Designation: D 3930 – 93a (Reapproved 1999)ε1

Standard Specification for Adhesives for Wood-Based Materials for Construction of Manufactured Homes[1]

This standard is issued under the fixed designation D 3930; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Keywords were added in April 1999.

INTRODUCTION

This specification provides a standard for measuring and evaluating the performance of adhesives that will be used in joints of wood-based materials in constructing manufactured homes. This specification has two parts: Part I contains the requirements necessary for an adhesive to conform to this specification; and Part II provides test methods by which the performance of the adhesives will be measured. A classification system is provided that groups adhesives according to resistance to deformation under load, resistance to moisture, and gap-filling ability. Minimum test values have been specified for certain properties of durability, while other property requirements are left open-ended. The test methods used to obtain these values reflect adverse exposure and stress conditions that exist during the construction, transit, and use of manufactured homes. By using values published from these prescribed test methods, the design engineer can select an adhesive that best meets the requirements of a specific adhesive application.

The test methods used in this specification were developed predominantly from existing ASTM standards, while others came from standards that have been generally accepted for years. Some test methods were more recently developed. In most instances, only parts of these standards have been used in this specification. Since no precision and bias statements are available from the original test methods, none can be made for this specification at this time.

PART I— REQUIREMENTS

1. Scope

1.1 This specification provides the means to measure and evaluate the performance of adhesives for structural or semi-structural bonding of wood-to-wood in manufactured homes. Wood as used in this specification includes lumber, plywood, particleboard, gypsum board, and all materials having wood-based surfaces at the bondline. This specification does not cover other adhesives used in manufactured homes such as adhesives for carpet, floor tile, ceramic fixtures, plastic laminates, trim and millwork, and similar nonstructural applications.

1.1.1 The performance of the adhesives is measured in the following tests:

Number	Test	Section
1	Low Temperature	15
2	Dry Lumber	16
3	Gap-Filling	17
4	High Temperature	18
5	Type 3 Qualification	19
6	Type 2 Qualification	20
7	Aging, Film Oxidation	21
8	Aging, Bond Oxidation	22
9	Resistance to Deformation, Creep	23
10	Mold	24
11	Type 1 Qualification	25

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

[1] This specification is under the jurisdiction of ASTM Committee D-14 on Adhesives and is the direct responsibility of Subcommittee D14.70 on Construction Adhesives.

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2. Referenced Documents

2.1 *ASTM Standards:*

A 269 Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service[2]

A 376/A376M Specification for Seamless Austenitic Steel Pipe for High-Temperature Central-Station Service[2]

D 905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading[3]

D 1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)[3]

D 2294 Test Method for Creep Properties of Adhesives in Shear by Tension Loading (Metal-to-Metal)[3]

D 2339 Test Method for Strength Properties of Adhesives in Two-Ply Wood Construction in Shear by Tension Loading[3]

D 3110 Specification for Adhesives Used in Laminate Joints for Nonstructural Glued Lumber Products[3]

D 3632 Practice for Accelerated Aging of Adhesive Joints by the Oxygen-Pressure Method[3]

D 3931 Test Method for Determining Strength of Gap-Filling Adhesive Bonds in Shear by Compression Loading[3]

D 4300 Test Methods for Ability of Adhesive Films to Support or Resist the Growth of Fungi[3]

3. Terminology

3.1 *Definitions*—Many terms in this specification are defined in Terminology D 907.

3.1.1 *creep, n—in an adhesive*, the time-dependent increase in strain resulting from a sustained stress.

3.1.2 *gap-filling adhesive, n*—an adhesive capable of forming and maintaining a bond between surfaces that are not close-fitting.

3.1.2.1 *Discussion*—Close fitting is relative to a given material and industry; for example, standards in construction differ from standards in electronics. Some adhesives will bond by bridging without completely filling the gap; others by filling the gap completely.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *manufactured home*[4]—a structure, transportable in one or more sections which in the traveling mode is 8 body feet or more in width or 40 body feet or more in length or when erected on site, is 320 or more square feet and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air-conditioning, and electrical systems contained therein. Calculations used to determine the number of square feet in a structure will be based on the structure's exterior dimensions measured at the largest horizontal projections when erected on site. These dimensions will include all expandable rooms, bay windows, cabinets, and other projections containing interior space.

3.2.2 *semi-structural adhesive*—an adhesive capable of transferring required loads between adherends and which deforms a maximum of 0.050 in. (1.27 mm) under static load when tested in accordance with Test 9, Section 23.

3.2.3 *structural adhesive*—an adhesive capable of transferring required loads between adherends and which deforms a maximum of 0.006 in. (0.15 mm) under static load when tested in accordance with Test 9, Section 23.

3.2.4 *total deformation*—the total dimensional change with time of a material under constant load, and consisting of the initial instantaneous elastic or rapid deformation and the slower time dependent deformation or creep.

3.2.5 *Type 1 adhesive*—an adhesive that will retain its bond integrity when the joint is repeatedly wetted and dried.

3.2.6 *Type 2 adhesive*—an adhesive intended for use in protected locations but that will maintain its bond integrity when the bond is subjected to occasional wetting.

3.2.7 *Type 3 adhesive*—an adhesive intended for use in interior locations, but that will maintain its bond integrity during conditions of high humidity.

NOTE 1—The following ASTM standards may be referred to for other terms used in this specification: D 9, Terms Relating to Timber; D 907, Terms Relating to Adhesives; D 1165, Nomenclature of Domestic Hardwoods and Softwoods; E 6, Terms Relating to Methods of Mechanical Testing; and E 41, Terms Relating to Conditioning.

4. Classification

4.1 Adhesives shall be classified as follows (see Table 1):

4.1.1 By resistance to deformation as:

4.1.1.1 Group A, Structural; or Group B, Semistructural,

4.1.2 By resistance to water and water vapor as:

4.1.2.1 Type 1, Type 2, or Type 3, and

4.1.3 By gap-filling ability.

4.1.3.1 Those adhesives tested in accordance with Test 3, Section 17, shall carry the designation G/F.

5. Significance and Use

5.1 *Shear Strength*— This specification requires determining ultimate shear strength of adhesive bonds under a variety of conditions of assembly and service.

5.2 *Gap-Filling Ability*—Gap-filling adhesives must be capable of maintaining a bond between construction members whose faying surfaces are not closely matched. The gap-filling ability and shear strength are determined for 1⁄16 -in. (1.6-mm) gap between members. The adhesive manufacturer may qualify

TABLE 1 Tests Required for Group A (Structural), and Group B (Semi-Structural) Adhesives

Type	Recommended Use	Tests Required (Test Number)
1[A]	interior-exterior	1, 2, 4, 7 (or 8), 9, 10, 11[B]
2[A]	interior-weather protected	1, 2, 4, 6, 7 (or 8), 9, 10
3[A]	interior	1, 2, 4, 5, 7 (or 8), 9, 10

[A] To qualify as G/F (gap-filling), adhesives must be tested by Test 3, Section 17.

[B] The exposure and testing conditions for the cyclic-boil and vacuum-pressure tests, described in 10.2.1.1 and 10.2.1.2 of Specification D 3110, shall apply to Test 11.

[2] *Annual Book of ASTM Standards*, Vol 01.01.

[3] *Annual Book of ASTM Standards*, Vol 15.06.

[4] This definition conforms to that of the U.S. Department of Housing and Urban Development (Manufactured Housing Construction and Safety Standards Act of 1974 as amended in proposed rules in the Federal Register, Vol 48, No. 152, Aug. 7, 1981, pp. 40498 to 40500).

larger gap-filling abilities, provided the adhesive is tested and shear values are provided for the greater dimension.

5.3 *Total Deformation Resistance*—The total deformation of an adhesive under static load is used to establish the structural grouping for the adhesive. The adhesive manufacturer determines the maximum shear stress below which the adhesive will perform structurally and semi-structurally in accordance with the description of terms used in this specification, and also reports the stress used for testing the adhesive. To ensure that the total deformation is approaching a zero rate of increase, no more than 25 % of the deformation is allowed to occur during the last half of the test period.

5.4 *Moisture and Temperature Limitations During Fabrication*—Adhesives may be used under a wide variety of moisture and temperature conditions. To ensure reliable performance under test conditions, adhesive shear strength is determined for specified adverse moisture and temperature conditions.

5.5 *High- and Low-Temperature Resistance*—The adhesive is tested at high and low temperatures to determine whether extremes in temperature would cause problems in bonding.

5.6 *Moisture Resistance*—The adhesive is tested at three levels of exposure. Adhesive durability for Type 1 is determined by exposure to a cyclic boil and a vacuum-pressure test. For Type 2, a vacuum-soak is used. For Type 3, a humidity test at elevated temperature is used.

5.7 *Aging, Oxidation Resistance*—To ensure that the adhesive does not become embrittled or substantially deteriorate with age, the adhesive film or tensile lap shear specimens bonded with the adhesive, are exposed to pure oxygen at an elevated temperature and pressure.

5.8 *Mold Resistance*— Conditions fostering the growth of mold are encountered in the structural spaces of walls, floors, and roofs. The adhesive is tested against three species of mold commonly present on wood, either as separate tests or as a single test with a mixed culture of the mold species.

6. Test Methods

6.1 The tests required for compliance with this specification are given in Table 1.

6.2 The compliance criteria for Tests 1 through 11, Sections 15-25, are given in Table 2.

6.2.1 For Tests 1 through 6, Sections 15-20, and Test 11, Section 25, only test results must be reported.

6.2.1.1 Type 1 adhesives in Group A or Group B shall be evaluated on the basis of test specimens prepared in accordance with Sections 13 and 25, and subsequently exposed and tested in accordance with the procedures for the cyclic-boil and vacuum-pressure tests specified for wet-use adhesives in 10.2.1.1 and 10.2.1.2 of Specification D 3110. The only exception is that average strength values shall be reported in pounds-force per square inch (or megapascals).

6.2.2 Minimum performance levels are given for Test 7, Section 21; Test 8, Section 22; and Test 10, Section 24.

6.2.3 For Test 9, Section 23, an evaluation shall be made on the basis of the loads used to test the adhesive for total deformation.

7. Sampling

7.1 Take a representative sample from each lot of adhesive to be tested.

7.1.1 For liquid or paste adhesives, the sample from each lot shall not be less than 1 qt (946 mL).

7.1.2 For adhesives consisting of more than one part, take a sufficient sample of each part in order to prepare not less than 2 lb (908 g) of adhesive at the time of use.

7.1.3 For dry adhesives, the sample from each lot shall not be less than 2 lb (908 g).

7.2 Consult the adhesive manufacturer as to proper packing and handling of the sample.

8. Retest and Rejection

8.1 If the results of any initial test do not conform to the requirements prescribed in this specification, that test shall be repeated on two additional sets of specimens from a new sample of the same lot of adhesive, each of which shall conform to the requirements specified. If either of these two additional sets of specimens fail to meet the requirements, the lot or batch of material shall be rejected.

TABLE 2 Performance Requirements

Test Number	Section Number	Test Description	Requirements
		Conditions of Application:	
1	15	low temperature	shear strength[A]
2	16	dry lumber	shear strength[A]
3	17	gap-filling	shear strength[A]
		Measurements of Durability:	
4	18	high temperature	shear strength[A]
5	19	Type 3 Qualification	shear strength[A]
6	20	Type 2 Qualification	shear strength[A]
7	21	aging, film oxidation	one, 180° bend around a ¼ -in. (6.4-mm) mandrel with none of the 5 specimens breaking
8	22	aging, bond oxidation	maintain 50 % of original shear strength
9	23	resistance to deformation (creep)	Group A: 0.006 in. (0.152 mm)[B] Group B: 0.050 in. (1.27 mm)[B]
10	24	mold	no growth after 14 days
11	25	Type 1 Qualification	shear strength[A]

[A] Post average shear strength.
[B] Maximum allowable total deformation under given load and conditions of 23.2.2.

9. Certification

9.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the adhesive was manufactured in conformance with this specification shall be furnished at the time of shipment.

10. Packaging

10.1 The material shall be packaged in standard commercial containers, as required by Department of Transportation regulations, if applicable. The containers shall be so constructed as to ensure acceptance by common or other carrier for safe transportation at the lowest rate to the point of delivery, unless otherwise specified in the contract or order. The container shall provide suitable protection of the contents to ensure that the adhesive is not spoiled due to exposure to the elements.

11. Marking

11.1 Shipping containers or cases shall be marked with the following information:

11.1.1 Manufacturer's name, product code number, batch lot number, and date of manufacture.

11.1.2 Group and type of adhesive as classified in Table 1, including use of the symbol G/F if the adhesive is gap-filling.

11.1.3 Special handling instructions during product transfer.

11.1.4 Special precautions required because of product toxicity, flammability, or such information pertinent to the proper handling and storage of the product.

12. Adhesive Manufacturer's Instructions

12.1 The adhesive manufacturer shall provide instructions for the proper preparation of the adhesive and proper use with the material to be bonded. Such instructions shall indicate:

12.1.1 The moisture content range of the materials being bonded at the time of bonding.

12.1.2 Complete mixing directions for the adhesives.

12.1.3 Conditions for application of the adhesive including the rate of spread or thickness of film, bead size, number of coats to be applied, temperature of application, whether to be applied to one or both surfaces, and the condition of drying where more than one coat is required.

12.1.4 Adhesive open and closed assembly time over the ambient temperature and humidity range specified.

12.1.5 Curing conditions, including the amount of pressure to be applied, if any, whether this pressure may be provided by nails or staples, or both, or by other means, the length of time under pressure and the temperature of the assembly when under pressure. It should be stated whether this temperature is that of the glue line, or of the atmosphere at which the assembly is to be maintained.

12.1.6 *Storage Conditions Prior to Use*—Instructions shall include data on shelf life and storage under various conditions.

PART II—TEST METHODS

13. Test Assemblies for Tests 1 through 6 and 11

13.1 *Materials*—Use the following materials for the preparation of test assemblies for Tests 1 through 6 and 11.

13.1.1 *Plywood*—Use ⅝ -in. (16-mm) commercial softwood plywood of underlayment grade with exterior adhesive, or sanded exterior-grade plywood (Group I species). To help ensure uniformity of the bonding surface, select plywood having all sapwood or all heartwood in the face veneer—not both (Note 2). Also check the face veneer to see that lathe checks do not appear in the bonding surface. The plywood must be free of splits, patches, core voids, knots, and knot holes in the bonding area. The plywood must be flat within 1/16 in. (2 mm), that is, the maximum permissible bow for a 16-in. (406-mm) length of plywood shall be 1/16 in. (2 mm). Bowed plywood may be used only if it meets the limitation above and if the convexity occurs on the bottom surface that contacts the lumber.

13.1.2 *Framing Lumber*— Use 2-in. (51-mm) (nominal) Douglas-fir or southern pine lumber that is clear and dry. Select lumber that is all sapwood or all heartwood, except as noted for southern pine (Note 2). The lumber must have been knife-planed on all four surfaces at the factory, or so prepared in the laboratory. The lumber must be free of splits, knots, knot holes, bark, and pitch on the surface being bonded.

NOTE 2—Only the sapwood of loblolly, slash, longleaf, and shortleaf pine may be used.

13.1.3 *Adhesive*—Use the adhesive in accordance with the manufacturer's instructions.

13.1.4 *Nails*—In preparing test joint assemblies, use six-penny (2.1 in. (53 mm) in length) double-headed scaffold nails to fasten plywood and lumber together (Note 3). If these are not available, use eight-penny (2.6 in. (66 mm) in length) double-headed nails. If the nail points are a problem when they protrude from the assembly, cut them to a minimum of 2 in. (51 mm) in length, as measured from the cut point to the inside head.

NOTE 3—Six-penny double-headed nails usually are not stocked in retail hardware stores. However, they are manufactured and may be obtained at some wholesale building supply dealers such as Georgia-Pacific Corp.

13.1.5 *Spacers*—For the gap-filling test, separate the plywood and lumber with spacers ¼ in. (6 mm) wide, 1/16 in. (1.6 mm) thick, and 4 in. (102 mm) long (Note 4).

NOTE 4—TFE-fluorocarbon sheet is suggested for use as spacers.

13.2 Clean the surfaces of wood to be bonded so they are free from oil, dust, and other contaminants that would be detrimental to satisfactory bonding.

13.3 Cut the lumber and plywood to the required size as shown in Fig. 1 or Fig. 2 (Note 5). If the lumber must be reduced in height, retain at least one mill-finished surface as the surface to be bonded. If the lumber must be reduced in width to achieve a maximum 1½ -in. (38-mm) dimension, plane both sides in equal amounts.

13.4 Predrill the plywood and lumber to receive nails as shown in Fig. 1 or Fig. 2. Drill to a depth of 1 in. (25 mm) through the plywood and into the lumber. Use a No. 46 (diameter 0.081 in. (2.05 mm)) drill for the six-penny nail and a No. 43 (diameter 0.089 in. (2.26 mm)) drill for the eight-penny nail.

13.5 *Conditioning of Materials Before Bonding*:

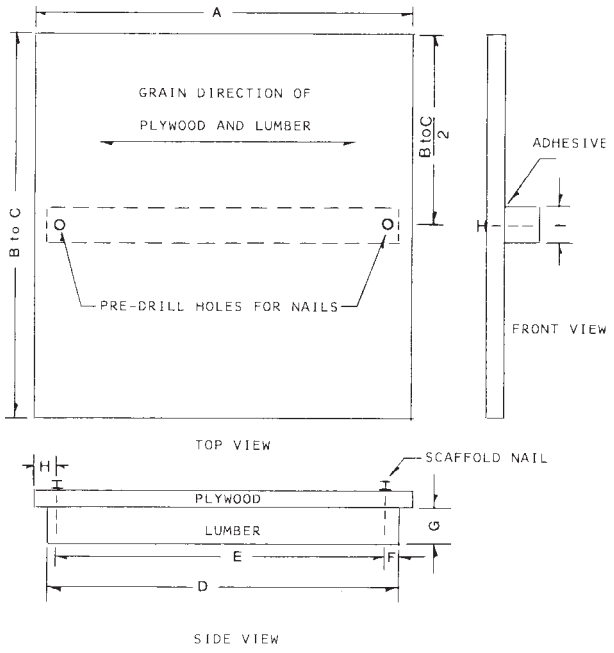


Table of Dimensions

	in. (mm)	
	Dimension	Tolerance
A	15¾ (400)	⅛ (3)
B	5½ (140)	...
C	16 (406)	...
D	15 (381)	⅛ (3)
E	13 (330)	⅛ (3)
F	1 (25)	⅛ (3)
G	1½ (38) min	1/16 (2)
H	1⅜ (33)	1/16 (2)
J	1½ (38) max	1/16 (2)

FIG. 1 Test Assembly

13.5.1 Prepare the adhesive in accordance with the manufacturer's instructions, or if ready to use, condition at 75 ± 5.0°F (23.9± 2.8°C) for a period of 48 h prior to use.

13.5.2 Condition the lumber and plywood to an EMC (equilibrium moisture content) of 10 to 12 % in accordance with the schedule in Appendix X2, before proceeding with the conditioning schedules of Table 3 for Tests 1 through 6.

13.6 *Number of Test Assemblies*—Prepare three test assemblies as shown in Fig. 1 or Fig. 2, using positioning jigs shown in Fig. 2 or Fig. 3, for each set of test conditions within each test (Note 5). Cut eight specimens from each of the assemblies.

NOTE 5—Fig. 2 shows the design of an alternative positioning jig and test assembly that allows three assemblies to be made from a single 6½ by 16-in. (165 by 406-mm) piece of plywood. This alternative positioning jig may be used for combinations of assemblies for Tests 3, 4, 5, 6, and 11 which require the same lumber conditioning. Do not combine assemblies for Test 1 or Test 2 with assemblies for other test numbers in the same jig.

13.7 *General Procedure for Preparation of Test Assemblies*:

13.7.1 Set nails in the plywood through the predrilled holes so that tips of the nails extend 3/16 in. (5 mm) beyond the bottom surface of the plywood. Apply adhesive along the mill-finished surface of the lumber, such that it extends from one predrilled hole to the other, but not beyond. Apply a single bead of adhesive just large enough to give 100 % coverage of the lumber surface, as evidenced by squeeze-out. If it is necessary to apply the adhesive outside of the lumber conditioning chamber (Tests 1 and 2), remove only one piece of lumber at a time in order to perform the operation before the temperature of the lumber changes appreciably. Apply the adhesive; then condition the lumber with adhesive applied for the open assembly time recommended by the adhesive manufacturer. Consult Table 3 for temperature and humidity conditions for each test number during this open assembly time. Then position the plywood on the adhesive-coated surface and allow it to stand for the recommended closed assembly time (same temperature and humidity conditions). Nail in place as shown in Fig. 1, with the aid of a positioning jig as shown in Fig. 2 or Fig. 3. Drive the top of the lower head of the scaffold nail so that it is flush with the surface of the plywood. Do not clamp or apply pressure other than supplied by nailing. Consult Table 3 or the individual test procedures in Sections 15-20 and Section 25 for time, temperature, and humidity conditions to be used for the period of cure.

13.7.2 At the end of the curing cycle, take assemblies to a work area maintained at 75 ± 5°F (23.9 ± 2.8°C) and 50 ± 10 % relative humidity. Remove the nails, trim excess lumber and plywood, and cut eight block shear specimens from each assembly as shown in Figs. 4 and 5. Before machining the laminations, remove adhesive squeeze-out from the sides of the assembly.

14. Specimens for Tests 8 and 9

14.1 See Section 22 for instructions on preparation of test specimens for Test 8, and Section 23 for Test 9.

15. Test 1—Low Temperature

15.1 *Preparation of Specimens*:

15.1.1 Condition the lumber and plywood, previously brought to 10 to 12 % EMC, for 48 h at the temperature selected by the adhesive manufacturer as the minimum temperature for application of the adhesive. Control the temperature within ±5°F (2.8°C). The relative humidity may be uncontrolled.

15.1.2 Prepare or condition the adhesive as instructed in 13.5.1.

15.1.3 Prepare three test assemblies in accordance with the general instructions in 13.7 and Fig. 1 and Fig. 3, or Fig. 2, using the adhesive manufacturer's recommendations as to open and closed assembly times.

15.1.4 Cure for 28 days at the minimum temperature previously selected by the adhesive manufacturer. Control the temperature within ±2.5°F (1.4°C). The relative humidity may be uncontrolled.

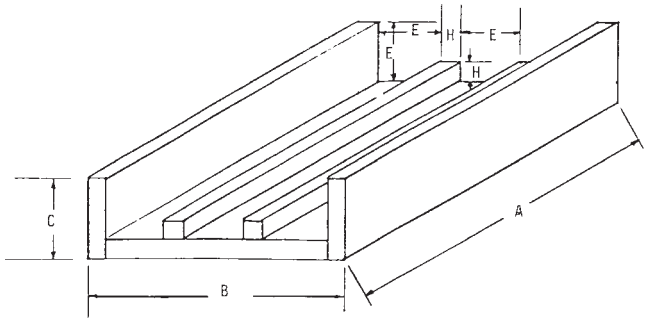
15.1.5 Remove from curing area and cut eight specimens from each test assembly (24 specimens) in accordance with 13.7.2 and Figs. 4 and 5.

15.1.6 Condition the specimens for 15 h at the previously selected minimum temperature within ±2.5°F (1.4°C).

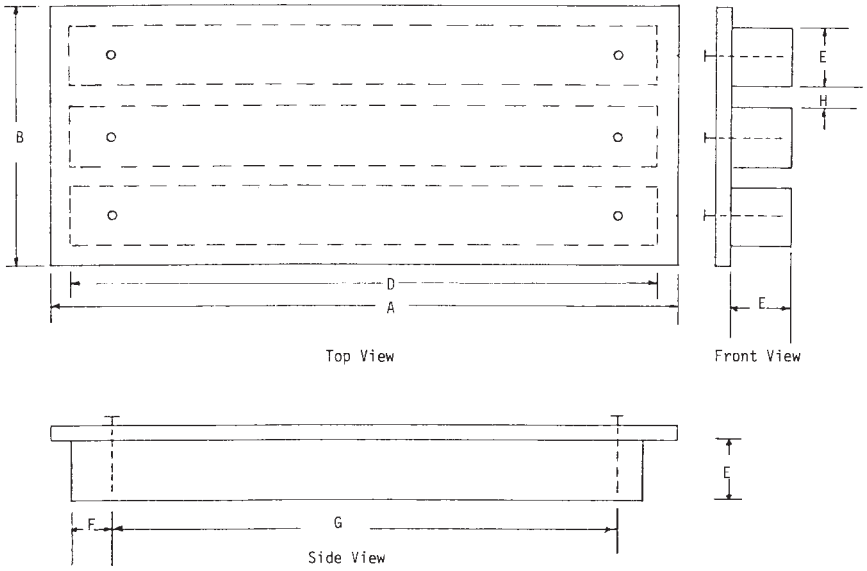
15.2 *Testing of Specimens*:

15.2.1 Remove the test specimens one at a time from the conditioning chamber and test while still at that temperature.

15.2.2 Test the specimens for shear strength by compression loading in a testing machine in a work area at 75 ± 5°F (23.9



(a) Positioning Jig



(b) Test Assemblies

Table of Dimensions

	in. (mm)	
	Dimension	Tolerance
A	15¾ (400)	⅛ (3)
B	6½ (165)	⅛ (3)
C	2 (51)	1/16 (2)
D	15 (381)	⅛ (3)
E	1½ (38)	1/16 (2)
F	1 (25)	⅛ (3)
G	13 (330)	⅛ (3)
H	½ (13)	1/16 (2)

FIG. 2 Alternative Positioning Jig and Test Assemblies

± 2.8°C) and 50 ± 10 % relative humidity. A shearing tool described in Method D 905 is recommended for this test, but other equipment may be used as long as the speed can be controlled and the shearing tool is self-aligning. Use a loading rate of 0.2 in. (5 mm)/min. Read the ultimate load to the nearest 1 lbf (or 1 N) for each of the 24 specimens.

15.3 *Reporting*—Report the shear strengths for each specimen in pounds-force per square inch (or megapascals) and percent wood failure, together with the overall average of the 24 specimens for each condition.

16. Test 2—Dry Lumber

16.1 *Preparation of Specimens*:

16.1.1 Condition the lumber and plywood, previously brought to 10 to 12 % EMC, for 7 days at 100 ± 5°F (37.8 ± 2.8°C) and 30 ± 10 % relative humidity to a MC (moisture content) maximum of 8 %.

16.1.2 Prepare or condition the adhesive as instructed in 13.5.1.

16.1.3 Prepare three test assemblies in accordance with the general instructions in 13.7 and Fig. 1 and Fig. 3, or Fig. 2, using the adhesive manufacturer's recommendations as to open and closed assembly times.

16.1.4 Cure the assemblies for 28 days at 100 ± 5°F (37.8 ± 2.8°C) and 30 ± 10 % relative humidity.

TABLE 3 Summary of Temperature and Relative Humidity Requirements for Conduct of Tests 1 Through 6

	Test 1 Low Temperature	Test 2 Dry Lumber	Test 3 Gap-Filling	Test 4 High Temperature	Test 5 Type 3 Qualification	Test 6 Type 2 Qualification
Specimen construction:						
Sections	13 and 15	13 and 16	13 and 17	13 and 18	13 and 19	13 and 20
Adherend conditioning:						
Time, h	48	48	48	48	48	48
Temperature, °F (°C)	[A]±5 (±2.8)	100 ± 5 (37.8 ± 2.8)	70 ± 5 (21.1 ± 2.8)	70 ± 5 (21.1 ± 2.8)	70 ± 5 (21.1 ± 2.8)	70 ± 5 (21.1 ± 2.8)
Relative humidity, %	uncontrolled	30 ± 10	50 ± 10	50 ± 10	50 ± 10	50 ± 10
Assembly conditions:						
Temperature, °F (°C)	[A]±2.5 (±1.4)	100 ± 5 (37.8± 2.8)	70 ± 5 (21.1 ± 2.8)	70 ± 5 (21.1± 2.8)	70 ± 5 (21.1 ± 2.8)	70 ± 5 (21.1± 2.8)
Relative humidity, %	uncontrolled	40 max	50 ± 10	50 ± 10	50 ± 10	50 ± 10
Curing conditions:						
Time, days	28	28	28	28	28	28
Temperature, °F (°C)	[A]± 2.5 (±1.4)	100 ± 5 (37.8 ± 2.8)	70 ± 5 (21.1 ± 2.8)	70 ± 5 (21.1 ± 2.8)	70 ± 5 (21.1 ± 2.8)	70 ± 5 (21.1 ± 2.8)
Relative humidity, %	uncontrolled	30 ± 10	50 ± 10	50 ± 10	50 ± 10	50 ± 10
Exposure conditions:	during cure	during cure	specimen construction	after cure	after cure	after cure
Section	15.1.4	16.1.4	17.1.3	18.2	19.2	20.2
Conditioning before testing:						
Time	15 h	≤8 h	≤8 h	(see 18.3)	(see 19.3)	7 days
Temperature, °F (°C)	[A]±2.5 (±1.4)	70 ± 5 (21.1 ± 2.8)	70 ± 5 (21.1 ± 2.8)			70 ± 5 (21.1 ± 2.8)
Relative humidity, %	uncontrolled	50± 10	50 ± 10			50 ± 10
Work area for testing:						
Temperature, °F (°C)	75 ± 5 (23.9 ± 2.8)	75 ± 5 (23.9 ± 2.8)	75 ± 5 (23.9 ± 2.8)	75 ± 5 (23.9 ± 2.8)	75 ± 5 (23.9 ± 2.8)	75 ± 5 (23.9 ± 2.8)
Relative humidity, %	50 ± 10	50 ± 10	50 ± 10	50 ± 10	50 ± 10	50 ± 10

[A] Temperature selected by the adhesive manufacturer as the minimum temperature for application of the adhesive.

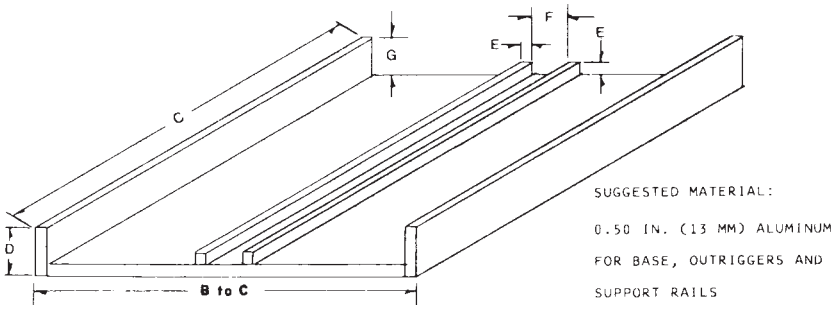


Table of Dimensions

	in. (mm.)	
	Dimension	Tolerance
A	15¾ (400)	⅛ (3)
B	5½ (140)	...
C	16 (406)	...
D	2 (51) max	1/16 (2)
E	½ (13)	1/16 (2)
F	1½ (38) min	1/16 (2)
G	1½ (38) max	1/16 (2)

FIG. 3 Positioning of Jig for Test Assembly

16.1.5 Remove the assemblies from curing area and cut eight specimens from each test assembly (24 specimens) in accordance with 13.7.2 and Figs. 4 and 5.

16.1.6 Keep the test specimens at 70 ± 5°F (21.1 ± 2.8°C) and 50± 10 % relative humidity until tested. This period of time must not exceed 8 h after removal from the oven.

16.2 *Testing*—Test as described in 15.2.2 in a work area at 75 ± 5°F (23.9 ± 2.8°C) and 50 ± 10 % relative humidity.

16.3 Report in the same manner as described in 15.3.

17. Test 3—Gap-Filling

17.1 *Preparation of Specimens*:

17.1.1 Condition the lumber and plywood previously brought to 10 to 12 % EMC, for 48 h at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % relative humidity.

17.1.2 Prepare or condition the adhesive as instructed in 13.5.1.

17.1.3 Prepare three assemblies at once as illustrated in Fig. 2 and in accordance with the general instructions in 13.7. Use

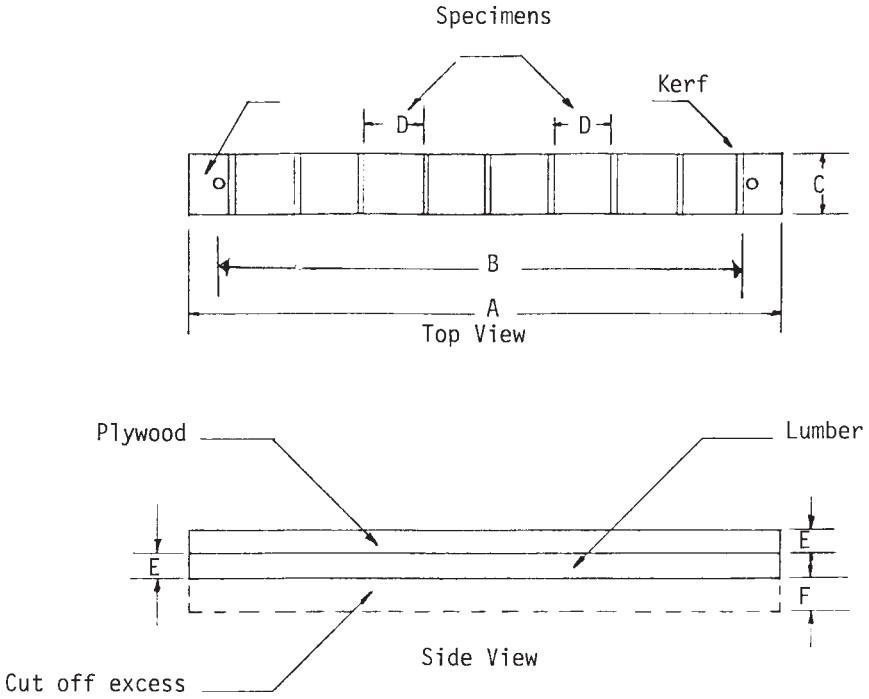


Table of Dimensions

	in. (mm)	
	Dimension	Tolerance
A	15 (381)	⅛ (3)
B	13 (330)	⅛ (3)
C	1½ (38) max	1/16 (2)
D	1⅜ (35)	1/32 (1)
E	⅝ (16)	1/32 (1)
F	⅞ (22)	1/32 (1)

FIG. 4 Method of Cutting Specimens from Test Assembly

assembly-line procedures, applying the adhesive to three pieces of lumber, inserting the spacers, placing the three pieces of plywood in position, and then nailing each in turn. Apply a single bead of adhesive approximately ⅜ in. (9 mm) in diameter, or large enough to cause continuous squeeze-out along the length of bondlines on both sides of each assembly. Allow 10-min open assembly time, unless instructed otherwise by the adhesive manufacturer. Consult Table 3 for the appropriate temperature and relative humidity for specimen assembly. Before placing the plywood on the adhesive-spread lumber surface, insert spacers, made ¼ in. (6 mm) wide, 1/16 in. (1.6 mm) thick, and 4 in. (102 mm) long, at positions shown in Fig. 6. Avoid disturbing the location of the spacers, and do not permit adhesive to get between the spacers and substrate. Do not scrape away the squeeze-out before completing the curing period.

17.1.3.1 In order to certify to a wider gap, substitute spacers of the gap thickness desired.

17.1.4 Cure for 28 days at 70 ± 5°F (21.1± 2.8°C) and 50 ± 10 % relative humidity.

17.1.5 After the curing period, remove the nails, spacers and adhesive squeeze-out from the sides of each assembly. Cut eight specimen blanks from each test assembly (24 specimens) as shown in Fig. 6. Do not cut specimens from areas where spacers were located. Prepare each specimen in accordance

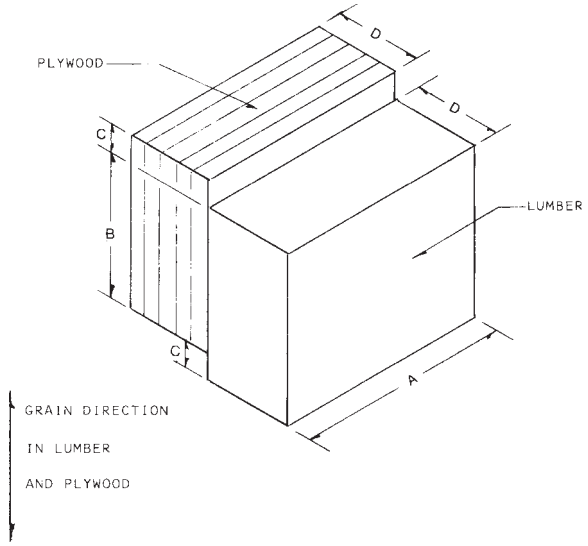


Table of Dimensions

	in. (mm)	
	Dimension	Tolerance
A	1½ (38) max	1/16 (2)
B	1 (25)	1/32 (1)
C	3/16 (5)	1/32 (1)
D	⅝ (16)	1/32 (1)

FIG. 5 Block-Shear Specimen

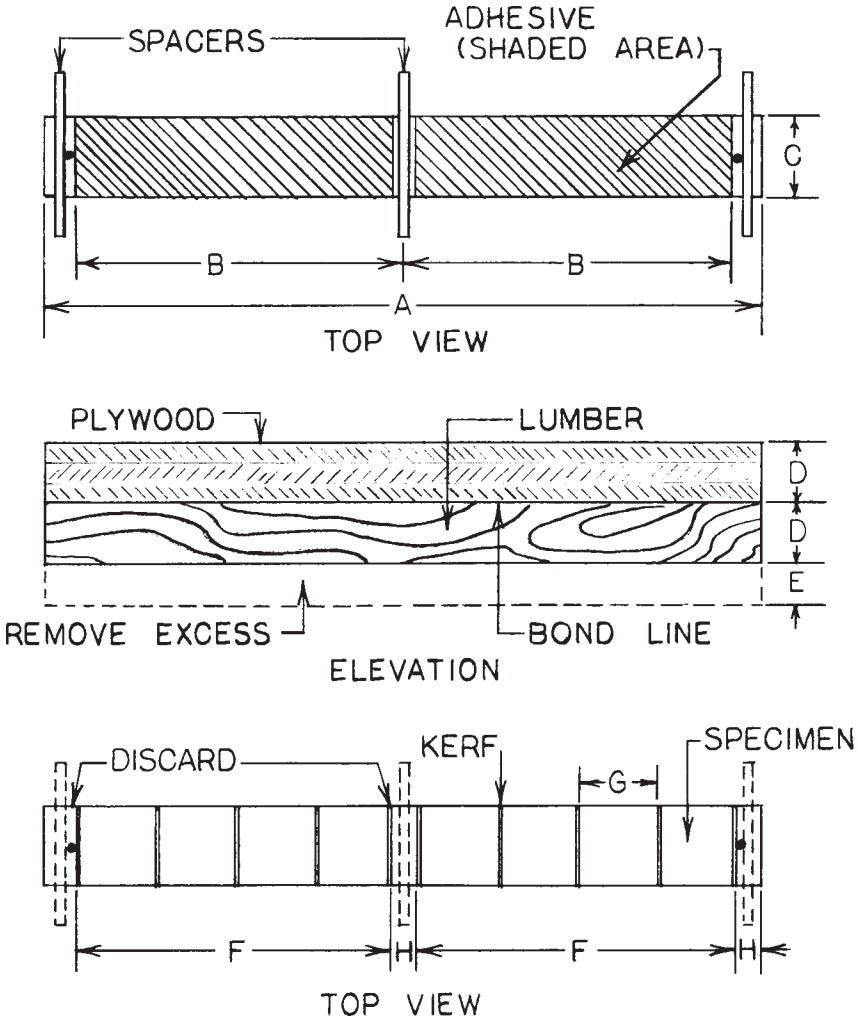


Table of Dimensions

	in. (mm)	
	Dimension	Tolerance
A	15 (381)	⅛ (3)
B	6½ (165)	⅛ (3)
C	1½ (38) max	1/16 (2)
D	⅝ (16)	1/32 (1)
E	⅞ (22)	1/32 (1)
F	6 (152)	⅛ (3)
G	1⅜ (35)	1/32 (1)
H	1 (25)	1/16 (2)

FIG. 6 Placement of Spacers and Cutting of Specimens

with the configuration and dimensions shown in Fig. 5, giving special attention to the following cutting procedures. These specimens have very thick bondlines, so they will be cut in such a manner as to direct the shearing force through the plane between the plywood face and adhesive film. This procedure forces the failure at the plywood face which is a weaker substrate than the lumber face. To do this, make the first notch by cutting *through* the lumber laminate and *through* the bondline *to* the plywood face. Make the other notch by cutting *through* the plywood, but only *to* the bondline. An example of this cutting procedure is illustrated in Fig. 3 of Test Method D 3931.

17.1.6 Keep test specimens at 70 ± 5°F (21.1± 2.8°C) and 50 ± 10 % relative humidity until tested. This period of time must not exceed 8 h.

17.2 *Testing*:

17.2.1 Test as described in 15.2.2 in a work area at 75 ± 5°F (23.9± 2.8°C) and 50 ± 10 % relative humidity.

17.2.2 Report in the same manner as described in 15.3.

18. Test 4—High Temperature

18.1 *Preparation of Specimen*:

18.1.1 Condition the lumber and plywood, previously brought to 10 to 12 % EMC, for 48 h at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % relative humidity before bonding.

18.1.2 Prepare or condition the adhesive as instructed in 13.5.1.

18.1.3 Prepare three test assemblies in accordance with the general instructions in 13.7 and Fig. 1 and Fig. 3, or Fig. 2. Use the adhesive manufacturer's recommendations as to open and closed assembly times. Control the temperature and humidity during assembly at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % relative humidity.

18.1.3.1 Cure for 28 days at 70 ± 5°F (21.1± 2.8°C) and 50 ± 10 % relative humidity.

18.1.4 Cut eight specimens from each test assembly (24 specimens) in accordance with 13.7 and Fig. 4 and Fig. 5.

18.2 *Exposure of Specimens*—Place test specimens in a convection oven at 158 ± 2°F (70± 1.1°C) with relative humidity uncontrolled for 15 h.

18.3 *Testing*—Remove the specimens one at a time from the oven, and while hot, test immediately as described in 15.2.2 in a work area at 75 ± 5°F (23.9 ± 2.8°C) and 50 ± 10 % relative humidity.

18.4 Report in the same manner as described in 15.3.

19. Test 5—Type 3 Qualification

19.1 *Preparation of Specimens*:

19.1.1 Condition the lumber and plywood, previously brought to 10 to 12 % EMC, for 48 h at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % relative humidity.

19.1.2 Prepare or condition the adhesive as instructed in 13.5.1.

19.1.3 Prepare three test assemblies in accordance with general instructions in 13.7 and Fig. 1 and Fig. 3, or Fig. 2. Use the adhesive manufacturer's recommendations as to open and closed assembly times.

19.1.4 Cure for 28 days at 70 ± 5°F (21.1± 2.8°C) and 50 ± 10 % relative humidity.

19.1.5 After the curing period, cut eight specimens from each test assembly (24 specimens) in accordance with 13.7.2 and Figs. 4 and 5.

19.2 *Exposure of Specimens*—Place the test specimens in a chamber at 90 ± 2°F (32.2 ± 1.1°C) and 85 ± 5 % relative humidity for 28 days.

19.3 *Testing*—Remove specimens from conditioning chamber one at a time. Test immediately as described in 15.2.2 in a work area at 75 ± 5°F (23.9 ± 2.8°C) and 50 ± 10 % relative humidity.

19.4 Report in the same manner as described in 15.3.

20. Test 6—Type 2 Qualification

20.1 *Preparation of Specimens*—Follow the procedure given in 19.1.1-19.1.5.

20.2 *Exposure of Specimens*—Place the test specimens in a vacuum vessel and completely submerge in water at 110 ± 5°F (43.3 ± 2.8°C). Draw a vacuum of 15 in. Hg (381 mm Hg) (50.8 kPa), maintain it for 30 min, and release. Allow the specimens to soak in the same water at atmospheric pressure for 4½ h with no additional heating. Then remove and dry them for 15 h at 150 ± 5°F (65.6 ± 2.8°C) in an oven with air circulated at 45 to 50 air changes per minute.

20.3 *Conditioning Before Testing*—After drying the test specimens, condition them for 7 days at 70 ± 5°F (21.1 ± 2.8°C) and 50 ± 10 % relative humidity.

20.4 *Testing*—Test as described in 15.2.2 in a work area at 75 ± 5°F (23.9 ± 2.8°C) and 50 ± 10 % relative humidity.

20.5 Report in the same manner as described in 15.3.

21. Test 7—Aging, Film Oxidation

21.1 Conduct this test in accordance with the procedures described in Practice D 3632. Use specimen Type C, the cast unsupported adhesive film, to test for retained flexibility after oxygen aging. Five unaged and five aged specimens are required. Condition all specimens for 3 days at 140 ± 5°F (60 ± 2.8°C) and ambient relative humidity. Expose five of the specimens to oxygen for 500 h at 300 psi (2.07 MPa), followed by a single test of film flexibility. Test the flexibility of the free-film specimens by a single bend of the strips 180° around a 0.25-in. (6.35-mm) mandrel. Report all findings as required in Practice D 3632.

22. Test 8—Aging, Bond Oxidation

22.1 Conduct this test in accordance with the procedures outlined in Practice D 3632. Use specimen Type A, the wood-to-wood lap specimen, to test for bond shear strength after oxygen aging. Make specimens from either Douglas-fir or southern pine veneer. Five unaged and five aged specimens are required. Condition all specimens for 3 days at 140 ± 5°F (60 ± 2.8°C) and ambient relative humidity. For the aged specimens, expose five of the specimens to oxygen for 500 h at 70 ± 1°C (158 ± 1.8°F) and at 300 psi (2.07 MPa), followed by a single test of shear strength in tension. Report all findings as required in Practice D 3632.

23. Test 9—Resistance to Deformation, Creep

23.1 *Specimen Preparation*:

23.1.1 Prepare five specimens that conform to the form and dimensions shown in Fig. 7. Use Test Methods D 1002 and D 2339 for guidance in preparing these specimens. Make up the specimens in multiples of five, and then cut the bonded assemblies into individual test specimens. Use pieces of maple or oak, ¼ in. (6.4 mm) in thickness, 4½ in. (114.3 mm) in length, and of sufficient width to make the five specimens plus saw kerf. Use wood that is straight-grained and free from defects. Orient the grain direction parallel to the direction of pull in the specimen. Prior to bonding, condition the wood to 10 to 12 % MC in accordance with the temperatures and relative humidities shown in Appendix X2. Ensure that the bonding surface is surfaced and free of dust, but not sanded. Prepare and apply the adhesive in accordance with the manufacturer's instructions. Apply the adhesive to a sufficient length of the area across the end of one or both pieces of wood so that the adhesive will more than cover the required overlap area of the test specimen. Assemble the pieces of wood so that the overlap area will be controlled to the required bondline area within ±0.01 in. (0.25 mm).

23.1.2 Cure the specimens for 28 days at 50 ± 10 % relative humidity and 70 ± 5°F (21.1 ± 2.8°C).

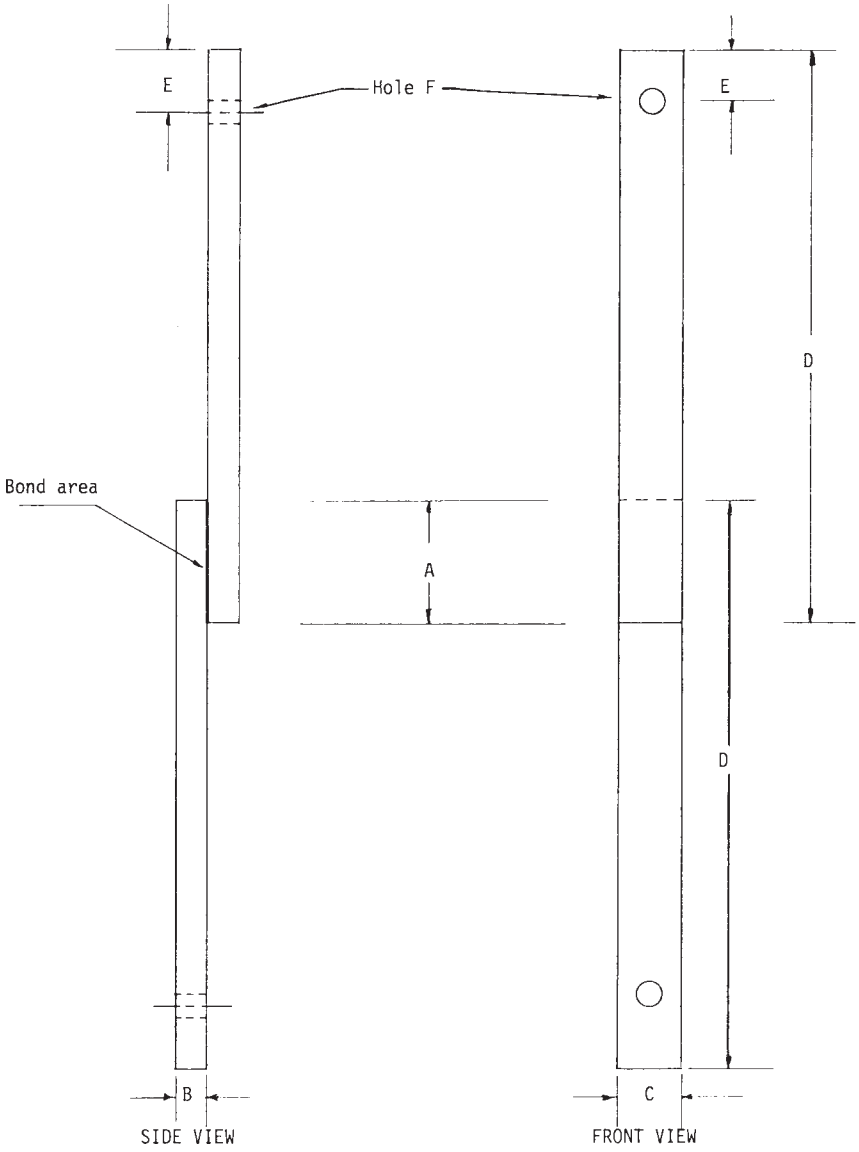


Table of Dimensions

	in. (mm)	
	Dimension	Tolerance
A	1 (25)	0.020 (0.50)
B	¼ (6)	0.020 (0.50)
C	½ (13)	0.020 (0.50)
D	4½ (114)	⅛ (3.0)
E	½ (13)	0.020 (0.50)
F	3⁄16 (5) dia	0.020 (0.50)

FIG. 7 Specimen for Total Deformation Test

23.1.3 Cut the assemblies into five specimens as shown in Fig. 7.

23.2 *Exposure and Testing*:

23.2.1 Conduct the creep test in accordance with Section 4 of Test Method D 2294, with the exception that the apparatus shown in Fig. A1.1 and described in Annex A1, or a suitable dead weight apparatus, shall be used to load the specimen.

23.2.2 Apply a load to the specimens such that the total deformation at the termination of the test does not exceed: for Group A, 0.006 in. (0.151 mm); or for Group B, 0.050 in. (1.27 mm). Allow no more than 25 % of this deformation to occur in the last half of the testing period.

23.2.3 Place five test specimens, loaded to meet the conditions of 23.2.2, in an oven at 158 ± 5°F (70± 2.8°C) for 7

days. Measure the amount of creep to the nearest 0.001 in. (0.025 mm) each hour for the first 8 h, then daily for the remainder of the week.

23.3 *Reporting*—Report the actual shear stress along with the average total deformation for each adhesive. Report for each adhesive the deformation at 3½ days, which is 50 % of the test period, and at 7 days for total deformation.

24. Test 10—Mold

24.1 Conduct this test in accordance with instructions for the adhesive film test in Test Methods D 4300.

24.1.1 For low-viscosity adhesives, use the test procedure described in 12.2 of Test Methods D 4300.

24.1.2 For high-viscosity or mastic-type adhesives, use the test procedure described in 12.3 of Test Methods D 4300.

25. Test 11—Type 1 Qualification

25.1 Use the instructions for Test 5, Section 19, with the following exceptions:

25.1.1 Prepare six test assemblies.

25.1.1.1 After the curing period, cut eight specimens from each assembly. Expose 24 specimens to each set of condi-tions, that is, cyclic-boil and vacuum-pressure tests for wetuse adhesives, in accordance with 10.2.1.1 and 10.2.1.2 of Specification D 3110.

25.1.2 Test and report in accordance with the respective sections in Specification D 3110, except give strength values in pounds-force per square inch (or in megapascals) with percent wood failure.

26. Keywords

26.1 adhesive; creep; durability; gap-filling; moisture resistance; oxidation; shear strength

ANNEX

(Mandatory Information)

A1. METHOD OF CONSTRUCTING CREEP TEST APPARATUS

A1.1 The apparatus may be constructed as shown in Fig. A1.1 and described herein.[5]

A1.2 *Specimen Holding Pins*—The bottom stainless steel specimen holding pin, dimensioned as shown in Fig. A1.1 (A), passes through a 3⁄16 -in. (4.76-mm) hole centered ½ in. (12.7 mm) from the end of the specimen. The shape of the pin aligns the specimen so that the stress on the joint is applied parallel to the plane of the glue joint. The pin, dimensioned as shown in Fig. A1.1 (B), is inserted through the holes in the clevis arms and specimen, with the specimen between the arms. The pin passes through a 3⁄16 -in. (4.76-mm) hole centered ½ in. (12.7 mm) from the end of the specimen. The pin also passes through the slots in the side of the jig body tube. When fully inserted, the pin aligns the specimen and prevents any twisting of the specimen during compression of the spring. This pin will safely restrain the spring and specimen if the specimen breaks.

A1.3 *Clevis and Adjusting Rod*—These are commercially available, or they can be machined from square bar stock and round threaded rod, both of stainless steel. The clevis must have a 9⁄32 -in. (7.14-mm) opening to accept the ¼ -in. (6.35-mm) thick specimen. It must have 3⁄16 -in. (4.76-mm) holes drilled with centers not less than 5⁄8 in. (15.85 mm) from the closed end of the slot. The clevis is fixed to a ¼ -in. (6.35-mm), 20-thread rod, fitted with a standard wing nut for compressing the spring.

A1.4 *Main Jig and Body Tube*—Use standard nominal 2-in. (50.8-mm), stainless steel pipe, Schedule 5S, having actual dimensions of outside diameter 2.375 in. (60.23 mm), inside diameter 2.245 in. (55.23 mm), and wall thickness 0.065 in. (1.65 mm). Cut the piping 11½ in. (292 mm) long, then machine slots for specimen holding pins. Fix a ¼ by ¼ -in. (6.35 by 6.35-mm) ring to the tube body to support the spring. This ring can be fixed by a shrink fit, by welding to the tube at four points, or by drilling and inserting four drive pins at 90° to each other.

A1.5 *Upper Spring Compression Tube*—Use standard 2¾ -in. (69.8-mm) outside diameter tubing, with 2.620 in. (66.6 mm) inside diameter, wall thickness 0.065 in. (1.65 mm), and 3½ in. (89.0 mm) long. ¾ -in. (69.8-mm) square piece of 12-gage (2.67-mm) stainless steel thick plate is welded to one end. Before welding, drill a 5⁄32 -in. (3.97-mm) hole in the exact center for the threaded adjusting rod. Also before welding on the plate, cut a ring from a standard 2⅝ by 3⁄16 -in. (66.7 by 4.76-mm) tube, and insert it in the end of the tube where it will act to center the upper end of the spring.

A1.6 *Spring*—Use a standard commercially available stainless steel spring, 2.100 in. (53.2 mm) in diameter and 5½ in. (140 mm) long, with ends ground square. The spring must have a linear stress-strain curve. This spring will produce a force of 44 lbf/in. (7.706 N/m) of compression.

A1.7 The jig is constructed to Type 304 stainless steel as specified in Specifications A 376 and A 269.

A1.8 The load on the specimen shall be set by a testing machine. Compress the spring to the required load; then tighten

[5] The apparatus may be purchased from Hull Machine Shop, 2A Glenn Carrier Road, Hull, GA 30604, or Utilicon Corp., P.O. Box 700, 4515 Ross Road, Forestville, CA 95436. There may be other suitable suppliers of this apparatus.

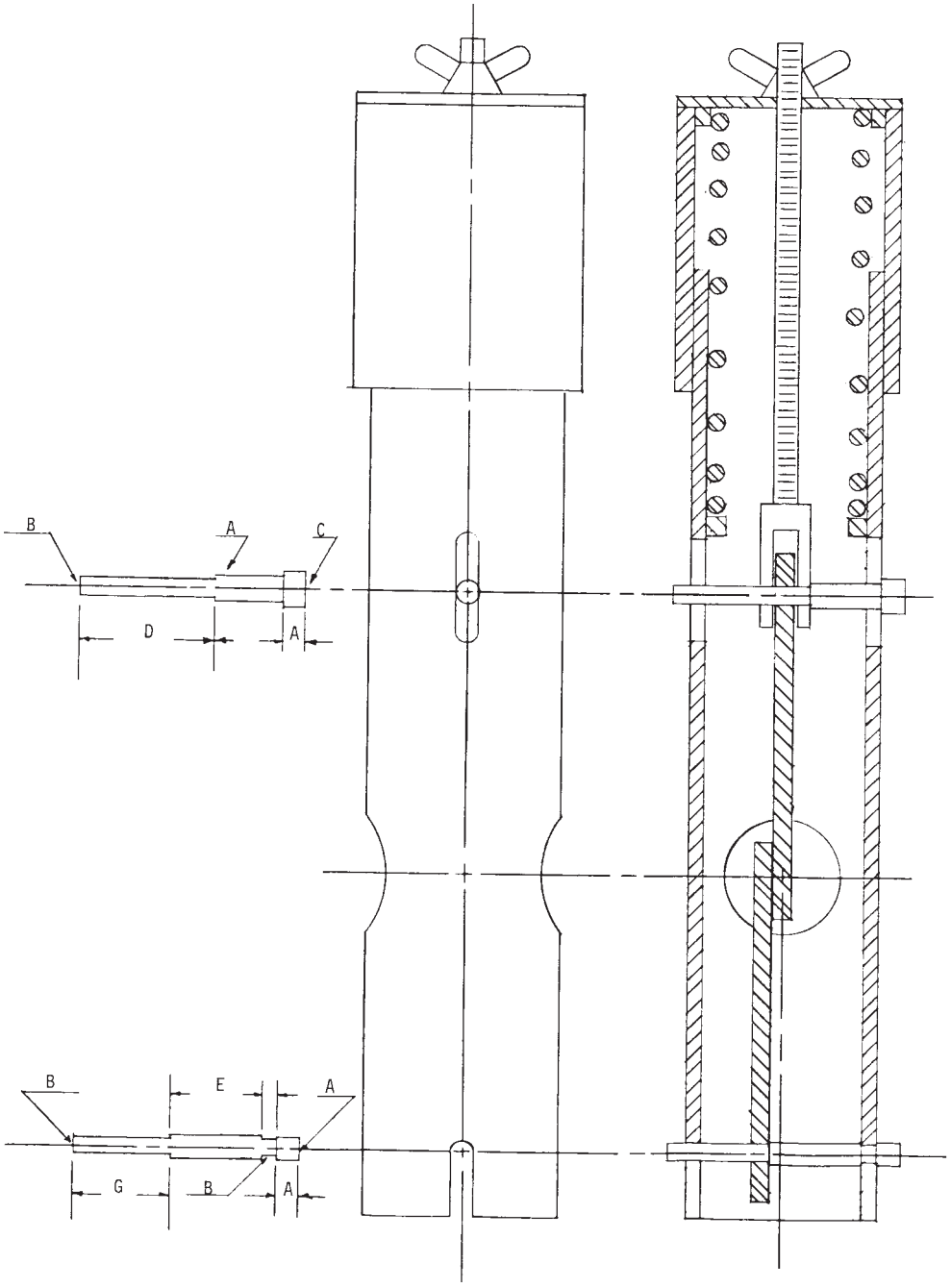


Table of Dimensions

	in. (mm)	
	Dimension	Tolerance
A	0.25 (6.35)	0.01 (0.254)
B	0.1875 (4.76)	0.01 (0.254)
C	0.375 (9.53)	0.01 (0.254)
D	1.900 (4.83)	0.01 (0.254)
E	1.247 (3.17)	0.01 (0.254)
F	0.070 (1.80)	0.01 (0.254)
G	1.25 (3.18)	0.01 (0.254)

FIG. A1.1 Total Deformation Test Apparatus

the wing nut to retain this tension on the spring.

A1.9 Alternatively, the unit can be calibrated in a suitable testing machine by compressing the assembled jig and marking the calibration points on the body of the tube at the edge of the spring compressing tube. After calibration, the stress on the sample can be set by screwing down the wing nut on the rod to the desired point.

APPENDIXES

(Nonmandatory Information)

X1. GUIDELINES FOR ALLOWABLE SHEAR VALUES FOR WOOD FRAMING AND SUBSTRATES

TABLE X1.1 Guidelines for Allowable Shear Values for Wood Framing and Substrates

Material	Minimum Horizontal Shear Value, psi (kPa)	Minimum Rolling Shear Value, psi (kPa)
Lumber	130 to 190 (896 to 1310), **(1)**[A]	50 to 100 (345 to 689), **(2)**
Particleboard	240 (1655), **(3)**	70 (483), **(4)**
Plywood, softwood	155 to 250 (1069 to 1586), **(5)**	44 to 75 (303 to 517), **(5)**
Plywood, hardwood	160 to 230 (1103 to 1586), **(6)**	48 (331), **(6)**
Hardboard paneling (standard)	210 to 240 (1448 to 1655), **(2)**	
Fiberboard	31 (214), **(7)**	
Gypsum wallboard	60 (414), **(8)**	
Upson board	40 (276), **(9)**	
Hardboard paneling (tempered)	435 to 450 (2999 to 3103), **(2)**	

[A] The numbers in boldface refer to the following references:

X2. TEMPERATURE AND RELATIVE HUMIDITY CONSTANT FOR BRINGING WOOD TOEMC OF 10 to 12 %[6]

TABLE X2.1 Temperature and Relative Humidity Constant for Bringing Wood to EMC of 10 to 12 %

Temperature,° F (°C)	Humidity, %	EMC, %	Temperature, °F (°C)	Humidity, %	EMC, %
	53	9.9		57	10.3
60 (15.6)	58	10.7	80 (26.7)	61	11.0
	63	11.7		64	11.5
				68	12.4
	56	10.3			
65 (18.3)	61	11.2		56	10.0
	66	12.3	85 (29.4)	59	10.5
				63	11.3
	55	10.1		66	11.8
70 (21.1)	59	10.8			
	64	11.8		58	10.2
			90 (32.2)	61	10.7
	58	10.5		65	11.5
75 (23.9)	62	11.3		68	12.2
	66	12.2			

[6] Wood Handbook: Wood as an Engineering Material, U.S. Dept. of Agriculture Handbook 72, Revised, U.S. Forest Products Laboratory, Madison, WI, 1974, Chapter 3, p. 8.

X3. ADHESIVE DATA SHEET

ADHESIVE MANUFACTURER _____
PRODUCT NAME AND CODE NUMBER _____
TEMPERATURE RANGES:
Storage _____°F to _____°F Application: Material _____°F to _____°F
Air _____°F to _____°F
SHELF LIFE:
SPECIAL STORAGE INSTRUCTIONS:
MIXING OR HANDLING INSTRUCTIONS PRIOR TO USE:
APPLICATION INSTRUCTIONS:
OPEN AND CLOSED ASSEMBLY TIME:
CURING CONDITIONS:
CLASSIFICATION: (Indicate Group Classification with check(V).
Group A—Structural (0.006-in. (0.15-mm) max deformation) _____
Group B—Semi-structural (0.050-in. (1.27-mm) max deformation _____
WOOD SPECIES USED:
Lumber _____
TEST RESULTS:
Tests 1 through 6—Use Appendix X3.
Test 7—Aging, Film Test:
No. Specimens Passing _____ No. Specimens Failing _____
Test 8—Use Appendix X3.
Test 9—Resistance to Deformation:
a. Stress Used for Test _____
b. Total Deformation at 3½ days _____in. (_____mm)
7 days _____in. (_____mm)
Test 10—Mold:
Species_____, Pass ___ Fail ___
Species_____, Pass ___ Fail ___
Species_____, Pass ___ Fail ___
Test was made with: (Check one)
Separate cultures_____
Mixed cultures_____
Test 11—Type 1 Qualification Test—Use Appendix X3.

	Test 1	Test 2	Test 3		Test 4	Test 5	Test 6
	Low Temperature _____°F _____°C	Dry Lumber	Gap-filling 1/16-in. gap	Gap-filling _____in. gap	High Temperature	Type 3 Quality High Humidity	Type 2 Quality Vacuum Soak
Shear Values (psi, % wood failure) Specimen No.							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
Average Shear Value							

X3. ADHESIVE DATA SHEET *(continued)*

	Test 8		Test 11	
	Bond Oxidation		Type 1 Qualifications	
	Control Specimens	Exposed Specimens	Cycle Boil (See Specification D 3110, 10.2.1.1)	Vacuum Pressure (See Specification D 3110, 10.2.1.2)
Shear Values (psi, % wood failure)				
Specimen No.				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
Average Shear Value				

REFERENCES

(**1**) Supplement to the 1977 Edition of National Design Specification (NDS) Footnote 11, National Forest Products Assn., 1619 Massachusetts Ave., N.W., Washington, DC 20036, p. 16.

(**2**) Forest Products Laboratory (FPL), Madison, WI.

(**3**) PFS Test Report #75-15, PFS Corp., 2402 Daniels St., Madison, WI 53704.

(**4**) 3.5.4 Physical Property Requirements for Particle Board Complying with NPA Grading Programs, National Particle Board Assn., 2306 Perkins Place, Silver Spring, Md 20910.

(**5**) Plywood Design Specification (PDS), published by American Plywood Assn., revised 1976, Table 3.

(**6**) HPMA Design Guide (HP SG-71), published by Hardwood Plywood Mfg's. Assn., Table 3.1.

(**7**) *The Celotex Corporation Technical Bulletin No. 501*, published by the Celotex Corp., March 31, 1969.

(**8**) Test data available from the Gypsum Assn.

(**9**) PFS Lab Test No. 951 - PFS Corporation, 2402 Daniels St., Madison, WI 53704.