



Designation: D6464 – 03a (Reapproved 2009)<sup>ε1</sup>

# Standard Specification for Expandable Foam Adhesives for Fastening Gypsum Wallboard to Wood Framing<sup>1</sup>

This standard is issued under the fixed designation D6464; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

<sup>ε1</sup> NOTE—Editorial changes were made throughout in November 2009.

## 1. Scope\*

1.1 This specification establishes minimum performance requirements for determining strength, aging, and working properties of expandable foam adhesives intended for bonding back surfaces of gypsum wallboards of all thicknesses to wood framing. Minimum physical and performance requirements are specified for all measured properties of adhesives and adhesive bonds.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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.*

## 2. Referenced Documents

- 2.1 *ASTM Standards*:<sup>2</sup>
- C1396/C1396M Specification for Gypsum Board
  - D905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading
  - D907 Terminology of Adhesives
  - E4 Practices for Force Verification of Testing Machines
  - E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

## 3. Terminology

3.1 *Definitions*—Many terms in this specification are defined in Terminology D907.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.70 on Construction Adhesives.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

## 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *expandable foam adhesive, n*—any polymer that expands during delivery or cure to fill the space between substrates.

## 4. Significance and Use

4.1 This specification applies to expandable foam adhesives used to bond the back surface of gypsum wallboard to Douglas-fir dimensional lumber or other lumber species of equivalent bonding qualities capable of meeting the test requirements.

4.2 The specification establishes the minimum strength requirements of the bond for the selected assembly materials.

4.3 The adhesive is not considered a substitute for mechanical fasteners. Fasteners will be required to restrict expansion of the foam adhesive while it cures. The recommended fastening schedule must appear in the manufacturer's application instructions.

4.4 The tests are suitable for product performance certification and quality control programs, and can be useful to the general public, adhesive manufacturers, distributors, specifiers, architects, contractors, testing laboratories and other businesses and professionals.

4.5 The results do not include all possible conditions, which may occur during final assembly, but indicate a set of performance characteristics for laboratory controlled bonding variables.

## 5. Adhesive Physical Property Requirements

5.1 *Open Assembly Time*—These adhesives have a distinct open assembly time and this time must be agreed upon by the user and the manufacturer.

5.2 *Storage Life*—The adhesive shall remain serviceable and meet all the requirements of this specification for not less than six months after delivery, when stored in original unopened containers at temperatures ranging from 40 to 85°F (4 to 30°C).

\*A Summary of Changes section appears at the end of this standard

**6. Adhesive Properties and Performance**

6.1 The adhesives shall conform to the requirements summarized in **Table 1**.

**7. Materials and Apparatus for Conducting Tests**

7.1 *Adhesives*—The adhesive shall be an expandable foam adhesive.

7.2 *Gypsum Wallboard*— $\frac{1}{2}$  in. (12.7 mm) thick, complying with Specification **C1396/C1396M**; the dimensions are specified in each test.

7.3 *Plywood*— $\frac{3}{4}$  or  $\frac{23}{32}$  in. (19 or 18.3 mm)-thick U.S. Product Standard PS-1-95 grade marked stamped, commercial plywood, Exterior, Group 1 Species, A-A or A-B grade face and back veneers. The test specimen dimensions are specified in each test.

7.4 *Douglas-Fir Lumber*— $1\frac{1}{2}$  by  $1\frac{1}{2}$  by  $3\frac{1}{2}$  in. (38 by 38 by 89 mm), clear, dry lumber, (moisture content of 8 to 10 %), with the bonding surface free of bark, knots, splits, and pitch.

NOTE 1—The tensile test will use one of the ends of the block as a bonding surface and should be an edge grain face.

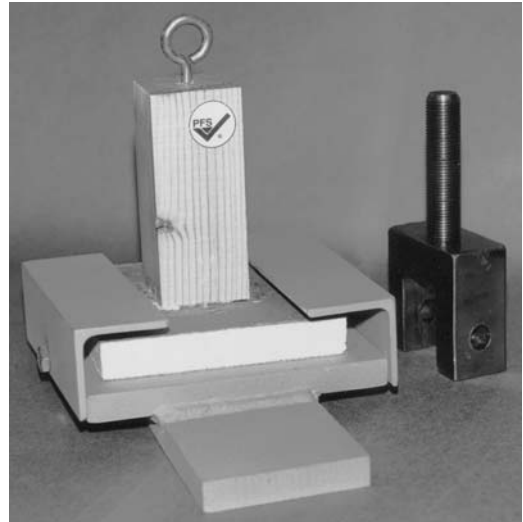
7.5 *Tensile Test Fixture*—An assembly of one, 5 by 5 in. (127 by 127 mm) by  $\frac{1}{2}$  in. (6.35 mm) thick steel plate and two 6 in. long sections of  $1\frac{1}{2}$  by  $1\frac{1}{2}$  (38.1 by 38.1 mm) by  $\frac{1}{4}$  in. (6.4 mm) thick steel angles (**Fig. 1**).

7.6 *Garnet Paper*—No. 120 grit, 3/0.

7.7 *Plywood Shim*—4 by  $3\frac{1}{2}$  in. or 4 by 4 in. (101.6 by 88.9 mm or 101.6 by 101.6 mm) piece of  $\frac{3}{4}$ -in. (19-mm) or  $\frac{23}{32}$ -in. (18.3-mm) thick U.S. Product Standard PS-1-95 grade marked stamped, commercial plywood, Exterior, Group 1 Species, A-A or A-B grade face and back veneers.

7.8 *Manila Folder*—Plain manila paper, 11 point weight, (.011-in. (0.28-mm) thick).

7.9 *Vinyl-Covered Wallboard*—A manufactured product consisting of gypsum wallboard with 2 mil minimum thickness vinyl overlay bonded to the wallboard front face.



**FIG. 1 Tensile Strength Test Specimen Assembly**

7.10 *1-Pt and 1-Gal Non-Reactive Metal Can*.

7.11 *Food Wrap Polyethylene Film*—0.8 mil thickness sheet.

7.12 *Steel Mandrel*—1 in. (25.4 mm) diameter steel rod or pipe section with smooth and uniform surface.

7.13 *Tension Rod*—A steel rod for connecting the tensile test specimen assembly to the test machine.

7.14 *Testing Machine*—Any suitable testing machine that is capable of operation at a constant rate of motion of the moveable head and has an accuracy of  $\pm 1\%$  when calibrated in accordance with Practices **E4** requirements.

7.15 *Compression Shear Test Fixture*—A compression-shear apparatus that is similar to, but of a larger scale than the fixture recommended in Test Method **D905**. A similar fixture is shown in **Fig. 2**.

7.16 *Wood Screw with Eyelet*—#6 by  $1\frac{1}{2}$  in. (38.1 mm) long,  $\frac{3}{8}$  in. (19.5 mm) inside diameter eyelet.

**TABLE 1 Adhesive Properties and Performance Requirements**

Test Method	Section	Property	Condition	Requirements
Rate of shear strength	10.1.4	shear strength	24 h at STD. COND.	10 psi (69 kPa) min
	10.1.5	shear strength	14 days at STD. COND.	40 psi (276 kPa) min
	10.1.6	shear strength	14 days at STD. COND., + cyclic lab exposure, + 2 days at STD. COND.	32 psi (220 kPa) min
	10.1.7	resistance to static load in shear	(a) 40 lb (178 N) for 24 h at STD. COND. (b) 20 lb (89 N) for 24 h at 100°F (38°C)	no bond separation no bond separation
Rate of strength development	10.2.2	tensile strength	24 h at STD. COND.	15 psi (103 kPa) min
	10.2.2	tensile strength	14 days at STD. COND.	25 psi (172 kPa) min
Adhesive open-time determination	10.3	open time	24 h at STD. COND.	75 % paper transfer, min
Substrate wet-out by adhesive	10.4.1	wet out	spatula applied	good wetting property
	10.4.2	wet out	spatula applied	good wetting property
Adhesive aging	10.5	accelerated aging	500 h at 158°F (70°C)	no cracking or chipping
Freeze thaw stability †	10.6	low temperature storage	3 cycles of 24 h at 0°F + 24 h at STD. COND.	no change in workability; 10 psi (69 kPa) shear strength, min
Suitability of a laminating adhesive for vinyl-covered wallboard	10.7	compatibility	24 h at 100°F (38°C)	no blistering, vinyl-film discoloration, or bond failure
Suitability for Stain Resistance for Vinyl-covered wallboard	10.8	staining	1 h at STD. COND.	no swelling or discoloration
Bridging	10.9	gap-filling	48 h at STD. COND.	intact adhesive bond line, report length and paper failure %

† Corrected editorially.

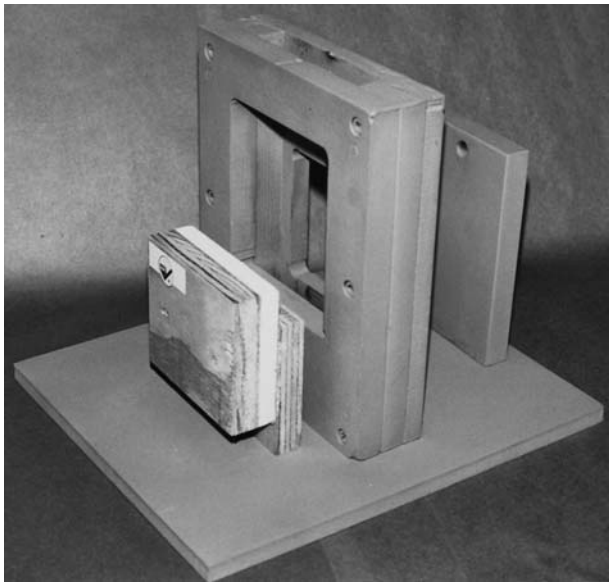


FIG. 2 Shear Strength Test Specimen Assembly

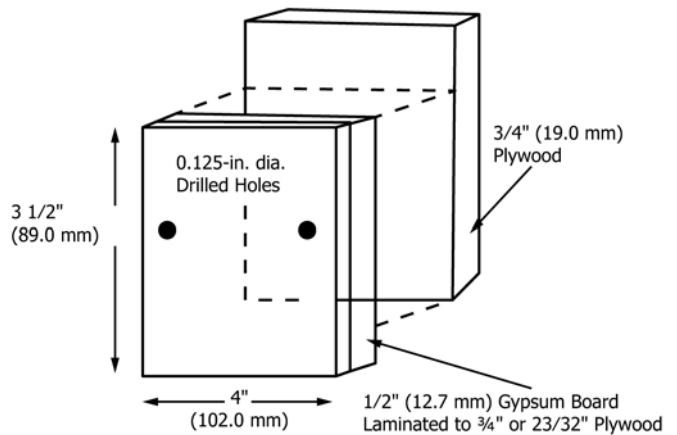


FIG. 3 Predrilled Shear Test Specimen Prior to Assembly

7.17 *Scaffolding Nails*—6d, double-head, smooth shaft, 0.113-in. (2.870-mm) diameter 2 in. (51 mm) long.

## 8. Sampling

8.1 The test adhesive sample size of 1 qt (approximately 1 L) is a minimum amount to complete one full series of testing. The sample is to be handled and stored according to the manufacturers recommendations. The sample is to be representative of the final product for which recognition is sought.

## 9. Conditioning of Materials and Adhesives

9.1 Standard condition will be defined as being  $73 \pm 2^\circ\text{F}$  ( $23 \pm 1^\circ\text{C}$ ) and  $50 \pm 5\%$  relative humidity.

9.2 Condition the Douglas-fir lumber, plywood, gypsum wallboard, and plain manila file folder for 48 h as described in 9.1. (The Douglas-fir lumber and plywood should not vary by 0.5 % after consecutive weighings.)

## 10. Test Methods

### 10.1 *Shear Strength (Rate-of-Shear Strength Development)*:

10.1.1 *Preparation of Wallboard-Plywood Laminates*—The gypsum wallboard must be reinforced with plywood. The plywood reinforced gypsum wallboard is referred to as the wallboard-plywood laminate. Each laminate is made by bonding the front surface of a piece of 4 by  $3\frac{1}{2}$  by  $\frac{1}{2}$  in. (101.6 by 88.9 by 12.7 mm) thick wallboard to a  $\frac{3}{4}$  or  $\frac{23}{32}$  in. (19 or 18.3 mm) thick plywood piece of the same dimensions with a commercially available adhesive. The grain of the wallboard back surface facing paper shall run parallel with the  $3\frac{1}{2}$  in. (89 mm) direction. Cure the adhesive in accordance with the adhesive manufacturer's recommendations. Condition the wallboard-plywood laminate to a constant weight in accordance with 9.2.

10.1.2 *Preparation of Test Assembly*—Prepare the test assembly by bonding a 4 by  $3\frac{1}{2}$  by  $\frac{3}{4}$  or  $\frac{23}{32}$  in. (102 by 89 by 19 mm) piece of plywood (7.3) to the previously prepared laminate as follows and shown in Fig. 3.

10.1.2.1 Sand the face of the  $\frac{3}{4}$ -in. (19-mm) thick plywood smooth with garnet paper and wipe the sanded surface free of dust. Drill two pilot holes through the wallboard-plywood laminate. Use a standard 0.125 in. (3.175 mm) drill bit and locate each pilot hole at  $\frac{3}{8}$ -in. (9.5 mm) from the sides and  $\frac{7}{8}$ -in. (22-mm) from the overlapped end.

10.1.2.2 Apply the adhesive on the sanded surface with the self-contained delivery system set at the manufacturer's recommended bead size. The amount of adhesive should be sufficient to cover the entire bond area without gaps in the adhesive.

10.1.2.3 Allow an open time of  $30 \pm 5$  s upon completion of spreading.

10.1.2.4 Squarely position the wallboard-plywood laminate on the coated plywood overlapping exactly  $2\frac{1}{2} \pm \frac{1}{16}$  in. (63.5 mm), thus forming the approximate 10 in.<sup>2</sup> (64.5 cm<sup>2</sup>) bonded area (see Fig. 3).

10.1.2.5 Insert six wire spacers (No. 20 gage) at least 2 in. (51 mm) long into the adhesive bondline joint. Position the spacers so that they are at each end of the test region. With the test specimen positioned horizontally on a firm surface and the wallboard plywood laminate piece on top, install two 6d scaffolding nails into the predrilled pilot holes.

NOTE 2—The pilot hole diameter should be slightly larger than the nail diameter. This is necessary to prevent the laminate from binding against the nail shaft and interfering with the uniform compression at the bond line. Carefully and uniformly set the nails into the lower plywood piece. Drive the nails until the scaffold head initially encounters the wallboard-plywood laminate.

10.1.2.6 After the adhesive has hardened, remove the scaffolding nails. Remove the spacers and cut away the excess adhesive from the bonded edges. Do not disturb the alignment of the bond line.

10.1.3 *Shear Strength—Dynamic Loading Determination*—Following the appropriate conditioning, test the specimen in shear using a compression-shear test fixture as shown in Fig. 2. The bottom edge of the wallboard-plywood laminate shall rest on a self-aligning seat as the test loading is simultaneously applied to the top edge of the plywood. The stress applied must be parallel and uniformly distributed to the joint (shear plane) and must require careful orientation using shims and self-aligning apparatus as necessary. Determine the shear strength

at a cross head speed of 0.2 in. (5.1 mm)/min. Observations are made during stress application to ensure the test assembly maintains proper alignment throughout the test. The test fixtures cannot in any way cause stress measurement error(s) such as with binding or friction. Report the maximum shear strength and the average shear strengths for the 24 h, the 14 day, and the cyclic exposure test conditions.

10.1.4 *Shear Strength After 24 h:*

10.1.4.1 Prepare five test assemblies using the procedure in 10.1.1 and 10.1.2.

10.1.4.2 After aging the assemblies  $24 \pm 1$  h at standard condition (9.1), determine the shear strength in accordance with 10.1.3.

10.1.5 *Shear Strength After 14 Days:*

10.1.5.1 Prepare five test assemblies using the procedure in 10.1.1 and 10.1.2.

10.1.5.2 After aging the assemblies 14 days at standard condition (9.1), determine the shear strength in accordance with 10.1.3.

10.1.6 *Shear Strength After Cyclic Exposure:*

10.1.6.1 Prepare five test assemblies using the procedure in 10.1.1 and 10.1.2.

10.1.6.2 After aging the assemblies 14 days at standard condition (9.1), process the assemblies through four complete cycles (see Table 2). Store the assemblies at standard condition (9.1) for 24 h after each cycle.

10.1.6.3 At the end of the cycling condition the test specimens for 2 days in standard conditions and determine the shear strength in accordance with 10.1.3.

10.1.7 *Resistance to Static Load in Shear:*

10.1.7.1 Prepare ten assemblies using the procedure in 10.1.1 and 10.1.2. Use a razor blade to scribe a line at both edges and perpendicular to the bond line where the gypsum wallboard-plywood laminate meets the plywood. The line will be useful when examining the assembly for noticeable separation or slippage.

10.1.7.2 Condition the assemblies 14 days at standard condition (9.1).

NOTE 3—This will allow sufficient time for the adhesive to cure.

10.1.7.3 Load five test assemblies to 40 lb (178 N) at  $73 \pm 2^\circ\text{F}$  ( $23 \pm 1^\circ\text{C}$ ) and five assemblies to 20 lb (89 N) at  $100 \pm 2^\circ\text{F}$  ( $38 \pm 1^\circ\text{C}$ ) for a period of 24 h. When testing, clamp the top (wallboard/plywood) of the assembly to a rigid frame and attach the load to the bottom (plywood), making sure that perfect alignment of the suspended assembly and the loads are achieved.

**TABLE 2 Cyclic-Exposure Conditioning for Shear-Test Assemblies (see 10.1.6)**

NOTE 1—Four complete aging cycles to be used.

NOTE 2—Room temperature storage required over weekends.

NOTE 3—This 24 h procedure represents one complete cycle.

Time, h	Temperature, °F (°C)	Relative Humidity, %
4	100 (38)	$85 \pm 2$
4	40 (4.5)	uncontrolled
16	122 (50)	uncontrolled

10.1.7.4 At the end of each condition's 24-h period, examine each test specimen assembly for bond separation and slippage between the wallboard-plywood laminate and the plywood adherend. Slippage or separation at the bond line of the adhesive is considered a failure. Report the results of analysis for each of the five static load shear test specimens for both conditions.

10.2 *Tensile Strength (Rate of Strength Development):*

10.2.1 *Preparation of Wallboard-Plywood Laminates*—Prepare the laminates using the same procedure in 10.1.1, but with 4 by 4 in. (101.6 by 101.6 mm) gypsum wallboard and plywood shims, or without plywood shim as shown in Fig. 1. Drill one pilot hole with a 0.125 in. (3.2 mm) drill bit through the center of the wallboard-plywood laminate. The pilot hole is for the installation of the 6d scaffolding nail to be used for the Douglas-fir wood block connection.

10.2.1.1 Prepare the  $1\frac{1}{2}$  by  $1\frac{1}{2}$  by  $3\frac{1}{2}$  in. (38 by 38 by 89 mm) Douglas-fir wood block by drilling a pilot hole for the wood screw with eyelet at the exact center end of test machine connection block end and a pilot hole for the 6d scaffold nail at the approximate center of the opposite block end. This eyelet will be used for the connection to the test machine. The pilot hole should be drilled straight and parallel with the block's length. The wood block end used for bonding to the wallboard back surface paper should be an edge grain face. Install the wood screw into the pilot hole with sufficient thread engagement to withstand the tensile force application.

10.2.1.2 Bond the back paper surface of the wallboard-plywood laminate to the Douglas-fir wood block. Apply excess foam adhesive to completely cover the bonding area. Uniform squeeze-out of excess adhesive should occur on all sides when the bond area is compressed to a bond line thickness of approximately  $\frac{1}{32}$  in. (0.8 mm).

10.2.1.3 Insert and position the tip of four wire spacers of No. 20 gage at least 2-in. (51-mm) long into the bonded area with the spacers positioned  $\frac{1}{4}$ -in. (6.3 mm) from each edge of the wood block. With the test specimen's wood block on a firm surface and the wallboard-plywood laminate centered on top, install the 6d scaffolding nail into the pre-drilled pilot hole.

NOTE 4—The pilot hole diameter should be slightly larger than the nail diameter. This will prevent the laminate from binding against the nail shaft and interfering with the uniform compression at the bond line. Carefully and uniformly set the nail into the wood block. Drive the nails until the scaffold head initially encounters the wallboard-plywood laminate.

10.2.1.4 Scrape all excess adhesive away from edges using a square-tipped spatula. After the adhesive has hardened, remove the scaffolding nails. Remove the spacers and cut away the excess adhesive from the bonded edges. Do not disturb the alignment of the bond line.

10.2.2 *Tensile-Strength Determination*—Measure the tensile strength of the test specimen assembly on a testing machine capable of providing a loading rate of 60 lb (267 N)/min. Position the test specimen with the Douglas-fir wood block centered between the angles. Refer to Fig. 1. The test fixture is mounted to a permanent base and includes self-alignment features to ensure the stress application is perpendicular to the joint until failure. Connect the tensile test specimen to the test machine by connecting the tension rod with a clevis to the