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MIL-I-22023C
10 May 1968
SUPERSEDING
MIL-I-22023B
16 October 1964
(See 6.3)

MILITARY SPECIFICATION

INSULATION FELT, THERMAL AND SOUND ABSORBING

FELT, FIBROUS GLASS, FLEXIBLE

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers lightweight, flexible fibrous glass felt for thermal and acoustical control for use with temperatures up to 400°F.

1.2 Classification. Fibrous glass felt shall be of the following types and classes, as specified (see 6.2):

Type I - Thermal insulation felt.
Type II - Sound absorbing felt.
Class 2 - Nominal density 0.75 pound per cubic foot.
Class 3 - Nominal density 1.0 pound per cubic foot.
Class 4 - Nominal density 1.5 pound per cubic foot.
Class 5 - Nominal density 2.0 pound per cubic foot.
Class 6 - Nominal density 3.0 pound per cubic foot.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATION

FEDERAL
PPP-B-636 - Box, Fiberboard.

STANDARDS

MILITARY
MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

UNIFORM CLASSIFICATION COMMITTEE
Uniform Freight Classification Rules.

(Application for copies should be addressed to the Uniform Classification Committee, 202 Union Station, 516 West Jackson Boulevard, Chicago, Illinois 60606.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

C 167 - Thickness and Density of Blanket-or Batt - Type Thermal Insulating Materials, Tests for.

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C 177 - Thermal Conductivity of Materials by Means of the Guarded Hot Plate, Test for.
C 423 - Method of Test for Sound Absorption of Acoustical Materials in Reverberation Rooms (Tentative).
D 1448 - Micronaire Reading of Cotton Fibers, Test for.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Material. The basic material shall be glass, processed from a molten state into fibrous form, bonded with a binder to form a flexible felt.

3.1.1 Fiber diameter. The average fiber diameter shall not exceed 0.00038 inch. (See 4.5.1).

3.2 Non-fibrous material (shot) content. The (non-fibrous material) shot content shall be not greater than 1.5 percent by weight when tested as specified in 4.5.2.

3.3 Dimensions and densities.

3.3.1 Dimensions.

3.3.1.1 Length. The felt shall be furnished in rolls, 50, 100, or 200 feet in length, except where thicknesses greater than 1 inch and densities greater than 2.0 pounds per cubic foot may be furnished in cut sheets in accordance with manufacturer's standard practice, as specified (see 6.2). Rolls may contain more than one piece but no piece shall be less than 10 feet.

3.3.1.2 Width. The width of the rolls shall be 24, 36, 48, or 72 inches, as specified (see 6.2).

3.3.1.3 Thickness. The felt shall be furnished in thicknesses of 1/2 inch to 4 inches in 1/2 inch increments, as specified (see 6.2), except that classes 5 and 6 shall have a maximumthickness of 2 inches.

3.3.1.4 Tolerances. A minus tolerance of 1/8 inch in width and thickness and an excess in all dimensions will be permitted.

3.3.2 Density. A plus or minus tolerance of 10 percent in the densities shown in 1.2 will be permitted.

3.4 Binder content. The binder content of the felt shall not exceed 30 percent (see 4.5.4).

3.5 Alkalinity and pH. The alkalinity of the felt expressed as equivalent sodium oxide (Na_2O) shall be not greater than 0.60 percent when tested as specified in 4.5.5.1. The pH shall be not less than 7.5 nor more than 12.0 when tested as specified in 4.5.5.2.

3.6 Flexibility. The felt shall show no visible rupture on its outside surface and shall spring back to its original shape and dimensions when tested as specified in 4.5.6.

3.7 Resistance to smoldering. Material shall not be smoldering at the expiration of the test specified in 4.5.7.

3.8 Fire resistance. The felt shall be incombustible or fire retardant as specified (see 6.2), when tested as specified in 4.5.8.

3.9 Thermal conductivity. The thermal conductivity (k) of type I felt expressed in B. t. u. -inch per hour square feet degree Fahrenheit shall not exceed the values shown in table I (see 4.5.9).

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Table I - Maximum thermal conductivities.

Class	Maximum Thermal conductivity (k) at mean temperatures (°F).				
	25°	50°	75°	100°	200°
2	0.26	0.28	0.30	0.32	0.43
3	.24	.26	.28	.30	.39
4	.23	.24	.26	.28	.35
5	.22	.23	.24	.25	.31
6	.21	.22	.23	.24	.30

3.10 Vibration resistance. There shall be not more than 0.50 percent by weight of the material passing through the screen and no sagging or settling of type II felt when subjected to the vibration test described in 4.5.10.

3.11 Sound-absorption coefficients. The coefficients of absorption of type II felt shall be not less than the values shown in table II (see 4.5.11).

Table II - Coefficients of absorption.

Felt thickness inches (nominal)	Frequency, cycles per second					
	125	250	500	1000	2000	4000
1/2	0.04	0.10	0.20	0.40	0.55	0.55
1	.06	.20	.45	.65	.65	.65
2	.15	.40	.75	.75	.75	.70
3	.20	.60	.90	.80	.80	.75
4	.25	.65	.95	.85	.85	.80

3.12 Workmanship. Since several requirements for this material are not easily defined by a numerical value, the insulation shall have no visual defect that will adversely affect its serviceability.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements

4.2 Sampling for quality conformance inspection.

4.2.1 Lot. For purposes of sampling, a lot shall consist of all felt of the same type, thickness, and width produced in one plant under essentially the same conditions and offered for delivery at one time.

4.2.2 Sampling for visual and dimensional examination. A random sample of rolls or sheets shall be selected from each lot offered for inspection in accordance with MIL-STD-105 at Inspection Level II. The Acceptable Quality Level shall be 2.5 percent defective.

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4.2.3 Sampling for tests. Samples of the proper size shall be selected from each lot at random for the tests specified in 4.4. The total quantity of felt in square feet shall be the lot size and the number of test specimens shall be in accordance with MIL-STD-105 at Inspection Level S-1.

4.3 Quality conformance inspection.

4.3.1 Examination. Each roll or sheet selected for visual and dimensional examination in accordance with 4.2.2 shall be surface examined and measured to determine conformance with the requirements of this specification which do not require tests.

4.3.2 Density. Each roll or sheet selected in accordance with 4.2.2 shall be weighed to verify the amount of content and density of material determined by the method specified in 4.5.3.

4.3.3 Thickness. The thickness of each roll or sheet selected in accordance with 4.2.2 shall be determined by the method specified in 4.5.3. It will not be necessary to cut samples from the rolls or sheets in order to determine the thickness of the rolls. A 36 by 36 inch section of each roll can be ruled off and used as the test specimen.

4.3.4 Rejection. Any roll or sheet containing one or more visual, dimensional, or density defects shall not be offered for delivery, and if the number of defective rolls or sheets in any sample exceeds the acceptance number for that sample, this shall be cause for rejection of the lot represented by the sample.

4.4 Tests. The samples selected in accordance with 4.2.3 shall be subjected to the tests specified in 4.5.1 through 4.5.11. If any specimen tested is found to be not in conformance with this specification, this shall be cause for rejection of the lot represented by the specimen. A lot which is resubmitted, shall be given a tightened inspection to detetermine conformance with the requirements which the lot failed to meet.

4.4.1 Thermal conductivity and sound absorption tests. The test of 4.5.9 and 4.5.11 need only be conducted for one of the following reasons:

(a) If within the three year period preceding the date of invitation for bids the felt has not been tested by an acceptable testing laboratory and found in compliance with the requirements of 3.9 and 3.11, respectively.
(b) If the felt offered for delivery is not the same in all respects as that previously tested by the testing laboratory.

4.5 Test procedures.

4.5.1 Fiber diameter. The diameter of the fiber shall be determined by either of the following methods:

(a) Microscopic. Diameter of fiber shall be determined microscopically on the basis of measuring 100 fibers on each of the samples selected in accordance with 4.2.3. The average diameter for purposes of deteriming conformance with 3.1 shall be the average of all measurements on all samples.
(b) Air flow. The air flow method as measured by the micronaire instrument in accordance with ASTM D 1448.

4.5.2 Nonfibrous material (shot) content. The nonfibrous material (shot) content of 10 grams of each sample shall be determined by finely separating or breaking it up by means of a piece of soft rubber against a coarse screen directly into a nest of two U. S. Standard sieves, Nos. 30 and 50, and a receiving pan. A soft brush or other means, at the discretion of the operator, may be used to facilitate sieving. Long fibers may be removed by hand or gentle blowing if their horizontal orientation prevents them from passing through. Shake by machine or by hand until essentially all of the fiber has been removed from the two sieves. The fine splinters and dust shall be aspirated and the remainder of the Nos. 30 and 50 sieves shall be combined, divided by the sample weight and multiplied by 100 to give the shot content in percent. CAUTION: At all stages of this test, avoid any loss of shot which would invalidate the test results.

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4.5.3 Thickness and density. Thickness and density shall be determined in accordance with ASTM C 167.

4.5.4 Binder content. The binder content of each sample tested shall be determined by heating not less than 1/2 square foot of material separated into small pieces to approximately 1000°F. for 1 hour in an oven adequately vented in such a manner as to insure complete circulation of the atmosphere of the entire oven chamber, preferably by fan or other forced circulation methods. The weight before and after heating shall be taken under atmospheric conditions of the same relative humidity.

4.5.5 Alkalinity and pH.

4.5.5.1 Alkalinity. The alkalinity test shall be performed as follows: Weigh a 5 gram (± 0.01 g.) representative sample 1/ of the insulation felt, and introduce into a 500 milliliter (ml.) pyrex Erlenmeyer flask. Wet with 5 ml. of 95 percent ethyl alcohol and add 400 ml. of distilled water. Reflux for 4 hours ± 5 minutes. At the end of this period, disconnect the condenser and filter at once through a No. 41 Whatman paper, or its equivalent, supported in a Buechners funnel and connected to a suction source. Wash the flask and residual material three times with 25 ml. portions of hot distilled water, using suction. Titrate the combined filtrate and wash solution immediately with 0.02 N H_2SO_4 using 6 to 8 drops of a 1 percent solution of phenol red indicator to the disappearance of the pink color. Run a blank determination on the total amount of distilled water and alcohol and substitute the titration value in the formula below:

$$\text{Percentage alkalinity} = \frac{(A-B)N \times 0.031 \times 100}{W}$$

Where A = ml. H_2SO_4 required to titrate total sample

B = ml. H_2SO_4 required to titrate blank

N = Normality of the H_2SO_4

W = Weight of sample in grams

4.5.5.2 pH. The pH test shall be performed as follows: A 25 gram sample shall be taken by means of a cork borer. A representative 1 gram portion, weighted to the nearest 0.01 g., shall be placed in a 500 ml. pyrex Erlenmeyer flask and 100 ml. of distilled water added. A mixed bed ion exchange resin shall be utilized to make this water. Macerate the glass insulation with the flattened end of a polyethylene stirring rod until the specimen is thoroughly wetted. Affix a 9 millimeter by 200 centimeter pyrex glass air condenser and set the flask on a hot plate adjusted to maintain the contents of the flask at 95 to 100°C. without boiling. The flask and contents shall be heated for 1 hour after which time the flask is cooled to 20 to 30°C. Transfer 50 ml. of the extract to a 100 ml. pyrex glass beaker and measure the pH on a pH meter with glass electrode and a saturated KCl - calomel electrode half cell capable of precision to within 0.1 pH.

4.5.6 Flexibility. A piece of felt 12 by 18 inches by ordered thickness shall be cut 18 inches lengthwise and bent on its 12 inch dimension over a 1 inch diameter mandril over an arc of 90° long enough to extend at least 1 inch beyond the ends of the test specimen and released. The specimen shall be maintained in the flexed position for 5 minutes before being released and then examined for rupture or visible cracking. Slight surface separation shall be disregarded.

4.5.7 Smolder test. A specimen 12 inches square shall be cut from each of six samples, and the specimens arranged in pairs. Between each pair of specimens a cherry red hot (approximately 1450°F.) rivet or rod, approximately 3/4 inch by 2 inches, shall be inserted so as to touch the center of each specimen. A uniform pressure of 2 pounds shall be placed on the upper sample and the rivet allowed to remain in place for 1 hour.

1/ A representative sample is conveniently prepared by taking borings with a large cork borer through the cross section of the felt.

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4.5.8 Fire tests.

4.5.8.1 A specimen, previously dried to a constant weight at a temperature of 225°F., 36 by 36 inches by ordered thickness shall be applied directly to a 36 inch square incombustible backing support. Loose or non-rigid material should be mounted on a 4 by 4 mesh standard hardware cloth held horizontally face downward toward the fire. A square frame, 30 inches by 30 inches, made of 2 inch by 2 inch by 1/8 inch angle iron supported on legs 30 inches or more above the floor shall support the specimen. The flame from a 3/4 to 7/8 inch gas air burner shall be directed against the center of the lower surface of the specimen. The top of the burner tube shall be 28-3/4 inches below the face of the specimen. Temperature indications shall be obtained with a chromel-alumel No. 8 B&S gage thermocouple having the hot junction and adjacent wire bent into a circle 3 inches in diameter and mounted horizontally 1 inch below the center of the specimen and with the wires bare for at least 2 inches from the junction. Temperature readings shall be taken at intervals not exceeding 2 minutes throughout the test.

4.5.8.2 The test shall be conducted in a room which is free from drafts or appreciable air currents and having a temperature of between 60° and 85°F.

4.5.8.3 Flame from the gas-air burner shall be applied during a test period of 40 minutes and shall be regulated to give temperatures at the thermocouple according to the time-temperature curve in figure 1. The area under the completed curve plotted from the readings shall be within 5 percent of that of the reference curve. The flame shall touch specimen during the entire period, excepting only the first 5 minutes if required for proper temperature regulation. At no time during the test should the flame cover an area of the specimen face greater than a 12 inch diameter circle.

4.5.8.4 The test specimen shall be left in place after removal of the flame until it has cooled. Note any tendency toward smoldering or whether or not flame issues from specimen at any time during or after the test. In case of flaming, note whether the flame is sustained or in short, intermittent flashes or whether it reaches the angle iron frame at any time. Also, note whether or not flame continues for 2 minutes or longer after removal of the test flame or, if a glow appears at the edge of the specimen at any time during or after the test, indicating progressive combustion within the specimen. Observe whether or not the specimen remains in place or portions of burned, charred, or disintegrated material fall from it, except that any portion having a total area less than 50 sq. inches shall be disregarded. Record whether or not self-sustained combustion ceases upon removal of test flame and the extent of smoke and fumes emitted.

4.5.8.5 Incombustible. When subjected to the test specified in 4.5.8 the material that has remained in place shall have no flame issue from it, during or after flame application.

4.5.8.6 Fire retardant. When subjected to the test specified in 4.5.8, the material that has remained in place shall have no sustained flame issue from it and any flame which occurs shall be limited to intermittent, short flame from the area directly exposed to the test flame. No flame from the specimen shall appear at the angle frame at any point. No glow shall appear at the edge of the material and all flaming shall stop within 2 minutes after removal of the test flame and no smoldering shall be in evidence.

4.5.9 Thermal conductivity. The Guarded Hot Plate (ASTM C 177) shall be the standard method for the determination of thermal conductivity (k) of insulation felt.

4.5.10 Vibration resistance. A test specimen 12 inches square which has been blown clean of loose, cut surface particles shall be placed in a tight fitting sheet-metal box covered with a No. 16 mesh wire screen tightly stretched and firmly attached to the box. The specimen shall be in intimate contact with the screen and five sides of the box. After being accurately weighed it shall be installed horizontally, exposed face down, in the vibration test machine. The specimen shall then be subjected to 700 horizontal vibrations per minute, through an arc of 15 minutes, with a radius of 30 inches, for a period of 100 hours. Any particles which sift through the wire screen shall be collected in a pan secured under the screen. Upon completion of the test, the specimen shall be removed, again weighed, and examined for compliance with 3.10. In addition, the specimen shall be examined for any sagging or settling.

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4.5.11 Sound absorption coefficients. Sound absorption coefficients shall be determined by laying felt on the floor of a reverberation room and testing in accordance with ASTM C 423.

4.6 Examination of preparation for delivery. Sample rolls, sheets, and shipping containers shall be selected and examined to determine conformance with the documents referenced in Section 5.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. Preparation for delivery requirements of referenced documents listed in Section 2 do not apply unless specifically stated in the contract or order. Preparation for delivery requirements for products procured by contractors shall be specified in the individual order.)

5.1 Packing. Packing shall be level A, B, or C as specified (see 6.2).

5.1.1 Level A. Insulation felt shall be packed in fiberboard boxes conforming to class weather-resistant of PPP-B-636, except that limitations on inside dimension of box shall not apply. All corners and edge seams, and manufacturer's joint shall be waterproofed with tape in accordance with the appendix to PPP-B-636.

5.1.2 Level B. Insulation felt shall be packed in fiberboard boxes conforming to class domestic of PPP-B-636, except that limitations on inside dimensions of box shall not apply.

5.1.3 Level C. Insulation felt shall be packed in containers, at the lowest rates, in a manner which will insure acceptance by common carrier and will afford protection against physical damage during direct shipment from the supply source to the first receiving activity for immediate use. This level in general shall conform to the Uniform Freight Classification Rules or other carrier regulation as applicable to the mode of transportation and may be the supplier's commercial practice when such meets the requirements of this level.

5.2 Marking. In addition to any special marking required by the contract or order, shipping containers shall be marked for shipment in accordance with MIL-STD-129.

6. NOTES

6.1 The material covered by this specification is intended to be used as thermal insulation or acoustic treatment or both for ventilation ducts.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Type and class required (see 1.2 and 3.3.2).
(c) Length, width, and thickness required (see 3.3.1).
(d) Incombustible or fire retardant as specified (see 3.8).
(e) Levels of packing required (see 5.1).
(f) Special marking, if required (see 5.2).

6.3 CHANGES FROM PREVIOUS ISSUE. THE OUTSIDE MARGINS OF THIS DOCUMENT HAVE BEEN MARKED "#" TO INDICATE WHERE CHANGES (DELETIONS, ADDITIONS, ETC.) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS HAS BEEN DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT AS WRITTEN IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

Custodians:
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Navy - SH
Air Force - 84

Review activities:
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Navy - SH
Air Force - 84, 85

Preparing activity:
Navy - SH
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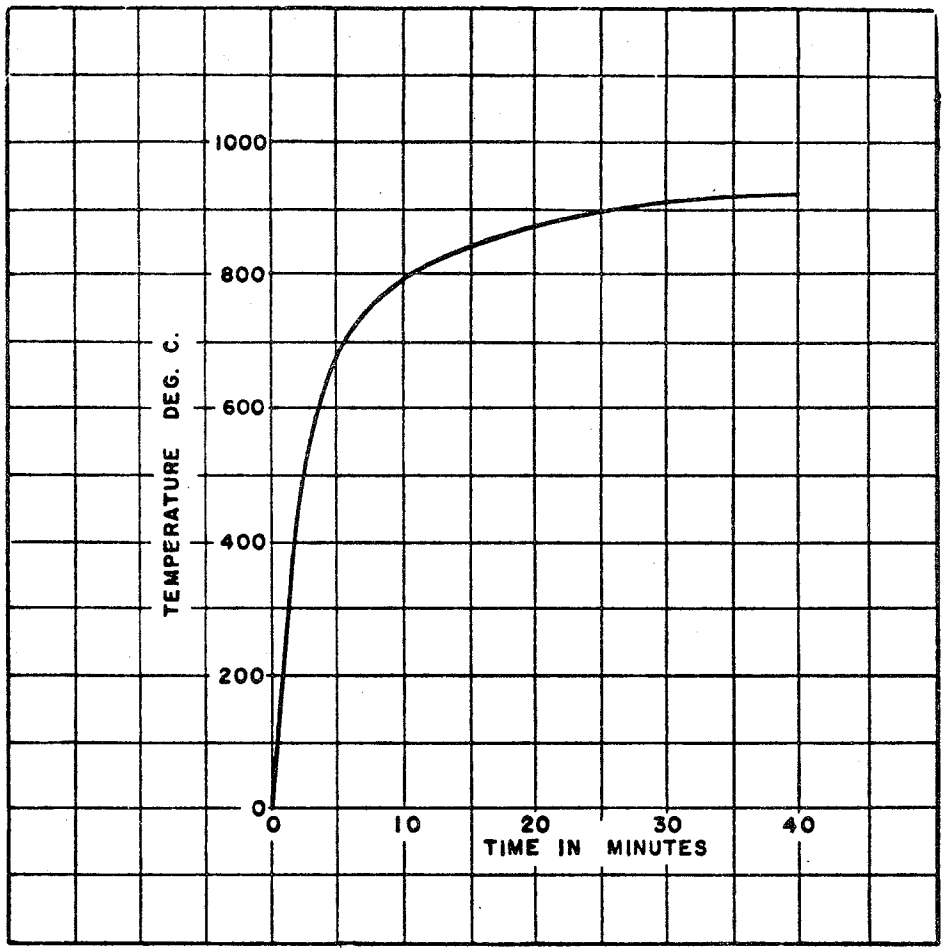

Figure 1 - Time temperature curve.

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SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity *(as indicated on reverse hereof)*.

SPECIFICATION

ORGANIZATION *(Of submitter)* | CITY AND STATE

CONTRACT NO. | QUANTITY OF ITEMS PROCURED | DOLLAR AMOUNT $

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)* | DATE

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