

NOT MEASUREMENT SENSITIVE

MIL-C-81945B(AS)

10 March 1989

SUPERSEDING

MIL-C-81945A(AS)

2 June 1980

MILITARY SPECIFICATION

COATING COMPOUNDS, WEAPON INSULATION, INTUMESCENT

This specification is approved for use by the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers intumescent coatings for the exterior surfaces of aircraft ordnance to provide protection from high-flux thermal environments. The composition of this mixture shall not contain any carcinogenic properties capable of contaminating the environment or endangering human health.

1.2 Classification. Coating compounds shall be of the following types as specified herein:

Type I - Coating for spray application

Type II - Coating for hand trowelled application and use in the manufacture of intumescent sheet materials

Type III - Intumescent sheet materials

The coating compounds may be provided as multi-component systems (resin and curing agent), or as single component systems. The intumescent sheet materials are provided as solid sheets for gluing to the object to be protected.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards 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).

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 53), Naval Air Engineering Center, Lakehurst, NJ 08733-5100, 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 8010

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SPECIFICATIONS

FEDERAL

L-P-1040	Plastic Sheets and Strips (Polyvinyl Fluoride)
QQ-A-250/5	Aluminum Alloy Alclad 2024, Plate and Sheet
QQ-A-250/11	Aluminum Alloy 6061, Plate and Sheet
PPP-D-711	Drum: Metal, Shipping, Steel, Lightweight (55 Gallon)
PPP-D-729	Drums, Shipping and Storage, Steel, 55 Gallon (208 Liters)
PPP-P-704	Pails, Metal: (Shipping, Steel, 1 Through 12 Gallons)

MILITARY

MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-P-23377	Primer Coatings: Epoxy-Polyamide, Chemical and Solvent Resistant
MIL-L-23699	Lubricating Oil, Aircraft Turbine Engines, Synthetic Base
MIL-C-81706	Chemical Conversion Materials for Coating Aluminum and Aluminum Alloys
MIL-C-83286	Coating, Urethane, Aliphatic Isocyanate, for Aerospace Applications
MIL-C-85285	Coating, Polyurethane, High-Solids

STANDARDS

FEDERAL

FED-STD-141	Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing
FED-STD-313	Material Safety Data Sheets; Preparation and Submission of
FED-STD-406	Plastics: Methods of Testing

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STANDARDS (Continued)

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MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-147	Palletized Unit Loads
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-1648	Criteria and Test Procedures for Ordnance Exposed to an Aircraft Fuel Fire
MIL-STD-2098	Ordnance Preparation and Application of Intumescent Sheet, Type III

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Naval Publications and Forms Center (Attn: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government documents and publications. The following other Government documents and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

CODE OF FEDERAL REGULATIONS

29 CFR 1910.1200	Material Safety Data Sheet; Preparation and Submission of
49 CFR 171-178	Regulations for the Transportation of Hazardous Materials

(Application for copies of the Code of Federal Regulations (CFR) should be addressed to the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

DEPARTMENT OF THE NAVY

WR-50	Warhead Safety Tests, Minimum for Air, Surface and Underwater Launched Weapons
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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 the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issue of the documents cited in the solicitation (see 6.2).

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AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI Z 129.1

Precautionary Labeling of Hazardous Industrial Chemicals

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 638

Tensile Properties of Plastics

ASTM D 1014

Conducting Exterior Exposure Tests of Paints on Steel

ASTM D 1475

Density of Paint, Varnish, Lacquer, and Related Products

ASTM D 1748

Rust Protection by Metal Preservatives in the Humidity Cabinet

ASTM D 2196

Viscosity Measurements and Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield) Viscometer

ASTM D 2794

Resistance of Organic Coatings on the Effects of Rapid Deformation (Impact)

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

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC., AGENT

National Motor Freight Classification

(Application for copies should be addressed to the National Motor Freight Traffic, Tariff Order Section, 1616 P Street, N.W., Washington, DC 20036.)

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification Rules

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 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.

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3. REQUIREMENTS

3.1 Qualification. The coating compounds 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 set for opening of bids (see 4.4 and 6.3). Any change in the formulation of a qualified product will necessitate its requalification. The material supplied under contract shall be identical, within manufacturing tolerances, to the product receiving qualification.

3.2 Materials. Materials specified herein shall be of such a quality as to produce products conforming to the requirements of this specification.

3.3 Toxicity. The manufacturer shall certify that the coating compounds contain no substance known to be toxic to the user under normal conditions of usage. Questions pertinent to the effect of these primer coatings 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 adviser to the acquiring activity (see 4.4.2 and 6.2(1)). Material Safety Data Sheets shall be prepared and submitted in accordance with FED-STD-313 and shall meet the requirements of 29 CFR 1910.1200. One copy shall accompany the samples being submitted to the qualifying activity for testing (see 4.4.2).

3.4 Performance characteristics.

3.4.1 Application. When used according to the manufacturer's directions, the coating compounds shall be usable by the intended application method.

3.4.1.1 Application, Type I. The coating shall be sprayable and yield a minimum dry film thickness per coat of 0.030 inch (0.75 millimeters (mm)) on a vertical surface. The coating shall show no streaking, sagging, cracking, or pronounced orange-peel (see 4.7.7.1). The admixed coating shall not gel within 45 minutes.

3.4.1.2 Application, Type II. Type II material shall be easily worked with a putty knife and must be compatible with the manufacturing process used in the preparation of Type III sheet material. Type II materials are used in repairing Type I and III materials. The admixed coating shall not gel within 30 minutes.

3.4.1.3 Application, Type III. Type III materials shall be capable of being bonded to the curved surface of ordnance items.

3.4.2 Thermal efficiency. The thermal efficiency of the coating compound shall not be less than 2.0 seconds per 0.001 inch (25.4 micrometer (m)) to reach a backface temperature of 260°C (500°F) (see 4.7.8) before and after being subjected to the humidity test of 4.7.14.

3.4.3 Adhesion. Panels coated and tested as specified in 4.7.11, when bent around a mandrel 1 ± 0.003 inch (25.4 \pm 0.08 mm) in diameter, shall not exhibit adhesive failure from the epoxy primer or polyurethane topcoat. Cracking of the coating is acceptable and shall not be cause for rejection.

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3.4.4 Impact resistance. The cured coating system (see 4.6) impact resistance when tested as specified in 4.7.13.2 shall not be less than 20 inch-pounds on direct (coated surface) impact.

3.5 Environmental requirements.

3.5.1 Storage stability. After storage in closed containers for six months from the date of manufacture, Type I, II and Type III coatings shall conform to the original chemical and physical properties (see 3.6). In addition, Type III coatings shall meet the requirements of 3.4.2, 3.8.1 and 3.8.2 for a period of at least five years.

3.5.2 Lubricating oil resistance. The cured coating compound shall withstand immersion in oil for a period of 4 hours at a temperature of $60^{\circ} \pm 2^{\circ}\text{C}$ ($140^{\circ} \pm 4^{\circ}\text{F}$). Four hours after removal, the coating shall show no blistering, softening or other defects (see 4.7.12). Discoloration shall not be a cause for rejection.

3.5.3 Humidity resistance. The cured coating system (see 4.6) after testing as specified in 4.7.14, shall have a minimum Shore D hardness of 55 upon removal of the panels from the cabinet (see 4.7.10.2).

3.5.4 Thermal shock resistance. There shall be no evidence of cracking, loss of adhesion, or film deterioration of the coating system (see 4.6) when tested as specified in 4.7.15.

3.5.5 Weather resistance. There shall be no evidence of cracking or coating deterioration after one year exposure as specified in 4.7.16.

3.6 Chemical and physical properties.

3.6.1 Condition in container.

3.6.1.1 Type I and Type II. Components shall mix easily to a smooth homogeneous condition. There shall be no trace of grit, seeds, skins, or lumps and no evidence of hard or objectionable settling which cannot be readily dispersed. No more than 0.1 percent by weight of each component shall be retained on United States Standard Sieve (USSS) No. 40 (see 4.7.4).

3.6.1.2 Type III coatings. The intumescent sheets shall bend to conform to the curvature of the ordnance items they are to be applied to and shall have no curling, shrinkage, discoloration, lumps, or voids that would interfere with their application or effectiveness (see 4.7.6). The outside surface of the Type III coating shall be covered with .002 inch thickness of plastic, L-P-1040, Type II, Grade B, Class I.

3.6.2 Hardness. Panels prepared as specified in 4.7.8.1 shall be cured at $23^{\circ} \pm 3^{\circ}\text{C}$ ($73^{\circ} \pm 5^{\circ}\text{F}$) and the coating shall conform to the following hardness requirements:

<u>Time/Hours</u>	<u>Minimum Shore A Hardness</u>
24	80
48	90

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3.6.3 Tensile properties. The minimum tensile properties of the coating compound when tested as specified in 4.7.9 shall be as follows:

Temperature (°C)	Ultimate Strength (psi)	Elongation at Break (percent)
-40	2550.0	1.7
23	450.0	3.2
60	70.0	7.0

3.6.4 Type III dimensional properties. Size shall be as specified in contract or purchase order (see 6.2.1(e)).

3.6.5 Color. The components shall be supplied in the manufactured color. When admixed in the ratio specified by the manufacturer, the resultant color of the coating shall range from white to amber.

3.7 Component requirements. The coating compound furnished under this specification consists of two separately packaged components. Component I shall consist of an epoxy modifier and curing agent, with thermally activated fillers, diluent and a thixotrope. Component II shall consist of an epoxy resin with active fillers, thixotrope and diluent. Component A of Type I shall conform to the requirements specified in 3.6, 3.7 and Table I. Component B of Type I shall conform to the requirements specified in 3.6, 3.7 and Table II.

TABLE I. Component A requirements (Type I only).

Characteristics	Requirements		Test Paragraph
	Minimum	Maximum	
Viscosity, Centipoises	13,000	100,000	4.7.1
Density, Pounds per Gallon	11.0	11.6	4.7.2
Nonvolatile Content, Percent by Weight	80.0	91.0	4.7.3

TABLE II. Component B requirements (Type I only).

Characteristics	Requirements		Test Paragraph
	Minimum	Maximum	
Viscosity, Centipoises	13,000	60,000	4.7.1
Density, Pounds per Gallon	11.0	11.6	4.7.2
Nonvolatile Content, Percent by Weight	85.0	95.0	4.7.3

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3.8 Full-scale testing.

3.8.1 Coated ordnance environmental performance. The coating system applied to ordnance items (see 4.6.7) shall pass the temperature and humidity cycling, transportation vibration and abrasion, and aircraft vibration environmental tests specified in 4.7.17 without evidence of loss of adhesion, blistering, flaking, or cracking to the substrate.

3.8.2 Fast cook-off. The ordnance specimen coated as specified in 4.6.7 shall meet the requirements of the fast cook-off test specified in MIL-STD-1648 (see 4.7.18).

3.9 Workmanship. Each coating shall be uniform in consistency and free of agglomerates or foreign particles. There shall be no other defects present that would render the end product unsuitable for its intended purpose (see 4.5.3.3).

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. The contractor shall furnish to the contracting activity the toxicological data and formulations 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.

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

- a. Qualification inspection (see 4.4).
- b. Quality conformance inspection (see 4.5).

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4.3 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in the test method document or the applicable paragraph of this specification.

4.4 Qualification inspection. Qualification inspection shall be as specified in Table III and performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures to be used in production. One or more failures shall be cause for refusal to grant qualification approval.

4.4.1 Qualification sample. Qualification samples shall consist of wet samples and test panels necessary for performing the tests specified in Table III. Test panels shall be prepared by the spraying method for Type I, the casting method for Type II or the adhesive method for Type III material (see 4.6.1 to 4.6.6). Wet samples shall consist of at least one gallon of coating compound. The samples shall be representative of the components and materials to be used during production. They shall be furnished in the containers to be used in filling contract orders. The samples shall be identified as follows and forwarded to the laboratory designated in the letter of authorization (see 6.3).

- . Qualification test sample
- . Specification MIL-C-81945B(AS), Type I, II or III (as applicable)
- . Coating Compounds, Weapon Insulation, Intumescent
- . Coating thickness, Type III only
- . Manufacturer's name and product number
- . Submitted by (name and date) for qualification testing in accordance with authorization (reference authorizing letter)

4.4.2 Test report. In addition to the qualification test samples, the manufacturer shall furnish a test report showing that the material conforms to the requirements of this specification. Material Safety Data Sheets shall be prepared and submitted in accordance with FED-STD-313 and 29 CFR 1910.1200.

4.4.3 Retention of qualification. In order to obtain qualification of products approved for listing on the Qualified Products List (QPL), the manufacturer shall verify by certification to the qualifying activity that his product(s) comply with the requirements of this specification. Unless otherwise specified by the qualifying activity, the time of periodic verification by certification shall be in two-year intervals from the date of original qualification. The certification action shall be initiated by the qualifying activity.

4.5 Quality conformance inspection.

4.5.1 Lot information. A lot shall consist of all the coating compound of the same type, manufactured at one time from one batch, forming part of one contract, and submitted for acceptance. A batch shall consist of all coating material manufactured during one continuous operation and forming part of one contract or order for delivery.

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4.5.2 Retention sample. Not less than one quart of the coating compound shall be selected at random from each batch by an authorized government representative and forwarded to the laboratory specified in the contract or purchase order.

TABLE III. Qualification and inspection.

Inspection	Requirement Paragraph	Test Method Paragraph	Qualification Testing	Quality Conformance Inspection
<u>Each Component</u>				
Color	3.6.5,		Yes	Yes
Viscosity	3.7	4.7.1	Yes	Yes
Density	3.7	4.7.2	Yes	Yes
Nonvolatile content	3.7	4.7.3	Yes	Yes
Condition in container	3.6.1	4.7.4	Yes	Yes
Storage stability	3.5.1	4.7.5	Yes	---
<u>As Used</u>				
Physical characteristics <u>1/</u>	3.6.1.2	4.7.6	Yes	Yes
Container fill		4.5.3.2	---	Yes
Workmanship	3.9	4.5.3.3	---	Yes
Packaging		4.5.3.3	---	Yes
Application	3.4.1	4.7.7	Yes	Yes
Thermal efficiency	3.4.2	4.7.8	Yes	---
Tensile properties	3.6.3	4.7.9	Yes	---
Hardness	3.6.2	4.7.10	Yes	Yes
Adhesion	3.4.3	4.7.11	Yes	Yes
Lubricating oil resistance	3.5.2	4.7.12	Yes	---
Impact resistance	3.4.4	4.7.13	Yes	---
Humidity resistance	3.5.3	4.7.14	Yes	---
Temperature shock resistance	3.5.4	4.7.15	Yes	---
Weather resistance	3.5.5	4.7.16	Yes	---
Environmental performance tests	3.8.1	4.7.17	Yes	---
Temperature and humidity cycling	3.8.1	4.7.17.1	Yes	---
Transportation, vibration and abrasion	3.8.1	4.7.17.2	Yes	---
Aircraft vibration	3.8.1	4.7.17.3	Yes	---
Fast cook-off	3.8.2	4.7.18	Yes	---

1/ Type III material only.

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4.5.2.1 Batch data. With each sample, the manufacturer shall furnish a certified test report showing that the material meets the quality conformance requirements (4.5). In addition, the manufacturers shall certify that there has been no formulation or process change from that which resulted in the production of the qualification inspection sample. Each ingredient material shall be identified with the name of its manufacturer and that manufacturer's trade name and formula number.

4.5.3 Examinations.

4.5.3.1 Tests. Quality conformance inspection tests shall be as specified in Table III. There shall be no failures. Samples shall be sufficient in size to conduct all the required tests. Containers shall only be opened when being tested.

4.5.3.2 Visual inspection of filled containers. Samples selected at random for examination in accordance with 4.5.3.3 shall be examined for proper filling and weight.

4.5.3.3 Examination of packaging and marking. An examination shall be made to determine that packaging, packing and marking comply with the requirements of Section 5 of this specification. Defects shall be scored in accordance with the list below. The sample unit for this examination shall be one shipping container fully prepared for delivery except that it shall not be palletized and need not be sealed. Shipping containers fully prepared for delivery that have not been palletized shall be examined for defects of closure. The lot size shall be the number of shipping containers in the end item inspection lot. The samples for this examination shall be selected at random in accordance with MIL-STD-105. Inspection level S-4 and acceptable quality level (AQL) 2.5 defects per hundred units.

Examine

Defect

Packaging

Container not as specified, closures not accomplished by specified or required methods or materials.
Leakage or seepage of contents.
Non-conforming component, component missing, damaged or otherwise defective. Bulged or distorted container.

Markings

Data, including directions for use, omitted, illegible, incorrect, incomplete or not in accordance with contract requirements.

4.5.3.4 Examination for palletization. An examination shall be made to determine that palletization complies with the requirements of Section 5 of this specification. Defects shall be scored in accordance with the list below. The sample unit shall be one palletized unit load fully prepared for delivery. The lot size shall be the number of palletized unit loads in the end item inspection lot. The samples for this examination shall be selected at random in accordance with MIL-STD-105, inspection level S-1 and acceptable quality level (AQL) 6.5 defects per hundred units.

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<u>Examine</u>	<u>Defect</u>
Finished dimension	Length, width, or height exceeds specified maximum requirement.
Palletization	Not as specified. Pallet pattern not as specified. Interlocking of loads not as specified. Load not bonded with required straps as specified.
Weight	Exceeds maximum load limits.
Marking	Omitted, incorrect, illegible, of improper size, location, sequence or method of application.

4.5.4 Rejection and retest. Failure in any quality conformance test shall result in rejection of that batch and shall constitute sufficient justification for removal from the qualified products list. Rejected material shall not be resubmitted for acceptance without written approval from the Naval Air Development Center, Code 6062, Warminster, PA 18974. The application for resubmission shall contain full particulars concerning previous rejections and measures taken to correct these deficiencies. Samples for retest shall be randomly selected as in 4.5.2 and forwarded to the testing activity.

4.6 Test specimens.

4.6.1 Test panels. Except as otherwise specified herein, test panels shall be 6061 aluminum alloy conforming to QQ-A-250/11, condition T-6. The panels shall be 0.040 by 3 by 6 inches (.1 by 7.6 by 15.2 cm) in size and treated with materials conforming to MIL-C-81706, Class 1A, to produce coatings conforming to MIL-C-5541, Class 1A.

4.6.2 Primer. Epoxy-polyamide primer conforming to MIL-P-23377 or MIL-P-85582, Type I, shall be applied to the panels of 4.6.1 to a dry film thickness of 0.0006 to 0.0009 inches (0.6 to 0.9 mils) and then dried for 1 to 24 hours.

4.6.3 Insulating coating compound Type I (spray method). Application of the coatings and preparation of the panels shall be as follows:

- a. Test panels prepared as specified in 4.6.1.
- b. Epoxy primer applied as specified in 4.6.2.
- c. Insulating coating compound sprayed (Type I) to a film thickness of 0.06 to 0.07 inches. Air dry 24 hours prior to application of the topcoat.
- d. Polyurethane topcoat applied as specified in 4.6.6.

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4.6.4 Insulating coating compound Type II (casting method). Coating compounds shall be mixed in accordance with the manufacturer's instructions. With a doctor blade, spread to a thickness of 0.06 to 0.07 inches on the prepared surface of the test panels. Except for panels prepared for the determination of hardness (3.6.2), all other panels shall be conditioned for a minimum of 7 days at $23^{\circ} \pm 3^{\circ}\text{C}$ ($73^{\circ} \pm 5^{\circ}\text{F}$) prior to testing.

4.6.5 Insulating coating compound Type III (adhesive method). The Type III material shall be adhered to test panels prepared as specified in 4.6.1 and 4.6.2 using manufacturer approved methods or methods required by the procuring activity (see 6.2.1(f)).

4.6.6 Topcoat. Test panels of 4.6.1 requiring topcoating for tests specified herein shall be coated by conventional spray application with polyurethane coating conforming to MIL-C-83286 or MIL-C-85285. Apply the topcoat to produce a dry film thickness of 0.0017 to 0.0023 inches (1.7 to 2.3 mils). Coated panels shall be conditioned for a minimum of 7 days at $73 \pm 5^{\circ}\text{F}$ ($23 \pm 3^{\circ}\text{C}$) prior to testing.

4.6.7 Application of coatings to the ordnance specimen. Application of the coating to the ordnance specimen shall be in accordance with applicable drawings, specifications and standards for the ordnance item being tested.

4.7 Test methods.

4.7.1 Viscosity. Each separate component shall be carefully mixed by hand, so as not to introduce entrapped air into the material. The test shall be conducted within 10 minutes after mixing (before settling or solvent migration can occur) in accordance with ASTM D 2196. Using a #6 spindle at a rotational speed of 10 rpm, determine the viscosity after 5 minutes of running time has elapsed.

4.7.2 Density. The density of each component shall be determined in accordance with ASTM D 1475.

4.7.3 Nonvolatile content. The nonvolatile content of each component shall be determined in accordance with Method 4042 of FED-STD-141, except use a 2.0 ± 0.5 gram sample, an oven temperature of $50^{\circ} \pm 1^{\circ}\text{C}$ ($122^{\circ} \pm 2^{\circ}\text{F}$) for 30 minutes under a continuous vacuum of 29 ± 0.5 inches Hg while maintaining a slight air blend, and omit the addition of the solvent toluene.

4.7.4 Condition in container.

4.7.4.1 Type I and Type II coatings. Each component shall be stirred. The presence of coarse particles shall be determined by pouring a weighed sample of the material into a No. 40 sieve and washing it through the screen with ample amounts of toluene. The weight of the solid particles retained on the sieve shall be compared to the weight of the original sample.

4.7.4.2 Type III intumescent sheet. The sheets shall show no shrinkage, curling, warping, delamination, or surface changes that prevent them from being applied using approved methods (see 4.6.5 and 6.1).

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4.7.5 Storage stability. Unopened containers of each component shall be stored for six months at temperatures of $18^{\circ} \pm 14^{\circ}\text{C}$ ($65^{\circ} \pm 25^{\circ}\text{F}$), remixed thoroughly, and tested for conformance to component requirements (see 3.7).

4.7.6 Physical characteristics of Type III coating. Unless otherwise specified in the contract or purchase order, inspection, test and repair procedures for assurance of physical characteristics shall be prepared by the contractor. Inspect the sheets to verify material size and conformance as specified in the contract or purchase order. The procedures shall include those necessary to ensure that Type III sheets meet the requirements of 3.6.1.2 (see 3.6.4).

4.7.7 Application.

4.7.7.1 Type I (sprayable coating). The material shall be spray applied in the ratio specified by the manufacturer with the high pressure airless spray equipment manufactured by the Gray Company (GRACO), Model No. FSQ-1700 or equivalent.

4.7.7.2 Type II (trowellable coating). Type II material shall be easily worked with a putty knife and must be compatible with the manufacturing process used in the preparation of Type III sheet material. Type II materials are used in repairing Type I and III materials and filling gaps during the application process.

4.7.7.3 Type III (adhesive bonded). Type III material shall adhere to ordnance items using methods as specified in MIL-STD-2098(AS).

4.7.8 Thermal efficiency.

4.7.8.1 Panel preparation. Prepare six panels each 0.040 by 3 by 3 inches (1 by 76 by 76 mm) in size and six discs each 15/16 inch (24 mm) in diameter by 0.040 inch (1 mm) in thickness from aluminum (6061) sheets conforming to QQ-A-250/11, Condition T-6. Cut a 1 inch (25 mm) hole in the center of each panel and cement the discs in the holes with a metal-to-metal type epoxy bonding compound capable of withstanding high temperatures. (Cementing the discs in the panels reduces thermal conductance effects from the edges.) The test panels shall be primed as specified in 4.6.2 and coated with the insulating coating compound by spraying (Type I), trowelling (Type II), or adhesive bonding (Type III). Type I coating shall be machined to uniform film thickness of 0.06 to 0.07 inches. Prior to testing, spray the topcoat over the (Type I or Type II) compound as specified in 4.6.6. Type III compound does not require a topcoat. Save three panels for the humidity resistance test (4.7.14).

4.7.8.2 Procedure. This test exposes the coating to a fire environment where a total flux of $10 \text{ BTU/Ft}^2 - \text{sec}$ ($113.5 \text{ kilowatt per meter}^2$ (kW/m^2)) as measured by an asymptotic calorimeter is 90 percent radiative in a slightly fuel rich condition. The average emissivity of the source of the radiant heat flux shall be at least equal to 0.9. Aviation fuel (JP-4 or JP-5) conforming to MIL-T-5624 shall be used to fire the unit. The coated panel thickness shall be measured and recorded. When ready to test, the panel

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shall be inserted in a transite mask or any thermally insulated holder which allows the panel to rest on the outer 1/4 inch (6.3 mm) of the coated surface. The backside of the test panel shall be insulated with 6 lbs/ft³ (96 kilogram per meter³ (kg/m³)) refractory fiber insulation. At time, $T = 0$, the masked panel shall be placed over the fire box and a thermocouple in contact with the back of the disc records the temperature rise on the panel. The maximum initial panel temperature prior to fire testing shall be 32°C (90°F). The flux shall be uniform over the entire panel and the center disc shall be approximately 8-10 percent of the exposed area and shall be representative of a larger, semi-infinite panel. The time-temperature data and the film thickness shall be recorded and a report made of the time, in seconds, to reach a backface temperature of 260°C (500°F) for the recorded thickness of the coating. The test results shall conform to 3.4.2 and the data reported shall be an average of three determinations.

4.7.9 Tensile properties. The tensile properties shall be determined in accordance with ASTM D 638 at -40°, 23° and 60°C (-40°, 73° and 140°F). The tension test specimen dimensions shall meet the requirements of Type I for a 1/4-inch maximum sheet, Figure 1011A, 0.125 inch thick.

4.7.10 Hardness.

4.7.10.1 Shore A hardness. Two panels shall be prepared as specified in 4.6.1 through 4.6.3 without a topcoat. The casting method shall be employed to form a uniform coating thickness of 0.06 to 0.07 inches. The coated panels shall be cured at $23^\circ \pm 3^\circ\text{C}$ ($73^\circ \pm 5^\circ\text{F}$) and the hardness determined at each time interval of 3.6.2 in accordance with Method 1082 of FED-STD-406.

4.7.10.2 Shore D hardness. Three coated panels of 4.7.15 shall be cooled to room temperature, and the Shore D hardness shall be determined in accordance with Method 1083 of FED-STD-406. Check for conformance to 3.5.3.

4.7.11 Adhesion. Panels shall be aluminum alloy conforming to QQ-A-250/5, 0 Condition, and anodized in accordance with MIL-A-8625, Type II. They shall be 0.020 by 3 by 6 inches (0.5 by 76 by 150 mm) in size and finished with the primer and coating compounds specified in 4.6. The panels shall be tested in accordance with Method 6221 of FED-STD-141 and checked for conformance to 3.4.3.

4.7.12 Lubricating oil resistance. Panels shall be prepared as specified in 4.6. The panels shall then be immersed in MIL-L-23699 lubricating oil at a temperature of $60^\circ \pm 3^\circ\text{C}$ ($140^\circ \pm 5^\circ\text{F}$) for a period of 4 hours. Four hours after removal, the panels shall be examined for conformance to 3.5.2.

4.7.13 Impact resistance.

4.7.13.1 Panel preparation. Panels shall be aluminum alloy conforming to QQ-A-250/5, 0 Condition, and anodized in accordance with MIL-A-8625, Type II. They shall be 0.020 by 3 by 6 inches (0.5 by 76 by 150 mm) in size and finished as follows: Apply epoxy primer, coating compound and topcoat as specified in 4.6.7.

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4.7.13.2 Impact test. The impact resistance shall be determined in accordance with ASTM D 2794. Panels from 4.7.14 shall be used with the film side up. Check for conformance to 3.4.4.

4.7.14 Humidity resistance. Three panels prepared as specified in 4.7.8.1 shall be subjected to 336 hours of exposure at 100 percent relative humidity at 49°C (120°F) in accordance with the method specified in ASTM D 1748. Determine the Shore D hardness in accordance with 4.7.10.2.

4.7.15 Thermal shock resistance. Three panels prepared as specified in 4.6 shall be tested in accordance with Method 503.1 of MIL-STD-810 except as follows:

- a. The internal hot chamber shall be maintained at 60°C (140°F) and 95 percent relative humidity.
- b. The internal cold chamber temperature shall be -40°C (-40°F).
- c. Panels shall be cycled every 24 hours in lieu of every 4.
- d. The complete test period shall be 28 days.

4.7.16 Weather resistance. Two panels shall be prepared as specified in 4.6.1 through 4.6.6 and exposed outdoors in accordance with ASTM D 1014 in the vicinity of Key West, FL for 12 continuous months. The panels shall be mounted at 45 degrees facing south. After exposure, the panels shall be checked for conformance to 3.5.5.

4.7.17 Environmental performance. The coated ordnance items, configured as all up rounds, shall be subjected to the tests of 4.7.17.1 through 4.7.17.3 and checked for conformance to 3.8.1.

4.7.17.1 Temperature and humidity cycling. Ordnance items shall be in the shipping configuration when tested. Testing shall be in accordance with WR-50 except that the temperatures shall be modified to 60°C (140°F), 95 percent relative humidity and -40°C (-40°F).

4.7.17.2 Transportation vibration. Ordnance items shall be in the shipping configuration when tested. Testing shall be in accordance with MIL-STD-810, Method 514.2, equipment category (g), Procedure X, Table 514.2-VII, Figure 514.2-7, and Curve (AV:AW). The ordnance items shall be tested at standard ambient conditions (MIL-STD-810), 60°C and -40°C (140°F and -40°F), in that order.

4.7.17.3 Aircraft vibration. The ordnance items shall be in the flight configuration and tested at standard ambient conditions (MIL-STD-810) and at -40°C (-40°F). The test procedure and time schedule shall be in accordance with MIL-STD-810, Method 514.2, equipment category (b.1), Procedure I, Table 514.2-II, and Curve H of Figure 514.2-2.

4.7.18 Fast cook-off. The fast cook-off test shall be conducted in accordance with MIL-STD-1648, except that the pass/fail criteria shall be established by the procuring activity. In addition, the following shall apply:

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- a. The quantity of fuel shall be sufficient to cause reaction of the ordnance or to ensure a 15-minute fire. Test fuel shall be JP-4 or JP-5 conforming to MIL-T-5624.
- b. The test pit shall not be less than 20 by 20 feet (6.1 by 6.1 meters).
- c. Flame temperature to the ordnance shall reach 538°C (1000°F) within 30 seconds after fire ignition.
- d. The ordnance specimen shall be suspended from its suspension lugs with its center 30 to 40 inches (.75 to 1.0 m) above the fuel.
- e. The test shall not be performed when the wind velocity exceeds 5 knots (2.5 meters per second).

4.7.19 Color. The coating compound shall be visually examined for conformance to 3.7.5.

5. PACKAGING

5.1 Packaging and packing. The coating compounds shall be packaged, packed and marked in accordance with PPP-P-1892. The level of packaging shall be A or C and the level of packing shall be A or C as specified (see 6.2).

5.2 Storage of Type III material. MIL-C-81945 Type III pre-cured sheet shall be stored flat, horizontal with release film covering the entire area between stacked sheets. Storage and shipping shall be maintained between 16°C to 32°C (60°F to 89°F) at all times.

5.3 Marking and labeling. In addition to the marking specified in PPP-P-1892, individual cans and containers shall bear printed labels showing the following nomenclature and information as applicable:

Specification MIL-C-81945B(AS), Type I, II or III (as applicable)
 Manufacturer's name and product number
 Date of manufacture by month and year
 Batch number
 Net contents
 Flash point (in accordance with ICC Regulations) (Type I and II)
 Dimensions (Type III)

5.3.1 Precautionary markings. Individual containers of Type I and Type II coating shall be labeled with the following warning label:

WARNING

Contact may cause skin irritation and should be avoided. Wash thoroughly with soap and water if contact occurs. If contact with eyes occurs, flush repeatedly with water and obtain medical attention.

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Shipping containers shall be marked in accordance with Department of Transportation regulations as specified in 49 CFR 171-178 and shall bear the "Flammable Liquid" red label as specified therein. All unit and intermediate packs of toxic and hazardous chemicals and materials shall also be labeled in accordance with the applicable laws, statutes, regulations or ordinances, including Federal, State and Municipal requirements. In addition, unit and intermediate containers, including unit containers that serve as shipping containers such as pails and drums shall be marked with the applicable precautionary information detailed in American National Standard ANSI Z 129.1.

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 insulating coating compounds are intended for use as exterior protective coatings on aircraft ordnance items. These coatings are formulated to meet applicable environmental conditions and also to delay an explosive reaction when coated ordnance items are exposed to high flux thermal environments. Usage of the coating compounds requires a topcoat in the specified color. Type I compound is intended for spray application. Type II compound is intended for use as a hard trowelled repair compound and for use in manufacturing. Type III coating is a solid sheet material manufactured from Type II coating. Type III coating is intended to be adhered to the ordnance item in accordance with MIL-STD-2098(AS).

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. Type of compound (see 1.2 and 6.1).
- c. Level of packaging and packing (see 5.1).
- d. Quantity in gallons (liters), Type I and Type II materials only (see 5.1).
- e. Size (length, width and thickness), Type III materials only (see 3.6.4).
- f. The manufacturer's approved application instructions for Type III materials shall be obtained if such instructions have not been provided by other activities (see 4.6.5).
- g. Fast cook-off pass/fail criteria (see 4.7.18).
- h. Special markings (see 5.3).

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- i. Toxicological data requirements (see 3.3 and 4.4.2).
- j. FAR clauses 23.303 and 52.223-3.
- k. Specify if palletization is required.

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 suppliers 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 Naval Air Development Center, Code 6062, Warminster, PA 18974; and information pertaining to qualification of products may be obtained from that activity. It is understood that the material furnished under this specification subsequent to final approval shall be of the same composition and shall be equal to products upon which approval was originally granted. In the event that the coating furnished under contract is found to deviate from the composition of the approved product or that the product fails to perform satisfactorily, approval of such products will be subject to immediate withdrawal from the Qualified Products List.

6.4 Subject term (key word) listing.

Coating compound
 Intumescent
 Material Safety Data Sheets
 Qualification
 Qualified Products List (QPL)
 Toxicity
 Weapon insulation

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 and meeting the requirements of 29 CFR 1910.1200. The pertinent government mailing addresses for submission of data are listed in Appendix B of FED-STD-313.

6.6 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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 Navy - AS
 (Project No. 8010-N348)

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