

INCH-POUND

MIL-I-2781F
21 August 1991
 SUPERSEDING
 MIL-I-2781E
 7 October 1975
 (see 6.10)

MILITARY SPECIFICATION
 INSULATION, PIPE, THERMAL

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

1. SCOPE

1.1 Scope. This specification establishes the requirements for preformed thermal insulation for use on pipes at surface temperatures up to 1200 degrees Fahrenheit (*F).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

PPP-F-320 - Fiberboard; Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes.

MILITARY

MIL-C-2861 - Cement, Insulation, High Temperature.
 MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5640

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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STANDARDS

FEDERAL

- FED-STD-313 - Material Safety Data Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities.

MILITARY

- MIL-STD-1623 - Fire Performance Requirements and Approved Specifications for Interior Finish Materials and Furnishings (Naval Shipboard Use).
- MIL-STD-2073-1 - DOD Materiel Procedures For Development And Application of Packaging Requirements.

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of DoDISS cited in the solicitation. Unless otherwise specified, the issues of the documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- C 302 - Standard Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
- C 335 - Standard Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
- C 356 - Standard Test Method for Linear Heat Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat.
- C 411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- C 421 - Standard Test Method for Tumbling Friability of Preformed Block-Type Thermal Insulation.
- C 446 - Standard Test Method for Breaking Load and Calculated Modulus of Rupture of Preformed Insulation for Pipes.
- C 449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- C 585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
- D 3951 - Standard Practice for Commercial Packaging. (DOD adopted)

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

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2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The thermal pipe insulation furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.4).

3.2 Material. The thermal pipe insulation shall consist of heat-resisting compounds suitable for the temperature conditions and the purpose intended.

3.2.1 Prohibited fibers. Neither asbestos nor ceramic (refractory) fibers nor materials containing any of these fibers shall be used in the insulation (see 5.5).

3.3 Form and dimensions.

3.3.1 Form and length. Thermal pipe insulation in nominal pipe sizes up to and including 10 inches shall be furnished in sections 3 feet long, split in half lengthwise. Pipe insulation for nominal pipe sizes larger than 10 inches may be furnished in semi-cylindrical sections or as curved segments, 3 feet in length. Each section or segment shall be true to shape and roundness and shall fit standard iron pipe sizes. A tolerance of plus or minus 1/4 inch in length will be permitted (see 4.5.2.1).

3.3.2 Inner diameter. The inner diameter of the pipe insulation shall be as specified in ASTM C 585 (see 4.5.2.2). The inner diameter of pipe insulation listed in ASTM C 585 approximates the outer diameter of iron pipe sizes. The insulation can be applied either to a pipe or as a second layer to a smaller size of pipe insulation.

3.3.3 Thickness. Pipe insulation shall be furnished in the thicknesses listed in ASTM C 585 as specified (see 6.2). A tolerance of plus 1/8-inch or minus 1/16-inch in actual thicknesses specified in ASTM C 585 will be permitted (see 4.5.2.3).

3.4 Physical requirements. Pipe insulation shall conform to the requirements specified in table I.

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Table III. Physical requirements.

Characteristics	Test	Physical Requirements
Density average, lb/ft ³ maximum	4.5.3	15.0
Thermal conductivity (average), Btu/hr. ft. ² deg F at mean temperature of: 200°F 300°F 400°F 500°F 600°F 700°F	4.5.4	0.42 0.45 0.50 0.60 0.65 0.70
Weight loss by tumbling, loss in weight (average) percent max. After first 10 minutes After second 10 minutes	4.5.5	20 40
Modulus of rupture (average), lb/in ² minimum	4.5.6	1 ^{1/}
Changes under soaking heat for 6 hours at 1200°F, Linear shrinkage (average) percent, max.	4.5.7	2.0

^{1/} Three times density (pounds per cubic foot (lbs/ft³)) of the sample tested.

3.5 Simulative service. Thermal pipe insulation shall not warp, crack or show other visible changes. Minor surface cracks that do not propagate more than 1/4-inch internally from the hot face surface of the pipe insulation shall be disregarded (see 4.5.9).

3.6 Fire resistance and smoke density. The finished insulation shall conform to the fire resistance and smoke density requirements set forth in MIL-STD-1623 (see 4.5.8).

3.7 Compatibility. The insulation material shall be compatible with thermal insulation cement conforming to ASTM C 449 and with high temperature thermal insulating cement conforming to MIL-C-2861. Without the application of a primer, the cements shall readily adhere to the insulation segments and form a smooth, protective surface. Drying time for each cement after application shall not exceed 2 hours (see 4.5.10).

3.8 Appearance and workmanship. Insulation shall be free of defects in appearance and workmanship (see 4.5.2.4).

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3.9 Material safety data sheet (MSDS). The contracting activity shall be provided a material safety data sheet at the time of contract award. The MSDS shall be provided in accordance with the requirements of FED-STD-313. The MSDS shall be included with each shipment of the material covered by this specification (see 6.5).

3.10 Recovered materials. Unless otherwise specified herein, all material incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable with jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used products is allowed under this specification unless otherwise specifically specified.

3.11 Toxicity. The material shall have no adverse effect on the health of personnel when used for its intended purpose (see 6.1 and 6.6). Questions pertinent to this effect shall be referred by the contracting activity to the Bureau of Medicine and Surgery (BUMED) who will act as an advisor to the contracting activity.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his 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 specifications where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- (a) Qualification inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).

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4.2.1 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be performed in accordance with the conditions specified herein.

4.3 Qualification inspection. Qualification inspection shall consist of the examinations and tests listed in table II. Qualification tests shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command.

Table II. Qualification inspection.

Inspection	Requirement	Test method
Material	3.2 & 3.2.1	Certification and visual
Dimensions	3.3	4.5.2
Density	3.4	4.5.3
Thermal conductivity	3.4	4.5.4
Weight loss by tumbling	3.4	4.5.5
Modulus of rupture	3.4	4.5.6
Changes under soaking heat- (6 hrs. at 1200°F), linear shrinkage	3.4	4.5.7
Fire resistance and smoke density	3.6	4.5.8
Simulative performance	3.5	4.5.9
Compatibility	3.7	4.5.10
Material safety data sheet	3.9	--
Appearance and workmanship	3.8	4.5.2.4

4.3.1 Qualification sample. Three samples for qualification tests shall be selected and subjected to the tests of 4.5.2, 4.5.3, 4.5.5, and 4.5.7; and one sample for the tests of 4.5.4, 4.5.8, 4.5.9 and 4.5.10.

4.3.2 Retention of qualification. The contractor shall conduct qualification examinations and tests every 3 years and shall submit the results to the Naval Sea Systems Command (see 6.4).

4.4 Quality conformance inspection. Quality conformance inspection shall consist of the examinations and tests listed in table III (see 6.3).

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Table III. Quality conformance inspection.

Inspection	Requirement	Test method
Material	3.2 & 3.2.1	Certification and visual
Dimensions	3.3	4.5.2
Density	3.4	4.5.3
Thermal conductivity	3.4	4.5.4
Weight loss by tumbling	3.4	4.5.5
Modulus of rupture	3.4	4.5.6
Changes under soaking heat- (6 hrs. at 1200°F), linear shrinkage	3.4	4.5.7
Fire resistance and smoke density	3.6	4.5.8
Simulative performance	3.5	4.5.9
Compatibility	3.7	4.5.10
Material safety data sheet	3.9	---
Appearance and workmanship	3.8	4.5.2.4
Packaging	5.1 thru 5.4	---

4.4.1 Lot. For purposes of inspection sampling, a lot is defined as all insulation sections of one size produced in the same facility, under the same conditions and from the same materials.

4.4.2 Sampling for quality conformance inspection. As a minimum, the contractor shall select a sample quantity of insulation sections from each lot in accordance with table IV and subject the sample sections to the examinations and tests listed in table III. If one or more defects are found in any sample, the entire lot shall be rejected. The contractor has the option of screening 100 percent of the lot for the defective characteristic(s), or providing a new lot which shall be inspected in accordance with the sampling plan herein.

Table IV. Sampling for quality conformance inspection.

Lot size	Sample size
2 to 25	3
26 to 50	5
51 to 90	6
91 to 150	7
151 to 280	10
281 to 500	11
501 to 1200	15
1201 to 3200	18
3201 to 10000	22
10001 and over	29

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4.5 Tests.

4.5.1 Conditioning samples. Test specimens shall be conditioned by drying to constant weight in an oven at a temperature of 215°F to 250°F.

4.5.2 Dimensions.

4.5.2.1 Length. Length shall be determined in accordance with ASTM C 302 (see 3.3.1).

4.5.2.2 Diameter. The inner diameter of the pipe insulation shall be determined in accordance with ASTM C 585 (see 3.3.2).

4.5.2.3 Thickness. Thickness shall be determined in accordance with ASTM C 302 (see 3.3.3).

4.5.2.4 Appearance and workmanship. The pipe insulation shall be examined to determine that none of the following defects exist (see 3.8):

- (a) Cracked or broken lengths.
- (b) Friable or lumpy surface.
- (c) Inner core of insulation not concentric with outer cylindrical surface.
- (d) Edges not plane.
- (e) Longitudinal cut surfaces not plane.
- (f) Excessive voids.
- (g) Warping.
- (h) Form not as required.

4.5.3 Density. The density shall be determined in accordance with ASTM C 302 (see table I).

4.5.4 Thermal conductivity. Thermal conductivity shall be determined in accordance with ASTM C 335 (see table I).

4.5.5 Weight loss by tumbling. Weight loss by tumbling shall be determined in accordance with ASTM C 421 (see table I).

4.5.6 Modulus of rupture. Modulus of rupture shall be determined in accordance with ASTM C 446 (see table I).

4.5.7 Physical changes after heat soaking. Specimens shall be weighed and measured. The specimens shall then be placed in an electrically heated oven and subjected to 1200°F for 6 hours. The specimens shall then be removed from the oven, cooled to room temperature, and tested to determine linear shrinkage in accordance with ASTM C 356.

4.5.8 Fire resistance and smoke density. Specimens shall be tested in accordance with test methods and requirements set forth in MIL-STD-1623.

4.5.9 Simulative performance. Simulative performance shall be determined in accordance with ASTM C 411 (see 3.5). Exposure temperature shall be 1200°F.

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4.5.10 Compatibility. A 6-inch section of pipe insulation, 1-1/2 inches thick, shall be uniformly surface coated while at room temperature, with approximately a 1/4-inch layer of finishing cement in accordance with ASTM C 449. Drying time under ambient air temperature conditions shall be determined. This test shall be repeated with a second pipe section using a cement in accordance with MIL-C-2861. The drying time for this cement shall also be determined.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.8).

5.1 General.5.1.1 Navy fire-retardant requirements.

- (a) Treated lumber and plywood. Unless otherwise specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping container and pallet construction, members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B - Type II - weather resistant.
Category 1 - general use.

Level C - Type I - non-weather resistant.
Category 1 - general use.

- (b) Fiberboard. Unless otherwise specified (see 6.2), fiberboard used in the construction of class-domestic, non-weather resistant fiberboard and cleated fiberboard boxes including interior packing forms shall meet the flamespread index and the specific optic density requirements of PPP-F-320.

5.2 Preservation. Not applicable.

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

5.3.1 General requirements for levels A, B, and C. Containers selected (see 5.3.2) shall be of minimum weight and cube consistent with the protection required, of uniform size, and contain quantities of like material (see 3.3).

5.3.2 Levels A, B, and C containers. Insulation shall be packed in exterior shipping containers for the level of packing specified (see 5.3), in accordance with exterior shipping container requirements of MIL-STD-2073-1, appendix C, and herein. Unless otherwise specified (see 6.2), container selection and options shall be at the contractor's option.

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5.3.2.1 Closure and gross weight.

5.3.2.1.1 Closure. Container closure, reinforcing, or banding shall be in accordance with the applicable container specification or appendix thereto except that weather-resistant fiberboard boxes shall be closed in accordance with method V and reinforced with non-metallic or tape banding and domestic or fire-retardant fiberboard boxes shall be closed in accordance with method I using pressure sensitive tape.

5.3.2.1.2 Weight. Wood, plywood, and cleated type containers exceeding 200 pounds gross weight shall be modified by the addition of skids in accordance with MIL-STD-2073-1 and the applicable container specification or appendix thereto.

5.3.3 Commercial. Insulation shall be packed for shipment in accordance with ASTM D 3951 and herein.

5.3.3.1 Container modification. Shipping containers exceeding 200 pounds gross weight shall have a minimum of two, 3- by 4-inch nominal wood skids laid flat, or a skid or sill type base which will support the material and facilitate handling by mechanical handling equipment during transportation, storage and stowage.

5.4 Marking levels A, B, C, and commercial. In addition to any special marking required (see 6.2 and herein), shipping containers shall be marked including bar coding for shipment, stowage and storage in accordance with MIL-STD-2073-1, appendix F. In addition, containers shall be marked "INSULATION FREE OF ASBESTOS AND CERAMIC (REFRACTORY) FIBERS" (see 3.2.1).

5.5 Material safety data sheet. A copy of the material safety data sheet (MSDS) shall be attached to the shipping document for each destination (see 3.9).

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The thermal insulation is to provide for piping operating at surface temperatures up to 1200°F.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number, and date of the specification.
- (b) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- (c) Nominal iron pipe size, and nominal thickness (see 3.3.3).
- (d) Inspection conditions, if different (see 4.2.1).
- (e) When fire-retardant material is not required (see 5.1.1(a) and (b)).
- (f) Level of packing required (see 5.3).

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- (g) Container selection and options if other than the contractor's (see 5.3.2).
- (h) Special marking required (see 5.4).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Description (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To insure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirements for a DD Form 1423.

<u>Reference paragraph</u>	<u>DID number</u>	<u>DID Title</u>	<u>Suggested Tailoring</u>
4.4	DI-T-2072	Reports, Test	---

The above DID's were those cleared as of the data of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 2781 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 51222, Department of the Navy, Washington, DC 20362-5101, and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests must be made in accordance with "Provisions Governing Qualification SD-6".

(Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

6.5 Material Safety Data Sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313.

6.6 Toxicity. To determine conformance to requirements of 3.11, the manufacturer of the material should disclose the formulation of his product to the Bureau of Medicine and Surgery (BUMED), MED 242, Washington, DC 20372. The disclosure of proprietary information, which will be held in confidence by BUMED, should include: the name, formula, and approximate percentage by

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weight and volume of each ingredient in the product; the results of any toxicological testing of the product; identification of its pyrolysis products; and any such other information as may be needed to permit an accurate appraisal of any toxicity problem associated with the handling, storage, application, use, disposal, or combustion of the material. Information submitted should be clearly marked or identified as to its being provided in connection with qualification under MIL-I-2781.

6.7 Certification. Consideration should be given to including certificates of compliance with each shipment of insulation. Certificates should indicate successful completion of the individual tests of the quality conformance inspection.

6.8 Sub-contracted materials and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.9 Subject term (key word) listing.

Conductivity, thermal
Density, smoke
Resistance, fire

6.10 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - ME
Navy - SH
Air Force - 84

Preparing activity:
Navy - SH
(Project 5640-0481)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I. RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-I-2781F	2. DOCUMENT DATE (YYMMDD) 21 AUGUST 1991
3. DOCUMENT TITLE INSULATION, PIPE, THERMAL		
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)		
5. REASON FOR RECOMMENDATION		
6. SUBMITTER		
a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	e. DATE SUBMITTED (YYMMDD)
8. PREPARING ACTIVITY		
a. NAME Technical Point of Contact (TPOC): Ms. Linda Lovell (SEA 5143) PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS	b. TELEPHONE (Include Area Code) (1) Commercial 703-602-0146	(2) AUTOVON 8-332-0146
c. ADDRESS (Include Zip Code) COMMANDER, NAVAL SEA SYSTEMS COMMAND SEA 5523, DEPARTMENT OF THE NAVY WASHINGTON, DC 20362-5101	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	