

INCH-POUND

MIL-T-3530H  
20 February 1991  
SUPERSEDING  
MIL-T-3530G  
24 September 1984

## MILITARY SPECIFICATION

THREAD AND TWINE, MILDEW RESISTANT OR WATER

REPELLENT TREATED

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

### 1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification contains the requirements for thread and twine treated for mildew resistance and thread treated for water repellency.

1.2 Classification. The treated thread or twine shall be of the following types and classes, as specified (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be used in improving this document should be addressed to: U.S. Army Natick Research, Development, and Engineering Center, Natick, MA 01760-5019 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 8310

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

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- Type I - Mildew resistant treated thread and twine
  - Class 1 - Copper 8-quinolinolate
  - Class 2 - 2,2' methylene-bis - (4-chlorophenol)
- Type II - Water repellent treated thread
  - Class 3 - Quarpel type for cotton, nylon, polyester, nomex and polyester-covered or cotton-covered polyester core thread (soft or bonded finish, as specified see 6.7).

## 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).

#### STANDARDS

##### FEDERAL

FED-STD-191 - Textile Test Methods

##### MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes

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

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, 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 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.3), in accordance with 4.3.

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3.2 Laboratory report approval. Unless otherwise specified (see 6.2), at the time of submission of a bid, the bidder shall submit to the contracting officer a certified copy of a recent laboratory report covering treated thread or twine which he proposes to deliver. Unless otherwise specified by the contracting officer, the bidder shall certify that the laboratory report submitted covers thread or twine which was treated in a plant where the thread or twine will be treated if the contract is awarded. This laboratory report shall contain the test data which demonstrates that the finished product which the bidder proposes to deliver has been tested in conformance with and found to comply with the requirements of this specification. Any one of the following types of reports will be satisfactory from the standpoint of this requirement:

- a. An independent or commercial laboratory report.
- b. The prospective contractor's own laboratory report.
- c. A government laboratory report from a contract within 6 months of date of submission of bid.

The purpose of the above requirement is to assist the Government in determining the capability of bidders to treat thread and twine so as to meet all the requirements of this specification. The submission of an acceptable report under this requirement shall not be construed as relieving a contractor from subsequently meeting all requirements of this specification on all deliveries.

3.3. Standard sample. When a standard sample is available (see 6.4), the treated thread or twine shall match the standard sample for shade and shall be equal to or better than the standard sample with respect to all characteristics for which the standard is referenced.

3.4 Material. It is encouraged that recycled material be used when practical as long as it meets the requirements of this specification.

3.4.1 Thread and twine. The document governing the untreated thread and twine to be treated under this specification shall be cited in the applicable acquisition document (see 6.2).

3.4.1.1 Requirements. Thread and twine shall conform to the requirements of the applicable document for the untreated thread and twine prior to and after mildew resistant or water repellent treatment except as otherwise indicated herein.

3.5 Type I, mildew resistant treated thread and twine.

3.5.1 Mildew inhibitor. The mildew inhibitor shall be class 1 or class 2 as specified (see 6.2).

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3.5.1.1 Class 1, copper 8-quinolinolate. The copper 8-quinolinolate shall be thoroughly dispersed and so formulated that it may be applied to effect proper penetration into the thread or twine. The contractor shall certify that any petroleum fractions, oils, or resins used are of a non-oxidizing type and are free of naphthenic acid and its salts.

3.5.1.1.1 Application (class 1). The inhibitor shall be applied from a solvent bath process so as to deposit within the thread or twine a minimum of 0.13 to a maximum of 0.40 percent copper as metal from copper 8-quinolinolate, when tested as specified in 4.4.5. The contractor shall certify that any petroleum fractions, oils, or resins are of a non-oxidizing type and shall be free of other copper compounds or naphthenic acid and its salts. When processing, it is necessary that the thread or twine be thoroughly dried, so that no residual solvent will be present.

3.5.1.2 Class 2; 2, 2'methylene-bis-(4-chlorophenol). The inhibitor shall be applied from a solvent or aqueous solution, or by a two-bath method from an aqueous solution in which the sodium salt is applied in the first bath and fixed with acetic acid in the second.

3.5.1.2.1 Application (class 2). The application of the inhibitor shall deposit  $1.5 \pm 0.5$  percent of 2, 2'methylene-bis-(4-chlorophenol) in the thread or twine when tested as specified in 4.4.5. The application shall be such that the thread or twine is well penetrated and shall provide a uniform deposit in the material. There shall be no noticable crystallization of the treatment on the thread or twine surface.

3.5.1.2.2 Size bath application. The size bath for glazed or polished finished thread or twine processed to meet the requirements for type I, class 2 thread or twine shall contain not less than 1/2 ounce of 2,2'methylene-bis-(4-chlorophenol) to each gallon of size solution. The contractor shall certify to this characteristic.

3.5.2 Breaking strength (type I, classes 1 and 2). The breaking strength shall not be less than 95 percent of the minimum breaking strength specified in the applicable document for the untreated thread or twine when tested as specified in 4.4.5.

3.5.3 Length per pound (type I, classes 1 and 2). The length per pound shall not be less than 90 percent of the minimum length per pound specified in the applicable document for the untreated thread or twine when tested as specified in 4.4.5.

3.6 Type II, class 3, Quarpel type treated thread (soft or bonded finish, as specified, see 6.7).

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3.6.1 Treatment. The type II, class 3 thread shall be treated with an approved "Quarapel type" water repellent (see 6.5 and 6.6) to meet the requirements specified below. There shall be no noticeable crystallization of the treatment on the thread surface or any noticeable wicking of the treatment on the thread to adjacent material when sewn.

3.6.2 Vertical rise wicking, type II, class 3.

3.6.2.1 Initially. The finished treated thread shall resist the wicking of water for a period of not less than 6 hours when tested as specified in 4.4.5.

3.6.2.2 After 3 launderings. The finished treated thread shall resist the wicking of water for a period of not less than 6 hours after 3 launderings when tested as specified in 4.4.5.

3.6.3 Breaking strength, type II, class 3. The breaking strength shall be not less than 90 percent of the minimum breaking strength in the applicable document for the untreated thread when tested as specified in 4.4.5.

3.6.4 Length per pound, type II, class 3. The length per pound shall be not less than 90 percent of the minimum length per pound specified in the applicable document for the untreated thread when tested as specified in 4.4.5.

3.7 pH, type I. The pH value of the water extract of the type I finished treated thread or twine shall be not lower than 5.5 nor higher than 8.5 when tested as specified in 4.4.5.

3.8 Nonfibrous material, type I. When a requirement exists for non-fibrous material or extractable matter in the applicable document for the untreated thread or twine, the treated thread or twine shall be considered acceptable when the untreated thread or twine has been tested and found to comply with that requirement.

3.9 Color.

3.9.1 Type I, classes 1 and 2. The thread or twine shall be undyed or colored as specified (see 6.2). When undyed and mildew resistant treated thread or twine is specified, the color of the thread or twine may deviate from the unbleached state to that degree imposed by the color of the mildew resistant agent used. When colored thread or twine is specified, the dyed thread or twine shall match the standard sample (see 6.4) prior to the application of the mildew resistant treatment and the color of the finished thread or twine shall be that resulting from the application of the mildew resistant treatment.

3.9.2 Type II, class 3. The color of the dyed and water repellent treated thread shall match the standard sample (see 6.4).

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3.9.3 Matching. The color of the treated thread or twine shall match the standard sample (see 6.4) under artificial daylight having a color temperature of  $7000 \pm 500$  K and shall be a good approximation to the standard sample under incandescent lamplight at  $2850 \pm 100$  K.

3.9.4 Colorfastness. The colorfastness requirements for the dyed thread or twine shall be as specified in the applicable end item document or as set forth in the acquisition document (see 6.2). Unless otherwise specified (see 6.2), the colorfastness shall be determined on the dyed and treated thread or twine in accordance with test methods specified in the applicable untreated thread or twine document.

3.10 Workmanship. The finished thread or twine shall conform to the quality of product established by this specification.

#### 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 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 this specification 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 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.

4.1.2 Certificates of compliance. When certificates of compliance are submitted, the Government reserves the right to inspect such items to determine the validity of the certification.

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

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

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4.3 First article inspection. When a first article is required (see 3.1 and 6.2), it shall be examined for the defects specified in 4.4.2, 4.4.3 and 4.4.4.

4.4 Quality conformance inspection. Unless otherwise specified, sampling for inspection shall be performed in accordance with MIL-STD-105.

4.4.1 Component and material inspection. In accordance with 4.1, components and materials shall be inspected in accordance with all the requirements of referenced documents unless otherwise excluded, amended, modified, or qualified in this specification or applicable purchase document.

4.4.1.1 Certification. The applicable material and application requirements listed below shall be accepted on the basis of a contractor's certification of compliance with the indicated requirements:

<u>Requirement</u>	<u>Requirement paragraph</u>
Copper 8-quinolinolate	3.5.1.1 and 3.5.1.1.1
2,2'methylene-bis-(4-chlorophenol)	3.5.1.2 and 3.5.1.2.1
Size bath application	3.5.1.2.2
Quarapel type water repellent	3.6.1

4.4.2 End item visual examination. The end items shall be examined for the defects listed in table I. The lot size shall be expressed in units of holders (i.e., cones, spools, or tubes as applicable). The sample unit shall be one holder of thread or twine. The inspection level shall be I and the acceptable quality level (AQL), expressed in terms of defects per hundred units, shall be 1.0 for major defects and 6.5 for total (major and minor combined) defects.

TABLE I. End item visual defects

Examine	Defect	Classification	
		Major	Minor
Thread or twine:			
Finish	Objectionable odor	101	
	Any clearly noticeable cry- stallization of treatment on thread or twine	102	
Shade for type I, class 1 and class 2, when specified; type II, class 3	Off shade, not within established tolerance	103	

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TABLE I. End item visual defects (cont'd)

Examine	Defect	Classification	
		Major	Minor
Thread or twine: (cont'd)			
Cleanliness	Spot, stain, soiling, or lint <u>1</u> /		201
Workmanship	Lumps		202
Type of holder (spool, cone or tube)	Other than specified	104	
Preservation	Cut, torn, or chafed packages affecting proper unwinding strength or serviceability of thread or twine	105	
	Broken, crushed, tangled or otherwise defective package, interfering with proper un- winding of thread or twine	106	
Labels and markings	Missing, incomplete, illegible, incorrect, or insecure		203

1/ Clearly visible at normal inspection distance (approximately 3 feet).

4.4.3 Examination for length per holder (when purchased on a length per holder basis). This examination shall be conducted in accordance with the provisions of the applicable document or contract for the untreated thread or twine.

4.4.4 Examination for weight per holder (when purchased on a weight per holder basis). This examination shall be conducted in accordance with the provisions of the applicable document or contract for the untreated thread or twine.

4.4.5 End item testing. The end items shall be tested as specified in table II. The methods of testing specified in FED-STD-191 wherever applicable, and as listed in table II shall be followed. The sample unit shall be one holder of thread or twine. The lot shall be unacceptable if any sample unit fails to meet any requirement specified. All test reports shall contain the individual values used in expressing the final results. The sample size shall be in accordance with the following:



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<u>Lot size (holders)</u>	<u>Sample size (sample units)</u>
800 or less	2
801 up to and including 22,000	3
22,001 and over	5

TABLE II. End item tests

<u>Characteristics</u>	<u>Requirement paragraph</u>	<u>Test method</u>
Copper 8-quinolinolate analysis, (type I, class 1)	3.5.1.1.1	2060 and 5762 <u>1/</u>
2,2'methylene-bis-(4-chlorophenol) (type I, class 2)	3.5.1.2.1	2011
Breaking strength change:		
Type I	3.5.2	4.5.1
Type II	3.6.3	4.5.1
Length per pound change:		
Type I	3.5.3	4.5.2
Type II	3.6.4	4.5.2
Vertical rise wicking (type II):		
Initial	3.6.2.1	4504
After 3 launderings	3.6.2.2	4.5.3 and 4504
pH (type I)	3.7	2811

1/ Two week soil burial test to show less than 10 percent loss in breaking strength after leaching by Test Method 5830 (see 6.8).

4.4.6 Packaging inspection. An examination shall be made in accordance with provisions of the applicable document for the untreated thread or twine to determine that packaging, packing and marking comply with the section 5 requirements.

#### 4.5 Methods of inspection.

4.5.1 Breaking strength test. The breaking strength of the treated thread or twine shall be determined in accordance with the application method of the document covering the untreated thread or twine. The breaking strength shall be

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computed as a percentage of the minimum breaking strength specified in the applicable document for the untreated thread or twine and shall be reported to the nearest 1 percent (see 3.5.2 and 3.6.3).

4.5.2 Length per pound. The length per pound of the untreated thread or twine shall be determined in accordance with the applicable method of the document covering the untreated thread or twine. The length per pound shall be computed as a percentage of the minimum length per pound specified in the applicable document for untreated thread or twine and shall be reported to the nearest 1 percent (see 3.5.3 and 3.6.4).

4.5.3 Laundrying procedure. The type II, class 3 treated thread shall be subjected to the following laundrying and drying procedure three times and then tested for vertical rise wicking in accordance with Method 4504 of FED-STD-191.

4.5.3.1 Apparatus and reagents.

4.5.3.1.1 Apparatus.

4.5.3.1.2 Laundry-Ometer. Laundry-Ometer or similar machine (see 6.9) in which tightly capped one-pint glass jars are held with their bases toward a horizontal shaft 2 inches from the center of rotation with the shaft rotating at a speed of 40 to 45 revolutions per minute (r.p.m.). The Laundry-Ometer shall be maintained at a temperature of  $160^{\circ} \pm 2^{\circ}\text{F}$ .

4.5.3.1.3 Circulating air oven. A circulating air oven capable of maintaining a temperature of  $221^{\circ}$  to  $230^{\circ}\text{F}$ .

4.5.3.1.4 Yarn reel. The reel for preparing the specimen shall be 54-inch periphery skein reel or other suitable device.

4.5.3.1.5 Twist tester. A twist tester or other suitable device for twisting and cabling skeins.

4.5.3.2 Reagents.

4.5.3.2.1 Water. Distilled water shall be used.

4.5.3.2.2 Detergent solution. A 0.25 percent solution of sodium sulfonate salt of oleyl methyl tauride (2.5 grams per liter) (see 6.10).

4.5.3.3 Procedure.

4.5.3.3.1 Preparation of specimen. The test specimen shall consist of a twenty strand skein of thread in one continuous 30-yard length made on a 54-inch periphery skein reel. The skein shall be folded flat then twisted around its long axis for a total of 25 turns by use of a twist tester or other suitable

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device in the same direction as that of the final ply twist of the thread. The two ends shall be brought together and the folded skein allowed to back twist on itself. The ends shall be tied off to prevent untwisting.

4.5.3.3.2 Laundrying of specimen. The specimen shall be placed in a 1 pint jar containing 100 mL of the 0.25 percent detergent solution at a temperature of  $160^{\circ} \pm 2^{\circ}\text{F}$ . The jar shall then be sealed and agitated for 45 minutes at a temperature of  $160^{\circ} \pm 2^{\circ}\text{F}$  in the Launder-Ometer at a speed of 40 to 45 r.p.m.

4.5.3.3.3 Rinsing and drying of specimen. At the end of the laundrying period, the specimen shall be removed from the jar and rinsed thoroughly in running water at a temperature of  $104^{\circ} \pm 9^{\circ}\text{F}$  and agitated occasionally during rinsing. Care should be exercised to insure that all traces of detergent are removed. The specimen shall then be extracted or wrung and oven dried at a temperature of  $221^{\circ}$  to  $230^{\circ}\text{F}$  until thoroughly dry.

## 5. PACKAGING

5.1 Put-up, preservation, packing and marking. Put-up, preservation, packing, and marking requirements for the treated thread and twine shall conform to the applicable document for the untreated thread and twine.

## 6. NOTES

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

### 6.1 Intended use.

6.1.1 Type I, class 1. Type I, class 1 thread or twine is intended for use in the fabrication of footwear, tents and equipment subject to considerable ground contact under conditions for actual use.

6.1.2 Type I, class 2. Type I, class 2 thread or twine is intended for use where color is of prime importance or in the fabrication of materials such as fabrics coated with natural rubber which by the nature of their construction or finish require that use of copper compound be avoided.

6.1.3 Type II, class 3. Type II, class 3 threads are intended for use in end items fabricated from Quarrel treated fabric which will be subject to repeated launderings.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Type and class required (see 1.2).

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- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1).
- d. When a first article is required (see 3.1, 4.3, and 6.3).
- e. When a laboratory report approval is not required (see 3.2).
- f. Title, number, and date of document governing untreated thread or twine (see 3.4.1).
- g. Color and colorfastness properties required (see 3.9 and 3.9.4).

6.3 First article. When a first article is required, it shall be inspected and approved under the appropriate provisions of Federal Acquisition Regulation (FAR) 52.209. The first article should be a preproduction sample. The contracting officer should specify the appropriate type of first article and the number of units to be furnished. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for selection, inspection, and approval of the first article.

6.4 Sample. For access to samples, address the contracting activity issuing the invitation for bids or request for proposal.

6.5 Quarapel water repellent. The type II, class 3 "Quarapel type" water repellent treatment consists of a one-bath application of an emulsified fluorocarbon and a quaternary ammonium salt or a melamine hydrophobe type of repellent (see 3.6.1).

6.6 Approval of water repellent treatment. Approval of the "Quarapel type" water repellent treatment for use under this document is the responsibility of the U.S. Army Natick Research, Development, and Engineering Center, Natick, MA 01760-5019, and is based on extensive tests, including those for toxicity, which are not set forth in this specification. Because of the time necessary to conduct full evaluation, only those chemical treatments already approved and so listed in the invitation for bids or request for proposal shall be considered acceptable for the related procurement (see 3.6.1). Information on currently approved materials may be obtained from the Defense Personnel Support Center, Philadelphia, PA 19101.

6.7 Application of sewing finish to type II, class 3 thread. Experience has shown that the sewing finish applied to type II, class 3 water repellent treated thread, must be selected carefully to avoid solvents and penetrating agents which would increase the wicking of the treated thread. The requirements specified herein apply to soft or bonded finish thread. Glazing (cotton) and polishing (linen) finishes have been shown to increase substantially the wicking properties of water repellent treated thread.

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6.8 Soil burial testing. The following company is capable of conducting the required soil burial test:

Le Blanc Industries  
6172 Post Road  
North Kingston, Rhode Island 02852

6.9 Launder-Ometer. A Launder-Ometer of the type described may be obtained from Atlas Electric Devices Company, 4114 North Ravenswood Avenue, Chicago, IL 60613.

6.10 Commercial source. This detergent may be obtained from the GAF Corporation, Chemical Group, 140 West 51st Street, New York, NY 10020 under the trade name IGEPON-T-77 (see 4.5.3.2.2).

6.11 Subject term (key word) listing.

Copper 8  
Equipage  
Footwear  
Methylene-bis  
Quarapel  
Tentage

6.12 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.

## MILITARY INTERESTS

## Custodians:

Army - GL  
Navy - NU  
Air Force - 99

## PREPARING ACTIVITY:

Army - GL  
(Project 8310-0178)

## Review activities:

Army - AR, EA, MD  
Navy - MC  
Air Force - 11, 82  
DLA - CT

## User activity:

Army - ME

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

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.

<b>1. RECOMMEND A CHANGE:</b>		1. DOCUMENT NUMBER MIL-T-3530H	2. DOCUMENT DATE (YYMMDD) 91/02/20
3. DOCUMENT TITLE THREAD AND TWINE, MILDEW RESISTANT OR WATER REPELLENT TREATED			
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)	7. DATE SUBMITTED (YYMMDD)
8. PREPARING ACTIVITY			
a. NAME 3. Army Natick RD&E Center		b. TELEPHONE (Include Area Code) (1) Commercial 508-651- 4532	(2) AUTOVON 256- 4532
c. ADDRESS (Include Zip Code) Commander, U.S. Army Natick RD&E Center		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office	