Designation: C 549 – 81 (Reapproved 1995)$^{\epsilon 1}$

Designation: C 549 – 02

Standard Specification for Perlite Loose Fill Insulation[1]

This standard is issued under the fixed designation C 549; 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.

This standard has been approved for use by agencies of the Department of Defense.

ε[1] NOTE—Keywords were added editorially in May 1995.

[1] This specification is under the jurisdiction of ASTM Committee C-16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.23 on Blanket and Loose Fill Insulation.

Current edition approved Oct. 30, 1981. June 10, 2002. Published February 1982. August 2002. Originally published as C 549 – 64 T. Last previous edition C 549 – 73 81(1979 5)ε1.

1. Scope

1.1 This specification covers the composition and physical properties of expanded perlite loose fill insulation. The specification also includes the testing procedures by which the acceptability of the material may be determined. These testing procedures deal primarily with material performance in the temperature range associated with the thermal envelope of buildings; however, the commercially usable temperature range for this insulation is from − 459 to 1400°F (1 to 1033 K). For specialized applications, refer to the manufacturer's instructions.

1.2 The specification also covers the composition and properties of perlite that has been surface-treated to produce water repellency and dust suppression for installations where liquid moisture and dust may be a factor.

1.3 *When the installation or use of thermal insulation materials, accessories and systems, may pose safety or health problems, the manufacturer shall provide the user appropriate current information regarding any known problems associated with the recommended use of the company's products, and shall also recommend protective measures to be employed in their safe utilization. The user shall establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use*. For additional precautionary statements, see Section 11.

1.4 The following precautionary caveat pertains to the test methods portion, Section 8, of this specification. *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:*

C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates[2]

C 168 Terminology Relating to Thermal Insulating Materials Insulation[3]

C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus[3]

C 390 Criteria for Sampling and Acceptance of Preformed Thermal Insulation Lots[3]

C 518 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus[3]

C 520 Test Methods for Density of Granular Loose Fill Insulations[3]

E 84 Test Method for Surface Burning Characteristics of Building Materials[4]

E 136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C[4]

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods[5]

2.2 *Federal Specification:*

HH-I-515D Insulation Thermal (Loose Fill for Pneumatic or Poured Application) Cellulosic or Wood Fiber[6]

[2] *Annual Book of ASTM Standards*, Vol 04.02.
[3] *Annual Book of ASTM Standards*, Vol 04.06.
[4] *Annual Book of ASTM Standards*, Vol 04.07.
[5] *Annual Book of ASTM Standards*, Vol 14.02.
[6] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

3. Classification

3.1 Perlite loose fill insulation shall be specified by four type designations as follows:

3.1.1 *Type I*—The product that results from the expanding of natural perlite ore by grading and heating to meet the requirements of this specification.

3.1.2 *Type II*—Expanded perlite that has been surface-treated to produce water repellency and limited absorption of moisture from both liquid and vapor phase.

3.1.3 *Type III*—Expanded perlite that has been surface-treated to limit the amount of dust generated during application.

3.1.4 *Type IV*—Expanded perlite that has been surface-treated to produce water repellency and to limit the dust generated during application.

4. Ordering Information

4.1 All purchase orders should designate the type of insulation desired. The type and grade classification in this specification differ from the classification in earlier issues. Purchasers referencing this specification should include the date of issue.

5. Materials and Manufacture

5.1 Perlite is a generic term for a naturally occurring siliceous mineral which is mined, crushed, sieved and dried to produce a crude perlite ore. The crude ore, in the form of particles of varying size, weighing 60 to 75 lb/ft^3 (960 to 1200 kg/m^3), is expanded in high-temperature furnaces to densities in the range from 2.0 to 11.0 lb/ft^3 (32 to 176 kg/m^3). As a naturally occurring mineral, it is classified as an elementary building material. It is noncombustible as determined by Test Method C 136.

6. Physical Requirements

6.1 The physical requirements listed in this section are defined as Inspection Requirements (see Criteria C 390). The insulation shall conform to the following requirements:

	All Types
Bulk density, lb/ft^3(kg/m^3)	2–11 (32–176)
Grading (particle size):	
Cumulative percentage retained, maximum (by weight), Sieve No. 4 (4.75 mm), %	5

	Types I and III	Types II and IV only
Water repellency, min mL of water repelled	N.A.	175
Small-scale fire test	no sparking or ignition	

6.2 The physical requirements listed in this section are defined as Qualification Requirements (see Criteria C 390). The insulation shall conform to the following requirements:

	All Types
Thermal resistance, h·ft^2·°F/Btu (m^2·K/W)	See Table 1
Moisture absorption, weight %/14 days, max, %	1.0

	Types I and III	Types II and IV
Wickability, max g wicked in 5 min	N.A.	1.0
Combustibility (by Test Method E 136)	noncombustible	N.A.[A]
Surface burning characteristics:		
Flame spread, max	0	25
Smoke developed, max	0	50
Dust suppression:		
Weight of collected material, max, mg	N.A.	85

[A] Federal Standards for attic floor insulation require conformance to two non-ASTM tests for combustibility: Critical Radiant Flux (HH-I-515D, 4.8.7) and Smoldering Combustion (HH-I-515D, 4.8.8). Types III and IV perlite insulation, when tested for Critical Radiant Flux, showed no ignition or flame front advance at a flux of 1.07 W/cm^2. When tested for Smoldering Combustion, Types III and IV perlite insulation showed no flaming combustion and 0 % weight loss.

7. Sampling

7.1 For purposes of standard tests, sampling shall be in accordance with Criteria C 390.

8. Test Methods

8.1 *Bulk Density*—Test Methods C 520, Method A.

8.2 *Grading*—Test Method C 136, except that when a mechanical sieving device is used, the sieving time shall be 5 min and the test sample shall be 50 g of material.

8.3 *Water Repellency* (Types II and IV only):

8.3.1 *Apparatus*:

8.3.1.1 *Rigid Plastic Tube*, 50 mm inside diameter by 300 mm long with a 150-µm (100-mesh) screen covering firmly fastened or adhered to the bottom. The tube shall be marked at 400 mL from the screen-covered end.

8.3.1.2 *Rubber Stopper*, No. 15.

8.3.1.3 *Graduated Cylinder*, 250-mL.

8.3.1.4 *Beaker*, 500-mL.

8.3.2 *Sample Preparation*:

8.3.2.1 Spoon a representative sample into the test cylinder to a level slightly above the 400-mL mark.

8.3.2.2 Compact it by dropping the tube from a height of approximately 75 mm on a large rubber stopper (No. 15 recommended) for a total of ten drops. As the sample compacts to a level below the 400-mL mark, add additional material so that after the tenth drop the level of the sample is within 3 mL of the 400-mL mark.

8.3.3 *Procedure*:

8.3.3.1 With the tube supported in a vertical position and a beaker positioned under the tube, pour 250 mL of cold tap water rapidly onto the perlite. Take care while pouring, that the stream hits the middle of the surface of the bed of perlite and does not merely slide down the side of the test cylinder.

8.3.3.2 Allow the water to drain through the bed of perlite for exactly 3 min. Tilt the tube at approximately 45° to drain water collected on the screen. Tilt it only momentarily for this purpose.

8.3.3.3 Measure the collected water in the 250-mL graduate.

8.3.4 *Calculations*:

8.3.4.1 Report the amount of collected water in millilitres as "millilitres repelled."

8.3.4.2 Report results as the mean of three independent tests.

8.3.5 *Precision and Bias*—The purpose of this test is to confirm that the intended degree of surface treatment has been accomplished to achieve water repellency. The specified characteristic is a minimum (no range or maximum). Quantitative values for conforming products exceeding the limit have no commercial significance.

8.4 *Small-Scale Fire Test*:

8.4.1 *Scope*—The purpose of this quality control test is to confirm that excessive coating or organic material has not been added during processing.

8.4.2 *Significance*—This test is intended as a means to determine the resistance of the material to heat and flame under controlled conditions and should not be used to describe or appraise the fire hazard or fire risk under actual conditions.

8.4.3 *Procedure*—Hold a small sample (such as 10 to 20 gr) of the perlite insulation in a suitable fixture (such as 6 by 6 by 2-in. deep wire mesh basket constructed from (150 µm 100-mesh) stainless steel woven wire cloth) and positioned in direct contact with the flame of a bunsen burner for about 20 s. Sparking or ignition indicates failure to conform to the requirements of 6.1

8.4.4 *Precision and Bias*—No statement is made about either the precision or the accuracy of the small-scale fire test for determining resistance of the perlite insulation to heat and flame since the result merely states whether there is conformance to the criteria for success specified in the procedure.

8.5 *Thermal Resistance*—Tests of thermal resistance may be made in accordance with Test Method C 177 or C 518. Testing shall be done at the design density. The thermal resistance of the various types shall not be lower than the values listed in Table 1, except that the average thermal resistance of any four specimens measured in accordance with 8.5, may fall up to 5 % below the value in the table. The thermal resistance (*R*-value) shall be determined at mean temperature of 75°F (24°C) and 40°F (4°C) at design density and in accordance with the current editions of Test Methods C 177 and C 518. Report the direction of heat flow. Thermal resistance at other mean temperatures may be determined if required.

8.6 *Moisture Absorption*—The test specimen shall be a sample of approximately 50 g. Loose fill and level the sample into a sample holder 9 by 9 by 5 in. (228 by 228 by 127 mm) deep.

8.6.1 Precondition in accordance with Test Method C 177 or C 518. Conditioning shall be with minimum air movement across the sample surface. Condition at 50 ± 2 % relative humidity and 120°F (49°C) to constant weight and record. State the density of the sample conditioned to constant weight in the report of results.

8.6.2 Increase the relative humidity to 90 ± 2 %. Condition to constant weight by check-weighing at 24-h intervals. Determine the moisture pickup as a percent of conditioned weight.

8.6.3 Record percent absorption at 14 days.

8.6.4 *Precision and Bias*—This test establishes a typical property of perlite. It is an inherent characteristic. It is only intended to indicate absorption under high humidity conditions which are known to be characteristic of its usual insulation end use.

8.7 *Wickability* (Types II and IV only):

8.7.1 *Apparatus*:

8.7.1.1 *Rigid Plastic Tube*, 50 mm inside diameter by 300 mm long with a 150-µm (100-mesh) screen covering firmly fastened or adhered to the bottom.

8.7.1.2 *Compaction Plug*, 50 mm long, fitting snugly inside the sample holder to give standard compaction to the sample.

8.7.1.3 *Tubing Rack*, capable of supporting the sample tube.

8.7.1.4 *Water Immersion Tray*.

8.7.2 *Sample Preparation*:

8.7.2.1 Spoon a representative sample into the test cylinder to a level slightly below the top of the cylinder.

8.7.2.2 Compact it with the plug until a moderate resistance pressure is felt. In no event insert the compaction plug into the sample holding tube more than 24 mm.

TABLE 1 Thermal Resistance

Density, lb/ft³(kg/m³)	All Types		
	Thermal Resistance for 1- in. (0.0254-m) Thickness, h·ft²·°F/Btu (m²·K/W)		
	Thermal Resistance for 1 in. (0.0254m) Thickness, h·ft²·°F/Btu (m²·K/W)		
Mean Temp	Density lb/ft[A]Mean(kg/m³)		
Mean Temp	Density lb/ft³(kg/m³)		
	Low Temperature,° F (°C)		
	Low Temperature Applications		
40 (4)	75 (24)	105 (66-118)	7.41)
°F (°C)	2-4.1 (32–66)	4.1-7.4 (66-118)	7.4-11 (118-176)
2.0–4.1 (32.0–65.6)	4.3–3.9 (0.78–0.69)	3.7–3.3 (0.65–0.58)	3.2 (1.1–0.92)
-300 (-184)	9.1–7.7 (1.6-1.4)	7.7-6.3 (1.4-1.1)	6.3–5.2 (1.1–0.92)
-200 (-129)	6.5-5.7–1.0)	5.7–4.8 (1.0–0.85)	4.8–4.0 (0.85–0.70)
-200 (-129)	6.5-5.7 (1.1–1.0)	5.7–4.8 (1.0–0.85)	4.8–4.0 (0.85–0.70)
-100 (-73)	5.1–4.5 (0.90–0.79)	4.5–3.8 (0.79–0.67)	3.8-3.3 (0.67–0.58)
0 (18)	4.2 (0.65)	3.7–0.56)	3.2–2.8 (0.56–0.49)
0 (-18)	4.2–3.7 (0.74–0.65)	3.7–3.2 (0.65–0.56)	3.2–2.8 (0.56–0.49)
4.1–7.4 (65.6–118.4)	3.9–3.3 (0.69–0.58)	3.5-3.0 (0.62–0.53)	3.0–2.6 (0.53–0.46)
40 (4)	3.9-3.5 (0.69–0.62)	3.5-3.0 (0.62–0.53)	3.0–2.6 (0.53–0.46)
75 (24)	3.7–3.3 (0.65–0.58)	3.3–2.8 (0.58–0.49)	3.2–2.7 (0.56–0.47)
75 (24)	3.7–3.3 (0.65–0.58)	3.3–2.8 (0.58–0.49)	2.8–2.5 (0.49–0.44)
7.4–11.0 (118.4–176.0)	3.3–2.9 (0.58–0.51)	2.8–0.49)	2.4 (0.49–0.42)
100 (38)	3.6–3.2 (0.63–0.56)	3.2–2.8 (0.56–0.49)	2.8–2.4 (0.49–0.42)
	High Temperature Applications		
	3 (48)	8 (128)	11 (176)
200 (93)	2.5 (0.44)	3.0 (0.53)	2.3 (0.41)
300 (149)	1.9 (0.33)	2.5 (0.44)	2.0 (0.35)
400 (204)	1.6 (0.28)	2.1 (0.37–)	1.8 (0.32)
400 (204)	1.6 (0.28)	2.1 (0.37)	1.8 (0.32)
500 (260)	1.3 (0.23)	1.9 (0.33)	1.5 (0.26)
600 (316)	1.1 (0.19)	1.6 (0.28)	1.3 (0.23)
700 (371)	0.96 (0.17)	1.4 (0.25)	1.2 (0.21)
800 (47–)	0.4 (0.15)	1.2 (0.21)	1.0 (0.18)
800 (427)	0.84 (0.15)	1.2 (0.21)	1.0 (0.18)
1000 (538)	0.65 (0.11)	0.96 (0.17)	0.81 (0.14)
1200 (649)	0.52 (0.092)	0.76 (0.13)	0.63 (0.11)
1400 (760)	0.42 (0.074)	0.60 (0.11)	0.49 (0.086)

[A] The thermal values in this table are given at 1 in. (0.0254 m) of thickness with a gradient of 50°F (10°C). Test data that cover the thickness range from 1 to 6 in. (0.0254 to 0.1524 m) show that thermal resistance per inch of thickness is essentially linear with respect to thickness. Test values do not deviate on the low side from the value in the table by more than 5 %.

8.7.3 *Procedure*:

8.7.3.1 Place the sample tube screen end down, on a rack in the water immersion tray. The water level in the tray will be 50 mm above the bottom of the tube.

8.7.3.2 Sample shall be in this position and allowed to wick water for 5 min.

8.7.3.3 Remove the tube from the tray onto a tared 75-mm watch glass so that all water that is allowed to drain is caught by the watch glass and is included in the weight of water picked up by the sample.

8.7.3.4 Determine the weight of the water picked up by the sample in grams.

8.7.4 *Calculations*:

8.7.4.1 Report the amount of water picked up by the perlite sample through this wicking action as grams.

8.7.4.2 Report results as the mean of three independent tests.

8.7.5 *Precision and Bias*—The purpose of this test is to ascertain the resistance of the material to wicking action of water. The specified characteristic is a maximum (no range or minimum). Quantitative values for conforming products below the limit have no commercial significance.

8.8 *Combustibility* of Types I and II perlite insulation may be determined in accordance with Test Method E 136. Combustibility of Types III and IV insulation may be determined in accordance with tests on Critical Radiant Flux and Smoldering Combustion as specified in Federal Specification HH-I-515D.

8.9 *Surface Burning Characteristics* of perlite insulation may be determined in accordance with Test Method E 84.

8.10 *Dust Suppression* (Types III and IV only):

8.10.1 *Apparatus*:

8.10.1.1 *Glass Plate*, 16½ by 16½ by ¼ in. (420 by 420 by 6.4 mm).

8.10.1.2 *Clear Methacrylate Sheet Box*, open bottom, 15½ by 15½ by 19⅝ in. (400 by 400 by 500 mm) high with a hole in the center of the top 2$\frac{1}{16}$ in. (52.4 mm) in diameter.

8.10.1.3 *Plastic Tube*, 2 in. outside diameter by 1¾ in. inside diameter (50 by 45 mm), 17¾ in. long (450 mm), with a rubber washer such that the washer snugly fits the outside diameter of the plastic tube and has a larger outside diameter than the hole in the box.

8.10.1.4 *Beaker*, 2000-mL.

8.10.1.5 *Laboratory Funnel* with a minimum nozzle inside diameter of 1 in. (25.4 mm).

8.10.1.6 *Graduated Cylinder*, 100-mL.

8.10.1.7 *Small Brush*.

8.10.1.8 *Scale* capable of measuring perlite material to 0.001 g.

8.10.2 *Sample Preparation*—Spoon a representative sample into the graduated cylinder to the 1000-mL level.

8.10.3 *Procedure*:

8.10.3.1 Place the glass plate flat on a suitable work surface.

8.10.3.2 Place the 2000-mL beaker in the exact center of the glass plate.

8.10.3.3 Place the plastic box on the glass plate such that the box is centered on the plate and hole in top of the box is centered directly over the 2000-mL beaker.

8.10.3.4 Insert the plastic pipe into the hole in the top of the box such that it protrudes down into the box such that the clear vertical distance from the bottom of the tube to the top of the 2000-mL beaker is 1³⁄₁₆ in. (30 mm). The tube is supported in the vertical position by the rubber washer.

8.10.3.5 Place the laboratory funnel into the plastic tube.

8.10.3.6 Pour 1000 mL of test material into the funnel such that it empties of all material in 10 s. It is the intent to have a uniform stream of material falling into the box for
10 s.

8.10.3.7 After all visible material has settled onto the glass plate, carefully remove the plastic box and gently sweep the material that has collected on the glass plate into a pile, remove it, and determine its weight.

8.10.4 *Calculations*:

8.10.4.1 Report the amount of test material in milligrams as "milligrams collected."

8.10.4.2 Report results as the average of five or more independent tests with no single reading over 100 mg with separate samples taken from the same source.

8.10.5 *Precision and Bias*—The single-specimen, single-operator, single-day precision is a standard deviation of ±0.02 g (1S) maximum for the dust-suppressed material over a range from 0.01 to 0.08 g as defined in Practice E 177.

9. Inspection

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

10. Packaging and Marking

10.1 *Packaging*—Unless otherwise specified, the insulation shall be packed in the manufacturer's standard commercial container. The insulation shall be packed to ensure carrier acceptance and safe delivery at destination in containers complying with the rules and regulations applicable to the mode of transportation.

10.2 *Marking*—Shipping containers shall be marked with the name of the insulation, minimum weight of container, and the name of the manufacturer. For residential insulation, a chart shall also be affixed or printed on the container listing the minimum thickness, maximum net coverage area, and maximum weight per square foot at minimum *R* values of 11, 19, and 22. In addition to this chart, the following statements must be added: 1. "*R* means resistance to heat flow. The higher the *R*-value, the greater the insulating power." 2. "To get the marked *R*-value, it is essential that this insulation be installed properly. If you do it yourself, follow the instructions carefully."

11. Health and Safety Precautions

11.1 *Preinstallation*—The insulation material should be handled and stored in accordance with manufacturer's instructions. It should be kept dry and free of extraneous materials.

11.2 *Installation*:

11.2.1 The insulating material should be poured into the spaces and cavities to be insulated in a manner that minimizes free-fall and impact. This will minimize crushing and breakdown of insulation particles and unnecessary formation of dust.

11.2.2 Perlite loose fill insulation that may be installed in confined, poorly ventilated attic spaces may generate a buildup of airborne nuisance dust. Avoid creating this nuisance dust. The use of respiratory and eye protection may be necessary in some applications. Refer to manufacturer's instructions regarding recommended installation practices.

12. Keywords

12.1 dust suppression; insulation; loose fill; perlite; water repellency