Designation: C1497 – 16

# Standard Specification for Cellulosic Fiber Stabilized Thermal Insulation[1]

This standard is issued under the fixed designation C1497; 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.

## 1. Scope

1.1 This specification covers the composition and physical properties of spray-applied cellulosic fiber stabilized thermal insulation applied to open or closed ceiling spaces, regardless of slope, where temperatures range from –49 to 194°F (–45 to 90°C).

1.2 Stabilized cellulosic fiber thermal insulation is produced by the addition of adhesive(s) to loose-fill cellulosic fiber insulation. The adhesive(s) are either added to the insulation at time of manufacture and, if necessary, activated by the addition of water when installed or the adhesive(s) are otherwise added to the insulation at the time of installation.

1.3 This is a material specification that is not intended to deal with methods of application that are supplied by the manufacturer.

1.4 The values stated in inch-pound units are to be regarded as standard. The SI units given in parentheses are for information only.

1.5 *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:*[2]

C167 Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations

C168 Terminology Relating to Thermal Insulation

C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C739 Specification for Cellulosic Fiber Loose-Fill Thermal Insulation

C1149 Specification for Self-Supported Spray Applied Cellulosic Thermal Insulation

C1304 Test Method for Assessing the Odor Emission of Thermal Insulation Materials

C1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E970 Test Method for Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, see Terminology C168.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *shrinkage*—decrease in thickness that occurs from the time of installation until the insulation is dry (see 7.2.5).

3.2.2 *stabilized cellulose*—a cellulosic insulation product treated to resist, after drying, further settling of no more than 5 %.

## 4. Materials and Manufacture

4.1 The basic material shall be recycled cellulosic fiber made from selected paper or paperboard stock. Additives are introduced to affect different performance characteristics, including those related to fire performance, processing, and handling. An adhesive is added to the insulation product to resist long-term settling of the insulation after installation and curing.

4.2 The materials are processed into a form suitable for installation by a pneumatic method.

4.3 The adhesive is added to the product either at the time of manufacture or at the time of installation by means of a liquid spray.

## 5. Physical and Chemical Properties

5.1 *Density*—The density of conditioned stabilized insulation in lb/ft$^3$ (kg/m$^3$) shall be determined in accordance with Section 7.

5.2 *Corrosiveness*—The loose-fill insulation material shall be tested for corrosiveness in accordance with Section 8. The

[1] This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.23 on Blanket and Loose Fill Insulation.

Current edition approved Oct. 1, 2016. Published October 2016. Originally approved in 2001. Last previous edition approved in 2012 as C1497 – 12. DOI: 10.1520/C1497-16.

[2] 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.

composition of the insulation material shall be such that after testing, no perforation of the 0.003 in. (0.076 mm) metal specimens shall be evident when the specimens are observed over a 40-W appliance light bulb. Notches extending into the coupon 0.1 in. (3 mm) or less from any edge shall be ignored.

5.3 *Critical Radiant Flux*—When tested in accordance with Section 9, the critical radiant flux shall be equal to or greater than 0.11 Btu/ft$^2$·s (0.12 W/cm$^2$). All values shall be reported to two significant digits.

5.4 *Fungi Resistance*—The loose-fill insulation material shall be tested and pass fungi resistance as specified in Section 10. All three test specimens shall exhibit growth less than or equal to the comparative material in order to pass.

5.5 *Water Vapor Sorption*—Moisture gain in the insulation shall be no more than 15 % by weight when tested in accordance with Section 11.

5.6 *Odor Emission*—Any sample producing a detectable odor that is classified as objectionable and strong or strong by more than two panel members shall be considered to have failed the test when tested in accordance with Section 12.

5.7 *Smoldering Combustion*—When tested in accordance with the smoldering combustion test method in Section 13, the insulation shall show no evidence of flaming and a weight loss of no greater than 15 % of the specimen weight.

5.8 *Thermal Resistance*—The standard thermal resistance values recommended for application shall be expressed in °F·h·ft$^2$/Btu (K·m$^2$/W). The R-value shall be measured in accordance with Section 14. During random sampling, an average measured R for four specimens that is 95 % of the labeled value shall be acceptable provided no measurement is less than 90 % of the labeled value.[3]

5.9 *Permanency of Flame Retardant Treatment*—It is important to ensure that the fire test response characteristics of the cellulosic fiber insulation, expressed as the critical radiant flux in accordance with 5.3 or as the smoldering performance in accordance with 5.7, not be degraded over time. The rationale for the concern is that the additives used for improving the fire test response characteristics of cellulosic fiber insulation are physically added to the cellulose and are not chemically bound to the cellulose. Studies have been made in the past indicating that cellulose insulation treated with boric acid (**1**),[4] borates (**2**), and ammonium sulfate (**3**) retains its fire test response characteristics for years, based on cellulose insulation that had been installed for periods of up to 14 years (**4**,**5**). No data has been presented to the committee to update or revise this information and no permanency test method has been developed to date.

5.10 *Shrinkage*—The shrinkage ($S_1$) determined in accordance with Section 7.

5.11 *Settling*—The settling ($S_2$) determined in accordance with Section 7 shall be no greater than 5 %.

## 6. Workmanship, Finish, and Appearance

6.1 The product shall be free of extraneous foreign materials such as metals and glass that will adversely affect the performance in service.

## 7. Shrinkage, Settling, and Density

7.1 *Density:*

7.1.1 *Scope*—This test method provides a basis for calculating the product coverage values and for conducting physical property tests requiring the use of density for specimen preparation. The shrinkage and settling results provide information for installation.

7.1.2 *Significance and Use*—The density is the weight per unit volume expected after long-term attic use. All testing of this product shall be done using specimens having the density determined by the drop box method described in this section.

7.1.3 *Apparatus:*

7.1.3.1 *Insulation Specimen Container*—The drop box apparatus shall consist of an open-top box with sides and bottom made from ¾-in. (19 mm) thick plywood. The interior of the box shall be treated with a water sealer. The interior dimensions of the box shall be 22 by 36 by 5-in. (deep) (559 by 914 by 127 mm) for insulation with R < 22 ft$^2$·h·°F/Btu (3.87 K·m$^2$/W), 22 by 36 by 7½-in. (deep) (559 by 914 by 191 mm) for insulation with 22 < R < 32 ft$^2$·h·°F/Btu and 22 by 36 by 10-in. (deep) (550 by 914 by 254 mm) for insulation with R > 32 ft$^2$·h·°F/Btu (5.64 K·m$^2$/W). A 1.0-in. (25 mm) steel "eye" shall be attached to each corner to facilitate lifting the box with a cable or rope harness and pulley system. All box dimensions shall be within ±3 % of the values specified above.

7.1.3.2 *Spacer*—A 6.0-in. (150 mm) thick spacer shall be fabricated for positioning the box above a concrete floor. The spacer shall be fitted with a handle or heavy cord to assist moving it from below the suspended box. Use a quick release device to drop the suspended box.

7.1.3.3 *Balance*—A balance having sufficient capacity to weigh a specimen container with freshly installed insulation to within 0.01 lb (5g).

7.1.3.4 *Probe and Ruler*—A 0.125 ± 0.008 in. (3.2 ± 0.2 mm) diameter metal rod that is pointed on one end shall be used as a pin gauge. A steel rule with 0.05 in. (1.0 mm) or finer readability shall be used to determine insulation thicknesses. The device pictured in Figure 1 of Test Methods C167 is suitable for use.

7.2 *Procedure:*

7.2.1 A partially enclosed area is required for specimen preparation. The enclosure must protect the blowing operation from wind or strong air currents. Ensure that the geometry of the room does not influence the stream of insulation from the hose. It is recommended that the area of the enclosure be at least 2.5 times the area of the test specimen container.

7.2.2 The weight of the empty box, $M_1$, shall be determined to within 0.06 lb (25 g).

7.2.3 The product to be tested shall be installed in the box using equipment and installation instructions recommended by

[3] The ranges of thermal resistance, R, listed in this section are allowed by Federal Trade Commission 16 CFR Part 460 Trade Regulation Rule: Labeling and Advertising of Home Insulation.

[4] The boldface numbers in parentheses refer to a list of references at the end of this standard.

**TABLE 1 Density (lbs per f$^3$)**

| Flame Retardant Additives | Average[A] $\bar{x}$ | Repeatability Standard Deviation Sr | Repeatability Limit r |
|---|---|---|---|
| 5 inch box | | | |
| Boric acid | 1.966 | 0.088 | 0.246 |
| Boric acid and ammonium sulfate | 1.678 | 0.054 | 0.152 |
| 7.5 inch box | | | |
| Boric acid | 2.022 | 0.063 | 0.175 |
| Boric acid and ammonium sulfate | 1.792 | 0.038 | 0.107 |
| 10 inch box | | | |
| Boric acid | 2.031 | 0.155 | 0.434 |
| Boric acid and ammonium sulfate | 1.848 | 0.012 | 0.034 |

[A]The average of the laboratories' calculated averages.

the manufacturer. Excess insulation shall be screed from the top of the test specimen to provide a level surface that coincides with the top edges of the box. The weight of the box and newly installed insulation, $M_2$, shall be determined to within 0.06 lb (25 g) and recorded.

7.2.4 The average depth of the insulation shall be determined to within 0.05-in. (1 mm) using a metal probe. Five individual depth measurements shall be averaged to obtain the depth that is representative of the newly installed insulation. Individual measurements shall be taken at the center of the box and in each quadrant of the box.

7.2.5 The insulation shall be allowed to dry in a conditioned space maintained at 75 ± 5°F and 50 ± 5 % RH until a change in net weight of the specimen is less than 0.06 lb (25 g) in two consecutive weight determinations with 24 h between determinations. The weight of the box with the conditioned (dry) insulation, $M_3$, shall be recorded. Since it is possible that moving of boxes containing insulation will disturb the insulation, a suitable solution involves preparing an additional 10-in. deep box of insulation installed in the same manner as the test specimens and using it to track the drying of the test specimens.

7.2.6 The thickness of the conditioned insulation shall be measured by the same method used to measure the initial thickness.

7.2.7 The box containing the conditioned insulation shall be dropped five times onto a solid concrete floor from a height of 6 –0/+1/2 in. (150 –0/+13 mm). The average thickness of the insulation shall be measured after five drops using the method used to measure the initial thickness.

7.2.8 The insulation shall be removed from the box and weighed to within 0.01 lb (5 g). This is weight $M_4$.

7.3 *Calculations*—All of the following are inside dimensions:

L = the length of the box, in. (mm)

W = the width of the box, in. (mm)

$M_1$ = the weight of the empty box in lbs (g)

$M_2$ = the weight of the box and insulation at installation in lbs (g)

$M_3$ = the weight of the box and insulation after conditioning in lbs (g)

$M_4$ = the weight of the conditioned insulation in lbs (g)

$T_1$ = the initial thickness of the insulation, in. (mm)

$T_2$ = the thickness of the insulation after conditioning , in. (mm)

$T_3$ = the thickness of the insulation after five drops, in. (mm)

Weight of water added during installation = $M_2 - M_3$ lbs (g)

percent water added during installation (dry basis) = $(M_2 - M_3)\times100/M_4$

V = volume of insulation before dropping = $L\times W\times T_2/1728$ ft$^3$ or $(L\times W\times T_2/1\times10^9(m^3))$

D = density of dry "stabilized" product = $M_4/V$ lb/ft$^3$ or $(M_4/1000V$ (kg/m$^3$))

$S_1$ = % shrinkage = $(T_1 - T_2)\times100/T_1$

$S_2$ = % settling = $(T_2 - T_3)\times100/T_2$

7.4 *Report:*

7.4.1 Test material identification,

7.4.2 The dimensions of the drop box,

7.4.3 The thickness tested,

7.4.4 The percentage water added (dry basis),

7.4.5 The density of the dry-stabilized product,

7.4.6 The percent shrinkage,

7.4.7 The percent settling.

7.5 *Precision and Bias:*

7.5.1 The precision of this test method is based on an interlaboratory study (ILS) of Specification C1497 conducted in 2009. Two laboratories measured the density, settling, and shrinkage of two different materials, in three size variations. Every "test result" represents an individual determination. Each laboratory was asked to submit three replicate test results, from a single operator, for each analysis and material type. Except for the limited number of reporting laboratories and materials tested, Practice E691 was followed for the design and analysis of the data.[5]

7.5.1.1 *Repeatability Limit (r)*—Two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the "*r*" value for that material; "*r*" is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment on the same day in the same laboratory.

*(1)* Repeatability limits are listed in Tables 1-3 below.

7.5.1.2 *Reproducibility Limit (R)*—Two test results shall be judged not equivalent if they differ by more than the "*R*" value for that material; "*R*" is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:C16-1039.

**TABLE 2 Settling (%)**

| Flame Retardant Additives | Average[A] $\bar{x}$ | Repeatability Standard Deviation $s_r$ | Repeatability Limit r |
|---|---|---|---|
| 5 inch box | | | |
| Boric acid | 4.864 | 1.666 | 4.664 |
| Boric acid and ammonium sulfate | 2.425 | 2.058 | 5.763 |
| 7.5 inch box | | | |
| Boric acid | 4.440 | 0.942 | 2.637 |
| Boric acid and ammonium sulfate | 3.183 | 0.736 | 2.061 |
| 10 inch box | | | |
| Boric acid | 4.198 | 1.221 | 3.418 |
| Boric acid and ammonium sulfate | 3.554 | 0.490 | 1.373 |

[A]The average of the laboratories' calculated averages.

**TABLE 3 Shrinkage (%)**

| Flame Retardant Additives | Average[A] $\bar{x}$ | Repeatability Standard Deviation $s_r$ | Repeatability Limit r |
|---|---|---|---|
| 5 inch box | | | |
| Boric acid | 5.558 | 0.737 | 2.064 |
| Boric acid and ammonium sulfate | 3.377 | 1.935 | 5.418 |
| 7.5 inch box | | | |
| Boric acid | 6.271 | 0.971 | 2.718 |
| Boric acid and ammonium sulfate | 4.021 | 0.368 | 1.031 |
| 10 inch box | | | |
| Boric acid | 5.906 | 0.711 | 1.992 |
| Boric acid and ammonium sulfate | 4.263 | 0.742 | 2.079 |

[A]The average of the laboratories' calculated averages.

*(1)* Reproducibility limits cannot accurately be determined with data from fewer than six laboratories.

7.5.1.3 The above terms (repeatability limit and reproducibility limit) are used as specified in Test Method C177.

7.5.1.4 Any judgment in accordance with statements 7.5.1.1 would normally have an approximate 95 % probability of being correct, however the precision statistics obtained in this ILS must not be treated as exact mathematical quantities which are applicable to all circumstances and uses. The limited number of materials tested and laboratories reporting results guarantees that there will be times when differences greater than predicted by the ILS results will arise, sometimes with considerably greater or smaller frequency than the 95 % probability limit would imply. Consider the repeatability limit and the reproducibility limit as general guides, and consider the associated probability of 95 % as only a rough indicator of what can be expected.

7.5.2 *Bias*—At the time of the study, there was no accepted reference material suitable for determining the bias for this test method, therefore no statement on bias is being made.

7.5.3 The precision statement was determined through statistical examination of 81 analytical results from two laboratories, on two materials, at three different dimensions.

7.5.4 To judge the equivalency of two test results, it is recommended to choose the material closest in characteristics to the test material.

NOTE 1—Further research is needed with greater laboratory participation to calculate installed thickness, shrinkage thickness, density after shrinkage and correlate this a with a pass/fail result after the "drop-box" part of the test.

## 8. Corrosiveness

8.1 *Determination*—Corrosiveness shall be determined in accordance with Subsection 6.7 of Specification C1149 using the density determined in Section 7 with a 10-in. deep (254 mm) drop box.

## 9. Critical Radiant Flux

9.1 *Specimen Preparation*—The specimen shall be prepared in accordance with the manufacturer's installation instructions.

9.2 *Measurement*—Critical Radiant Flux shall be determined in accordance with Test Method E970. Products shall be tested after a test specimen including the adhesive has been conditioned to constant weight.

9.3 *Report*—Each of the three measurements shall be reported.

## 10. Fungi Resistance

10.1 *Measurement*—Fungi resistance shall be measured in accordance with Test Method C1338.

10.2 *Comparative Material*—A section of untreated southern yellow pine approximately 2 by 2 by ⅜ in. (51 by 51 by 9.5 mm) will be used as the comparative material. The upper surface of the pine shall be planed smooth to determine the relative growth on specimens being tested. For insulation intended to be mixed with adhesive at the time of installation, determine the amount of adhesive concentrate required for 0.35 oz (10 g) of dry insulation. Mix the adhesive with 37.5 mL of distilled or deionized water and add this to the dry insulation to form a slurry. For material intended to be mixed only with

water at the time of installation, mix 37.5 mL of distilled or deionized water with 0.35 oz (10 g) of dry material.

## 11. Water Vapor Sorption

11.1 *Measurement*—Water vapor sorption shall be determined in accordance with Section 12 of Specification C739 for the density determined using a 10-in. deep drop box.

## 12. Odor Emissions

12.1 Odor emission shall be determined in accordance with Test Method C1304.

## 13. Smoldering Combustion

13.1 *Specimen Preparation:*

13.1.1 Specimen preparation shall be in accordance with Subsection 6.5 of Specification C1149 or Subsection 8.4 of Specification C739.

13.2 The smoldering combustion test shall be done for test specimens at a density within 5 % of the density determined in Section 7 using a 10-in. deep drop box. The test shall be performed on dry material containing adhesive in the case of a product containing a dry adhesive. Products that use a spray-applied adhesive shall be tested after a specimen including adhesive has been allowed to condition to constant weight. The criteria given in 7.2.5 shall be used to identify conditioned specimens for the purpose of this test.

## 14. Thermal Resistance

14.1 Thermal resistance shall be determined in accordance with Section 15 of Specification C739. The test specimens must be stabilized product that has been prepared in accordance with manufacturer's recommendations and allowed to dry in accordance with 7.2.5. Three specimens shall be tested at each of the densities determined in Section 7. The thermal test specimens must have an average density that is within 5 % of the density determined in Section 7. The thermal tests shall be carried out at a thickness that equals or exceeds the representative thickness or 4 in. (102 mm) whichever is smaller. The thermal resistivity (R-per-inch of thickness) reported for each of the densities tested shall be the average of the three measured values.

**TABLE 4 Example of Suggested Form for Attic Insulation Coverage Chart**

| R-Value at 75°F Mean Temperature | Maximum Net Coverage | | Thickness, when installed, inches (minimum)[A] | Thickness, when dry, inches (minimum) | Weight, lb/ft$^2$ (minimum)[B] |
|---|---|---|---|---|---|
| | Bags/1000 ft$^2$ (minimum) | Maximum coverage per Bag, ft$^2$ | | | |
| R-49 | ____ | ____ | ____ | ____ | ____ |
| R-44 | ____ | ____ | ____ | ____ | ____ |
| R-40 | ____ | ____ | ____ | ____ | ____ |
| R-38 | ____ | ____ | ____ | ____ | ____ |
| R-32 | ____ | ____ | ____ | ____ | ____ |
| R-30 | ____ | ____ | ____ | ____ | ____ |
| R-24 | ____ | ____ | ____ | ____ | ____ |
| R-22 | ____ | ____ | ____ | ____ | ____ |
| R-19 | ____ | ____ | ____ | ____ | ____ |
| R-13 | ____ | ____ | ____ | ____ | ____ |
| R-11 | ____ | ____ | ____ | ____ | ____ |

[A] Minimum thickness at time of installation (inches).
[B] Minimum weight of dry insulation (lb/ft$^2$)

## 15. Inspection

15.1 Inspection of the insulation shall be made as agreed upon by the purchaser and the manufacturer as part of the purchase contract.

## 16. Packaging and Package Marking

16.1 *Packaging*—Unless otherwise specified, the insulation shall be packaged in the manufacturer's standard commercial containers.

16.2 *Package Marking*—Each bag of insulation shall be marked to include the following:

16.2.1 Name, plant location and telephone number of manufacturer,

16.2.2 Manufacturing date and location,

16.2.3 Net weight of insulation per bag,

16.2.4 The manufacturer specifies that to provide the levels of thermal resistance shown, the insulation must be installed to satisfy each of these conditions: minimum thickness, minimum weight per unit area, and maximum coverage.

16.2.5 Filled-in coverage chart shall be based on the appropriate density determined in Section 7, which shall contain the information prescribed in Table 4.

## 17. Supplementary Requirements

17.1 The manufacturer's specification for the weight percent water or amount of adhesive to be added to the insulation at the time of installation.

17.2 *Certification*—"This insulation has been installed in conformance with the above recommendations, to provide a value of R-_____ using _____ bags of this insulation to cover _____ square feet of area," including: a place for the builder's signature, company name, address and telephone number, date, and place for applicator's signature, company, name, and date.

## 18. Keywords

18.1 cellulose; R-value; shrinkage; stabilized cellulose; thermal insulation

## REFERENCES


**(1)** Chiou, N. and Yarbrough, D., "Permanency of Boric Acid Used as a Fire Retardant in Cellulosic Insulation," *Energy and Buildings*, Vol. 14, 1990, pp. 351–361.

**(2)** Yarbrough, D. (Tennessee Technological University), "Thermal Decomposition of Ammonium Sulfate at Low Temperatures," *Letter Report to the Cellulose Marketing Council*, September 1991.

**(3)** Ferm, D.J., and Shen, K.K., "Study on the Permanence of Borates in Cellulosic Insulation," *Proceedings of the Tenth International Conference on Thermal Insulation*, 1994, p. 311.

**(4)** Yarbrough, D., "A Review of Research on the Permanency of Chemical Fire Retardant Chemicals Contained in Cellulosic Insulation," *Thermal Performance of the Exterior Envelope of Buildings-V*, Clearwater, FL, December 7-10, 1992.

**(5)** Yarbrough, D., "Permanency of Chemical Fire Retardants Used in Cellulosic Insulation," *Proc. of the International Conference on Thermal Insulations*, Vol. 9, 1993, pp. 87–93.