FILE NAME: Keene (KNE)

DATE: 0000

DOC#: KNE028

DOCUMENT DESCRIPTION: Draft of Federal Specs for Insulation - Thermal, Magnesia, Elock, Pipe & Cement

USAA 620100

NOTE: This draft, dated 31 May 1955, prepared by the Technical Committee of The Magnesia Insulation Manufacturers Association, has not been approved by the Bureau of Federal Supply and is subject to modification. DO NOT USE FOR PROCUREMENT PURPOSES.

1955

SUPERSEDING
HH-M-61a
Amendment-2
4 December 1947

FEDERAL SPECIFICATION FOR INSULATION: THERMAL, MAGNESIA, BLOCK, PIPE AND CEMENT

1. SCOPE AND CLASSIFICATION

1.1 Scope.- This specification covers requirements for magnesia block, pipe and cement thermal insulation, which shall be satisfactory for use on surfaces at temperatures up to 600°F.

1.2 Classification.- Magnesia thermal insulation covered by this specification shall be furnished in one grade only, and in the following types and classes, as specified.

Type I - Block

Class 1 - Flat Block.

Class 2 - Curved Block.

Type II - Pipe

Type III - Cement

2. APPLICABLE DOCUMENTS

2.1 The following specifications, of the issue in effect on

date of invitation for bids, form a part of this specification.

SPECIFICATIONS

ASTM SPECIFICATIONS

ASTM-C165 - Compressive Strength of preformed block type thermal insulation, standard method of test for.

ASTM-C177 - Thermal conductivity of materials by means of the guarded hot plate, standard method of test for.

ASTM-C302 - Density of preformed pipe covering - type thermal insulation, tentative method of test for.

ASTM-C303 - Density of preformed block type thermal insulation, tentative method of test for.

ASTM-C335 - Thermal conductivity of pipe insulation, tentative method of test for.

(Copies of ASTM Specifications may be purchased from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania.)

3. REQUIREMENTS

3.1 Material.- The Magnesia thermal insulation materials covered by this specification shall be composed of heat resisting compounds suitable for the temperature conditions and the purpose intended.

3.2 Chemical Requirements.- The thermal insulation materials covered by this specification shall contain not less than 85 per cent of hydrated magnesium carbonate ($4MgCO_3Mg(OH)_2 \cdot 5H_2O$) rein-

forced with mineral fiber. The mixture of the magnesia and the mineral fiber shall be homogeneous throughout.

3.3 Physical Requirements.- The magnesia block and pipe thermal insulation furnished under this specification shall conform to the respective physical requirements prescribed in Table I.

Table I - Physical Requirements

Characteristics	Method of Test, Paragraph	Requirements
Density, Average, lbs./cu.ft., Maximum	4.5.3	14.0
Thermal Conductivity, Average,	4.5.4	
B.t.u. in./hr./sq.ft./°F. maximum at mean temperatures of:		
200° F.		0.48
300° F.		0.51
400° F.		0.53
(2) Flexural Strength, Average, lbs./sq.in., Min	4.5.5	(1)
(2) Compressive Strength, Average, lbs./sq.in., at 10% Reduction in Thickness, Min.	4.5.6	50.0
Linear Shrinkage, Average, Percent, Max.	4.5.7	2.0

(1) Three times density (lbs. per cu. ft.) of Sample Tested.
(2) If flexural strength or compressive strength values are required for magnesia pipe thermal insulation, approximate values may be secured by testing block from the same production run as the pipe insulation.

3.4 Form and Dimensions.-

3.4.1 Type I - Blocks.-

3.4.1.1 Type I - Class 1.- Flat blocks shall be furnished in rectangular pieces, not less than 6 inches wide, 18 inches or 36 inches long, and 1, 1-1/2, 2, 2-1/2 and 3 inches thick, as specified.

3.4.1.2 Type I - Class 2.- Curved blocks shall be furnished curved to inside radii of over 16½ inches, not less than 6 inches wide, 36 inches long and 1-1/2, 2, 2-1/2 and 3 inches thick, as specified.

3.4.2 Type II - Pipe insulation shall be supplied as semi-cylindrical sections, or as curved segments 36 inches long to properly fit standard pipe sizes. The thicknesses of Type II pipe insulation furnished for the various sizes of pipe shall be as shown in Table II.

Table II, (a)

Insulation Thickness - Copper Tubing

Copper Tubing Size		Nominal 1 inch thick
Nominal	O.D	Actual Thickness
inches	inches	inches
3/8	.500	7/8
1/2	.625	1-3/32
3/4	.875	1
1	1.125	7/8
1-1/4	1.375	1-1/16
1-1/2	1.625	15/16
2	2.125	15/16
2-1/2	2.625	15/16
3	3.125	15/16

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Table II, (b)

Insulation Thickness - Iron Pipe.

(Table II, (b), same as MIL-I-2761B)

NOTE: (1) On 7, 8, 11 and 15 inch pipe sizes 3 inch thick pipe insulation may be furnished by the supplier in lieu of the 2-1/2 inch thick pipe insulation specified.

3.4.2.1 - Pipe insulation for sizes up to and including 10 inches shall be furnished in sections. Pipe insulation for sizes larger than 10 inches shall be furnished in curved segments or sections.

3.4.2.2 - Pipe insulation may be furnished in two layers to form total required thickness. Sections may be furnished for all sizes. Where two layers are furnished, the inner layer for sizes larger than 12 inches and the outer layer for sizes larger than 10 inches may be furnished in curved segments.

3.4.2.3 - Sectional pipe insulation for nominal pipe sizes of 10 inches and under shall be furnished with a cotton sheeting jacket covering the entire length of the insulation. The jacket shall have a 1 inch, minimum, lap on one end.

3.4.2.4 - When specified in the invitation for bids, metal bands shall be furnished, five for every two sections of pipe insulation.

3.4.3 Tolerance.- A tolerance of ± 1/8 inch in length, width and thickness will be permitted.

3.4.4 Type III - Cement.- Magnesia insulating cement shall be furnished in a dry finely divided form which when mixed with water to proper troweling consistency shall form a light, incombustible thermal insulation suitable for application to pipe fittings, valves and other surfaces.

3.5 Workmanship.- The workmanship shall be first class in every respect.

4. SAMPLING, INSPECTION AND TEST PROCEDURES

4.1 Inspection Procedures.- The thermal insulation materials covered by this specification shall be inspected in accordance with the procedures specified in 4.4.

4.2 Test Procedures.- The physical requirements specified in Table I and the chemical requirements specified in paragraph 3.2 shall be determined in accordance with the tests specified in 4.5.

4.3 Sampling for Lot Acceptance.

4.3.1 Inspection Lot.- All blocks and half-sections and segments of pipe insulation and magnesia cement presented at one time shall be considered a lot for purposes of acceptance, inspection, and tests.

4.3.2 Sampling for Inspection and Lot Acceptance Tests.

4.3.2.1 Types I and II - Block and Pipe.- A random sample of full-sized blocks and half-sections and segments of pipe insulation shall be selected and shall be representative of the inspection lot from which the samples are taken. When a lot contains material of more than one size, a representative selection of sizes and thicknesses shall be included among the samples. Table III gives the number of samples which shall be selected from each inspection lot.

Table III - Sampling for Inspection and Lot Acceptance

Number of blocks, half sections or segments in inspection lot	Number of blocks, half sections or segments in sample
40 or Under	2
41 to 110	3
111 to 500	5
501 to 1300	7
1301 and Over	10

4.3.2.2 Type III - Cement.- From each inspection lot of Magnesia Cement, samples shall be taken at random. The amount shall vary with the size of the inspection lot and sufficient shall be taken to thoroughly represent the material presented for inspection and test. At least 25 grams shall be taken from each inspection lot.

4.4 Inspection.

4.4.1 Types I and II - Block and Pipe.- Several lengths of pipe half-sections, segments or blocks taken from the sample shall be visually and dimensionally inspected and the density determined (see Par. 4.5.3) to verify compliance with this specification.

4.4.2 Type III - Cement.- A sample of the material which has been molded in a form and dried shall be subjected to a soaking heat of 600° F without baking hard, burning, or producing a flame.

4.5 Test Procedures.

4.5.1 Conditioning Samples.- Test specimens for inspection and lot acceptance tests shall be dried to constant weight by heating to 215° to 250° F before testing.

4.5.2 Chemical Analysis.- The composition shall be determined by chemical analysis, in accordance with the following method:

4.5.2.1 Preparation of Sample.- Prepare a sample by taking at least ten small fragments from each lot. Trim each fragment to a smooth surface, leaving no fibers projecting from any surface. Thoroughly crush the fragments and, if necessary, quarter them down to a 25 gram sample. Store the sample in a rubber-stoppered glass bottle.

4.5.2.2 Hygroscopic Moisture.- Place 2 grams of the sample on a weighed watch glass and dry to constant weight at 100°C. Record the loss in weight as hygroscopic moisture.

4.5.2.3 Fiber.- Add 100 milliliters of water and 2 drops of methyl orange to 5 grams of the sample, then slowly add, with stirring, 1 N HCl until a persistent pink color appears. (This will require about 125 milliliters.) Wash thoroughly with cold water and collect the asbestos by filtering through a weighed Gooch crucible. Dry the crucible and its contents at 110° C, and weigh. (The weight of fiber so obtained may be corrected by a blank determination on the asbestos used in the product.)

4.5.2.4 Filtrate.- Make up the combined filtrate and wash-

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ings, obtained as prescribed in paragraph 4.5.2.3, to 1 liter in a standardized flask. One hundred milliliters of this solution are used for further analysis.

4.5.2.5 Iron and Alumina.- Dilute a 100-milliliter portion of the solution described in paragraph 4.5.2.4 to 200 milliliters, add 10 milliliters of HCl (specific gravity 1.19) and heat the solution to boiling temperature. Slowly add dilute NH_4OH to slight excess, and then boil the solution for a minute or two to coagulate the precipitate and to expel the excess ammonia. Filter off the precipitate, which consists of the hydroxides of aluminum and iron, wash with hot water, and, if desired, ignite and weight as $Fe_2O_3 + Al_2O_3$.

4.5.2.6 Lime.- Heat to boiling temperature the combined filtrate and washings obtained as prescribed in paragraph 4.5.2.5, and make slightly acid with HCl. Add about 10 milliliters of a saturated solution of ammonium oxalate, and make the solution slightly alkaline with NH_4OH. After boiling for 5 minutes, allow the solution to cool, and, when thoroughly cold, decant the bulk of the solution through a filter and wash the precipitate in the beaker two or three times by decantation with cold water, using about 50 milliliters of water each time. Dissolve the precipitate on the filter in dilute HCl and return to the beaker in which the precipitation was made. Add sufficient HCl to redissolve the entire precipitate, heat the solution to boil-

ing, add a few milliliters of ammonium oxalate solution, and then add dilute NH_4OH in slight excess. When cold, collect the precipitate of calcium oxalate on a filter, wash with cold water and, if desired, ignite and weigh as CaO. It is especially important that the double precipitation of lime be carried out in order that the occlusion of magnesia with the lime shall be avoided.

4.5.2.7 Magnesia.- Acidify the combined filtrates, but not the washings, from the last lime precipitation with HCl, and evaporate on a hot plate to about 500 milliliters. Add a sufficient quantity of a saturated solution of sodium ammonium phosphate to precipitate all of the magnesia, and a considerable excess of ammonia. Thoroughly stir the solution until precipitation is complete, and allow to stand at least 12 hours in the cold. Decant the bulk of the liquid through the filter, wash the precipitate on the filter back into the beaker, and dissolve in the least possible amount of dilute HCl. Add a few drops of phosphate solution and then ammonia in slight excess, with stirring, as before. After standing at least 6 hours, filter off the precipitate and wash with dilute ammonia (1:10). Dry, detach the precipitate from the paper, and burn the paper on a platinum wire above the crucible containing the bulk of the precipitate, adding the ash to the contents of the crucible. Heat the covered crucible, gently at first, and then, when ammonia is no longer evolved, increase the heating to a full

blast until constant weight is obtained. The residue is magnesium pyrophosphate ($Mg_2P_2O_7$). The following formula may be used to determine the weight of the basic magnesium carbonate: $Mg_2P_2O_7 \times 0.8723 = 4MgCO_3Mg(OH)_2 \cdot 5H_2O$ (In place of 0.8723, the fraction $\frac{0.349}{0.4}$ may be used.)

4.5.2.8 Loss of Ignition.- Place about 2 grams of the sample in a weighed covered crucible, and heat slowly to redness and then at the full temperature of the blast for 15 minutes. After weighing, blast for 5 minutes more to insure constant weight. The loss in weight includes water and CO_2 from the magnesium carbonate and loss due to heating the asbestos.

4.5.2.9 Carbon Dioxide.- Place about 1 gram of the sample in a weighed Schroedter alkalimeter. Allow dilute HCl (1:1) to run in on the sample and, when the main reaction is over, boil the solution gently for 2 minutes. When cold, draw air through to displace the CO_2, and weigh the apparatus. The loss in weight is CO_2. This method is subject to errors of precision of as much as 0.5 per cent.

4.5.3 Density.

4.5.3.1 Type I - Block.- The density of Type I, block insulation shall be determined in accordance with the method specified in ASTM Specification C303.

4.5.3.2 Type II - Pipe.- The density of Type II, pipe insulation shall be determined in accordance with the method speci-

fied in ASTM Specification C302.

4.5.4 Conductivity.

4.5.4.1 Type I - Block.- The thermal conductivity of Type I, block insulation shall be determined in accordance with the method specified in ASTM Specification C177.

4.5.4.2 Type II - Pipe.- The thermal conductivity of Type II, pipe insulation shall be determined in accordance with the method specified in ASTM Specification C335.

4.5.5 Flexural Strength.

4.5.5.1 Type I - Block.- The flexural strength of Type I, block insulation shall be determined in accordance with the following method:

4.5.5.1.1 Apparatus.- The apparatus shall consist of any form of standard testing machine capable of applying and measuring the required load with an accuracy of plus or minus 2 per cent. The cylindrical bearing edges shall be 1-1/4 ± 1/4 inches in diameter and shall be straight and self-aligning so as to maintain full contact with the specimen throughout the test. They shall have a length at least equal to the width of the specimen.

4.5.5.1.2 Test Specimens.- The test specimens shall be preferable 6 inches but not less than 3 inches in width and shall be approximately 12 inches in length. If the test specimen is cut to obtain a narrower width than as-received, the cut shall be

made lengthwise of the block. The specimens shall be cut from larger blocks or irregular shapes in such a manner as to preserve as many of the original surfaces as possible. Only one specimen shall be cut from a single block or shape. The bearing faces of the test specimen shall be approximately parallel planes. When the original surfaces of the block are substantially plane and parallel, no special preparation of the surfaces will usually be necessary. In preparing specimens from pieces of irregular shape, any means such a band saw, or any method involving the use of abrasives such as a high-speed abrasion wheel or a rubbing bed, that will produce a specimen with approximately plane and parallel faces without weakening the structure of the specimen may be used.

4.5.5.1.3 Test Procedure.

4.5.5.1.3.1 At least four specimens shall be tested. The test specimens shall be dried in a vented oven for not less than 16 hours at 215° to 230° F.

4.5.5.1.3.2 The bearing edges shall be placed so as to provide a span of 10 inches. A test specimen shall be placed flatwise on the bearing edges and the load applied at mid-span, across the width and perpendicular to the top face of the specimen.

4.5.5.1.3.3 The speed of the moving head of the testing machine, during the application of the load, shall be not more than 0.5 inches per minute, or the rate of loading shall be not

more than 500 pounds per minute.

4.5.5.1.3.4 The load shall be applied until definite failure occurs, and the maximum load in pounds as indicated by the testing equipment shall be recorded. The average value of the flexural strength shall be reported in pounds per square inch.

4.5.5.1.4 Calculation.- The flexural strength shall be calculated as follows:

$$R = \frac{3Wl}{2bd^2}$$

where:

R = Flexural strength in pounds per square inch,

W = Load in pounds at which the specimen failed,

l = Distance between the supports in inches,

b = Width of the specimen in inches, and

d = Thickness of the specimen in inches

4.5.5.2 Type II - Pipe.- If the flexural strength of Type II, pipe insulation is required, approximate values may be secured by testing block, from the same production run as the pipe insulation furnished under this specification. The method of testing block is specified in paragraph 4.5.5.1.

4.5.6 Compressive Strength.

4.5.6.1 Type I - Block.- The compressive strength of Type I, block insulation shall be determined in accordance with the method specified in ASTM Specification C165.

4.5.6.2 Type II - Pipe.- If the compressive strength of Type II, pipe insulation is required, approximate values may be

secured by testing block from the same production run and the pipe insulation furnished under this specification. The method of testing block is specified in paragraph 4.5.6.1.

4.5.7 Linear Shrinkage.- The linear shrinkage of the sample, after soaking heat shall be determined by placing carefully sized specimens (minimum size 5 x 2 x 1 inches) in an electrically heated oven. The specimens shall be heated at the manufacturer's recommended temperature limit plus or minus 10° F for 24 hours. After removal from the oven, the specimens shall be examined to determine linear shrinkage.

4.6 Rejected Lots.- If the sample lot fails to conform to the requirements of this specification, a second sample from the same lot shall be examined and tested. The results of the retest shall be averaged with the results of the original test to determine compliance with this specification. Rejected lots may be offered again for Government inspection provided the contractor has repaired or removed all non-conforming samples. Samples shall again be selected and examined to verify compliance with this specification.

5. PREPARATION FOR DELIVERY

5.1 Packaging.- Unless otherwise specified, commercial packages are acceptable under this specification.

5.2 Packing.- Unless otherwise specified, the subject commodity shall be packed in substantial commercial containers of the type, size, and kind commonly used for the purpose, so con-

structed as to insure acceptance and safe delivery by common or other carriers, at the lowest rate, to the point of delivery called for in the contract or purchase order.

5.3 Marking.- Unless otherwise specified, shipping containers shall be marked with the name of the material, the size, the type, and the quantity contained therein, as defined by the contract or order under which the shipment is made, the name of the contractor and the number of the contract or order.

6. DEPARTMENTAL REQUIREMENTS

6.1 The following departmental specifications of the issue in effect on date of invitation for bids, and special requirements shall form a part of this specification, and shall be applicable to purchases made under this specification by the respective departments.

6.2 Army.- The U. S. Army Specification No. 100-2, Standard Specification for Marking Shipment. Copies of this specification may be obtained without cost upon application to the agency issuing the proposal for bids.

6.3 Navy.-

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6.3.1 Applicable specifications and other publications -

FEDERAL SPECIFICATIONS

NN-B-591--Boxes; Wood-Cleated-Fiberboard.

NN-B-601--Boxes; Wood-Cleated-Plywood (for Domestic Shipments).

NN-B-621--Boxes; Wood, Nailed and Lock Corner.

NN-B-631--Boxes; Wood, Wire-Bound, (for Domestic Shipment.)

UU-S-48--Sacks; Paper, Shipping.

LLL-B-631--Boxes; Fiber, Corrugated (for Domestic Shipment.)

MILITARY

JAN-P-105--Packaging and Packing for Overseas Shipment--Boxes, Wood, Cleated, Plywood.

JAN-P-100--Packaging and Packing for Overseas Shipment.

6.3.2 Packing.

6.3.2.1 For Domestic Shipment.

6.3.2.1.1 Pipe and Block Insulation.- Pipe and block insulation shall be packed in substantial commercial containers of the type, size, and kind commonly used for the purpose, so constructed as to insure acceptance and safe delivery by common or other carriers, at the lowest rate, to the point of delivery. When

wood-cleated fiberboard boxes, wood-cleated plywood boxes, nailed wood boxes, wire-bound wood boxes, corrugated fiber boxes, or solid fiber boxes are used, they shall conform to the requirements of Federal Specifications NN-B-591, NN-B-601, NN-B-621, NN-B-631, LLL-B-631, and LLL-B-638, respectively. The gross weight of wood boxes shall not exceed approximately 200 pounds; of fiberboard boxes, 70 pounds.

6.3.2.1.2 Cement.- Dry cement shall be packed in multi-wall paper sacks conforming to the requirements of Federal Specification UU-S-48.

6.3.2.2 For Overseas Shipment.-

6.3.2.2.1 Pipe and Block Insulation.- Pipe and Block Insulation shall be packed in cleated-plywood boxes, nailed wood boxes, wire-bound wood boxes, fiberboard boxes, or fiberboard-lined wood boxes conforming to the requirements of Joint Army-Navy Specifications JAN-P-108, JAN-P-100, JAN-P-107, JAN-P-108, and JAN-P-138, respectively. Shipping containers shall be lined with a sealed waterproof bag, or its equivalent, made from material conforming to the requirements of Joint Army-Navy Specification JAN-P-125. The seams and closures shall be sealed with water-resistant adhesive conforming to the requirements of Joint Army-Navy Specification JAN-P-140. The gross weight of wood boxes shall not exceed approximately 200 pounds; of fiberboard boxes, 70 pounds.

6.3.2.2.2 Cement.- Dry cement shall be packed in multi-wall

paper sacks conforming to the requirements of Joint Army-Navy Specification JAN-P-118 barrels conforming to the requirements of Joint Army-Navy Specification JAN-P-122.

6.3.3 Marking.- In addition to any special marking required by the contract or order, marking of interior packages and shipping containers shall be in accordance with the requirements of the Navy Shipment Marking Handbook.

6.3.4 Ordering Information.- Requests, requisitions, schedules, and contracts or orders should specify whether the subject commodity is to be packed and shipping containers marked for domestic or overseas shipment.

6.3.5 Purchases.

6.3.5.1 For other than the Bureau of Aeronautics - For administrative reasons, such purchases will be made under the issues in effect, on date of invitation for bids of the following Navy Department Specifications.

6.3.5.2 For Bureau of Aeronautics - Such purchases will be made under this Federal Specification.

7. NOTES

7.1 Purchasers should exercise any desired options offered herein, and should specify the type and thickness of the block and pipe insulation required. If metal bands are required they should be specified in the invitation for bids. (See Par. 1.2, 3.4.1.1, 3.4.1.2, 3.4.2, 3.4.2.4).

7.1.1 If a cotton sheeting jacket for sectional insulation for nominal pipe sizes larger than 10 inches is required, it should be so stated in the invitation for bids.

7.2 This material is intended for insulation where the temperature does not exceed 600° F.

7.3 It is believed that this specification adequately describes the characteristics necessary to secure the desired material and that normally no samples will be necessary prior to award to determine compliance with this specification. If, for any particular purpose, samples with bids are necessary, they should be specifically asked for in the invitation for bids, and the particular purpose to be served by the bid sample should be definitely stated, the specification to apply in all other respects.

7.4 Federal specifications do not include all types, classes, grades, etc., of the commodities indicated by the titles of the specifications, or which are commercially available but are intended to cover the types, etc., which are suitable for Federal Government requirements.

7.5 An index of Federal Specifications may be purchased as noted in paragraph below, price to be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Price 5 cents.

Notice.- When Government drawings, specifications or other

data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any supplied the said drawings, specifications, or other data, is not to be regarded by the implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.