

MIL-I-22110C
26 September 1985
SUPERSEDING
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7 April 1975

MILITARY SPECIFICATION

INHIBITORS, CORROSION, VOLATILE, CRYSTALLINE POWDER

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

1. SCOPE

1.1 Scope. This specification gives the requirements for volatile corrosion inhibitors (VCI) in crystalline powder form. The corrosion inhibiting vapors from the crystals shall provide corrosion protection for most metals under specific conditions. The crystals shall be one type for general application.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards and handbooks. Unless otherwise specified, the following specifications, standards and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-C-576	Copper Flat Products With Slit, Slit and Edgerolled, Sheared, Sawed, or Machined Edges, (Plate, Bar, Sheet and Strip)
TT-T-291	Thinner, Paint, Mineral Spirits, Regular and Odorless
PPP-B-621	Boxes, Wood, Nailed and Lock-Corner

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Systems Engineering and Standardization Department (Code 93), Lakehurst NJ 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter

FSC 6850

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

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FEDERAL

PPP-B-601	Boxes, Wood, Cleated Plywood
PPP-B-636	Box, Shipping, Fiberboard
PPP-B-640	Boxes, Fiberboard, Corrugated, Triple-Wall
PPP-C-96	Cans, Metal, 28 Gage and Lighter
PPP-C-186	Container, Packaging and Packing for Drugs, Chemicals and Pharmaceuticals
PPP-D-723	Drum, Fiber
PPP-P-704	Pails, Metal (Shipping, Steel, 1 through 12 Gallons)

MILITARY

MIL-I-8574	Inhibitors, Corrosion, Volatile, Utilization of
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STANDARDS

FEDERAL

FED-STD-101	Test Procedures for Packaging Materials
FED-STD-313	Material Safety Data Sheets, Preparation and Submission of

MILITARY

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

(Copies of specifications and standards, required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other Publications. The following document forms a part of this specification to the extent specified herein. The issues of the document which are indicated as DoD adopted shall be the issue listed in the current DoDISS and supplement thereto, if applicable.

American Society for Testing and Materials

ASTM D 3951	Commercial Packaging
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(Applications for copies should be addressed to 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 specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Qualification. VCI crystals furnished under this specification shall be products which are qualified for listing on the applicable Qualified Products List (QPL) at the time set for opening of bids (see 4.5 and 6.3).

3.2 Materials. VCI crystals shall be non hygroscopic and made from such materials and by such processes as to assure compliance with this specification.

3.2.1 Material safety data sheets. A Material Safety Data Sheet (MSDS) shall be prepared and submitted in accordance with FED-STD-313. Questions pertinent to the effect of the VCI crystals on the health of personnel when used for its intended purpose shall be referred by the acquiring activity to the appropriate medical service who will act as advisor to the acquiring activity (see 4.3 and 6.2).

3.2.2 Compatibility. VCI crystals shall be compatible with the materials they are to protect when tested as specified in MIL-I-8574 and 4.11.2 (see 6.1).

3.3 Physical properties. The VCI crystals shall comply with the applicable requirements of table I when tested as specified in Section 4.

3.4 Formulation changes. When data has been submitted for a particular formulation of VCI crystals, no change in formulation affecting the hazardous characteristics is permitted without prior approval of the Naval Air Systems Command. The Naval Air System Command will determine if the formulation change warrants a new designation. The contractor must submit the modified material for qualification inspection under the specification using the new designation (see 3.1, 4.5.1 and 6.3).

3.5 Workmanship. The VCI crystals shall be free from suspended matter, grit, water, or any other adulterants or defects which could cause the material to be unsuitable for the purpose intended (see 4.7).

4. QUALITY ASSURANCE PROVISION

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 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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

- a. Qualification inspection (see 4.5).
- b. Quality conformance inspection (see 4.6).

4.3 Submission of Material Safety Data Sheets. The contractor shall furnish to the contracting activity the toxicological data and formulation required to evaluate the safety of the material for the proposed use through the submission of the Material Safety Data Sheet detailed in FED-STD-313. The qualifying laboratory copy shall be submitted with qualification sample (see 3.2.1, 4.5.1 and 6.2).

4.4 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in the applicable paragraph of the specification (see 4.9).

4.5 Qualification inspection. The qualification inspection shall consist of the tests specified in table I.

4.5.1 Qualification sampling instructions. Qualification inspection sample shall consist of one pound of material. The contractor shall submit with the qualification sample a certified copy of test results showing conformance with all the requirements of this specification. Information shall be furnished including the plant address(es), as to the plant(s) in which the VCI crystals are or will be manufactured. If more than one address is listed, a certificate of equivalence of other plants to the plant in which the sample was manufactured must be furnished. The sample shall be forwarded to the Commander, Naval Air Development Center, Aircraft and Crew Systems Technology Directorate (Code 60622), Warminster, PA 18974. Samples shall be plainly identified by securely attached, durable tags with the following information:

Inhibitor, Corrosion, Volatile, Crystalline
 Samples for qualification tests
 Name of manufacturer (plant where inhibitor
 is manufactured)
 Material designation
 Date of manufacture
 Submitted by (name) (date) for qualification
 test in accordance with the requirements of
 MIL-I-22110C under authorization.
 (Reference authorizing letter.)

4.5.2 Retention of qualification. The retention of qualification of the product approved for listing on the Qualified Products List (QPL) shall be maintained by periodic verification to determine compliance of the qualified product with the requirements of this specification. Unless otherwise specified by the activity responsible for the Qualified Products List, periodic verification shall be by certification and such certification shall be at intervals of not more than two years.

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TABLE I. Physical properties.

Properties	Test Paragraph	Requirements
Compatibility with barrier materials	4.11.1	No delamination, swelling, embrittlement dissolution or other deterioration to impair usefulness of barrier material.
Vapor inhibitor ability (VIA)	4.11.1	No corrosion, etching or pitting of polished surface of steel panel. <u>1/</u>
Vapor inhibitor ability after exhaustion	4.11.1	Comply with requirements of VIA test. <u>1/</u>
Contact corrosion	4.11.1	VCI specimens shall not cause (within marks) corrosion, etching, or pitting in contact area of panel.
Compatibility with copper	4.11.2	No pitting, etching or severe discoloration of vapor exposed copper surface. Discount attacks within 1/16 inch of edge of the test panel. <u>1/</u>
Temperature stability	4.11.3	Comply with requirements of VIA test.
Package stability	4.11.4	Comply with requirements of VIA test.
Sprayability	4.11.5	Sample must be sprayed without clogging through a 1/8 inch ID glass tube.

1/ Discount crystal haze or stain readily removed with methanol saturated gauze.

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4.6 Quality conformance inspection. The quality conformance inspection shall consist of the quality conformance tests listed in 4.8 and the examinations listed in table II.

4.6.1 Inspection lot. An inspection lot shall consist of a batch of VCI crystals manufactured from the same components, processed at the same time and offered for inspection at one time.

4.6.2 Sampling for quality conformance inspection. The sampling plan for quality conformance inspection shall be in accordance with MIL-STD-105, except where otherwise indicated in the specification.

TABLE II. Quality conformance examination and acceptance criteria.

Examination	Requirement para.	Inspection level	Acceptance quality level (AQL)
Shipping Containers	4.7.1	I	2.5
Unit Pack quantity	4.7.2	I	2.5
Packaging	4.7.3	S-3	2.5

4.7 Examination of end item.

4.7.1 Visual examination of shipping containers. A random sample of shipping containers shall be selected from each inspection lot at the inspection level and AQL specified in table II to verify conformance with closure, marking and packing requirements in Section 5.

4.7.2 Examination of unit pack for quantity of crystals. A random sample of unit packs shall be examined for the average quantity per unit pack. The average shall not be less than that required in 5.1. The inspection level and AQL shall be as specified in table II.

4.7.3 Examination of packaging. The sampling units used in 4.7.1 may be used in the examination of the unit pack for the preservation and container required in Section 5. The inspection level and AQL level shall be as specified in table II.

4.8 Quality conformance tests. The quality conformance tests shall be: vapor inhibitor ability, vapor inhibitor ability after exhaustion and spray-ability (see 4.11.1, 4.11.5).

4.8.1 Sampling for quality conformance tests. A one-pound sample shall be selected at random from each inspection lot.

4.8.2 Acceptance criteria for quality conformance tests. If the sample fails one or more tests the lot shall be rejected.

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4.9 Test conditions. The physical tests contained in this specification shall be made under controlled atmospheric conditions having a relative humidity of 50 \pm 5 percent and a temperature range from 70°F to 80°F (21°C to 27°C). Waiver of these requirements may be permitted where proper conditioning facilities are not available for control testing. However, for referee purposes, the specified tests shall be made upon the material in the specified atmospheric condition.

4.10 Preparation of equipment for test.4.10.1 Cleaning.

- a. The utensils and cloths used in the preparation of panels and test specimens shall be clean and free of contamination. Solvents shall be clean and renewed frequently. In all stages of treatment the handling of panels with bare hands shall be avoided. Panels shall not be permitted to contact contaminated surfaces during the cleaning procedure.
- b. After polishing metal panels and test specimens as specified for each procedure they shall be cleaned with surgical gauze and then scrubbed in a beaker of hot mineral spirits conforming to grade I of TT-T-291 with a surgical gauze swab. This shall be followed by successive immersions in hot mineral spirits, boiling 95 percent methanol and boiling absolute methanol, and then allowed to dry and stored in a desiccator until ready for use. If storage of more than 24 hours occurs, the surface preparation shall be repeated starting with the hand polishing.
- c. Apparatus used in the VIA test and exhaustion procedure shall be cleaned in a solution of hot water and detergent, followed by a double rinse in distilled water.
- d. Precautions - After all tests, the apparatus shall be thoroughly cleaned as described. Care should be taken to segregate test samples and to avoid accidental contamination. Hands should be washed after handling VCI and between periods of handling different VCI materials.

4.11 Test methods.

4.11.1 Tests from FED-STD-101. The following tests shall be conducted in accordance with the methods specified under FED-STD-101:

<u>TESTS</u>	<u>FED-STD-101 METHODS</u>
Compatibility with barrier materials	3004
Vapor Inhibitor Ability (VIA)	4031 Procedure A
VIA after exhaustion	4031 Procedure A
Contact corrosivity	3005

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4.11.2 Compatibility with copper.

4.11.2.1 Preparation of test assembly panel. Three panels of cold-rolled, hard temper copper conforming to QQ-C-576 and measuring 1/16 by 1/2 by 3 inches shall be polished to remove pits and irregularities from all surfaces. The panels shall be finished with 240 grit alundum. The use of "wet" or "dry" paper is prohibited. Iron oxide abrasives shall not be used. The final abrasion shall be in a direction parallel to the length of the panel. A glass jar with a screw type plastic lid of one pint capacity measuring approximately 2-1/2 inches in diameter and 5-1/2 inches in height shall be used as the test jar.

4.11.2.2 Procedure. Twenty-five ml of a solution of glycerine (synthetic grade) and distilled water having a specific gravity of $1.103 \pm 3^\circ\text{F}$ ($24 \pm 2^\circ\text{C}$) shall be poured into the test jar to provide a relative humidity of 85 ± 3 percent at $150^\circ \pm 2^\circ\text{F}$ ($66 \pm 1^\circ\text{C}$). A glass vessel suitable for use as a stage shall be inverted and placed inside test jar. Then $0.10 \pm .005$ gram of VCI shall be placed over the area of the stage. The copper specimens shall be suspended from the lid of the jar in such a manner as to prevent contact with the stage or sidewalls of the jar and be approximately 1/4 inch above the VCI. The test jar shall be sealed and the junction of the lid with the glass covered with a tape having a low water vapor transmission rate. The test jar shall then be placed in a circulating air oven maintained at $150 \pm 2^\circ\text{F}$ ($66 \pm 1^\circ\text{C}$) for 7 days, after which time it shall be removed from the oven and allowed to cool to room temperature. The copper panels shall be removed and examined for evidence of corrosive effects from the vapor such as pitting, etching, or severe discoloration (see table I). Light brown, purplish, bluish, or "peacocking" stains or any slight discoloration normally associated with light oxidation of copper shall not be considered corrosive effects for the purpose of this test.

4.11.3 Temperature stability.

4.11.3.1 Preparation of assembly. A $0.50 \pm .005$ gram sample of crystals shall be weighed into a glass vial approximately 3 by 1 inch I.D. A No. 4 rubber stopper shall be used to seal the vial. The junction of the rubber stopper and the glass vial shall be covered with a tape having a low water vapor transmission rate. The vial shall then be exposed to a temperature of $140 \pm 2^\circ\text{F}$ ($60 \pm 1^\circ\text{C}$) for 72 hours, at the end of which time it shall be permitted to cool at room temperature.

4.11.3.2 Procedure. A $0.10 \pm .005$ gram sample of the above material shall be atomized (see figures 1 and 2, Test Method 4031, of FED-STD-101) into a VIA test assembly, and a VIA test run. Test shall be performed in triplicate (see table I for requirements).

4.11.4 Package stability. A closed, filled unit pack of the crystals shall be stored at a temperature of 70°F to 90°F (21°C to 32°C) for one year. At the end of the storage period the unit pack shall be opened, and the crystals shall be tested for compliance with the requirements of the vapor inhibiting ability (VIA) test (see table I).

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4.11.5 Sprayability.

4.11.5.1 Preparation of material. Sufficient sample of the crystals shall be placed in a 2-by 7/8-inch vial to fill it to a depth of 1 inch. The half filled vial shall remain for 24 hours at conditions of $75 \pm 5^{\circ}\text{F}$ ($24 \pm 3^{\circ}\text{C}$) and 50 ± 10 percent relative humidity.

4.11.5.2 Procedure. The vial shall be attached to the test apparatus as shown in figure 1. The sample shall be exhausted by squeezing the bulb while gently shaking the apparatus. All of the samples should be exhausted without clogging tube D. This test shall be run on samples both as received and on samples which have been exposed at $70 \pm 2^{\circ}\text{F}$ ($21 \pm 1^{\circ}\text{C}$) and 85% relative humidity for 14 days. The entire sample shall be sprayable without clogging the tube (see table I).

5. PACKAGING.

5.1 Preservation. Preservation shall be level A or Commercial, as specified (see 6.2). The quantity per unit pack shall be 1 pound, 5 pounds, 10 pounds, 25 pounds or 50 pounds as specified by the acquiring activity (see 6.2).

5.1.1 Level A. The VCI crystals in one pound quantities shall be preserved in containers conforming to PPP-C-186, group A, class 1 or class 2 with type, style, closure and seal optional. Five and ten pound quantities shall be preserved in cans conforming to PPP-C-96, type V, class 2. Twenty-five and fifty pound quantities shall be preserved in fiber drums conforming to PPP-D-723, type III, grade A or metal pails conforming to PPP-P-704, type III, class 1.

5.1.2 Commercial. The VCI crystals shall be preserved in accordance with ASTM D 3951.

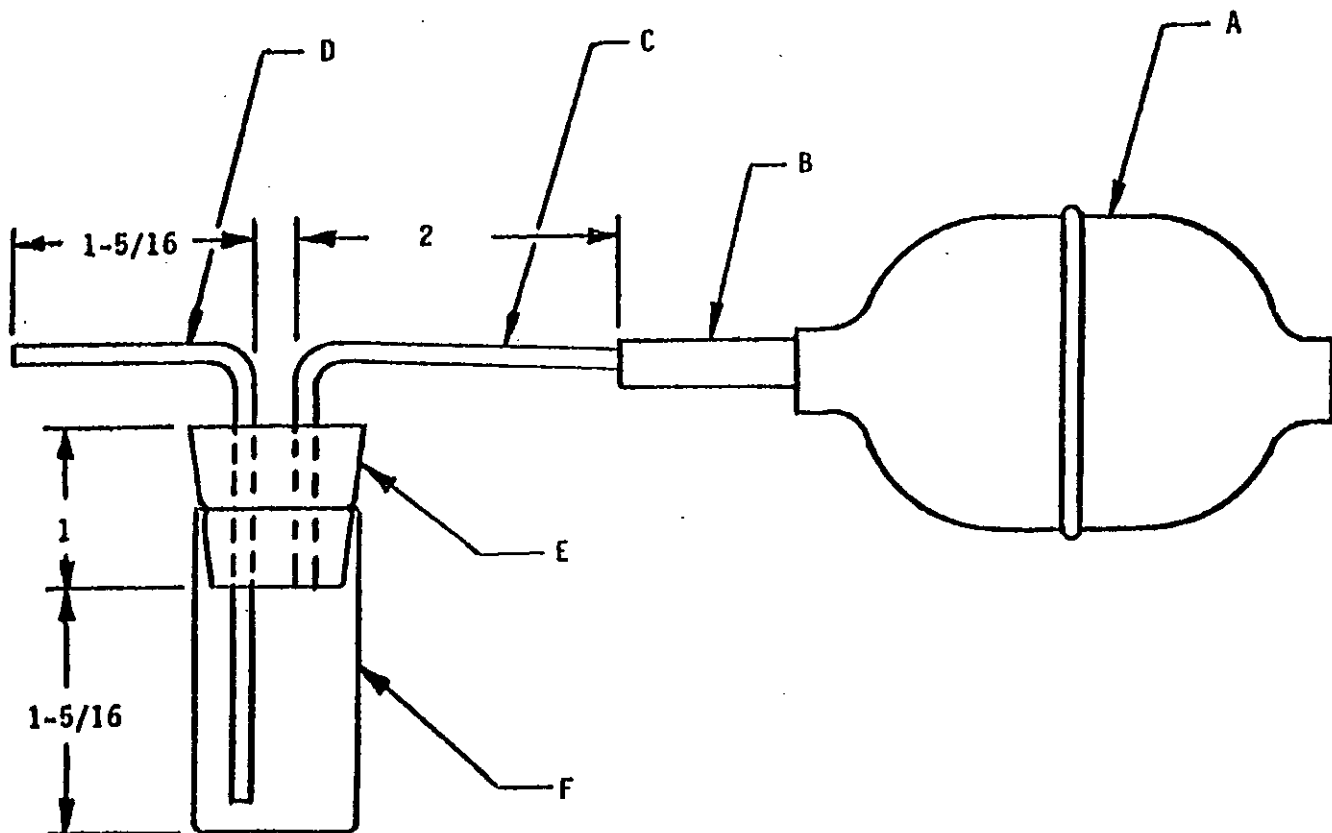
5.2 Packing. Packing shall be level A, B or Commercial as specified (see 6.2).

5.2.1 Level A. The VCI crystals preserved as specified for one, five and ten pound quantities shall be overpacked in overseas type exterior containers conforming to PPP-B-601 or PPP-B-621. Twenty-five and fifty pound quantities preserved in metal pails conforming to PPP-P-704, type III, class 1, require no overpacking.

5.2.2 Level B. The VCI crystals preserved as specified for one, five and ten pound quantities, in fiber drums or metal cans (see 5.1.1) shall be packed in weather-resistant type exterior containers conforming to PPP-B-636 or PPP-B-640 as specified by the acquiring activity. The VCI crystals preserved in fiber drums conforming to PPP-D-723, type III, grade A shall require no overpacking.

5.2.3 Commercial. VCI crystals shall be packed in accordance with ASTM D 3951.

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**LEGEND:**

A - Bulb, Davol Rubber Co.,
Providence, R.I., Bulb No. 1051S.

B - Rubber tubing - 1 inch long.

C - Pyrex glass tubing - 1/8 ID,
length to suit.

D - Pyrex glass tubing - 1/8 ID,
length to suit.

E - Rubber stopper - No. 4 with
suitable holes to accommodate
glass tubing.

F - Glass vial - 2 by 7/8 ID.

DIMENSIONS IN INCHES.

Figure 1. Apparatus for determining sprayability of
the volatile corrosion inhibitor.

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5.3 Marking.

5.3.1 Interior and exterior containers shall be marked as specified in MIL-STD-129.

5.3.2 Precautionary markings. All individual containers shall be marked with the following precautionary marking:

WARNING: KEEP IN COOL, DRY PLACE. KEEP CONTAINERS CLOSED, WHEN NOT IN USE. DO NOT RUB OR WIPE EYES WHILE HANDLING THIS PRODUCT. AFTER HANDLING, WASH HANDS. PRODUCT MAY CONTAIN MILD IRRITANT TO EYES AND HANDS.

6. NOTES

6.1 Intended use. The VCI crystals covered by this specification are intended for use as a preservative for ferrous, aluminum, aluminum-base alloys and components containing zinc plate, cadmium, zinc-base alloys, magnesium-base alloys, lead-base alloys and alloys of other metals (including solders and brazing alloys) having less than 30 percent of zinc and 9 percent of lead. (Direct contact with nonferrous metals except aluminum and aluminum-base alloys shall be avoided. Direct contact with nonmetals shall be avoided unless the specific inhibitor has passed the compatibility test specified in MIL-I-8574.) Unit packs must be sealed to prevent escape of VCI vapors. Application instructions for the use of VCI crystals may be found in MIL-I-8574.

6.2 Ordering data. Requests, requisitions, schedules and contracts or orders should contain the following:

- a. Title, number and date of this specification.
- b. Total quantity and quantity per unit pack (see 5.1).
- c. Selection of applicable levels of preservation and packing (see 5.1 and 5.2).
- d. Addresses for submission of MSDS's (see 3.2.1 and 4.3).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products, which are at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the contractors is called to this requirement, 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 orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Commander, Naval Air Systems Command, Department of the Navy, Washington, D.C. 20360; however, information pertaining to qualification of products may be obtained from the Commander, Naval Air Development Center, Aircraft and Crew Systems Technology Directorate (Code 60622), Warminster, Pennsylvania 18974. It is understood, after

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receipt of the letter of authorization, that samples shall be furnished at no cost to the Government and that the manufacturer will pay all transportation charges to and from the point where the tests are made. In case of failure of the sample or samples submitted, consideration will be given to the request of the manufacturer for additional tests only after it has been clearly shown that changes have been made in the product which the Government considers sufficient to warrant additional tests. The cost of retests will be borne by the manufacturer.

Custodians:

Army - EA
Navy - AS
Air Force - 69
DSC - GS

Preparing activity:

Navy - AS
(Project No. 6850-0775)

Review activities:

Army - AT, SM, EA, AR
Navy - SH, YD, SA, OS
Air Force - 99

User activities:

Navy - MC, CG