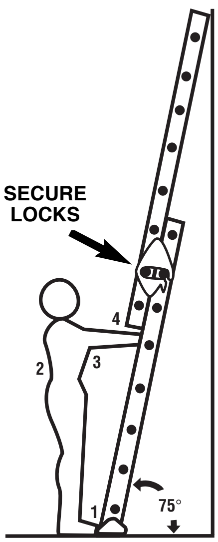
Corrosive Substances. When ladders are to be subjected to certain acids, alkali solutions, or other corrosive substances, consult the corrosion resistance guide on page four prior to their use. Contact the manufacturer if still in doubt.

Oil and Grease. Equipment shall be free of oil, grease, or slippery materials on climbing or gripping surfaces.

Damaged Ladders. Ladders having damage or excessive wear are to be marked and taken out of service until repaired by an authorized repair center or call Werner Co. at the number shown on the back cover for assistance. Never straighten or attempt to use a bent ladder.

Electrical Insulating Qualities. To ensure the retention of the original electrical insulating characteristics, the ladder shall be maintained in a clean condition. All surface buildup of dirt, dust, grease, grime, carbonaceous, and other conductive materials shall be removed. The presence of such materials will provide a ready path for electrical currents to travel over the surface of the ladder and potentially endanger the user.

CARE, USE, AND QUALITY CONTROL OF REINFORCED PLASTIC LADDERS (Continued)



Proper set up of a ladder

USE OF LADDERS

General. Restrict ladder usage to the purpose for which the ladder is designed.

Self-supporting ladders, such as stepladders and platform ladders, are not to be used as single ladders, that is, in the closed position.

A non-self-supporting ladder, such as an extension or single ladder, needs to be erected a minimum of one to three feet above the top support point when using for access to a roof or other work level. Do not step on any rung above the upper support point since this could cause the ladder to slip. Secure the ladder or have someone hold it while using it.

Pitch. Portable non-self-supporting ladders are to be erected at an angle of 75-1/2 degrees from horizontal. Combination ladders are to be erected so that the top surface of the steps are parallel to the surface supporting the base or bottom section. A simple rule for setting up a non-self-supporting ladder at the proper angle is to place the base a distance from the vertical support equal to one-fourth the effective working length of the ladder. The effective working length is the distance along the side rails from the bottom to the top support points. A simple procedure for setting a ladder up properly is as follows:

1. Place toes against bottom of ladder side rails.
2. Stand erect.
3. Extend arms straight out.
4. Palms of hands should touch top of rung at shoulder level.

TABLE A1 — DUTY CLASSIFICATIONS

Ladder Duty Rating	Capable of Supporting (pounds)	Ladder Duty Rating	Capable of Supporting (pounds)
Special Duty (Type IAA)	375	Medium Duty (Type II)	225
Extra Heavy Duty (Type IA)	300	Light Duty (Type III)	200
Heavy Duty (Type I)	250		

Generally accepted usage/duty relationships are:

- Special duty: for users requiring a 375-pound load capacity or for service requirements such as industry, utilities, contractors, etc.
- Extra heavy duty: for users requiring a 300-pound load capacity or for service requirements such as industry, utilities, contractors, etc.
- Heavy duty: for users requiring a 250-pound load capacity or for service requirements such as industry, utilities, contractors, etc.
- Medium duty: for users requiring a 225-pound load capacity or for service requirements such as painters, offices, light maintenance use, etc.
- Light duty: for users requiring no more than a 200-pound load capacity or for a service requirement such as general household use.

Werner Co. recommends only extra heavy duty ladders for use with ladder jacks and scaffold planks.

Ladder Selection. Portable ladders are designed as one-man working ladders including any material supported by the ladders. An exception is double front self-supporting ladders which are designed to be used by two workers, one per side. The five duty ratings are shown in Table A1. Werner Co. FRP ladders are available in Type IAA, Type IA, Type I and Type II duty ratings. Users should give consideration to the length required, the type of loading, and service to which the ladder will be subjected. Never overload a ladder.

Footing Support. The bottom ends of the ladder must be placed with a secure footing on a firm level base. On firm but uneven ground, ladder levelers may be used. Safety shoes, spurs, spikes, or similar devices of good substantial design are installed on all Werner Co. ladders. Ladders without safety shoes, spikes, spurs, slip resistant pads or similar devices shall not be used. Do not use ladders on ice, snow, or slippery surfaces, unless suitable means to prevent slipping are employed. Do not place ladders on boxes, barrels, or other unstable bases to obtain additional height.

Top Support. The top of the straight or extension ladder shall be placed with the two rails supported. A V-rung, pole lash, pole strap, or other device designed to support the ladder under load, shall be used when using a non-self-supporting ladder against a pole. To support the top of a ladder at a window opening, attach an extension ladder stabilizer to the ladder, extending across the window opening to provide firm support against the building walls or window frames.

Climbing Ladders. When ascending or descending, always face the ladder. Maintain a firm hold on the ladder when climbing up or down. Never climb onto a ladder from the side, or from one ladder to another ladder. Only climb from a ladder to a stage platform when both the ladder and stage platform are secured against sideways motion. Never climb a damaged ladder.

Fastening Together. Never tie or fasten additional ladders or ladder sections together to make a longer ladder.

Improper Use. Ladders shall not be used as a brace, skid, lever, guy or gin pole, gangway, platform, scaffold plank, material hoist, or for other uses for which they were not intended, unless specifically recommended by the manufacturer.

Ladders on Scaffolds. Ladders shall never be used on scaffolds to gain additional height since the forces imposed when climbing the ladder may cause the scaffold to tip.

Electrical Hazards. Users are cautioned to take proper safety measures when FRP ladders are used in areas with power lines and electric circuits to prevent short circuits, electrical shock or electrocution. Have the power turned off before starting work whenever possible. Never use metal ladders near power lines or other electrical circuits.

Doorways. Ladders should not be placed in front of doors opening toward the ladder unless the door is blocked open, locked, or guarded.

Access to Roof. No ladder shall be used to gain access to a roof unless the top of the ladder extends at least one to three feet above the upper support point at the eave, gutter, or roofline. Secure the ladder to prevent slipping before ascending onto roof.

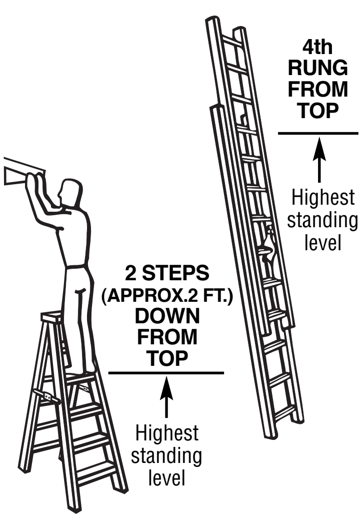
Adjustment of Extension Ladders. Adjustment of extension ladders should only be made by the user when standing at the base of the ladder, so that the user may observe when the locks are properly engaged. Adjustment of extension ladders from the top of the ladder (or any level over the locking device) is a dangerous practice and should not be attempted. Adjustment shall not be made while the user is standing on the ladder.

Use of Sections Of Sectional Ladders. Middle and top sections of sectional ladders shall not be used for bottom sections unless the user equips them with safety shoes.

Erection of Extension Ladders. Werner Co. extension ladders are always to be erected so that the upper (fly) section is above and resting on the climber's side of the bottom (base) section. Werner Co. ladders shall never be used in the reverse position where the upper end of the fly section becomes the lower end of the ladder, and the lower end of the base section becomes the upper end of the ladder. Where an extension ladder has been separated and the sections used separately, exercise extreme care to ensure that reassembly of these sections is done properly. Make sure that the interlocking guides or brackets are properly engaged before further use, and that only sections manufactured by the same manufacturer and from the same model ladder are used together in the same ladder.

Bracing. The bracing on the back sections of stepladders is not designed for climbing. Twin or double front stepladders and combination ladders are designed for using both the front and rear sections.

Cable (strand) Hooks. When use conditions warrant, cable (strand) hooks may be attached at or near the top of non-self-supporting portable ladders to give added security. A cable (strand) hook shall not be used as a stand off and shall not be used as a means of total support or suspension of a ladder.



Side Loading. Keep the ladder close to the work. Do not overreach, but descend the ladder and relocate the ladder instead. When using a ladder, use caution pushing or pulling anything, you may tip the ladder. Secure the ladder to prevent tipping whenever possible.

Climbing and Working Locations. Never stand on the ladder top cap, the first step below the top cap, the bucket shelf, or the rear section of a step or platform ladder (unless the rear section has been specifically designated and stated for this purpose by the manufacturer). The highest standing level on a stepladder is two steps down from the top. Never stand higher than the fourth highest rung from the top of a single or extension ladder.

Ladder Jacks. Werner Co. recommends only extra heavy duty (Type IA) and special duty (Type IAA) single and extension ladders shall be used in conjunction with ladder jacks and stages or planks. Medium duty (Type II) and Light duty (Type III) ladders shall never be used with ladder jacks. ANSI A10.8 allows the use of heavy duty (Type I) ladders with ladder jacks.

Relocating Ladders. Never relocate a ladder while the user is on the ladder.

Accessories. Use only those accessories supplied or approved by Werner Co. with Werner Co. ladders.

NOTES:

LADDERS WITH NON-CONDUCTIVE FIBERGLASS RAILS

Model	Type	Description	Sizes
5900	II	Stepladder	4' thru 8'
5900S	II	Stepladder w/Shelf	4' thru 8'
D5900-2	II	Flat D-rung Extension	16' thru 24'
6000	I	Stepladder	4' thru 8'
6000S	I	Stepladder w/Shelf	4' thru 8'
6002	I	Step Stool	2'
T6000	I	Twin Stepladder	4' thru 8'
PT6000-4C	I	Stockr's Ladder®	2' thru 10'
D6000-2	I	Flat D-rung Extension	16' thru 28'
T6202	IA	Twin Step Stool	2'
6200	IA	Stepladder	3' thru 12'
D6200-2 D6200-1	IA IA	Flat D-rung Extension & Single Ladder	16' thru 40' 8' thru 20'
P6200	IA	Platform Ladder	2' thru 10'
T6200	IA	Twin Stepladder	3' thru 12'
7100-1 7100-2	IAA IAA	Round Rung Single & Extension Ladder	8' thru 16' 16' thru 32'
B7100	IA	Round Rung Butt Ladder	8' thru 16'
M7100	IA	Round Rung Manhole Ldr.	8' thru 16'
D7100-2	IA & IAA	Flat D-rung Extension Ladder	36' thru 40' 16' thru 32'
7300	IAA	Stepladder	3' thru 12'
PT7400-4C	IA	Stockr's Ladder®	4' thru 10'
7400	IAA	Stepladder	3' thru 12'
T7400	IA & IAA	Twin Stepladder	14' thru 20' 4' thru 12'
P7400	IA & IAA	Platform Ladder	8' thru 10' 3' thru 6'
E7400	IA	Extension Trestle Ladder	8' thru 16'
S7700	I	Parallel Sectional Ladder	6'
7800	IAA	Combination Step/Extension	6' thru 8'
S7900	IA & IAA	Interchangeable Tapered Ladder	4 Sections 3 Sections
SSF00	IA	Stepstool	2' and 3'

CORPORATE HEADQUARTERS

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Greenville, PA 16125-9499

To contact us, please visit:
www.wernerladder.com/about/contact.php

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