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SUPERSEDING  
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FEDERAL SPECIFICATION  
PAINT, ALUMINUM, HEAT RESISTING

The General Services Administration has authorized the use of this federal specification, by all federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers aluminum pigmented, heat resisting paint that will withstand solvents and elevated temperatures.

1.2 Classification. The heat resisting coatings described by this specification shall be of the following types (see 6.1 and 6.2).

- Type I - An ambient dry/heat cure, aluminum pigmented, heat resistant, liquid paint that will withstand temperatures to a maximum of 650 °C (1200 °F) with dry times in accordance with Table I.
- Type II - A functional aluminum pigmented, heat resistant, powder coating that will withstand elevated temperatures to a maximum of 372 °C (700 °F).

2. APPLICABLE DOCUMENTS

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

FEDERAL STANDARDS

- FED-STD-141 - Paint, Varnish, Lacquer and Related Materials: Methods of Inspection, Sampling and Testing
- FED-STD-313 - Material Safety Data, Transportation Data, and Disposal Data for Hazardous Materials Furnished to Government Activities
- FED-STD-595/17178 - Colors Used in Government Procurement: Miscellaneous, Gloss

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any data that may improve this document should be sent to: Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to [CommandStandards@navy.mil](mailto:CommandStandards@navy.mil), with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

FEDERAL REGULATIONS

- 40 CFR 60, Appendix A, Method 24 - Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings
- 29 CFR 1910 - Occupational Safety and Health Administration, Department of Labor

(Copies of these documents are available from the Superintendent of Documents, U.S. Government Printing Office, Washington DC 20401 or online at [www.gpoaccess.gov/index.html](http://www.gpoaccess.gov/index.html).)

- EPA SW-846, Method 1311 - TCLP (Toxicity Characteristic Leaching Procedure)

(Copies of this document are available from the Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Washington DC 20460 or online at [www.epa.gov](http://www.epa.gov).)

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI Z129.1 - Hazardous Industrial Chemicals – Precautionary Labeling (DoD adopted)

(Copies of this document are available from the American National Standards Institute, 25 W. 43rd St, 4th Floor, New York, NY 10036 or online at <http://webstore.ansi.org/>.)

ASTM INTERNATIONAL

- ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
- ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
- ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus (DoD adopted)
- ASTM D562 - Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer (DoD adopted)
- ASTM D609 - Standard Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products (DoD adopted)
- ASTM D610 - Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces (DoD adopted)
- ASTM D962 - Standard Specification for Aluminum Powder and Paste Pigments For Paints
- ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes (DoD adopted)
- ASTM D2698 - Standard Test Method for Determination of the Pigment Content of Solvent-Reducible Paints by High-Speed Centrifuging (DoD adopted)

ASTM D3278	-	Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus (DoD adopted)
ASTM D3924	-	Standard Specification for Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials (DoD adopted)
ASTM E1252	-	Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis
ASTM F718	-	Standard for Shipbuilders and Marine Paints and Coatings Product/Procedure Data Sheet (DoD adopted)

(Copies of these documents are available from ASTM International, 100 Barr Harbor Dr., PO Box C700, West Conshohocken, PA 19428-2959 or online at [www.astm.org](http://www.astm.org).)

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC-SP 1	-	Solvent Cleaning (DoD adopted)
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(Copies of this document are available from SSPC Publication Sales, 40 24<sup>th</sup> Street, 6<sup>th</sup> Floor, Pittsburgh, PA 15222-4656 or online at [www.sspc.org](http://www.sspc.org).)

U.S. DEPARTMENT OF LABOR, OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

ID-191	-	Polarized Light Microscopy of Asbestos
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(Copies of this document are available from the U.S. Department of Labor/OSHA, OSHA Publications, PO Box 37535, Washington DC 20013-7535 or online at [www.osha.gov](http://www.osha.gov).)

3. REQUIREMENTS

3.1 Qualification. The paints furnished under this specification shall be a product qualified for listing on the applicable qualified products list.

3.2 Composition.

3.2.1 Pigment. The pigment shall be a commercially pure, extra fine, leafing, aluminum pigment powder meeting the requirements of ASTM D962, Type I, Class B at a minimum.

3.2.2 Vehicle.

3.2.2.1 Type I vehicle. The Type I vehicle shall be a silicone resin or modified silicone resin together with driers as required to meet the requirements of this specification.

3.2.2.2 Type II vehicle. The Type II vehicle shall be a silicone or modified silicone powder dispersed in an epoxy powder with flow control agents as required to meet the requirements of this specification.

3.2.3 Volatile organic compound content (VOC).

3.2.3.1 Type I VOC. The maximum VOC of the Type I paint shall be 250 grams of solvent per liter of paint.

3.2.3.2 Type II VOC. The maximum VOC of the Type II powder coating shall be 75 grams of solvent per liter of coating. For planning purposes, 5.3 pounds of powder shall be considered the equivalent of one liter of liquid paint.

3.3 Quantitative requirements. When tested in accordance with 4.5, the paint shall conform to the quantitative requirements specified in Table I. Table I requirements not applicable to Type II powder coatings are total solids and vehicle solids (both assumed to be 100 percent), water content, flash point and consistency.

TABLE I. Quantitative requirements.

Requirements	Requirements	
	Minimum	Maximum
Total solids, percent by weight of paint	40	---
Pigment, percent by weight of paint	23	27
Vehicle solids, percent by weight of paint	18	---
Silica (SiO <sub>2</sub> ), percent by weight of vehicle solids	30	---
Water content, percent by weight of paint	---	0.2
Consistency (package), kreb stormer shearing rate 200 RPM (grams)	100	150
Equivalent kreb units (KU)	61	72
Flash point, °C (°F)	38(100)	---
Drying time, hours (Type I)		
Set to touch (ambient dry)	---	1
Dry hard (ambient dry)	---	3
Full hardness, heat cure baked at 204 °C (400 °F), hours	---	1
Full hardness (Type II), baked at 204 °C (400 °F), minutes	---	20
VOC, grams per liter [g/L] (pounds per gallon [lb/gal]) Type I/Type II	---	250/75 (2.08/0.62)
Asbestos, percent by weight in dry film	---	0.1

3.3.1 Color. When tested in accordance with Table IV, the color of the final paint dry film shall match color 17178 of FED-STD-595.

3.3.2 Solvents and hazardous air pollutant (HAP) content. When tested in accordance with 4.5.17, the solvents and HAPs content in the paint shall not exceed the percent by weight (%WT) values listed in Table II. Within these limitations and the requirement that the finished paint meet all requirements of this specification, solvent selection is the responsibility of the manufacturer.

TABLE II. Hazardous air pollutant solvent content limits.

<b>Hazardous solvent in total paint</b>	<b>Maximum, %WT</b>
Benzene	0.05
Chlorinated solvent(s), total [carbon tetrachloride, chloroform (trichloromethane), methylene chloride (dichloromethane), tetrachloroethylene (perchloroethylene), 1,1,1-trichloroethylene (methyl chloroform) trichloroethylene]	0.05
Ethyl benzene	0.05
Methyl, ethyl and butyl mono-ethers of ethylene glycol or the acetates thereof, total (also known as: methyl, ethyl and butyl cellosolves and methyl, ethyl and butyl cellosolve acetates)	0.05
Methyl ethyl ketone (MEK)	0.05
Methyl isobutyl ketone (MIBK)	0.05
Toluene	0.05
Xylene (all forms), total	0.1

3.3.3 Hazardous pigments and additives of paint. When tested in accordance with 4.5.18, the content of each soluble metal and the total content of each metal of the paint shall be less than the values listed in Table III. If the total metal content for an individual metal is less than the allowed soluble metal content for that metal, the total metal value may be submitted for the soluble metal value and the actual test for the soluble metal need not be performed.

TABLE III. Hazardous metal content.

<b>Metal and/or its compound in each coating dry film</b>	<b>Soluble metal, maximum, mg/L</b>	<b>Total metals content, maximum, %WT</b>
Antimony	15	0.015
Arsenic	5	0.005
Barium (excluding barite)	100	0.10
Beryllium	0.75	0.0002
Cadmium	1	0.0005
Chromium (VI) compounds	1	0.001
Chromium [including chromium (III)]	560	0.56
Cobalt <sup>1/</sup>	50	0.005
Copper	25	0.01
Fluoride salts	180	0.18
Lead	5	0.005
Mercury	0.2	0.0002
Molybdenum	350	0.35
Nickel	20	0.02
Selenium	1	0.002
Silver	5	0.001
Tantalum	100	0.100

TABLE III. Hazardous metal content - Continued.

<b>Metal and/or its compound in each coating dry film</b>	<b>Soluble metal, maximum, mg/L</b>	<b>Total metals content, maximum, %WT</b>
Thallium	7	0.007
Tungsten	100	0.100
Vanadium	24	0.01
Zinc	250	0.25

## NOTE:

1/ Total cobalt content may exceed 0.005 %WT (up to 0.2 %WT) only if a cobalt drier is used to effect proper drying. Regardless of whether a cobalt drier is used, soluble cobalt content may not exceed Table III requirements.

3.4 Qualitative requirements. The following qualitative requirements apply equally to Type I and Type II products unless specifically modified for Type I liquid or Type II powder coatings.

3.4.1 Condition in container (type I). The unopened can shall show no evidence of gas build-up, such as bulging of can. When tested in accordance with 4.5.7, a freshly opened full container of the paint shall be free from grit, seeds, skins, lumps, abnormal thickening or livering and shall show no more pigment settling or caking than can be readily reincorporated to a smooth uniform state.

3.4.2 Storage stability.

3.4.2.1 Partially full container (type I). When tested in accordance with 4.5.8.1, a three-quarter filled, closed 8-ounce glass jar of the paint shall show no skinning. At the end of the 7-day heat test, the treated sample shall be cooled to room temperature and it shall show no pressure build-up; also, no livering, curdling, hardcaking or gummed sediment shall be observed. The paint shall mix readily to a smooth uniform state, and any skin formed shall be continuous and easily removed. The aged paint after the 7-day heat test shall be suitable for the purpose intended.

3.4.2.2 Full container (type I). When tested in accordance with 4.5.8.2, a full quart can of the paint shall show no "gas" pressure in the can, no skinning, livering, curdling, hard dry caking, or tough gummy sediment. The paint shall mix readily to a smooth uniform state and shall be suitable for the purpose intended.

3.4.2.3 Type II storage stability. Type II powder coatings shall meet the requirements of this specification for one year from the date of manufacture when stored in the original unopened container when tested in accordance with 4.5.8.3.

3.4.3 Brushing properties (type I only). When tested in accordance with 4.5.9, the paint shall brush easily with good flow and leveling properties and shall dry to a smooth uniform film free from seeds, runs, sags, or streaks.

3.4.4 Spraying properties (type I). When tested in accordance with 4.5.10, the paint shall spray satisfactorily in all respects and shall show no running, sagging, or streaking. The dried film shall show no dusting or mottling and shall present a smooth uniform finish free from seeds.

3.4.4.1 Spraying properties (type II). When applied by established powder coating application methods (see 4.5.10.1), the film produced shall melt, fuse and cure to a film thickness of 2 to 4 mils (nominal 3 mils). The cured film shall be uniform, smooth, even, free of runs, sags, and streaks and meet the applicable requirements of this specification.

3.4.5 Heat resistance testing. Type I and Type II heat resistance test panel preparation and testing shall be in accordance with 4.5.11.

3.4.5.1 Type I heat resistance. When prepared in accordance with 4.5.11.1.1 and tested in accordance with 4.5.11.1.2, films of paint shall show no cracking, blistering, flaking, or peeling. When the knife test (see 4.5.11.1.2) is done, the paint shall adhere tightly to the metal.

3.4.5.2 Type II heat resistance. The heat resistance test of 4.5.11.1.2 for Type II powder coatings shall be terminated and results reported only for panels heated in sequence up to 372 °C (700 °F). When the knife test (see 4.5.11.1.2) is done, the paint shall adhere tightly to the metal.

3.4.6 Salt spray resistance. When prepared and tested in accordance with 4.5.12, films of the paint examined immediately after removal from the test shall show no more than a trace of rusting and no more than 5 scattered blisters, none of which is larger than 1 mm in diameter. Some dulling or staining unaccompanied by red rusting shall be permitted. On removal of the paint from the panels tested as specified in 4.5.12.2, the surface of the steel shall show no more than a trace of rusting, pitting, or corrosion (ASTM D610, Figure 1, No. 9).

3.4.7 Water resistance. When prepared and tested in accordance with 4.5.13, a film of paint shall show no wrinkling or blistering immediately upon removal of the panel from the water. The paint shall not be significantly affected when examined 2 hours after removal, and after 24 hours air drying, the portion of the paint which was immersed shall show no more than an insignificant whitening or dulling in comparison to the portion that was not immersed.

3.4.8 Hydrocarbon fluid resistance. When prepared and tested in accordance with 4.5.14, a film of paint shall show no wrinkling or blistering immediately after removal from the fluid. After 24 hours air drying, the portion of the panel which was immersed shall be almost indistinguishable with regard to hardness and adhesion from a panel that was prepared by at the same time but not immersed.

3.4.9 Toxins, carcinogens, and reproductive stressors. All paints proposed for qualification shall be referred to the Navy Environmental Health Center (NEHC) for an administrative Health Hazard Assessment (HHA) relative to human health hazards (see 4.5.15).

3.4.10 Recoat. When tested in accordance with 4.5.11.1.4 fully cured Type II powder coatings shall be compatible with Type I liquid coating. When recoated with Type I liquid paint, there shall be no blistering, wrinkling or lifting of either coating.

3.5 Material safety data sheet. The contractor shall provide to the qualifying agency a completed material safety data sheet (MSDS) in accordance with ANSI Z129.1 or FED-STD-313 (see 6.2).

3.6 Directions for mixing and applying. The manufacturer shall provide written directions for mixing and applying the paint on each container to the qualifying agency. These directions shall cover both small (1 L or 4 L [1 quart {qt} or 1 gallon {gal}]) and field (19 L [5 gal]) procedures, and shall specifically state the differences, if any, between the two. These directions shall be in the format specified in ASTM F718 and shall include, as a minimum, information on the upper and lower temperature and humidity limits for application, coverage per L (gal), and safety precautions. Type II powders shall be furnished in unit containers consistent with the powder coating manufacturing process.

3.7 Batch specific VOC certification. Manufacturer shall prepare label instruction in accordance with 29 CFR 1910. Each container shall be affixed with a hazardous chemical warning label in accordance with 29 CFR 1910.1200. To comply with the Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollutants (NESHAP) requirements for shipbuilding and ship repair, the two following statements shall appear on each paint can label:

- a. Certification that the paint in the container meets the NESHAP requirements for shipbuilding and ship repair.
- b. Statement of the ratio of volatile content to solids expressed as grams of volatile organic hazardous air pollutants (VOHAP) per liter of solids.

3.8 Recovered materials. The offeror/contractor is encouraged to use recovered materials to the maximum extent practicable, in accordance with paragraph 23.403 of the Federal Acquisition Regulation (FAR).

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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 that supplies and services conform to prescribed requirements.

4.2 Classification of examinations and tests. Examinations and tests shall be classified as follows:

- a. Qualification inspection (see 4.3).
- b. Acceptance testing of individual lots (see 4.3.2).
- c. Inspection of preparation for delivery (see 4.6).

4.3 Qualification inspection. Qualification testing shall consist of all the tests in Table IV except as modified to qualify powder coatings. Items marked with a superscript 2 in Table IV shall not be conducted as qualification tests for Type II coatings. Qualification inspection shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command (NAVSEA) on sample units produced with equipment and procedures normally used in production.

4.3.1 Loss of qualification. After qualified product list (QPL) approval, any subsequent change in product composition or rejection of lots in conformance testing may result in cancellation of QPL listing and require the manufacturer to apply for re-qualification.

4.3.2 Acceptance testing. Acceptance testing of individual lots shall consist of testing for those requirements specified by the appropriate superscript following Table IV.

4.4 Quality conformance inspection sampling. For the purposes of sampling and inspection, the unit of production is a lot. A lot shall consist of all paint manufactured as one batch and offered for delivery at one time. A batch may be one production batch or the resultant of the uniform blending or mixing of a number of smaller production batches.

TABLE IV. Test methods.

Required test	Applicable method in FED-STD-141	ASTM method	Inspection paragraph	Requirement paragraph
Total solids <sup>2/</sup>	---	---	4.5.3	Table I
Pigment content	---	D2698	---	Table I
Vehicle solids <sup>2/</sup>	---	D2698	---	Table I
Silica	---	---	4.5.4	Table I
Water content <sup>2/</sup>	---	---	4.5.16	Table I
VOC	---	---	4.5.5	Table I
Color <sup>1/, 3/</sup>	4250	---	---	3.3.2
Consistency <sup>1/, 2/</sup>	---	D562	---	Table I
Flash point <sup>1/, 2/</sup>	---	D3278	---	Table I
Drying time:				
Set to touch <sup>1/</sup>	4061	---	4.5.6.1	Table I
Dry hard	4061	---	4.5.6.1	Table I
Full hardness	---	---	4.5.6.2	Table I
Condition in container <sup>1/, 3/</sup>	3011	---	4.5.7	3.4.1



TABLE IV. Test methods - Continued.

Required test	Applicable method in FED-STD-141	ASTM method	Inspection paragraph	Requirement paragraph
Storage stability: Partially full container	3021	---	4.5.8.1	3.4.2.1
Full container	3022	---	4.5.8.2	3.4.2.2
Brushing properties <sup>1/, 2/</sup>	4321	---	4.5.9	3.4.3
Spraying properties	4331	---	4.5.10	3.4.4
Heat resistance: - Hot rolled metal	---	---	4.5.11.1	3.4.5
- Cold rolled metal <sup>2/</sup>	---	---	4.5.11.2	3.4.5
Salt spray resistance: - Hot rolled metal	---	B117	4.5.12	3.4.6
- Cold rolled metal <sup>2/</sup>	---	B117	4.5.12	3.4.6
Water resistance	---	D1308	4.5.13	3.4.7
Hydrocarbon fluid Resistance	---	D1308	4.5.14	3.4.8
Toxicity	---	---	4.5.15	3.4.9
Solvents and hazardous air pollutants (HAPs)	7356 7360	E1252	4.5.17	3.3.2
Hazardous metal content	---	---	4.5.18	3.3.3
Material safety data sheets (MSDS) <sup>1/</sup>	---	---	---	3.5
Directions for mixing and applying	---	F718 <sup>1/</sup>	---	3.6
Knife adhesion	6304.2	---	4.5.11.1.2	3.4.5.1 3.4.5.2

## NOTES:

1/ Lot conformance test for Type I

2/ Qualification test not applicable to Type II

3/ Lot conformance test for Type II (see 4.3.2)

4.5 Tests.

4.5.1 Test conditions. The routine and referee testing conditions shall be in accordance with ASTM D3924 except as otherwise specified herein. All temperatures and dimensions are nominal unless a specific limit is otherwise indicated.

4.5.1.1 Test paint films (type I). All paint films shall be 20.3 to 30.5 microns (0.0008 to 0.0012 inch; 0.8 to 1.2 mils) in dry film thickness per coat, unless otherwise specified. The dry film thickness shall be measured after the coated panel has been baked at 204 °C (400 °F) for 15 minutes. If the test method specifies that the film is not to be heated, the DFT shall then be measured after the 24-hour ambient temperature cure.

4.5.1.1.1 Test paint films (type II). Type II paint test films shall be applied at a dry film thickness (nominal 3 mils) applied in accordance with the powder coating manufacturer's recommendations for powder coatings to meet the requirements of this specification.

4.5.2 Test methods. Tests shall be conducted in accordance with the FED-STD-141, ASTM applicable methods or as required by this specification. The issue of the test method shall be as required by section 2. The right is reserved to make any additional tests deemed necessary to determine that the paint meets the requirements of this specification. Failure to pass any test and non-compliance to the requirements of section 3 shall be cause for consideration to reject the lot.

4.5.3 Nonvolatile (total solids) content (type I). Place a portion of the thoroughly mixed sample in a dropping bottle and weigh to the nearest 0.1 milligram (mg). Weigh a 60 millimeter (mm) diameter aluminum dish to the nearest 0.1 mg. Transfer a small sample that does not exceed 0.3 gram (g) to the dish. Determine its exact weight by loss in weight of the bottle. Dissolve the sample in 2 milliliters (ml) American Chemical Society (A.C.S.) reagent grade toluene and dry in a gravity convection oven at 105 °C (221 °F) for 30 minutes. Upon cooling, reweigh the dish to the nearest 0.1 mg. From the weight of the residue in the dish and the weight of the sample taken, calculate the percent nonvolatile (total solid) as required. Nonvolatile vehicle (total solids) shall be in accordance with the requirements of Table I.

4.5.4 Silica content of vehicle. From a stoppered bottle or weighing pipette, weigh by difference (to the nearest 0.1 mg) about 3 grams of vehicle ( $V_1$ ) isolated by ASTM D2698 into a previously ignited and weighed 3-inch porcelain evaporating dish ( $V_2$ ). Dry at 105 °C (221 °F), in an oven for 3 hours. Place the dried sample in a cold muffle furnace and gradually increase the temperature over a period of 3 hours to 538 °C (1000 °F) then maintain this temperature for an additional hour. After cooling in a desiccator, weigh the dish and contents ( $V_3$ ). Calculate weight of ash (silica) ( $V_3-V_2$ ). Calculate the percent of silica as follows:

$$\text{Percent silica by weight of vehicle} = \frac{\text{Weight of ash } (V_3-V_2) \times 100}{\text{Weight of sample } (V_1) \times \text{nonvolatile vehicle fraction}}$$

Silica content shall be in accordance with the requirements of Table I.

4.5.5 VOC (volatile organic content). When tested in accordance with 40 CFR CH. 1, Part 60, Appendix A, (U. S. EPA) Method 24, the VOC in the paint shall be in accordance with the requirements of 3.2.3.

4.5.6 Drying time.

4.5.6.1 Air drying, type I. Draw down a film of the paint on a glass panel or Leneta chart using a 20.3-micron (0.0008-inch) applicator (50 micron [0.002 inch] gap clearance) and determine air drying time at nominal laboratory conditions in accordance with method 4061 of FED-STD-141. Drying time shall be in accordance with the requirements of Table I.

4.5.6.2 Full hardness, type I. Determine full hardness by spraying a film of paint to a dry film thickness of 20.3 micron (0.0008 inch) to 30.5 micron (0.0012 inch) on a steel panel that has been solvent cleaned with the Aliphatic Naptha-Ethylene Glycol Monoethyl ether mixture in accordance with method 2011 of FED-STD-141. Air dry 30 minutes and then bake at 204±2 °C (400±5 °F) for 1 hour. Determine compliance with full hardness requirement of Table I. The film shall be considered to have reached full hardness when it is very difficult to remove with a knife blade in accordance with Method 6304.2 of FED-STD-141.

4.5.6.3 Full hardness (type II). Full hardness and cure of Type II powder coatings when baked at 204 °C (400 °F) shall be no longer than 20 minutes.

4.5.7 Condition in container. Determine package condition for conformance testing in accordance with method 3011 of FED-STD-141. Package condition shall be in accordance with the requirements of 3.4.1. The unopened can shall show no evidence of gas build-up, such as bulging of can. Do not agitate the can. Open the container, but do not stir. Evaluate pigment settling or caking by proceeding as in method 3011 of FED-STD-141. Reseal and agitate the can for 3 minutes on a paint shaker. On re-examination of the contents, the disclosure of any gel bodies, undispersed pigment, floating or undispersed settled pigment indicates unsatisfactory settling properties. Contents shall be in accordance with the requirements of 3.4.1.

#### 4.5.8 Storage stability.

4.5.8.1 Partially full container (type I). Determine skinning after 48 hours in accordance with method 3021 of FED-STD-141 and observe for compliance with 3.4.2.1. Reseal, tape lid and all glass areas with masking tape. Place taped jar in gallon can with loose fitting lid and expose to 7 days of heating at 52 °C (125 °F). Observe sample cautiously for first few days to note rupture of jar or leakage. Cool test assembly to room temperature and handle with caution when opening jar. Contents shall be in accordance with the requirements of 3.4.2.1 (heat aged requirement).

4.5.8.2 Full container (type I). In accordance with method 3022 of FED-STD-141, allow a full standard quart can of the paint to stand undisturbed for 1 year and then examine the contents. Evaluate pigment settling or caking as in 4.5.7 except agitate the can for 5 minutes on the paint shaker prior to re-examination. Properties shall be in accordance with 3.4.2.2.

4.5.8.3 Storage stability (type II). Two unopened containers of Type II powder coatings shall be stored in a room maintained at or below 27 °C (80 °F) and at relative humidity of 50 percent for one year from the date of manufacture. Check for compliance with 3.4.2.3.

4.5.9 Brushing properties (type I). Apply the paint as packaged using a 6-cm (2½-inch) brush to a dry film thickness of 20.3 to 30.5 microns (0.8 to 1.2 mils) and observe for brushing properties in accordance with method 4321 of FED-STD-141, as well as for flow and leveling properties, a smooth uniform film, seeds, runs, sags, or streaks. Brushing properties shall be in accordance with the requirements of 3.4.3.

4.5.10 Spraying properties (type I). Spray the paint in accordance with manufacturer instructions, on a steel panel to a dry film thickness of 20.3 to 30.5 microns (0.8 to 1.2 mils) and observe for spraying properties in accordance with method 4331 of FED-STD-141, as well as for running, sagging, streaking, dusting, mottling, smoothness, and uniformity. For referee test use automatic application in accordance with method 2131 of FED-STD-141. Spraying properties and drying shall be in accordance with the requirements of 3.4.4.

4.5.10.1 Spraying properties (type II). Powder shall be spray applied to five panels at the dry film thickness recommended by the coating manufacturer (nominal 3 mils) by accepted industrial methods for applying powder coatings. The coating shall comply with 3.4.4.1.

#### 4.5.11 Heat resistance testing of type I (liquid heat resistant paint) and type II powder coatings.

4.5.11.1 Hot-rolled steel. This applies to either Type I liquid paints or Type II powder coatings.

4.5.11.1.1 Panel preparation. For each test paint, select eight panels which are completely free of loose mill scale and have been cut out to 8 by 15 cm (3 by 6 inch) from 14 gauge low-carbon steel conforming to ASTM A1011/1011M. Remove mill scale and rust by any means desired prior to solvent cleaning. Solvent clean to SSPC-SP 1. Type I paints shall be sprayed in one coat to a total dry film thickness between 20.3 to 30.5 microns (0.8 to 1.2 mils), then air dried for at least 24 hours. Type II powder coatings shall be applied in accordance with 4.5.10.1.

4.5.11.1.2 Heat test. Following panel preparation in accordance with 4.5.11.1.1, place the panels in an oven on a suitable rack or holder so that no part of the panels are in direct contact with the bottom or sides of the oven and subject to the following heating schedule of nominal temperatures:

TABLE V. Heat schedule of nominal temperatures.

<b>Heating schedule</b>	<b>°C</b>	<b>°F</b>
8 hours (first day)	204	400
16 hours (overnight)	260	500
8 hours	316	600
16 hours	372	700
8 hours	428	800
16 hours	484	900
8 hours	538	1000
16 hours	590	1100
8 hours	650	1200

Remove the panels from the oven for as short a period of time as possible and inspect (except for the knife test) for compliance with 3.4.5 at the end of each heating period. Remove two panels at the end of the 260 °C (500 °F), 316 °C (600 °F) and 484 °C (900 °F) (see 4.5.12.4) heating periods for use in the salt spray test (see 4.5.12). At the conclusion of the heating schedule, remove the remaining two panels, allow to cool in air, inspect the films of paint for cracking, blistering, flaking, or peeling and cut with a knife blade in accordance with method 6304.2 of FED-STD-141 to determine adhesion. Test panels shall be in accordance with the requirements of 3.4.5.

4.5.11.1.3 Heat resistance. Panels coated with Type II powder coating materials shall be tested for heat resistance as specified for Table V, but only up to 372 °C (700 °F). Panels coated with Type II materials shall be removed from the heat resistance test at the end of the 260 °C (500 °F), 316 °C (600 °F), and 372 °C (700 °F) heating periods for subsequent testing.

4.5.11.1.4 Recoat properties. To verify the recoat properties of the Type II powder, conduct the following evaluation:

- a. The Type II coating applied in 4.5.10.1 and conforming to 3.4.4.1 shall be used.
- b. Following removal from the heat test after the 204 °C (400 °F), 260 °C (500 °F), 316 °C (600 °F), and 372 °C (700 °F) exposure, abrade a single spot equal to about 25 percent of the Type II coating applied.
- c. Apply a 50-micron to 75-micron (2-mils to 3-mils) wet film of Type I paint.

Check for compliance with 3.4.10.

4.5.11.2 Cold-rolled steel. This applies to Type I coatings and does not apply to Type II powder coatings.

4.5.11.2.1 Test panel preparation. Test paints require two 8- by 15-cm (3- by 6-inch) test panels. Panels shall be ASTM A1008/A1008M free of mill scale (see 4.5.11.1.1) and solvent degreased. One side of each test panel shall be flat polished as described in ASTM D609. Spray apply two coats of the test paint to the side of the panel that has been flat polished. Air dry 30 minutes after each coat. After air drying the second coat, bake the test panels at 204 °C (400 °F) (nominal) for 1 hour. Cool to room temperature.

4.5.11.2.2 Heat test. After the bake-cured panels have returned to room temperature, place the panels on a rack as in 4.5.11.1.2 and heat for 24 hours in an oven that has been previously raised to a temperature of 650 °C (1200 °F). Remove from the oven and cool. Inspect the films of paint for cracking, blistering, flaking, or peeling and perform the knife test in accordance with Method 6304.2 of FED-STD-141. Test panel shall be in accordance with the requirements of 3.4.5.

#### 4.5.12 Salt spray resistance.

4.5.12.1 Type I liquid paint. Remove the unscored panels from the 260 °C (500 °F), 316 °C (600 °F) and 484 °C (900 °F) heating periods of 4.5.11.1.2. Allow them to reach room temperature. Protect back and edges with separate applications of paint or wax. Expose the panels to the salt spray for 24 hours in accordance with ASTM B117. Upon removal, wash the panels gently in warm running water until free from any visible salt deposits and examine immediately for traces of rusting, blisters and dulling or staining unaccompanied by red rusting. When paint is removed from the panels tested, inspect the surface of the steel for rusting, pitting, or corrosion. Test panels shall be in accordance with the requirements of 3.4.6.

4.5.12.2 Cold-rolled steel, type I – ambient dry. Prepare three 10- by 30-cm (4- by 12-inch) (nominal), ASTM A1008/A1008M steel panels for each test paint as specified in 4.5.11.2.1 except, do not bake. Protect the back and edges with separate applications of paint or wax. Allow the test panels to cure for 14 days at ambient room temperature. Do not score the panels. Expose the unscored panels to the ASTM B117 salt spray for 96 hours. Upon removal, wash the panels gently in warm running water until free from any visible salt deposits and examine immediately for traces of rusting, blisters and dulling or staining unaccompanied by red rusting. When paint is removed from the panels tested, inspect the surface of the steel for rusting, pitting, or corrosion. Test panels shall be in accordance with the requirements of 3.4.6.

4.5.12.3 Cold rolled steel, type I – heat cure. Prepare three 10- by 30-cm (4- by 12-inch) (nominal), ASTM A1008/A1008M steel panels for each test paint as specified in 4.5.11.2.1. Protect back and edges with separate applications of paint or wax. Do not score the panels. Expose the unscored panels to the salt spray for 96 hours in accordance with ASTM B117. Upon removal, wash the panels gently in warm running water until free from any visible salt deposits and examine immediately for traces of rusting, blisters and dulling or staining unaccompanied by red rusting. When paint is removed from the panels tested, inspect the surface of the steel for rusting, pitting, or corrosion. Test panels shall be in accordance with the requirements of 3.4.6.

4.5.12.4 Type II, powder coating. For Type II powder coated panels, remove from the 4.5.11.1.3 heat resistance test after the 260 °C (500 °F), 316 °C (600 °F), and the 372 °C (700 °F) heating periods and then conduct the ASTM B117 salt spray test for 24 hours. Upon removal, wash the panels gently in warm running water until free from any visible salt deposits and examine immediately for traces of rusting, blisters and dulling, or staining unaccompanied by red rusting. When paint is removed from the panels tested, inspect the surface of the steel for rusting, pitting, or corrosion. Test panels shall be in accordance with the requirements of 3.4.6.

4.5.13 Water resistance. Prepare three test panels as specified in 4.5.11.2.1. Coat all exposed uncoated metal surfaces with wax or suitable coating and immerse the panel for 24 hours at 23 °C (73 °F) in accordance with ASTM D1308. Inspect for wrinkling or blistering immediately upon removal of the panel from the water. Two (2) hours after removal from test, inspect for significant effects. Inspect after 24 hours air drying for any changes in the portion of the paint which was immersed when compared to the portion that was not immersed. The paint condition shall be in accordance with the requirements of 3.4.7.

4.5.14 Hydrocarbon fluid resistance. Prepare three test panels in accordance with 4.5.11.2.1. Immerse the panels for 4 hours in a hydrocarbon fluid conforming to JP8 at 25±1 °C (77±2 °F). Panels shall be immersed at a minimum depth of 50 percent. Examine the film of paint for wrinkling or blistering immediately after removal from the fluid. After air drying for 24 hours, examine the portion of the panel which was immersed with regard to hardness and knife adhesion in accordance with Method 6304.2 of FED-STD-141. Paint shall be in accordance with the requirements of 3.4.8.

4.5.15 Toxins, carcinogens, and reproductive stressors. The manufacturer shall have the formulations and associated toxicological information available for review by the Navy Environmental Health Center (NEHC) as directed by the qualifying activity. The toxicology shall be in accordance with the requirements of 3.4.9.

4.5.16 Water content (type I only). The water content shall be run on the vehicle as isolated in 4.5.4 using commercially available automated titration devices. Metrohm® Systems automated Karl Fischer titration device from Brinkmann Instruments or Photovolt Aquatest II from Photovolt Aquatest Co. are acceptable.

Check for compliance with Table I.

4.5.17 Hazardous solvent content. Content of hazardous solvents shall be determined in accordance with methods 7356 and 7360 of FED-STD-141. Solvent fractions shall be identified in accordance with ASTM E1252. Test results shall be reported as percent by weight of the total paint. The test results for each solvent shall be in accordance with the requirement in 3.3.2 and Table II.

4.5.18 Hazardous pigments and additives. Soluble and total metal content, except tantalum and tungsten, shall be determined on a dry paint film of the coatings in accordance with EPA SW-846, (TCLP) Toxicity Characteristic Leaching Procedure, and the appropriate test listed below. Asbestos shall be analyzed in accordance with OSHA Validated Analytical Method ID-191, "Polarization Light Microscopy of Asbestos" and test result reported as percent by weight of the dry paint film. Soluble metal content shall be reported as milligrams per liter (mg/L). Total metal content shall be reported as %WT of the dry paint film. The test results for metal shall be in conformance with the appropriate requirements of 3.3.3 and Table III. Tantalum and tungsten soluble metal content and total metal content shall be analyzed as specified in 4.5.18.1.

TABLE VI. Physical and chemical test methods of materials.

<b>Metal/material</b>	<b>Test methods for evaluating solid waste – physical/chemical methods, SW-846 digestion test method</b>
All metals, except chromium (VI)	3050
Chromium (VI)	3060
Antimony	7040 or 7041
Arsenic	7060 or 7061
Barium	7080 or 7081
Cadmium	7131
Total chromium	7190
Chromium (VI)	7195, 7196, or 7197
Lead	7421
Barium	7080 or 7081
Nickel	7520 or 7521
Selenium	7740 or 7741
Silver	7760 or 7761
Beryllium	210.1 or 210.2
Cobalt	219.1 or 219.2
Copper	220.1 or 220.2
Fluoride	340.1, 340.2, or 340.3
Molybdenum	246.1 or 246.2
Thallium	279.1 or 279.2
Vanadium	286.1 or 286.2
Zinc	289.1 or 289.2

4.5.18.1 Tantalum and tungsten content. Determine the tantalum and tungsten content of the paint using any appropriate spectroscopy test method. Conduct the tests in accordance with the instrument manufacturer's directions for the use of the instrument. Manufacturer is responsible for establishing data supporting the test method choice and analytical accuracy. The test results for tantalum or tungsten shall be in conformance with the requirements of 3.3.3.

#### 4.6 Inspection of preparation for delivery.

##### 4.6.1 Quality conformance inspection of preparation for delivery.

4.6.1.1 Unit of product. For the purpose of inspection, a complete pack prepared for shipment shall be considered a unit of product.

4.6.1.2 Sampling. Sampling for examination shall be in accordance with the requirements of the contract.

4.6.1.3 Examination. Samples selected in accordance with 4.6.1.2 shall be examined for conformance to the requirements of Table VII and Table VIII (see 6.5). The AQL shall be 2.5 percent defective.

### 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's systems commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

5.2 Packaging for type II powder coatings. Packaging for Type II powder coatings shall be in accordance with commercial practices in effect for qualified manufacturers.

### 6. NOTES

INFORMATION FOR GUIDANCE ONLY. (This section contains information of a general or explanatory nature that is helpful, but is not mandatory.)

6.1 Intended use. This paint covered by this specification is of two types. Type I liquid paint is intended for use on heated steel surfaces, at temperatures up to 650 °C (1200 °F). This paint is low VOC (250 g/L; 2.08 lb/gal). Such use may be on superheated steam lines, boiler casings, boiler drums, super heater heads, and similar high temperature applications. It is also intended for painting military equipment such as personnel heaters, rocket launchers and other components, where operating temperatures preclude the use of conventional paints. It may also be used for application to engraved, stamped, or stenciled lettering or numerals on metallic gun or weapon components for identification or functioning purposes when those components are exposed to temperatures up to 650 °C (1200 °F). Type II powder coating is intended for use on similar steel surfaces, temperature of which will not exceed 372 °C (700 °F).

6.1.1 Welding practices. Neither Type I nor Type II paints described by this specification are intended to be weld-through paints. Type I and Type II paints should be removed to a distance of six inches prior to any welding procedure.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification, including any amendments.
- b. Type required (if unspecified by the user, Type I will be supplied).
- c. Quantity/unit of purchase required.
- d. Material safety data sheet (see 3.6).
- e. Degree of packaging and degree of packing required (see 6.5, Table VII).
- f. When palletization is required (see 6.5, Table VII).
- g. Any special marking (see 6.5, Table VIII).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of the supplier is called to this requirement, and manufacturers are urged to arrange to have the products 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 Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160, and information pertaining to qualification of products may be obtained from that activity.

6.4 Supersession data. This specification supersedes TT-P-28G dated July 8, 1985 and GSA technical purchase description (TPD-1000) dated 11 August 1994, as follows:

TT-P-28H                      TT-P-28G                      TPD-1000A

6.5 Packaging recommendations. Suggested packaging and marking requirements are contained in Table VII and VIII.

TABLE VII. Packaging.

<b>Packaging</b>	<b>Recommended requirements for direct Government acquisitions</b>
Containers	(1) Type I paints should be specified to be furnished in cans capable of holding 0.47 liters (L) (1 pint), 0.945L (1 quart), 3.78L (1 gallon) and 18.9L (5 gallons). (2) Friction plug containers should be in accordance with PPP-C-96, Type V, Class 2. Interior coatings should be as specified therein. Exterior coatings, including side seam stripping, should be as specified therein for plan B. Wire handles as specified therein should be provided for the 1-gallon container. Closure of the properly filled and sealed cans should be as specified in the appendix thereto. (3) All containers should comply with the requirements of the Uniform Freight Classifications (UFC), the National Motor Freight Classification (NMFC), and the applicable requirements of the Code of Federal Regulations 49CFR178, Department of Transportation (DOT). (4) Unit of procurement: The paints covered by this specification should be purchased by volume. The unit of procurement should be in multiples of 1 L or 1 U.S. liquid gallon at 15.5 °C (60 °F).
Commercial packaging	(1) Commercial packaging should be to ASTM D3951. (2) All containers should comply with the requirements of the Uniform Freight Classifications (UFC), the National Motor Freight Classification (NMFC), and the applicable requirements of the Code of Federal Regulations 49 CFR 178, Department of Transportation (DOT).
Packing	Packing should be specified as follows: (1) Overseas delivery packing. Intermediate containers of like sizes of paint should be ASTM D6251 packed in close-fitting wood boxes. Box closure and strapping should be as specified in the applicable box specification or the appendix thereto except that strapping should be flat and the finish B. (2) Domestic delivery (Level B) packing. Level B packing should be as for level A, except that boxes should be domestic type or class and the strapping should be finish A or B. (3) Commercial packing. The paint, in the unit and intermediate containers should, as applicable, be packed in multiples of like sizes in accordance with UFC, NMFC and 49 CFR 178 requirements.
Palletization	Intermediate containers should be palletized in accordance with MIL-HDBK-774. Only one size unit or intermediate container should be placed on a pallet.



TABLE VII. Packaging – Continued.

<b>Packaging</b>	<b>Recommended requirements for direct Government acquisitions</b>
Intermediate containers	Intermediate containers should be close fitting corrugated fiberboard boxes in accordance with UFC, NMFC and 49 CFR 178 requirements. Fiberboard used in the construction of interior (unit and intermediate) and exterior containers, including interior packaging forms, should conform to the ASTM D4727/D4727M, classes should be domestic fire-retardant or weather resistant fire-retardant (see 6.2).
Packing for acquisitions involving direct delivery to Navy ships or installations	Treated lumber and plywood. All lumber and plywood, including laminated veneer materials, used in shipping container and pallet construction, member, blocking, bracing, and reinforcing must be fire-retardant treated material in accordance with MIL-L-19140 as follows: (a) General use, weather resistant: MIL-L-19140, Type II, Category I. (b) General use, non-weather resistant: MIL-L-19140, Type I, Category I.
Material safety data sheets (MSDS) and Product / procedure data sheets	A copy of the MSDS and company product data/procedure sheets should be attached to the shipping document for each destination (see 3.5).
VOC certification sheets	VOC certification sheets for each batch of coating will be provided when requested by the procuring activity.

TABLE VIII. Marking.

<b>Marking type</b>	<b>Recommended marking</b>
Bar codes	Marking should include bar codes
Hazardous warnings	(a) Labels should be in accordance with 29 CFR Parts 1910, 1915, 1917, 1918, 1926 and 1928, as well as PPP-P-1892. (b) All individual containers should have the following marking: “CAUTION: This paint contains volatile solvents, with probable hazardous vapors. Use with adequate ventilation. Avoid prolonged breathing of vapors or spray mists. The solvents are highly flammable, avoid open flame and smoking.” (c) Each container, shipping container, and palletized load should be marked with the appropriate hazardous symbol. (d) Unit containers should be marked: “This product is Asbestos, Lead, Chromium, Cadmium free, except for possible trace levels.”
Volatile organic content (VOC)	“Contains (insert VOC content) grams per liter (insert VOC content in lb/gal) of volatile organic content per 40 CFR CH. 1, Part 60, Appendix A (EPA) Method 24. Maximum thinning allowed is (insert number in g/L, lb/gal and volume/gal [if appropriate]).”
Hazardous air pollutants	“Contains (insert HAP content here in g/L and lb/gal) solids (non-volatiles) per 40 CFR 63.”
Shelf life	Each unit container, intermediate container where applicable, and shipping container should be marked as follows: “Date of first re-inspection (insert here date 2 years after date of manufacture).”

