Designation: C592 – 16

Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)[1]

This standard is issued under the fixed designation C592; 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 U.S. Department of Defense.

1. Scope

1.1 This specification covers the composition, dimensions, and physical properties of mineral fiber (rock, slag, or glass) metal mesh covered and industrial type blanket and blanket-type pipe insulation (typically on 24 in. (610 mm) diameters or larger)). Its use is for cooled surfaces at temperatures operating below ambient to 0°F (−18°C) and on heated surfaces on expansion joints to large diameter vessels and tanks operating at temperatures up to 1200°F (649°C). Specific applications outside the actual use temperatures shall be agreed upon between the manufacturer and purchaser.

1.2 For satisfactory performance, properly installed protective vapor retarders or barriers shall be used on below ambient temperature applications to reduce movement of moisture/water vapor through or around the insulation towards the colder surface. Failure to use a vapor retarder can lead to insulation and system damage. Refer to Practice C921 to aid material selection. Although vapor retarder properties are not part of this specification, properties required in Specification C1136 are pertinent to applications or performance.

1.3 The orientation of the fibers within the blanket is primarily parallel to the heated surface. This specification does not cover fabricated pipe and tank wrap insulation where the insulation has been cut and fabricated to provide fiber orientation that is perpendicular to the heated surface.

1.4 This standard does not purport to provide the performance requirements of hourly-rated fire systems. Consult the manufacturer for the appropriate system.

1.5 See Supplementary Requirements for modifications to sections in this standard only when specified by purchaser in the contract or order from the U.S. Military specifications utilized by the U.S. Department of Defense, Department of the Navy, and the Naval Systems Command.

1.6 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.

1.7 *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 requirements 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

C356 Test Method for Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat

C390 Practice for Sampling and Acceptance of Thermal Insulation Lots

C411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

C447 Practice for Estimating the Maximum Use Temperature of Thermal Insulations

C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C665 Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

C680 Practice for Estimate of the Heat Gain or Loss and the Surface Temperatures of Insulated Flat, Cylindrical, and Spherical Systems by Use of Computer Programs

C795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel

[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 May 1, 2016. Published June 2016. Originally approved in 1966. Last previous edition approved in 2013 as C592 – 13. DOI: 10.1520/C0592-16.

[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.

TABLE 1 Physical Requirements

Properties	Type I	Type II	Type III	Type IV[A]
Maximum use temperature °F (°C) (see 6.2.1) (Excluding metal-mesh all facings and metal tie- wires/stitching)	850 (454)	1200 (649)	1200 (649)	1200 (649)
Apparent Thermal Conductivity[B] (Excluding all facings and metal tie-wires/stitching) max Btu, in./h ft^2 °F (W/m K) Mean Temperature, °F (°C)				
25 (–4)	0.21 (0.030)	0.21 (0.030)	0.23 (0.033)	0.23 (0.033)
75 (24)	0.25 (0.036)	0.25 (0.036)	0.24 (0.035)	0.24 (0.035)
100 (38)	0.27 (0.039)	0.27 (0.039)	0.26 (0.038)	0.26 (0.038)
200 (93)	0.34 (0.049)	0.34 (0.049)	0.31 (0.045)	0.31 (0.045)
300 (149)	0.43 (0.062)	0.42 (0.060)	0.37 (0.053)	0.37 (0.053)
400 (204)	0.55 (0.079)	0.53 (0.076)	0.44 (0.063)	0.44 (0.063)
500 (260)	0.70 (0.101)	0.64 (0.092)	0.52 (0.075)	0.52 (0.075)
600 (316)		0.75 (0.108)	0.60 (0.087)	0.60 (0.087)
700 (371)		0.86 (0.124)	0.70 (0.101)	0.70 (0.101)
Linear Shrinkage, max % at maximum use temperature	4.0	4.0	4.0	4.0
Water Vapor Sorption,[C] max % by weight	5.0	5.0	1.25	1.25
Surface Burning Characteristics				
Maximum-flame spread index	25	25	25	25
Maximum smoke developed index	50	50	50	50
Density maximum,[D] lb/ft^3 (kg/m^3)	10 (160)	12 (192)	8 (128)	8 (128)

[A] Type IV is for the Industrial Type, non-metal-mesh covered blankets only.
[B] Values for apparent thermal conductivity are for insulation and do not include mesh and wire through insulation thickness. Therefore, Practice C680 or other heat loss analysis using these data are not possible without accounting for heat losses through attaching media.
[C] Some water sorption characteristics will change after the product is subjected to elevated temperatures within normal service conditions.
[D] The maximum density specified is for the weight design purpose only and includes weight for the facings. Additional density requirements including the density for the blanket without facing(s) are permitted to be specified by agreement between the purchaser and the manufacturer or seller.

C921 Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
C1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation
C1104/C1104M Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation
C1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
C1136 Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
C1304 Test Method for Assessing the Odor Emission of Thermal Insulation Materials
C1335 Test Method for Measuring Non-Fibrous Content of Man-Made Rock and Slag Mineral Fiber Insulation
C1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings
C1617 Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals
E84 Test Method for Surface Burning Characteristics of Building Materials
E136 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C

2.2 *Other Document:*
CAN/ULC-S102 Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies[3]

3. Terminology

3.1 Terminology C168 shall be the terms used in this specification.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *mean temperature*—the sum of the cold surface temperature and the hot surface temperature divided by two.

3.2.2 *metal-mesh covered blanket*—mineral fiber thermal insulation held together by metal-mesh facings on one or both sides with heat-resistant metal ties attached through the blanket from one face to the other.

3.2.3 *metal-mesh covered blanket-type pipe*—mineral fiber thermal insulation sized to fit around a large Nominal Pipe Size (NPS) and held together by metal-mesh facings on one or both sides with heat-resistant metal ties attached through the blanket from one face to the other.

3.2.4 *industrial type (faced and unfaced) blanket*—mineral fiber thermal insulation without a metal mesh covering.

[3] Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, http://www.ul.com.

3.2.5 *industrial type (faced and unfaced) blanket-type pipe*—mineral fiber thermal insulation without a metal mesh covering and sized to fit around a large Nominal Pipe Sizes (NPS)

4. Classification

4.1 Mineral fiber blanket insulation covered by this specification shall be classified into the four types shown in Table 1. TYPE I, II, and III are classified as metal-mesh covered blankets and TYPE IV is classified as industrial type, non-metal-mesh covered (faced & unfaced) blanket. The classification is based upon the maximum use temperature and apparent thermal conductivity.

5. Ordering Information

5.1 The type, dimensions, maximum use temperature, and metal mesh covering or facings for one or both sides, or a combination thereof, shall be specified by the purchaser. A product certification shall be specified in the purchase order.

6. Materials and Manufacture

6.1 *Composition*—Mineral fiber blanket shall be composed of rock, slag, or glass processed from the molten state into fibrous form, bonded with or without an organic binder; the metal-mesh covered blanket is secured with tie-wires or metal stitching. Asbestos shall not be used as an ingredient or component part of the product.

6.2 *Facings:*

6.2.1 Types of facings for one or both sides of blanket units shall be specified. When both sides are to be faced, units are permitted to have the same or different types on the two sides.

6.2.1.1 The user of this specification is advised that the maximum use temperature of some facings and adhesives will be lower than the maximum use temperature of the insulation. For example, usually galvanized hexagonal wire-woven netting and tie wires or stitching perform well under continuous exposure to temperatures up to 392°F (200°C). Exposure to temperatures above this limit will cause the outer free zinc layer to peel. Though there are potential or occasional concerns for corrosion conditions at various temperatures, galvanized wire, stitching, or facings are not recommended for temperatures above 500°F (260°C). In addition, the user of this specification shall ensure that sufficient insulation thickness is installed so that none of the accessory items (facings, adhesive, coatings, and lagging) are exposed to temperatures above their maximum use temperature. As a general rule, Practice C680 shall be used to determine surface temperatures.)

6.2.2 *Standard Types of Metal Mesh Used as Facings:*

6.2.2.1 Woven netting, No. 20 to 22 gage (0.88 to 0.73 mm) diameter, galvanized wire mesh, 1 in. (25 mm) hexagonal shaped.

6.2.2.2 Woven netting, nonferrous No. 20 to 22 gage (0.82 to 0.64 mm) diameter, 300 series stainless steel wire mesh, 1 in. (25 mm) hexagonal shaped.

6.2.2.3 Stucco expanded metal lath, (painted finish, not flattened, not galvanized) having 1.5 in. (38 mm) diamond-shaped openings, No. 18 gage (1.2 mm) thickness, weighing 1.8 lb/yd^2 (1010 g/m^2).

6.2.2.4 Expanded metal lath, (painted finish, not flattened, not galvanized) having diamond-shaped openings, weighing 2.5 lb/yd^2 (1400 g/m^2).

6.2.3 Other kinds or compositions of facings are permitted to be specified.

6.3 *Manufacture/Fabrication:*

6.3.1 Metal mesh facing(s) shall be secured to the insulation face on one or both side(s) with minimum (diameter) No. 28 gage (0.32 mm), 300 Series alloy, non-ferrous stainless steel tie wires or stitching no greater than 12 in. (305 mm) apart passing vertically through the blanket. Spacing (attachment pattern) for vertical steel tie wires and stitching must include rows within 2 in. (51 mm) from all edges of the blanket.

6.3.2 Minimum (diameter) No. 28 gage (0.41 mm) galvanized steel tie wires or stitching is permitted to be used for securement with galvanized steel facings.

6.4 Any non-metal mesh-facings for industrial type blanket and blanket-type pipe shall be adhered to the insulation face on one or both side(s).

7. Physical Requirements

7.1 *Handling and Transporting*—Each piece of blanket insulation shall be coherent to permit handling/transportation and installation as a unit.

7.2 The blanket insulation type shall conform to the following requirements in Table 1: maximum use temperature, density (for weight design purposes only), apparent thermal conductivity, water vapor sorption, and surface burning characteristics.

7.3 *Odor Emission*—A detectable odor of objectionable nature recorded by more than two of the five panel members shall constitute rejection of the material when tested in accordance with 11.6.

7.4 *Corrosiveness to Steel, Copper, Aluminum*—When tested and evaluated in accordance with Specification C665 in 11.7, the corrosion resulting from the unfaced insulation blanket in contact with metal plates shall be judged to be no greater than comparative plates in contact with sterile cotton.

7.4.1 The use of Practice C1617 is an acceptable alternative to the test procedure in 7.3 for corrosiveness to steel with the mass loss corrosion rate of the steel test sample exposed to the unfaced insulation extract not to exceed that of the 5 ppm chloride solution.

7.5 *Non-Fibrous (Shot) Content*—The averaged maximum shot content of mineral fiber rock or slag type products shall not exceed 25 % by weight as defined in 11.3.

7.6 *Maximum Use Temperature*—When tested in accordance with 11.1, the blanket insulation shall not warp, flame, or glow during hot surface exposure. No evidence of melting or fiber degradation shall be evident upon post test inspection.

7.7 *Maximum Exothermic Temperature*—When tested in accordance with 11.1, the internal temperature shall not at any time exceed the hot surface temperature by more than 200°F (93.3°C). The 200°F (93.3°C) criterion applies during heat-up as well as steady state conditions. Exceeding this limit constitutes noncompliance to specification.

7.8 *Non-Combustibility*—When the blanket insulation, with all facings removed, is tested in accordance with 11.10, the recorded temperature rise shall not exceed more than 54°F (30°C) with no flaming and weight loss exceeding 5 %.

7.9 *Stress Corrosion to Austenitic Stainless Steel*—When specified, shall be tested and evaluated in accordance with 11.11.

7.10 *Fungi Resistance*—Shall be tested in accordance with 11.12; growth no greater than that on a comparative item (white birch wood) shall be considered to have passed the test method criteria.

8. Dimensions and Permissible Variations

8.1 *Dimensions:*

8.1.1 Standard sizes of metal-mesh blanket insulation and non-metal-mesh industrial type blanket insulation shall be as follows:

Standard sizes of metal-mesh blanket insulation		
Length	=	48 in. (1219 mm) and 96 in. (2438 mm) (except for Nominal Pipe Sizes (NPS) system
Width	=	24 in. (610 mm) and 36 in. (914 mm)
Thickness	=	1 to 6 in. (25 mm to 152 mm)[A] in ½ in. (13 mm) increments
Standard sizes of non-metal-mesh industrial type blanket insulation		
Length	=	48 in. (1219 mm), 96 in. (2438 mm) and up to 25 ft. (7.62 m) (except for Nominal Pipe Sizes (NPS) system)
Width	=	24 in. (610 mm), 36 in. (914 mm), and 48 in. (1219 mm)
Thickness	=	1 to 6 in. (25 mm to 152 mm)[B] in ½ in. (13 mm) increments

[A] It is acceptable for thickness over 2 in. (51 mm) to be composed of two or more blankets plied together to establish total thickness before facings applied.
[B] Consult manufacturer for maximum available thickness.

8.2 *Dimensional Tolerances*—The average measured length, width, and thickness shall differ from the standard dimensions from the manufacturer by not more than the following:

		Blanket	Blanket-Type Pipe	Blanket-Type Roll
Length	=	± ½ in. (13 mm)	± ¼ in. (6 mm)	-0 in., excess permitted
Width	=	± ¼ in. (6 mm)	Not applicable	±½ in. (12.7 mm)
Thickness	=	± ¼ in. (6 mm), −⅛ in. (3 mm)	+¼ in. (6 mm), −⅛ in. (3 mm)	-⅛ in. (3mm), (excess permitted)

8.2.1 *Pipe Diameters (Fit and Closure)*—When fitted around the appropriate size pipe, by banding on 9-in. (229-mm) centers, the longitudinal seams on both sides of the pipe insulation shall close along the entire length of the section or piece.

9. Workmanship

9.1 The insulation blanket shall have good workmanship and shall not have defects that adversely affect its installation and performance qualities.

10. Sampling

10.1 Inspection and qualification of the insulation shall be in accordance with Practice C390 or as otherwise specified in the purchase order or contract as agreed upon between the purchaser, supplier, or the manufacturer, or a combination thereof.

11. Test Methods

11.1 *Maximum Use and Exothermic Temperature Rise*—The insulation blanket without any facings shall be tested in accordance with Test Method C411 and the hot surface performance section of Practice C447 at the maximum use temperature of the insulation and at the maximum recommended thickness stipulated by the manufacturer for that temperature. The test surface shall be at the intended surface temperature when test begins. No special requirements for heat up shall be specified by the manufacturer.

11.2 *Density:*

11.2.1 The thickness and density of insulation shall be tested in accordance with Test Methods C167.

11.2.2 The maximum density of a rock, slag or glass type of blanket insulation shall not exceed that shown in Table 1. When density is part of the purchase contract, the delivered product density shall be calculated on the basis of single package units excluding the container and facing weights and with a tolerance of not more than –10 % on the individual container contents.

11.3 *Non-Fibrous (Shot) Content:*

11.3.1 The maximum non-fibrous (shot) content that would be retained on all screens (sieves) up to and including 100-mesh (150 µm) screen (sieve) as determined by the test method and calculation procedure in Test Method C1335.

11.3.2 A minimum of three specimens per lot (shipment) shall determine the averaged non-fibrous (shot) content. The manufacturer shall furnish certification of the shot content of the delivered product if so specified at time of purchase.

11.4 *Apparent Thermal Conductivity:*

11.4.1 The thermal conductivity as a function of temperature for the representative specimens shall be determined with data obtained from a series of thermal tests utilizing Test Methods C177, C518, or C1114 as appropriate for the material under study. Specimen shall be tested unfaced and at a maximum thickness of 2 in. (51 mm).

11.4.1.1 Test Method C518 shall not be used at temperatures or resistances other than those in the range of the calibration.

11.4.1.2 Test Method C1114 shall not be used at temperatures or resistance ranges other than those with comparable results to Test Method C177.

11.4.1.3 Mineral fiber blanket-type insulations for pipes are typically used at 24-in. (610-mm) or larger diameter surfaces. Thermal calculations shall be based on a flat surface.

11.4.2 The test method selected shall have proven correlation with Test Method C177 over the temperature range of conditions used. In cases of dispute, Test Method C177 shall be the final authority for material having flat geometry.

11.4.3 Practice C1058 shall be used to obtain recommended test temperature combinations for testing purposes.

11.4.4 As specified in Practice C1045, the range of test conditions must include at least one test where the hot surface temperature is greater than, or equal to, the hot limit of the temperature range of desired data and at least one test where the cold surface temperature is less than, or equal to, the cold limit of the temperature range desired. Additional tests, at least two, shall be distributed somewhat evenly over the rest of the temperature range.

11.4.5 Conduct final analysis of the thermal data in accordance with Practice C1045 to generate a thermal conductivity versus temperature relationship for the specimen.

11.4.6 The final step of Practice C1045 analysis would be to calculate the thermal conductivity using the equations generated at a set of mean temperatures for comparison to the specification.

11.4.6.1 While it is recommended that the specification data be presented as thermal conductivity versus temperature, several existing specifications shall contain mean temperature data from tests conducted at specific hot and cold surface temperatures. In these cases, the thermal conductivity as a function of temperature from the Practice C1045 analysis will provide different results. To insure that the data are compatible, a Practice C680 analysis, using the thermal conductivity versus temperature relationship from Practice C1045 and the specific hot and cold surface temperatures, is required to determine the effective thermal conductivity for comparison to the specification requirements.

11.5 *Surface Burning Characteristics*—Test the surface burning characteristics in accordance with Test Method E84. For Canada, test in accordance with Test Method CAN/ULC-S102. When the referenced Canadian document in this standard is referred to in applicable Canadian building codes, the editions, referenced by those building codes; shall govern. The test shall be performed with any facing in place, if facing is intended to be the end product. Tests for unfaced mineral fiber blankets are allowed provided the facings are constructed with inorganic materials and contain no organic adhesives.

11.6 *Odor Emission*—The insulation shall be tested in accordance with Test Method C1304.

11.7 *Corrosiveness to Steel, Copper, and Aluminum*—The insulation shall be tested in accordance with the corrosiveness method of Specification C665 or Practice C1617.

11.8 *Water Vapor Sorption*—The insulation shall be tested in accordance with Test Method C1104/C1104M for determining vapor sorption of unfaced mineral fiber insulation.

11.9 *Linear Shrinkage*—The insulation shall be tested in accordance with method described in Test Method C356.

11.10 *Non-combustibility*—Shall be determined with passing the requirements of Test Method E136.

11.11 *Stress Corrosion Performance for Use on Austenitic Stainless Steel*—When specified, test in accordance with Specification C795. All test specimens must include the facing and adhesive if intended to be the end product.

11.12 *Fungi Resistance*—Test in accordance with Test Method C1338 using a white birch tongue depressor as the comparative item.

12. Qualification Requirements

12.1 The following requirements shall be employed for the purpose of initial material or product qualification:

12.1.1 Maximum use and exothermic temperatures,
12.1.2 Apparent thermal conductivity,
12.1.3 Non-combustibility,
12.1.4 Water vapor sorption,
12.1.5 Odor emission,
12.1.6 Surface burning characteristics,
12.1.7 Corrosiveness,
12.1.8 Shot content,
12.1.9 Flexibility, and
12.1.10 Fungi resistance.

13. Inspection

13.1 The following requirements are employed for the purpose of acceptance sampling of lots or shipments of qualified insulation:

13.1.1 This test does not address the effects of thermal bridging due to the effect of any tie wire system,

13.1.2 Density (when specified) (shall be calculated in accordance with 11.2.2),

13.1.3 Dimensional tolerances,

13.1.4 Compliance with facing type specification, facing attachment, and

13.1.5 Workmanship.

14. Rejection

14.1 Failure to conform to the requirements in this specification shall constitute cause for rejection. Rejection shall be reported to the manufacturer or the supplier promptly and in writing. The manufacturer and supplier have the right to verify the results causing the rejection and inspect the rejected products.

15. Certification

15.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

16. Packaging and Marking

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

16.2 *Marking*—Unless otherwise specified, each container shall be plainly marked as follows:

16.2.1 *Blanket Insulation*—Manufacturer name, address and phone number of manufacturer, product name, type, description of facing(s), quantity in square feet (meters) and number of pieces, nominal dimensions, manufacturers lot or date code, and identification of the material in the container.

16.2.2 *Pipe Insulation*—Manufacturer name, address and phone number of manufacturer, product name, type, description of facing(s), quantity in linear feet (meters) and number of

pieces, nominal dimensions including pipe size if applicable, manufacturers lot or date code, and identification of the material in the container.

16.3 When specified in the purchase order or contract, each container shall be marked with the appropriate Specification C592 type.

17. Keywords

17.1 blanket insulation; blanket-type pipe insulation; facing; metal-mesh covered; mineral fiber insulation; stitching; tie wires; vibration resistance

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by purchaser in the contract or order for the U.S. Military specifications utilized by the U.S. Department of Defense, Department of Navy and Naval Sea Systems Command.

S1. Add 1.8 to Section 1, Scope:

S1.1 1.8 The Supplementary Requirements and exceptions are for thermal insulation materials on piping, machinery, equipment for non-nuclear shipboard applications, and not applicable on nuclear submarines.

S2. Amend and Add subsections to 6.1 Composition:

S2.1 *Amend last sentence 6.1*—Asbestos and ceramic (refractory) fibers shall not be used as an ingredient or component part of the product.

S2.2 *Add* 6.1.1 *Binder*—The organic binder shall not exceed 1.5 % by mass of the total mineral fiber blanket mass less any facings, adhesives, and securement wires.

S3. Amend 6.1 Standard Types of Metal Mesh Used as Facings:

S3.1 *Delete* 6.2.2.1.

S4. Amend 6.3 Manufacture/Fabrication:

S4.1 6.3.1 The blanket insulation shall be secured between the wire mesh facings, or members by 300 series stainless steel tiewire or stitching no greater than 7 in. (178 mm) apart passing vertically through the blanket. Spacing for vertical wires must include rows within 1 in. (25 mm) from all face edges of the blanket.

S4.2 *Replace* 6.3.2.

S4.2.1 6.3.2 Type IV blanket shall not be secured between any wire mesh facings, tie-wires, or stitching. All other physical properties shall be identical to Type III as shown in Table 1.

S5. Amend Section 7, Physical Requirements:

S5.1 *Replace* 7.7.

S5.2 7.7 *Maximum Exothermic Temperature*—When tested in accordance with 11.1, the internal temperature shall not at any time exceed the hot surface temperature by more than 100°F (55.5°C). The 100°F (55.5°C) criterion applies during heat-up as well as steady state conditions. Exceeding this limit constitutes noncompliance to specification.

S6. Add 7.11 Resistance to Vibration to Section 7, Physical Requirements:

S6.1 7.11 *Resistance to Vibration*—The insulation blanket without supporting members or tie wires, or both, shall not sag, settle, or shake down beyond criteria when tested in accordance within Supplementary Requirements 11.13 *Resistance to Vibration*.

S6.2 11.1 *Rejection Criteria*:

S6.3 11.1.1 Sag difference of 3 in. (76 mm) between before the test specimen and after the same test specimen has been heat treated/vibrated.

S6.4 11.1.2 Mass loss difference of 15 % between before the tested specimen and after the same test specimen has been heat treated/vibrated.

S6.5 11.1.3 Detrimental heat/vibration affects the overall physical characteristics of the blanket when comparing to a test specimen. Obvious observations, for example, are the bolts cutting through the insulation material which cause large quantities of fiber or insulation blanket pieces to drop off the test stand holder during or after the test.

S7. Replace 11.8 Water Vapor Sorption:

S7.1 11.8 *Water Vapor Sorption*—The insulation shall be tested in accordance with Test Method C1104/C1104M for determining vapor sorption of unfaced mineral fiber insulation. The moisture absorption percent will be determined after 6 h at 120°F (49°C) and 90 % relative humidity.

S8. Add 11.13 to Section 11, Test Methods:

S8.1 11.13 *Resistance to Vibration:*

11.13.1 *Scope*—This is a method of determining the sag, settlement, or shake down of the mineral fiber blanket insulation without the attachment of any tie wires or metal mesh coverings (facings). The comparison is between the measured mass and sag of the sample material before applying to heating apparatus; heating to a designated temperature; removing sample to a vibration machine; vibrating to a designated frequency, amplitude, and duration; removal from vibrating machine; and measuring its change in mass and or sag.

11.13.2 *Significance and Use*—It is possible that vibration after heating will create excessive sagging or loss of structural integrity of the insulation, adversely affecting overall thermal performance.

FIG. S8.1 Electrically Heated Hot-Plate Furnace

11.13.3 *Apparatus:*

11.13.3.1 Electrically heated hot-plate furnace capable to heat uniformly one side of a 24 in. (610 mm) by 36 in. (914 mm) panel at controlled and maintain temperatures of 750 ± 10°F (400 ± 12°C) is shown in Fig. S8.1.

11.13.3.2 *Vibration Machine*, capable of timed end-plane vibrations at 12 Hz and 0.131 in. (3 mm) amplitude (total vertical displacement 0.131 in. (3 mm)) is shown in the following Fig. S8.2.

11.13.3.3 Balance Scale, capable of weighing 4 in. (102 mm) by 24 in. (610 mm) by 36 in. (914 mm) sample up to 24 lb ± 0.7 oz (10.9 kg ± 1 g).

11.13.3.4 Ruler capable of measuring up to 36 in. (914 mm) with ±1⁄32 in. (±1 mm) tolerance.

11.13.4 *Specimens*—Cut with a knife one test specimen piece (representative thickness by 24 in. (610 mm) by 36 in. (914 mm) of mineral fiber blanket without tie wires, facings, etc. The mass of the specimen shall be determined to within ± 1 gram and the density shall be calculated for identity purposes if multiply samples are to be tested. The dimensions of each specimen shall be determined by averaging 10 measurements to with in 1⁄32 in. (1 mm) in each dimension. The same test specimen shall be compared before and after heat treating/vibration.

11.13.5 *Procedure for Test Specimen:*

11.13.5.1 The test specimen shall be placed on a rigid horizontal surface with 6 in. (152 mm) of the long dimension of the insulation extending beyond the edge of the surface. The vertical distance from the horizontal surface to the bottom on the insulation furthest from the edge shall be measured to ±1⁄32 in. (±1 mm) at ten equally spaced locations. The specimen shall be turned over and the sag measurements repeated. The sag measurements shall be repeated on the opposite end of the specimen to provide four each "sag" average lengths.

11.13.5.2 The measurements shall be completed within 5 to 30 min after the specimen is positioned. The average of the 40 measurements shall be identified as the control specimen sag length.

11.13.5.3 Record the following measurements for comparison:

Measurement Descriptions		Recorded Measurements
Mass of specimen before heating and vibration	=	
Average 10 Sag, end up; before	=	
Average 10 Sag, end down; before	=	
Average 10 Sag, other end up; before	=	
Average 10 Sag, other end down; before	=	
Test specimen "sag" average lengths	=	
Mass of specimen after heating and vibration	=	
Average 10 Sag, end up; after	=	

FIG. S8.2 Vibration Machine

Average 10 Sag, end down; after	=
Average 10 Sag, other end up; after	=
Average 10 Sag, other end down; after	=
Any pertinent unusual observation	>>>

11.13.6 *Procedure for Heat and Vibration:*

11.13.6.1 Place test specimen on the hot-plate furnace surface. Subject one face (bottom side) of the specimen to the following time temperature schedule heat-up. Expose the top face to ambient room temperature.

Ramp Time	Temperature
0–10 min	Ramp from room temperature to 250°F (121°C)
10–20 min	Ramp from 250°F (121°C) to 500°F (260°C)
20–30min	Ramp from 500°F (260°C) to 750°F (399°C)
30–300 min	Hold at 750°F (399°C)
After 300 (±5) min	Turn off heat and allow to cool to room temperature for 17 to 24 h

11.13.6.2 Remove specimen from furnace taking particular care not to drop or lose any blanket insulation.

11.13.6.3 After the heat treated specimen has been cooled significantly to handle, horizontally move the blanket insulation to the horizontal mounting holder on the vibration machine. Impale the heat treated blanket with the heated side of the blanket toward the removed horizontal vibration holder on six equally spaced ⅜ in. (10 mm) diameter bolts and fasten with 1 in. (25 mm) washers on the outside face/surface of the blanket material. Attached the vibration holder with the attached blanket insulation in a vertical configuration on to the vibration machine.

11.13.6.4 Operate vibration machine for 6 h at 12 Hz and amplitude total displacement 0.131 in. (3 mm).

11.13.6.5 During Vibration, make note of any pertinent observation.

11.13.6.6 After vibration time has expired, removed the holder with the pinned blanket insulation from the vibration machine and lay the flat side (insulation on upper side) of holder horizontally on the table. Remove the 1 in. (25 mm) washer and carefully remove the "heated/vibrated" specimen for weighing and sag testing.

11.13.6.7 Move control/vibrated test specimen back to the original horizontal surface referenced in paragraph 11.13.5.1 and perform the total sag testing procedures per 11.13.5.1 through 11.13.5.3.

11.13.7 *Calculations:*

11.13.7.1 Calculate the sag difference(s) as follows:

$$S_c - S_{hv} = S_{dhv}$$

where:

S_c = average 40 measurements of sag on the control specimen,
S_{hv} = average 40 measurements of sag on the heat/vibrated specimen
S_{dhv} = total sag difference, between test specimen and heated/vibrated specimen.

11.13.7.2 Calculate mass loss differences in percent as follows:

$$\frac{W_c - W_{hv}}{W_c} = (P_{dhv})\ \%$$

where:

W_c = mass of test specimen,
W_{hv} = mass of heat/vibrated specimen,
P_{dhv} = percent difference between test specimen and heated/vibrated specimen.

11.13.8 *Precision and Bias:*

11.13.8.1 *Precision*—It is not possible to specify the precision of the procedure in 11.13 Resistance to Vibration because the only test data and details for 28 mineral fiber high temperature insulation specimens were provided by Tennessee Technological University for the Naval Ship Systems Engineering Station. This test research report by Dr. David W. Yarbrough has been filed at ASTM International Headquarters.

11.13.8.2 *Bias*—No information can be presented on the bias of the procedure in 11.13 *Resistance to Vibration* because no material having an acceptable reference value is available.