INCH-POUND

TT-C-490F
31 January 2013
SUPERSEDING
TT-C-490E
22 July 2002

FEDERAL SPECIFICATION

CHEMICAL CONVERSION COATINGS AND PRETREATMENTS FOR METALLIC SUBSTRATES (BASE FOR ORGANIC COATINGS)

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 processes, pretreatments, and pre-primer surface preparations of metallic substrates for coating applicators. It covers metal surface preparation for delaying corrosion initiation and promoting primer adhesion. In addition, this specification covers the testing requirements for qualification of conversion coatings, the pretreatments and pre-primer coatings.

1.2 Classification. This specification covers the following cleaning methods, surface preparation processes, and metal classes (see 6.2).

1.2.1 Surface cleaning. Surface cleaning may include one or more of the following methods to meet surface cleanliness requirements (see 6.1.1 and 6.1.2).

Method I	- Mechanical or abrasive blast cleaning, sanding, grinding, in accordance with The Society For Protective Coatings (SSPC) standards.
Method II	- Solvent cleaning by immersion, spray, vapor, or hand wiping.
Method III	- Detergent cleaning by immersion, spray, ultrasonic, hot alkaline, or electrolytic methods.

Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any data that may improve this document should be sent to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Materials Manufacturing Technology Branch, Specification and Standards Office, ATTN: RDRL-WMM-D, Aberdeen Proving Ground, MD 21005-5069 or emailed to richard.j.squillacioti.civ@mail.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil/online/start/.

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Method IV - Emulsion cleaning, with or without added water.
Method V - Derusting by chemical means.
Method VI - Phosphoric acid cleaner (detergent or solvent-type with detergent).
Method VII - Steam cleaning, with or without assisted pressure washing.

1.2.1.1 Ozone depleting chemicals. To comply with the Clean Air Act regulations, materials can not contain class I or class II ozone depleting substances.

1.2.2 Conversion coatings, pretreatments, and pre-primer coatings. Chemical conversion and pretreatment coatings will be furnished in the following types (see 6.2).

Type I - Zinc phosphate.
Type II - Aqueous iron phosphate.
Type III - Organic pretreatment.
Type IV - Inorganic pretreatment.
Type V - Medium weight zinc phosphate.
Type VI - MIL-DTL-5541, Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
Type VII - Anodic coating and electrolytic passivation.
Type VIII - Metal-rich coating for abrasive blasted surfaces.

1.2.2.1 Method of application. New design documents, engineering drawings and ordering data should indicate the type of coating required and method of application when applicable.

1.2.3 Metal classes. Each of the aforementioned types may have materials that are appropriate for multiple metals qualification. In order to systematize the listing of products qualified to this specification found in the Qualified Products Database (QPD), a class will be assigned to each metal type.

Class A - Steel alloys consisting mostly of iron other than corrosion resistant steel alloys which would be classified under class C.
Class B - Aluminum alloys.
Class C - Other alloys, multi-metal combinations of steel and aluminum or applications for other metallic substrates as required by the manufacturer and where approved by the Army Research Laboratory (ARL) during the qualification process.

2. APPLICABLE DOCUMENTS

2.1 Government publications. The issues of the following documents, 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 313 - Material Safety Data, Transportation Data, And Disposal Data For Hazardous Materials Furnished To Government Activities.

COMMERCIAL ITEM DESCRIPTIONS

A-A-59745 - Zinc-Rich Coatings.

(Single copies of this specification, and other federal specifications and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from the General Services Administration, Federal Supply Service, Specification Section, Suite 8100, 470 L'Enfant Plaza, SW, Washington, DC, 20407.)

(Federal Government activities may obtain copies of federal standardization documents online at https://assist.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-5541 - Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
MIL-C-8514 - Coating Compound, Metal Pretreatment, Resin-Acid.
MIL-A-8625 - Anodic Coatings for Aluminum and Aluminum Alloys.
DOD-P-15328 - Primer (Wash), Pretreatment (Formula No. 117 For Metals) (Metric).
MIL-PRF-16173 - Corrosion Preventive Compound, Solvent Cutback, Cold-Application.
MIL-PRF-23377 - Primer Coatings: Epoxy, High-Solids.
MIL-PRF-32348 - Powder Coating, Camouflage Chemical Agent Resistant Systems.
MIL-DTL-53022 - Primer, Epoxy Coating, Corrosion Inhibiting Lead and Chromate Free.
MIL-DTL-53030 - Primer Coating, Epoxy, Water Based, Lead and Chromate Free.
MIL-DTL-53072 - Chemical Agent Resistant Coating (CARC) System Application Procedures and Quality Control Inspection.
MIL-DTL-53084 - Primer, Cathodic Electrodeposition, Chemical Agent Resistant.
MIL-PRF-85582 - Primer Coatings: Epoxy, Waterborne.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-171 - Finishing of Metal and Wood Surfaces.

(Copies of military specifications and standards required by contractors in connection with specific procurement functions are available online at https://assist.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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 the date of invitation for bids or request for proposal shall apply.

ASTM INTERNATIONAL

ASTM A109/ A109M - Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold Rolled. (DoD adopted)

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. (DoD adopted)
ASTM B117	- Standard Practice for Operating Salt Spray (Fog) Apparatus. (DoD adopted)
ASTM D522	- Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings. (DoD adopted)
ASTM D610	- Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces. (DoD adopted)
ASTM D1654	- Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments. (DoD adopted)
ASTM D1849	- Standard Test Method for Package Stability of Paint. (DoD adopted)
ASTM D3330/ D3330M	- Standard Test Method for Peel Adhesion of Pressure Sensitive Tape. (DoD adopted)
ASTM D3359	- Standard Test Methods for Measuring Adhesion by Tape Test.
ASTM D3363	- Standard Test Method for Film Hardness by Pencil Test. (DoD adopted)
ASTM D3924	- Standard Specification for Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials. (DoD adopted)
ASTM D5486/ D5486M	- Standard Specification for Pressure-Sensitive Tape for Packaging, Box Closure, and Sealing. (DoD adopted)
ASTM F519	- Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments. (DoD adopted)

Copies of these documents are available from www.astm.org or ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959.

GENERAL MOTORS ENGINEERING STANDARDS

GMW 14872	- Cyclic Corrosion Laboratory Test

(Copies of this document are available from www.ihs.com or General Motors International, General Motors Technical Center. Warren, MI 48092.)

SSPC: THE SOCIETY FOR PROTECTIVE COATINGS

SSPC-Guide 15	- Field Methods for Retrieval and Analysis of Soluble Salts on Steel and other Nonporous Substrates.
SSPC-SP 5/ NACE No. 1	- White Metal Blast Cleaning.
SSPC-SP 10/ NACE No. 2	- Near-White Blast Cleaning.
SSPC-VIS 3	- Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning.

(Copies of these documents are available from www.sspc.org or SSPC: The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh, PA 15222-4656.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ISO 9000/17025 standards – Quality management systems of standards and guidelines

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Material. All material used shall be as specified herein, on the drawings, or in the contract. Materials not specified shall be selected by the contractor and shall be subject to all provisions of this specification. The prime and sub-tier contractor shall meet all requirements unless directed otherwise by the contract.

3.2 Preproduction approval. Preproduction approval for types I, II, and V as required by contract.

3.2.1 Procedure approval (types I , II, and V). Prior to production, a detailed written procedure identifying cleaning, pretreatment and painting processes shall be submitted to the procuring agency for approval. Process time, temperature, chemical concentrations, process controls and acceptance criteria and any other pertinent details shall be listed for each step of the application process. The procedure shall include the manufacturer and exact proprietary designation of any material used as well as any equipment used in the application of the procedure. The complete procedure which demonstrates ability to pass the performance tests contained herein is to be signed by a company official prior to its submittal for approval. Deviation from the approved procedure is not permitted without written approval from the procuring agency.

3.2.2 Preproduction validation panels. (types I , II, and V). The contractor shall coat fifteen (4 X 6 inch) panels (see 4.7.2) by the proposed zinc phosphate coating procedure outlined for use in the contract. The test panels shall be the same substrate as will be used in production. Standard test coupons may be used for processing low carbon steels only. Six of the coupons shall be coated with the primer (or paint for single coat systems) to be used in production. The primer dry film thickness shall be 1.5 (+/- 0.2) mils unless otherwise specified in the contract. Three of the non-primed coupons shall be checked for phosphate coating weight, and the resultant coating weight test analysis report shall be provided to the procuring agency. Three of the primed coupons shall be performance tested by the contractor in neutral salt spray for accelerated corrosion resistance unless superceded by an accelerated corrosion test specified in the contract. Ferrous surface specimens of zinc or zinc alloy coated surfaces shall be exposed as specified in ASTM B117. The remaining nine panels (three phosphated only; three phosphate plus primer; three phosphate, primer, and topcoat) shall be forwarded to the procuring activity for evaluation and testing.

3.2.3 Stress Relief. (types I, II, and V). Unless otherwise specified in acquisition documents, parts with a surface or through hardness of Rockwell C 39 or greater shall be given a stress relief treatment. This includes carburized, induction hardened, flame hardened, etc. treatments. Also, any part that is ground,

cold formed, cold straightened, etc., that may induce residual tensile stresses after machining or heat treatment shall be given a stress relief treatment. The stress relief treatment shall consist of a heat treatment at 177 to 204°C (350 to 400°F) for a minimum of one hour for every inch of thickness but not less than one half hour for thicknesses less than one-half inch. Optional heat treatment for carburized parts is 104 to 155°C (225 to 275°F) for 8 hours.

3.2.4 Qualification (types III, IV, and VIII). The conversion coatings, pretreatments, and pre-primer coatings furnished under this specification shall be products which are qualified for listing on the applicable QPD before contract award (see 4.3, 6.3). Any change in the formulation of a qualified product shall necessitate its requalification. The material supplied under contract shall be identical, within manufacturing tolerances, to the product receiving qualification.

3.2.5 Prior to introduction for production or use. Materials as described for each coating type and substrate class shall be validated for performance by the applicator in accordance with the requirements of this specification and by the individual performance requirements of each primer or coating system. Test specimens/coupons representing types III, IV, and VIII materials and process shall be submitted to the Army Research Laboratory (ARL) for testing, and possible consideration for inclusion in the QPD for this specification. One exception to this is the type VI coating. This coating shall be validated for performance in accordance with MIL-DTL-5541 materials and processes.

3.2.6 Contractors prior to using approved materials in production. Contractors shall have Objective Quality Evidence (OQE) (see 6.11) of performance in accordance with this document from an ISO 9000/17025 certified laboratory. The minimum corrosion resistance and adhesion requirements for the types and corresponding classes described herein shall be driven by this specification, the referenced specifications sited herein, and the performance requirements of the selected primer/topcoat system. The requirements that are greater, that is, more stringent, shall apply. Verification of the contractor's process shall be performed on a monthly basis using a certified lab or test facility with substantiating OQE or as required by contract.

3.2.7 Embrittlement testing for steel alloys at Rockwell C hardness (HRC) 39 or greater. Materials and corresponding application processes for conversion coating or other coatings described within this specification shall not contribute to hydrogen embrittlement issues for high strength steels or other materials susceptible to embrittlement during the application and service life of the coatings or pretreatments. Testing to validate that the materials to be processed or procedures do not contribute to hydrogen embrittlement shall be performed for Types III, IV, and VIII during the process for qualification of the supplier's coating materials by ARL (see 4.8.11). Procedures for each contractor's process shall be tested prior to the production start in accordance with ASTM F519 and verified, at a minimum of every 120 days using an ISO 9000/17025 certified laboratory for OQE, that the treated substrates are not compromised. Any application to steel alloys at HRC 39 or greater shall require this testing. The effects of cleaning or processing shall not contribute to hydrogen embrittlement. If the process is demonstrated to contribute to hydrogen embrittlement, then relief shall be performed in accordance with MIL-STD-171.

3.3 Cleaning.

3.3.1 Removal of soils, corrosion, and salts. The parts shall be thoroughly free of oil, grease, wax, dirt, scale, and other foreign matter and shall not show visible signs of corrosion products. With all cleaning methods the water break test specified in 4.7.3.1 shall be used to check for freedom from organic contaminants. Inorganic contamination may still be present even if the water break test is acceptable and

tests for those materials are necessary to ensure performance of the coating system. To ensure process robustness, a test for salts shall be performed periodically. The frequency for this testing shall be agreed upon between the applicator and the procuring authority to provide OQE for the process. Use SSPC-Guide 15 to determine salt contamination. The maximum allowable levels of chloride shall be measured by the adhesive patch/conductivity meter method. Currently the adhesive patch requirements are 3 $\mu g/cm^2$ for tanks and immersed surfaces and 5 $\mu g/cm^2$ for topside and non-immersed surfaces. Similarly, the conductivity requirements are 30 µS/cm for immersed surfaces and 70 µS/cm for non-immersed applications.

3.3.1.1 Removal of weld by-products. All weld slag/flux residues shall be removed. Weld spatter shall be removed from all surfaces exposed to beyond normal view in the end item configuration. If the weld spatter has been overcoated with a zinc or zinc alloy deposit, removal of the spatter is not required unless there are functional or cosmetic concerns. The method or combination of methods used shall be selected to suit the properties of the metal, the type of soil and the degree of contamination present. Surface cleaning methods V or VI shall not be used on steels with HRC greater than 39 unless test data can substantiate that the combined chemical cleaning or phosphoric acid cleaning and subsequent coating pretreatments are not detrimental to the steels being treated. Ferrous materials harder than HRC 39 shall not be chemically etched or chemically derusted unless the coating material and process performed has been preapproved during the approval process described in 3.2 and are tested in accordance with ASTM F519 at an ISO 9000/17025 certified laboratory a minimum of every 120 days for OQE that the treated substrates are not compromised.

3.3.2 Rinsing. Adequate rinsing shall be performed following any chemical process to remove residual material remaining from the cleaning operation. Special care shall be exercised in rinsing complex shapes to prevent contamination of any subsequent cleaning or coating process. Rinse water in a cleaning or pretreatment system that is reused or recycled shall be monitored for contaminants and controlled in accordance with the technical requirements of the material supplier (see 4.7.4 and 4.7.4.1).

3.3.2.1 Drying. Care shall be exercised to ensure complete drying in crevices, seams, or other difficult to dry places prior to painting.

3.3.3 Cleaning methods.

3.3.3.1 Method I - mechanical or abrasive cleaning; sanding, grinding, in accordance with SSPC standards. Abrasive blast cleaning shall be in accordance with the minimum requirements for SSPC-SP 10/NACE No. 2 near-white metal cleanliness unless otherwise specified by contract or the technical data package. Method I shall always be preceded by cleaning methods II, III, IV, VI, or VII, whichever is most appropriate for the application, to assure the substrate is water-break free clean. Using clean water, for example, distilled, deionized, Reverse Osmosis (RO) purified or filtered water in an atomizing sprayer works well in this method and method II for determining the results as described in 4.7.3.1. The blast media and maintenance of the abrasive blasting system shall be such that a consistent surface profile is maintained throughout the process and subsequent abrasive blast cleaning. Surface profile measurements shall not exceed the recommended range for the coating system applied. If not specifically regulated by the coating system specification, the surface profile requirement shall be specified by the coating manufacturer so as to maintain the performance for coating adhesion and corrosion resistance. Ferrous media or media contaminated with ferrous spoils from previous abrasive blasting shall not be used on non-ferrous metallic substrates. Sanding and grinding to remove scale and rust shall also be preceded by the aforementioned cleaning methods contained herein. Cleanliness shall

be in accordance with SSPC-VIS 3, with any of the appropriate SSPC cleaning standards to achieve visual cleanliness condition A, SP3/SD minimum unless otherwise specified by drawing or design engineering. Use the visual standards for cleanliness for steel as a guide for other metal substrates as well. Water break testing for surface cleanliness shall precede and follow mechanical or abrasive blast cleaning to ensure that the cleaning tools or media do not become contaminated and the substrate is meticulously clean.

3.3.3.2 Method II - solvent cleaning by immersion, spray, vapor, or hand wiping. Solvent cleaning often leaves a hydrophobic surface even though organic soils have been removed. This method may not be the best choice. Failure of the water break test shall require the use of one or more of the other Methods cited. Do not use solvents that would damage any existing coatings, sealants, adhesives or other materials that are to remain in place. The wipers or cloths used and the cleaning solvent shall be kept clean so as not to spread the contaminant over the substrate. Do not use halide solvents to clean titanium, magnesium or aluminum. Unless in a vapor controlled system whereby the solvent is distilled and reused, cleaning with solvent shall not be the first choice for cleaning. Substrates that are solvent cleaned shall pass the water break test as described in 4.7.3.1.

3.3.3.3 Method III - detergent cleaning by immersion, spray or electrolytic methods. Detergent cleaning shall be used to remove unwanted substances, contamination and soils. Do not use detergents that are so aggressive as to damage the metal substrate or any coatings or other materials that are to remain in place. Use guidance that is supplied by the detergent supplier's technical data sheet to avoid excessive etching or other deleterious effects. Substrates that are detergent cleaned shall pass the water break test as described in 4.7.3.1.

3.3.3.4 Method IV- emulsion cleaning. With this method of cleaning three distinct steps shall be performed. Step 1 is pre-cleaning whereby the heavy soils are removed using the cleaning solutions either by immersion or delivered with pressurized nozzles. This pre-cleaning keeps the heavy soils from fouling the secondary cleaning system. Step 2 is a secondary cleaning cycle utilizing the same or similar cleaning solutions delivered by an array of pressurized nozzles to remove the soils. Step 3 is a rinse cycle utilizing clean water to thoroughly rinse the cleaning solution from the parts. Use the same controls to check visual cleanliness and water break as described in 4.7.3.1. Do not use cleaning materials or temperatures that could cause damage to any coated surface that is to remain in place or to the metallic substrate. Use guidance provided by the chemical supplier's technical data sheet to avoid etching or other deleterious effects. Substrates that are emulsion cleaned shall pass the water break test as described in 4.7.3.1.

3.3.3.5 Method V - derusting/deoxidizing by chemical means. Deoxidize or derust metals by chemical means or enhance the process by using electrolytic systems for faster removal. Extreme caution shall be exercised to avoid excessive material removal especially on critical surfaces with close tolerances and materials subject to hydrogen embrittlement. Ferrous materials, harder than HRC 39, shall not be chemically etched or derusted unless the materials used and the process has been preapproved (see 3.2.7). Substrates that are derusted/deoxidized by chemical means shall pass the water break test as described in 4.7.3.1.

3.3.3.6 Method VI - phosphoric acid cleaning (detergent or solvent type with detergent). Ferrous materials, harder than HRC 39, shall not be cleaned or derusted with phosphoric acid containing compounds unless the materials and process used has been pre-approved. Substrates that are phosphoric acid cleaned shall pass the water break test as described in 4.7.3.1.

3.3.3.7 Method VII - steam cleaning. Steam cleaning shall be followed with methods II, III, or IV to achieve a water-break free surface (see 4.7.3.1). Substrates that are steam cleaned shall pass the water break test as described in 4.7.3.1.

3.4 Types of conversion coatings, pretreatments and pre-primer coatings.

3.4.1 Type I. Type I coatings shall be applied by spray or immersion and have coating weights in the range of 300 - 500 mg/ft^2 (1.5 - 5.0 g/m^2). When painted, all corrosion and testing within this document applies.

3.4.2 Type II. Type II coatings shall be applied by spray, steam, immersion or hand wiping and have a minimum coating weight of 35 mg/ft^2 (3.5 g/m^2). When painted, all corrosion and testing within this document applies.

3.4.3 Type III. Type III coatings shall contain greater than 50% organic compounds by weight in the dried film, such as wash primers, adhesion promoters and flash-rush inhibitors as defined by the manufacturer of the coating. When painted, all corrosion and adhesion testing within this document applies. With the exception of wash primer conforming to DOD-P-15328 and MIL-C-8514, all products under this type shall be Cr^{6+} free and shall require product qualification.

3.4.4 Type IV. Type IV coatings shall contain greater than 50% inorganic compounds by weight in the dried film, such as conversion coatings, adhesion promoters, and flash-rust inhibitors, as defined by the manufacturer of the coating. When painted, all corrosion and adhesion testing within this document applies. Product qualification required for this coating type.

3.4.5 Type V. Type V coatings are the same as type I coatings except that the coating weight is in the range of 500 - 1100 mg/ft^2 (5.0 - 11 g/m^2). When painted, all corrosion and testing within this document applies.

3.4.6 Type VI. Type VI coatings shall be validated for performance using MIL-DTL-5541. Whenever one of the coating types is not cited in a relevant contractual document or drawing, select the type II coating in MIL-DTL-5541.

3.4.7 Type VII. Type VII coatings shall be validated for performance using MIL-A-8625, Anodic Coatings for Aluminum and Aluminum Alloys. When painted, all corrosion and adhesion testing within MIL-A-8625 applies.

3.4.8 Type VIII. Type VIII coated surfaces shall be abrasive blast cleaned. These coatings are classified as metal-rich finely divided metal powder, including ethyl silicates, alkyl silicates, potassium silicates, and metal-rich polymer coatings. When painted, all corrosion and adhesion testing within this document applies. Product qualification required for this coating type. In accordance with MIL-DTL-53072, a sealer coating of MIL-DTL-53022 or MIL-DTL-53030 shall be applied over the zinc-rich primer.

3.5 End item requirements. The following requirements shall apply to the applicator of the coating systems. All test specimens/coupons shall be produced in the same manner as the end item.

3.5.1 Type I and type V, zinc phosphate. Type I and type V coating deposits shall be gray to black in color. The coating shall be uniformly colored and be free of smut, powder, corrosion products, or white residues. Nonuniformity of color due to heat treatment, composition of the base metal, the degree of cold work performed on the base metal or presence of brown or orange stains inherent from the acidified final rinsing process shall not be cause for rejection.

3.5.2 Lighting conditions. A minimum light intensity of 50 lumens/ft^2 or 538 lux shall be provided at the working surface where manually controlled paint finish operations are performed. Minimum lighting shall apply to the final inspection areas (see 4.7.1.1).

3.5.3 Phosphate coating weight (types I, II, and V). Coating weight shall be controlled and tested every four hours.

3.5.4 Application of paint. The paint shall be applied to thoroughly dried surfaces within 24 hours after pretreatment to prevent contamination or rusting. Should 24 hours be exceeded, the applicator shall maintain OQE to determine if the substrate is suitable for coating. Use the manufacturer's technical data sheets for paint application of metal-rich coatings. The dried surface shall not show any corrosion or soiling prior to painting and be meticulously cleaned (see 3.3). The temperature of the metal surface and the application environment shall be controlled to eliminate blistering, poor adhesion or other film irregularities.

3.5.5 Paint thickness. For all tests requiring painted test specimens/coupons, the dry film thickness (see 4.7.6.1) on all surfaces shall be in accordance with MIL-DTL-53072 or as specified for the end item. When the paint thickness is not covered in the end item specification, the drawing, or paint specification requirement, the precedence shall be in the order cited in the contract.

3.5.6 Paint adhesion (all methods and types). The CARC or non-CARC painted items or specimens / coupons shall show the following satisfactory paint adhesion when tested as in 4.7.6.2 and 4.7.6.3.

3.5.6.1 CARC painted items. The painted items, evaluated by using ASTM D3359 method B, shall have a minimum rating of 4B at 2 mm spacing. Removal of topcoat or topcoat-primer-pretreatment coating from any individual cross-hatch test on the unit with a rating of less than 4B constitutes failure of this test (see 4.7.6.2).

3.5.6.2 Non-CARC painted items. Unless contraindicated by contract, coating system or engineering design when tested in accordance with ASTM D3359 method B, unsatisfactory adhesion shall be indicated by exposure of primer, bare metal, or underlying pretreatment by any of the following conditions:

(a) Any exposed area exceeding 1/8 inch average diameter.
(b) More than one exposed area exceeding 1/16 inch average diameter.
(c) More than five exposed areas less than 1/16 inch diameter.

3.5.7 Accelerated corrosion resistance (all types). After pretreatment and primer (or paint for single coat systems) application, the specimens/coupons shall be subjected to the accelerated corrosion test as in 4.7.7, 4.7.7.1, 4.7.7.2 and 4.7.7.3 for the required number of hours/cycles specified. Specimens/coupons shall show no blistering or loss of adhesion of the paint from the scribe mark (for steel, a rating of 6, for aluminum, a rating of 8, ASTM D1654 method A). Blisters shall cover no more than 5% of the exposed

area (rating of 7, ASTM D1654 method B), none larger than 3 mm in diameter on a standard test specimen/coupon or equivalent area of test specimen/coupon or item. Neutral salt spray testing shall not be used to qualify zinc or zinc alloy coated substrates (see 4.8.10.1 and 6.1.3). GMW14872 cyclic corrosion testing shall be required.

3.6 Qualitative requirements of pretreatments (types III, IV, and VIII). The following test requirements shall be for qualification testing of the pretreatment coatings, as specified in 4.8. All tests, other than storage stability, shall be conducted on specimens/coupons, as specified in 4.8.2, and coated with epoxy primer, as specified in 4.8.4. Pretreatments designed for aircraft and their assets application, and other than those qualified to type VI (see 1.2.2), shall include additional testing, as specified in MIL-DTL-5541.

3.6.1 Storage stability. The manufacturer of the pretreatment to be qualified shall provide details on the storage stability of their product, storage conditions required to maintain storage life and the containers required for storage (see 4.8.5). To verify the storage stability of the pretreatment, ARL has the option to perform additional testing.

3.6.2 Adhesion. The assessment of the adhesion of the coating film shall be determined by its ability to not peel from the substrate when tested in accordance with ASTM D3359, as specified in 4.8.6. The resultant test rating shall be classified as scale 4B or better.

3.6.3 Flexibility. A pretreatment with a film of primer, tested as specified in 4.8.7, shall withstand bending without cracking or flaking. Type VIII coatings are exempted from this requirement.

3.6.4 Water resistance. A pretreatment with a film of primer, tested as specified in 4.8.8, shall show no wrinkling or blistering immediately after removal of the specimen/coupon from the water. The primer shall be no more than slightly affected when examined 2 hours after removal. After 24 hours air drying, the portion of the specimen/coupon which was immersed shall be the same with regard to hardness, adhesion, color and gloss as compared to the portion which was not immersed. Film softening shall not exceed a difference in magnitude of 2 pencil hardness values (see ASTM D3363) from an unexposed film with identical cure history prior to water exposure.

3.6.5 Hydrocarbon fluid resistance. A pretreatment with a film of primer, tested as specified in 4.8.9, shall show no blistering or wrinkling and no more than a slight yellow to beige color change on submerged area of specimen/coupon. Upon removal from the fluid slight softening is acceptable. After 2 hours air drying, the portion of the panel which was immersed shall be the same with regard to hardness, adhesion, color and gloss as compared to the portion which was not immersed. Film softening shall not exceed a difference in magnitude of 2 pencil hardness values (see ASTM D3363) from an unexposed film with identical cure history prior to hydrocarbon fluid exposure.

3.6.6 Corrosion resistance.

3.6.6.1 Salt spray resistance. A pretreatment with a film of primer tested as specified in 4.8.10.1 and examined immediately after removal from the salt spray test shall show no blistering or loss of adhesion of the paint from the scribe mark (for steel, a rating of 6, for aluminum, a rating of 8, ASTM D1654 method A). Blisters shall cover no more than 5% of the exposed area (rating of 7, ASTM D1654 method B).

3.6.6.2 Cyclic corrosion test. A pretreatment with a film of the primer tested as specified in 4.8.10.2 and evaluated using ASTM D1654 method A shall have a rating of not less than seven (7). Blisters shall cover no more than 5% of the exposed area (rating of 7, ASTM D1654 method B).

3.7 Toxic ingredients. Other than parachlorobenzotrifluoride (PCBTF), the pretreatment material being supplied by the applicator or chemical/coating manufacturer for qualification to ARL shall contain no benzene (benzol), chlorinated solvents or ethylene based glycol ethers and their acetates (see 4.8.12). The solvents used in the cleaning methods cited herein shall have no adverse effects on human health when used as intended. With the exception of type VI, compounds of antimony, arsenic, beryllium, cadmium, chromium, cobalt, cyanide, lead, manganese, mercury, nickel and selenium shall also be absent from all pigments in the products being submitted for qualification. Pigments contained in these materials shall be HAP-free.

3.8 User instruction markings. All primary containers shall be legibly marked or labeled, as applicable, with the manufacturer's mixing instructions, the VOC content (in pounds/gallon or grams/liter), hazardous air pollutant (HAP) content for the applicator and the following:

PRECAUTION: The Surgeon General requires airline respirators to be used unless air sampling shows exposure to be below standards. Then, either chemical cartridge respirators or airline respirators are required. Avoid contact with skin and eyes. Use with adequate ventilation. For other safety recommendations refer to the Material Safety Datasheet (MSDS). Keep containers closed.

3.9 MSDS. The manufacturer shall comply with the requirements set forth by the Hazardous Communication Standard, 29 CFR 1910.1200. A MSDS shall be prepared for the material in accordance with FED-STD-313 and forwarded to the qualifying activity (see 6.3). The MSDS shall be included with each shipment of the material covered by this specification and submitted to pertinent Government agencies as stated in a FED-STD-313.

3.9.1 Safety Data Sheets (SDSs). A Safety Data Sheets (SDSs) shall be phased into the system by the following deadline of June 1, 2015 and after June 1, 2016 the Material Safety Data Sheets (MSDSs) becomes extinct and you must ensure that each hazardous chemical in your workplace has an SDS and only an SDS as specified in the OSHA Brief http://www.osha.gov/dsg/hazcom/osha-brief.html and as specified in Appendix D of 29 CFR 1910.1200 (see: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10103 .

3.10 Toxicity clearance. All new chemicals and materials being added to the Army supply system shall have a toxicity clearance. A toxicity clearance involves a toxicological evaluation of materials prior to introduction into the Army supply system. The Army program manager shall be responsible for identifying technically feasible materials and requesting a toxicity clearance for use of that material within their program (see 6.5).

4. QUALITY ASSURANCE PROVISIONS

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

a. Responsibility for inspection (see 4.2).
b. Qualification inspection (see 4.3).
c. Quality conformance inspection (see 4.4).

4.2 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 to do suitable testing IAW ISO 9000 quality standards for the performance of the inspection requirements specified herein. 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.

4.3 Qualification inspection. Qualification of submitted pretreatments for types III, IV and VIII shall be conducted by the qualifying activity (see 6.3). The qualification test sample size shall be designated by the qualifying activity and shall be determined based upon the type of pretreatment (see 1.2.2). Precoated test specimens/coupons shall also be required, as designated by the qualifying activity. The samples shall be legibly identified (see 6.3.2). Qualification inspection shall consist of tests for all requirements specified in section 3.6 and table I. These test methods described in 3.6 and table 1 are for chemical and coating suppliers submitting their products to ARL for qualification for types III, IV and VIII. Qualification inspection shall examine for user instruction markings (see 3.8). The results of each test shall be compared with the applicable requirement in section 3.6. Failure to conform to any requirement shall be counted as a defect and the material represented by the sample test shall not be approved for inclusion in the QPD under this specification. Coated specimens/coupons in accordance with this document shall be forwarded to ARL, ATTN: RDRL-WMM-C, Corrosion Team, Building 4600, Deer Creek Loop, Aberdeen Proving Ground (APG), MD 21005-5066.

TABLE I. Qualification test methods.[1/]

Item	ASTM Method	Test Paragraph	Requirement Paragraph or Table
Storage stability	D1849	4.8.5	3.6.1
Adhesion	D3359	4.8.6	3.6.2
Flexibility	D522	4.8.7	3.6.3
Water resistance	-	4.8.8	3.6.4
Hydrocarbon fluid resistance	-	4.8.9	3.6.5
Salt spray resistance	B117	4.8.10.1	3.6.6.1
Cyclic corrosion resistance [2/]	-	4.8.10.2	3.6.6.2

1/ These test methods pertain to qualification submissions of types III, IV and VIII pretreatments only. Tests in this table does not apply to the end user and applicator of pretreatments.

2/ General Motors Standard: GMW 14872.

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

4.5 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with ASTM D3924. Also, unless otherwise stated in the test method or paragraph, room temperature shall be 73 ± 4 °F (23 ± 2 °C) and a 40 - 70 percent relative humidity.

4.6 MSDS. The MSDS shall address all components of the pretreatment and be in compliance with FED-STD-313. Noncompliance to 3.9 shall be cause for rejection.

4.7 End item test methods. The tests specified in 4.7.1-4.7.8 pertain to the applicator of the pretreatments and coatings and does not apply to qualification of pretreatments.

4.7.1 Tests. Tests shall be conducted as required in this specification. The right is reserved to make any additional tests deemed necessary to determine that the process meets the requirements of this specification.

4.7.1.1 Lighting adequacy. Light intensity at the work or inspection surface shall be 50 lumens/ft^2 or 538 lux minimum.

4.7.2 Test specimens/coupons. Where practical, test specimens/coupons shall be prepared from actual production items or parts thereof, or if size is prohibitive, from scrap parts of the same kind and finish (from the same manufacturing lot if possible) which have been rejected for causes other than phosphating, material composition, heat treatment or any combination thereof. Specimens/coupons need not be identical in shape or size but shall be stamped, etched, or otherwise indelibly marked for identification as a test specimen/coupon. When parts are not available, use standard specimens/coupons not less than 4 x 6 x 0.0312 inches in size. Standard specimens/coupons, cold rolled SAE 1010 steel, shall be used when authorized by the contracting officer. These specimens/coupons shall conform to ASTM A109/A109M or ASTM A1008/A1008M and have a surface roughness of 30 to 45 micro inches (arithmetic average) as rolled prior to any mechanical cleaning method. For zinc coated surfaces, the specimens/coupons shall be made of the same coated material as specified in the contract. When coated steels are used, the standard test specimens/coupons shall be made of the same material as that specified in the contract. All test specimens/coupons shall be processed through all the cleaning, pretreating, painting, and drying steps along with the items being processed. Test specimens/coupons shall not be reused.

4.7.3 Removal of soils, corrosion, and weld by-products. Multiple cleaning procedures may be required to provide the required water break free surface. After cleaning and rinsing, and prior to the application of a coating, at least two production test specimens/coupons shall be subjected to a water break test at the conclusion of a maximum of every four hours of production. These specimens/coupons shall be dried and examined visually for rust, corrosion products, and soils. If specimens/coupons fail the water break test or if the surface shows signs of soils or corrosion products, all items processed since last acceptance shall be rejected and corrective action taken. After corrective action, testing shall be continued at least once every hour during production until indications of soils or corrosion products are eliminated. Testing frequency shall then revert to at least two test specimens/coupons at the conclusion of a maximum of every four hours of production.

4.7.3.1 Water break test. As specified in MIL-DTL-53072, all properly cleaned and pretreated surfaces shall be examined just prior to painting to assure that the surface is dry and free from soil or contamination of any kind. Immediately prior to painting, the surface shall be subjected to a water break

test. The water break test shall be conducted by subjecting the surface to a mist of distilled water by means of a convenient small atomizing device. If the water droplets tend to coalesce into large lenses lasting for 25 seconds, (without a sudden flash out), the surface shall be considered as having satisfactorily passed the water break test. If the water gathers into droplets within 25 seconds (if the surface shows a “water break” within that time), the surface shall be considered as having failed the test. If the water forms a continuous film by flashing out suddenly over a large area, this shall be considered as evidence of the presence of an impurity on the surface such as free alkali or residual detergent, and the surface shall be considered as having failed the test. Failure to support an unbroken water film shall be sufficient cause to do additional cleaning. If more than four hours have passed since performing the water break test, re-examine the surface for corrosion, foreign matter or oily residues and repeat the water break test prior to pretreatment or coating. Cleaning materials which may be effective against one type of contaminant may be ineffective against others. Multiple cleaning procedures may be required to provide the required water break free surface.

4.7.3.2 Metal-rich coatings. Cleaning and surface profile shall be verified in accordance with SSPC-SP 5/NACE No. 1, SSPC-SP 10/NACE No. 2 or manufacturer’s recommendations for application (see 3.4.8).

4.7.4 Rinsing. The water rinses in series systems such as pretreating shall be tested for contamination at practical intervals of production unless independent fresh water or suitably treated water is used as a secondary rinse (see 3.3.2). Technical data supplied by the material manufacturers should be used for guidance. The frequency for this testing shall be agreed upon between the applicator and the procuring authority to provide OQE for the process.

4.7.4.1 Final rinse. (types I, II, and V). Proprietary final acid/alkaline rinses are available and permissible for use over phosphate coatings provided they are specifically approved by the procuring agency. The materials, temperature, concentrations, and other process controls (including replenishment and discard criteria) shall be stated in the procedure. Phosphatized coatings must meet the requirements specified for paint adhesion and salt spray resistance or must meet those requirements specified for the designated coating system for CARC and non-CARC paints.

4.7.5 Pretreatment coating process controls. All controls as designated by the coating supplier shall be followed. Titration, pH management, temperature, and discard criteria shall be established for each chemical phase of the process and maintained as OQE.

4.7.5.1 Phosphate coating process controls. Discard criteria shall be established for each chemical phase of the process. A free acid, total acid and accelerator titration as specified or recommended by the supplier's maintenance procedure for control. If additional process control tests such as titanium concentration or ferrous iron are required by the chemical suppliers product technical bulletin, these additional tests shall also be performed by the contractor.

4.7.6 Organic coating controls. Organic coatings shall be put into practical use in accordance with the relevant coating application, system, or item specification.

4.7.6.1 Thickness of coatings. All applicable surfaces shall be coated and the basis for acceptance (including the number of specimens/coupons tested) shall be as specified in the contract. All coatings, inorganic and organic shall be verified daily for film weight or dry film thickness, as required by the relevant specification or drawing. Film thickness gages shall be used for determining organic coating

thickness (see 6.6) after the gage has been standardized using the same surface (indexing) as that over which the organic finish has been applied.

4.7.6.2 Adhesion test for CARC. After the complete specified paint finish has been applied and cured, three samples from each day's production shall be selected for paint adhesion testing (see 4.7.2). Adhesion testing on the painted test specimens/coupons shall be performed after the complete paint finish has fully cured for a minimum of 168 hours at ambient conditions or by force-curing. A two coat paint system shall be tested after drying in accordance with applicable paint specifications. Each sample shall be tested using ASTM D3359, method B using any commercially available tape (1 inch width) that will yield a minimum of 80 oz of adhesive resistance over the tested coating when tested in accordance with ASTM D3330/D3330M. CARC adhesion shall not be less than scale 4B with any layer of the system. Where CARC dry film thickness has exceeded 5 mils (125 microns), method A of ASTM D3359 shall be used if permitted by the procuring authority. Nonconformance to 3.6.2 shall constitute failure of this test. All items processed since last acceptance shall be rejected and corrective action shall be taken. Contact the CARC Commodity Item Manager at ARL, ATTN: RDRL-WMM-C, Building 4600, APG, MD 21005-5069 for a current listing of approved adhesion test tapes.

4.7.6.3 Paint adhesion test for non CARC. Unless otherwise specified, a minimum of two test specimens/coupons (see 4.7.2) from each day's production shall be run through all steps of the regular production process including painting. Adhesion testing on the painted test specimens/coupons shall be performed after the coating has dried in accordance with the applicable paint specification. Press a 2 inch length of a somewhat longer piece of pressure sensitive adhesive tape (1 inch width) conforming to ASTM D5486/D5486M type I or type II firmly onto a flat or cylindrical surface of the item, rubbing out all air bubbles under the tape. Allow approximately 10 seconds for the test area to return to room temperature. Grasp a free end of the tape and at a rapid speed strip it from the item by pulling the tape back upon itself at 180 degrees in such a manner that the tape is folded back to back during the procedure. Observe for bared areas where the paint is removed. Disregard flecks of paint on tape where the underlying metal or phosphate coating is not visibly exposed. Nonconformance to 3.5.6.2 shall constitute failure of this test, and all items processed since last acceptance shall be rejected and corrective action shall be taken.

4.7.7 Accelerated corrosion resistance. Prior to initiation of production on a contract, or whenever a change in the production process or coating system occurs, or when required by the procuring activity, a minimum of three test specimens/coupons (see 4.7.2), shall be run through all steps of the regular production process including primer application. The specimens/coupons shall be coated and cured for the time and temperature recommended for use in production. When approved by the procuring activity, an alternate test shall be used, which allows one of the organic coatings listed in table II, to be substituted for that used in production. The painted specimens/coupons shall be scribed with two intersecting lines using the scribe tool as described in ASTM D1654. In instances where more than one metal is used, each metal shall be rated for corrosion resistance pertaining to the requirements of the specification of the primer being used. During production, one specimen/coupon (see 4.7.2) from each day’s production shall be subjected to the accelerated corrosion test specified below until five consecutive day’s productions have successfully passed the test. Sampling may then be reduced to one sample twice a week. If failure occurs, all items processed since last acceptance shall be rejected and corrective action taken. Sampling shall revert to one specimen/coupon from each day's production until five consecutive day’s productions have again successfully passed the test. For the purpose of this test, the significant surface on cylindrical items shall be an area 60º on either side of a scribe mark. Production shall not be initiated until results of the salt spray test are received, except at the contractor's

risk. When specified, the painted specimens/coupons shall be scribed with two intersecting lines using the scribe tool described in ASTM D1654.

4.7.7.1 Ferrous surfaces. The specimens/coupons, prepared above (see 4.7.2), shall then be exposed to the 5 percent salt spray specified in ASTM B117. The primers shall be tested as specified in table II. When specified, the painted specimens/coupons shall be scribed with two intersecting lines using the scribe tool as described in ASTM D1654. Upon removal, rinse the specimens/coupons gently in warm running water until free from any visible salt deposits and examine for compliance as specified in 3.5.7 for CARC systems. When visual examination is indeterminate, the specimens/coupons shall be scraped with a 2 inch wide metal putty knife or strip primer and inspected for rust, pitting or corrosion not evident with paint present. Nonconformance shall constitute failure of test.

4.7.7.2 Zinc or zinc alloy coated surfaces. All pretreatments and primers used on zinc or zinc alloy coated surfaces shall be qualified for 40 cycles by the GMW 14872 accelerated cyclic corrosion test. The test protocol and calibration tests for mass loss shall be conducted as noted in the test specification. The test specimens/coupons shall be subjected to 40 cycles of testing. Upon removal from the cabinet, scrape them with a 2 inch wide metal putty knife. The specimens/coupons shall meet the acceptance criteria as specified in 3.5.7 for CARC systems.

4.7.7.3 Aluminum surfaces. Pretreatments shall be applied in accordance with manufacturer's instructions to clean aluminum surfaces. Unless specifically called for in the contract, a chromate containing primer shall not be used for qualification of a pretreatment. All pretreatments and primers shall be tested as specified in table II. Upon removal, rinse the specimens/coupons gently in warm running water until free from any visible salt deposits and examine for compliance as specified in 3.5.7 for CARC systems. When visual examination is indeterminate, the specimens/coupons shall be scraped with a 2 inch wide metal putty knife or strip primer and inspected for pitting or corrosion not evident with paint present. Evaluate for compliance as specified in 3.5.7 for CARC systems.

4.7.8 Hydrogen embrittlement relief test. Unless otherwise specified, the test for the effectiveness of the procedures used to control hydrogen embrittlement shall be performed using procedures outlined in ASTM F519 using type 1a.1, which is a standard size notched specimen/coupon at a frequency of every 120 days.

TABLE II. CARC approved primers.

Specification	Dry film thickness	Substrate [1/]	ASTM B117 (hours)	GMW 14872 (cycles)
MIL-PRF-23377	0.6 - 0.9 mils	AL	2,000	-
MIL-PRF-32348, type I	1.8 - 2.2 mils	CRS and AL	1,500 (CRS) 3,000 (AL)	60 (CRS)
MIL-PRF-32348, type II	1.8 - 2.2 mils	CRS and AL	1,000 (CRS) 3,000 (AL)	60 (CRS)
MIL-DTL-53022, type II	1.3 - 1.7 mils	CRS and AL	336	-
MIL-DTL-53022, type III	1.3 - 1.7 mils	CRS and AL	336	-

TABLE II. CARC approved primers - Continued.

Specification	Dry film thickness	Substrate 1/	ASTM B117 (hours)	GMW 14872 (cycles)
MIL-DTL-53022, type IV	1.3 - 1.7 mils	CRS and AL	1,000	40
MIL-DTL-53030, type II	1.3 - 1.7 mils	CRS and AL	1,000	40
MIL-DTL-53084	0.8 - 1.2 mils	CRS and AL	1,000	-
A-A-59745	2.5 - 3.5 mils	CRS	-	120
MIL-PRF-85582	0.6 - 0.9 mils	AL	2,000	-

1/ Aluminum (AL) and cold rolled steel (CRS).
TERMS: 1 mil = 25.4 microns.

4.8 Qualification testing of pretreatments. Tests specified in 4.8.1-4.8.11 pertain to the chemical and coating suppliers submitting products for qualification to types III, IV and VIII.

4.8.1 Test conditions. Except as otherwise specified herein, the routine testing and referee testing shall be conducted in accordance with ASTM D3924. The dry film thickness of the epoxy primer being used in this testing shall be as specified in 4.8.4. Failure of any test result to fall within the specified ranges in section 3 shall constitute failure of the applicable test.

4.8.2 Test specimens/coupons. Steel test specimens/coupons shall be cold rolled SAE 1010 steel conforming to ASTM A109/A109M or ASTM A1008/A1008M. Hydrogen embrittlement coupons shall be type 1e as described in ASTM F519. The specimens/coupons shall have Rockwell B hardness (HRB) 55 to 75 and a surface roughness of 30 to 45 micro inches (arithmetic average) as rolled. Aluminum test specimens/coupons shall be aluminum alloy 2024-T3. Standard steel and aluminum test specimens/coupons shall be 3 x 6 x 0.0312 inches in size, except as specified herein.

4.8.3 Test procedures. Tests shall be conducted in accordance with ASTM, GM, or as specified herein (see 4.3). The right is reserved to make any additional tests deemed necessary to determine that the pretreatment meets the requirements of this specification.

4.8.4 Epoxy primer. Test specimens/coupons shall be prepared with the appropriate pretreatment that is being tested. These test specimens/coupons shall be solvent wiped and cleaned prior to applying epoxy primer. Apply epoxy primer conforming to MIL-DTL-53022, type IV or MIL-DTL-53030, type II to a dry film thickness of 1.5 ± 0.2 mils (37.5 ± 5 microns). For aviation system application evaluation, MIL-PRF-23377 or MIL-PRF-85582 epoxy primers shall be used and applied to a dry film thickness of 0.6 - 0.9 mils (15 - 22.5 microns).

4.8.5 Storage stability. Along with the submission of the samples for testing, the manufacturer shall provide a statement describing the storage life of the material, the conditions for storage and the containers for storage. Check for compliance with 3.6.1.

4.8.6 Adhesion. Prepare three (3) steel and three (3) aluminum test specimens/coupons as specified in 4.8.2 and 4.8.4. Air dry the specimens/coupons for seven (7) days. Perform adhesion testing as specified in ASTM D3359, method B and examine for compliance with 3.6.2.

4.8.7 Flexibility. Prepare a steel and aluminum test specimen/coupon as specified in 4.8.2 and 4.8.4. Air dry the specimens/coupons for seven (7) days. Bend the coated specimens/coupons over a 1 inch mandrel. Examine the coating for cracks over the area of the bend for compliance with 3.6.3.

4.8.8 Water resistance. Prepare a steel and aluminum test specimen/coupon as specified in 4.8.2 and 4.8.4. Air dry the specimens/coupons for seven (7) days. Coat all exposed unpainted metal surfaces with wax or suitable protective coating and immerse in deionized water at 25 ± 1 °C (77 ± 2 °F) for 168 hours. Specimens/coupons shall be immersed at a minimum depth of 50%. At the end of the test period, remove and examine for compliance with 3.6.4.

4.8.9 Hydrocarbon fluid resistance. Prepare a steel and aluminum test specimen/coupon as specified in 4.8.2 and 4.8.4. Air dry the specimen/coupon for 168 hours and then immerse for 168 hours in a hydrocarbon fluid conforming to JP8 at 25 ± 1 °C (77 ± 2 °F). Specimens/coupons shall be immersed at a minimum depth of 50%. At the end of the test period, remove and examine for compliance with 3.6.5.

4.8.10 Corrosion testing. Prepare ten (10) steel and ten (10) aluminum pretreated and primed 4 x 6 inch specimens/coupons as specified in 4.8.2 and 4.8.4. Five (5) each of the steel and aluminum prepared specimens/coupons shall be exposed to the salt spray resistance and cyclic corrosion resistance. Allow to air dry for seven (7) days. Coat the edges and uncoated metal surfaces with suitable coating. For pretreatments that qualified to only class A or B, use only steel or aluminum specimens/coupons as appropriate.

4.8.10.1 Salt spray resistance. Take five (5) of the steel specimens/coupons and the five (5) aluminum specimens/coupons from 4.8.10 and make an “X” scribe through the primer. Expose these for the number of hours as specified in table II in accordance with ASTM B117. Upon removal, wash the specimens/coupons gently in warm running water until free from any visible salt deposits and examine immediately for compliance with 3.6.6.1. When visual examination is indeterminate, the specimens/coupons shall be scraped with a 2 inch wide metal putty knife or strip primer and inspect for rust, pitting or corrosion not evident with paint present. Nonconformance shall constitute failure of this test.

4.8.10.2 Cyclic corrosion resistance. Take remaining five (5) steel and aluminum specimens/coupons from 4.8.10 and make an “X” scribe through the primer. Expose the specimens/coupons to accelerated cyclic corrosion for the number of cycles as specified in table II in accordance with GMW 14872. Upon removal, rinse specimens/coupons until visible salt deposits are removed. Examine immediately for compliance with 3.6.6.2. When visual examination is indeterminate, the specimens/coupons shall be scraped with a 2 inch wide metal putty knife or strip primer and inspect for rust, pitting or corrosion not evident with paint present. Nonconformance shall constitute failure of this test.

4.8.11 Hydrogen Embrittlement. Apply pretreatment to three (3) type 1e coupons according to manufacturer’s recommended cleaning and application procedures. The notch should be masked for any mechanical cleaning procedures. Coupons shall be tested according to A3 of ASTM F519. If product is found to contribute to hydrogen embrittlement, a statement to that effect will be required on

packaging and relief procedures in accordance with MIL-STD-171 shall be provided with application procedure.

4.8.12 Toxic ingredients. Other than PCBTF, the manufacturer of the chemical or coating being supplied for qualification to ARL shall certify that the pretreatments contain no benzene (benzol), chlorinated solvents or ethylene based glycol ethers and their acetates. All products being submitted for qualification, with the exception of type VI, shall be absent of pigments containing compounds of antimony, arsenic, beryllium, cadmium, chromium, cobalt, cyanide, lead, manganese, mercury, nickel and selenium. Pigments contained in these materials shall be HAP-free. Nonconformance to 3.7 constitutes failure of this requirement.

5. PACKAGING

This section is not applicable to this specification.

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 specification is intended to provide the acceptable methods for cleaning, surface preparation, conditioning and pretreatment of metals prior to the application of the CARC and non CARC coating systems. The pretreatment methods for the metal preparation are by the use of chemical conversion coatings and corrosion inhibiting and/or adhesion promoting base coatings for subsequent military coatings. The intent for the use of the cleaning and pretreatment coatings is described in 6.1.1, 6.1.2 and 6.1.3. The cleaning methods and chemical conversion coatings covered in this specification are suitable for use as adhesion promoters and corrosion preventatives/removers for metallic substrates prior to application of paints. Organic finishing of prepared surfaces should not be delayed as contamination from ambient sources may occur causing a reduction in adhesion, compromising the corrosion resistance of the organic coating.

6.1.1 Metal surfaces. Cleaning methods are intended primarily for metal cleaning, rust removing, descaling, or surface etching purposes in conjunction with chemical pretreatment processes or a pre-primer coating prior to the application of CARC. Method I (abrasive blasting) is generally recommended to remove heavy rust and mill scale on metals with thicknesses greater than 1/8 inch and to produce an even surface profile. Abrasive blasted high strength steels and corrosion resistant metals may not be coated without being given a conversion coating unless authorized by the procuring activity. Method VI (phosphoric acid) may be used to remove light to moderate rusting but is not considered an acceptable substitute for a chemical pretreatment process. The selection of the cleaning process is dependent on the type and amount of soil and corrosion products on the items.

6.1.2 Nonferrous surfaces. The cleaning processes in this specification may also be used on nonferrous surfaces. Care should be exercised to ensure that cleaning materials do not have detrimental effects on the items being cleaned. Mixed metal assemblies or fabrications will need additional attention to prevent damage or unwanted results.

6.1.3 Nonferrous substrate testing variations. Coated substrates are tested in accordance with the GMW 14872 accelerated cyclic corrosion test for 40 cycles (see 4.8.10.2), then scraped after exposure and

examined using the same acceptance criteria noted for the accelerated corrosion test in 3.6.6.2 of this specification, unless an accelerated corrosion test such as the sulfur dioxide salt spray test specified in ASTM G85 is specified in the contract. In that case, that test protocol as indicated in the contract should be used to qualify the pretreatment/primer. MIL-DTL-5541 requires some testing other than that covered in this document for aluminum and aluminum alloys.

6.1.4 Method of application. New design documents, engineering drawings and ordering data should indicate the type of coating required, cleaning requirements and methods of application when practicable.

6.1.5 Application conditions. The contractor should be cognizant of the environmental controls necessary so as not to apply any coating outside the coating manufacturer's recommendations. Organic coatings should not be applied when the surface temperature, air temperature, or relative humidity would cause a negative effect on the application and subsequent function of the applied coating. When surface temperature or air temperature are < 5 ºF above dew point, the coating is adversely affected. At relative humidity in excess of 50%, a dew point calculation may be necessary to avoid the formation of moisture on the substrate to be coated. Limits on humidity during application of a coating should be determined in the guidelines set forth by the manufacturer of the coating (see table III).

TABLE III. Dew Point.

	AMBIENT AIR TEMPERATURE (°F)										
% RELATIVE HUMIDITY	20	30	40	50	60	70	80	90	100	110	120
90	18	28	37	47	57	67	77	87	97	107	117
85	17	26	36	45	55	65	75	84	95	104	113
80	16	25	34	44	54	63	73	82	93	102	110
75	15	24	33	42	52	62	71	80	91	100	108
70	13	22	31	40	50	60	68	78	88	96	105
65	12	20	29	38	47	57	66	76	85	93	103
60	11	19	27	36	45	55	64	73	83	92	101
55	9	17	25	34	43	53	61	70	80	89	98
50	6	15	23	31	40	50	59	67	77	86	94
45	4	13	21	29	37	47	56	64	73	82	91
40	1	11	18	26	35	43	52	61	69	78	87
35	-2	8	16	23	31	40	48	57	65	74	83
30	-6	4	13	20	28	36	44	52	61	69	77

Note 1: Dew point is the temperature at which moisture will condense on the surface. No organic coatings should be applied unless the surface temperature of the substrate is a minimum of 5 ºF above the dew point at the point of application.

Note 2: In the example shown above, if the air temperature is 70 ºF and relative humidity is 65%, the dew point is 57 ºF. In this example, no organic coating should be applied unless the surface temperature is 62 ºF minimum.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, revision letter, amendment, and date of this specification.
b. Surface cleaning method, surface preparation process and metal class required (see 1.2).
c. Whether a MSDS is required with each shipment (see 3.9/3.9.1 and 4.6).
d. If a toxicity clearance is required (see 3.10).
e. If qualification samples are required and where to send them (see 4.3 and 6.3).
f. Sampling and inspection requirements.

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 (ARL, ATTN: RDRL-WMM-C, Corrosion Team, Building 4600, Deer Creek Loop, Aberdeen Proving Ground, MD 21005-5066, thomas.braswell2.civ@mail.mil). An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil/online/start/.

6.3.1 Retention of qualification. In order to retain qualification of a product approved for listing on the qualified products list (QPD), the manufacturer will verify by certification to the qualifying activity that the manufacturer's product complies with the requirements of this specification. Unless otherwise specified, the time of periodic verification by certification will be in two year intervals from the date of the original qualification, and will be initiated by the qualifying activity. No change will be made in formulation, raw materials or supplier(s) of raw materials, methods of manufacture, equipment, or geographic location without prior written Government approval. The Government reserves the right to re-examine the qualified product whenever deemed necessary to determine that the product continues to meet any or all of the specification requirements.

6.3.2 Sample identification for qualification inspection. Samples for QPD testing are to be identified in a cover letter with the following information:

Manufacturer's name and product number.
Submitted by (name and date).
Specify the number of samples.
Specify the reason for submitting the samples.
Specification TT-C-490F; Method_____, Type_____, Class_____,
"Chemical Conversion Coatings And Pretreatments For Metallic Substrates (Base For Organic Coatings)".
Provide a copy of the MSDS.
Provide a copy of the notarized statement of composition.
Provide a copy of the technical data sheet.
Provide a copy of the test report.

6.4 MSDS. Contracting officers will identify those activities requiring copies of a completed MSDS prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313.

6.5 Toxicity request. Department of the Army Regulation (AR) 40-5, Preventive Medicine, (AR) 70-1, Acquisition Policy, and Department of the Army Pamphlet 70-3, Acquisition Procedures, require a toxicity clearance. Army toxicity questions and/or a toxicity clearance request should be addressed to: US Army Public Health Command (USAPHC), ATTN: MCHB-IP-TTE, 5158 Blackhawk Road, APG-EA, MD 21010-5403 or emailed to usaphctepinfo@amedd.army.mil.

6.6 Measuring paint thickness. Eddy current, magnetic, ultrasonic or other paint thickness measurement gages recognized by SSPC or NACE International are appropriate provided regular calibration is maintained.

6.7 CARC approved primers. Listed in table II are the primers that are approved for use in a CARC coatings system. Contact ARL for any updates to this table.

6.8 Appearance. After application of chemical conversion coating or use of one of the cleaning methods, changes in appearance are to be expected. Conversion coatings leave a visible chemical deposit. Some variation in uniformity is to be expected. Appearance should be in accordance with good commercial practices.

6.8.1 Type II coatings. The color ranges, when using an aqueous iron phosphate pretreatment, from light brown to violet to blue to gold to gray.

6.9 Pretreatment. Application of organic coatings over bare untreated ferrous surfaces is not a recommended practice. Organic coating should be applied to surfaces prepared with a conversion coating or pretreatment.

6.10 Scanning electron microscope. The scanning electron microscope (SEM) is often used to study the morphology of zinc phosphate crystals. It can be used to assure proper coverage on production parts and is useful for preproduction approval.

6.11 OQE. A documented statement of fact, or supporting record, either quantitative or qualitative, pertaining to the quality of an item or process, based on observations, measurements, or tests that can be verified as required within the document. Evidence will be expressed in terms of specific quality requirements or characteristics in a certified lab report. These characteristics are identified in drawings, specifications and other documents which describe the item, process or procedure.

6.12 Subject term (key word) listing.

Aluminum
Class
Cleaning
Method
Process
Steel
Type

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

CONCLUDING MATERIAL

MILITARY INTERESTS:

Custodians
Army - MR
Navy - SH
Air Force - 11

Review Activities
Army - AV, MI, PT
Navy - AS, MC
Air Force - 13, 19, 99
DLA - DH, IS, GS4
DISA - DC5

CIVIL AGENCY COORDINATING ACTIVITY:

GSA/FAS

Preparing Activity:
Army - MR

DoD Project MFFP-2012-002

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil/online/start/.