Engineering and Technical Services for Joint Group on Pollution Prevention (JG-PP) Projects

Joint Test Protocol
J-99-OC-014-P

For Low/No VOC and Nonchromate Coating System for Support Equipment

4 November 1999
Revised 10 August 2000

Contract No. F09603-95-D-0177
Delivery Order RZ03

Prepared by
Science Applications International Corporation
Warner Robins, Georgia 31088

PREFACE

While much attention has been addressed to weapon system de-painting and re-painting issues, less concern has been directed to those issues with respect to support equipment (SE). The Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA) has both powered and non-powered SE utilized in broad mission profiles. However, each service within the DOD and NASA defines the SE end-item differently. In an effort to consolidate the various SE definitions and for the purpose of defining the scope of this Joint Test Protocol (JTP), SE is defined as mobile and fixed, combat- and aviation-related ground SE in powered and non-powered categories. Powered SE includes, but is not limited to, portable/mobile generators, air compressors, hydraulic service units, air conditioners, ground heaters, light carts, gas turbine service equipment, universal maintenance stands, and self-propelled bomblifts. Non-powered SE includes, but is not limited to, maintenance stands, towbars, oxygen/nitrogen servicing carts, and jacks. However, any coating systems, which have met the requirements of this JTP, with cognizant engineering approval, could be transitioned to any piece of equipment owned by the DOD or NASA.

The difficulty in selecting a single primer/topcoat system for the entire SE inventory is compounded not only by the varied model design series of the equipment but also by varied substrate prepaint preparations. First, when applied by the Original Equipment Manufacturer (OEM) in production, the substrates are chemically cleaned and pretreated (e.g., iron or zinc phosphate for steel and chromate conversion coating for aluminum). Second, when applied during organizational level maintenance, the substrates are either rotary sanded, abrasive blasted, or a combination of both processes are used to de-paint the surfaces and remove corrosion. During these maintenance operations, the steel and aluminum pre-treatments are typically removed and not replaced. Accordingly, the designated primer must perform adequately on bare (not pretreated) substrates for the required paint system life cycle.

This JTP outlines testing requirements required by the Air Force, Army, Marine Corps, Navy and NASA subject matter experts (SME) to facilitate the standardized testing and qualification of new SE coating and coating systems.

Note:
This JTP was revised by the National Defense Center for Environmental Excellence/Concurrent Technologies Corporation to make the following non-technical clarifications. These changes were approved by the project participants and by the Joint Acquisition Sustainment Pollution Prevention Activity (JASPPA). The below changes are highlighted by revision marks in the border of the modified pages. No other changes have been made.

(a) **JTP Section 3.1.2, Surface Appearance** – (1) The surface appearance of the topcoats is required to be evaluated only after the entire primer/topcoat system is applied. (2) Only one color per alternative is required to be tested for matching

FED-STD-595B color chips (either color 34094 or color 17925). (3) St-2a and St-2b coupons from Section 3.1.1, Ease of Application, are required to be used for this test (the previous version of the JTP stated that the St-6 coupons from Section 3.2.1, Removability, were required to be used for this test).

(b) **JTP Section 3.1.4, Dry-To-Touch (Sanding)** – (1) Both liquid primers and liquid topcoats are required to be tested. (2) The acceptance criteria of this test is "No rolling or scribing during sanding, and "easy" sanding (as evaluated by technician)" (the previous version of the JTP stated an acceptance criteria of "No rolling or scribing during sanding, and "easy" sanding (as evaluated by technician) no more than 12 hours after application").

(c) **JTP Section 3.1.5, Cure Time (MEK Solvent Rub)** – (1) This test is not applicable to metal wire arc spray coatings. (2) Both liquid primers and liquid primer/topcoat coating systems are required to be tested against this requirement.

(d) **JTP Section 3.2.1, Removability** – Characteristics concerning blasting were added during this revision. A ½-inch ventury nozzle is required to be used for this test. Media flow must be set in accordance with the media manufacturer's specifications.

(e) **JTP Section 3.2.2, Reparability** – This test requires that the baseline control coating be repaired with each of the alternative coatings (the previous version of the JTP stated that the baseline control coating was required to be repaired with one alternative coating).

(f) **JTP Section 3.2.3/Section 3.4.7, Accelerated Weathering** – If required by chamber size restraints, the coupon size may be reduced to 2.75 inches by 4 inches by 0.032 inches.

(g) **JTP Section 3.2.4, Filiform Corrosion Resistance** – The NASA control coating is not required to be tested; filiform corrosion resistance is not a NASA requirement.

(h) **JTP Section 3.2.6, Mandrel Bend Flexibility** – Material characteristics of the alternatives after this test is performed must be reported.

(i) **JTP Section 3.2.7, Accelerated Storage Stability** – Film technology alternatives are required to be tested against this requirement (these alternatives were not required to be tested in the previous version of the JTP).

(j) **JTP Section 3.4.4, Cyclic Corrosion Resistance** – (1) The inspection cycle has been revised. The previous version of the JTP required inspections every 24 hours. Inspections are now required after 24, 48, 72, 96, and 168 hours of exposure, and subsequent inspections at a maximum of every 168 hours of exposure. (2) If required by chamber size restraints, the coupon size may be reduced to 3 inches by 6 inches by 0.032 inches.

(k) **JTP Section 3.4.6, B 117 Salt Fog Corrosion Resistance** – If required by chamber size restraints, the coupon size may be reduced to 3 inches by 6 inches by 0.032 inches.

(l) **JTP Section 3.4.12, Infrared Reflectance** – The acceptance criteria of this test is "Field Green (34094): reflectance ≤ 8% reflectance in 450-500 and 600-2,700 nm wavelength ranges and reflectance ≤ 10% in 500-600 nm wavelength range" (the previous version of the JTP stated "Field Green (34094): reflectance ≤ 8% reflectance in 450-500 and 600-2,700 nm wavelength ranges and reflectance ≤ 10% in 500-600 nm wavelength range. For other MIL-C-46168 colors, refer to Tables 3-2 of this JTP").

(m) **JTP Section 3.4.13, Acid Resistance** – The acceptance criteria for this test is "No blistering or color change" (the previous version of the JTP stated "Visual examination, no blistering and no color").

(n) **JTP Section 3.4.15, Chromaticity** – The acceptance criteria of this test is "Color within 2.0 NBS units of chromaticity coordinates in Table 3-3" (the previous version of the JTP stated "Color within 2.0 NBS units of chromaticity coordinates in Table 3-2").

(o) **Acceptance Criteria** – In the previous version of the JTP, the description of acceptance criteria varied between the summary tables of the JTP (Tables 2-1 through 2-4) and the test descriptions (Section 3.0). In this revised version, the acceptance criteria in the summary tables were replaced by the acceptance criteria described in the test descriptions.

(p) **References** – The following references to specifications have been updated and/or revised:

- Table 2-4 of the previous version of the JTP referenced GM ASTM B 117-97; this reference was replaced by ASTM B 117-97.
- The previous version of the JTP referenced ASTM D 523-89 and ASTM D 1200-94; these references have been updated to ASTM D 523-89 (1999) and ASTM D 1200-94 (1999) (no changes occurred in these ASTM revisions).
- Table 2-4 of the previous version of the JTP referenced ASTM D 1654-92, Procedure A, Method 1 9540 P; this reference was replaced by ASTM D 1654-92, Procedure A, Method 1.
- References to ASTM D 3359-92a and ASTM D 3359-95a were updated to reference ASTM D 3359-97.
- References to ASTM D 3363-92a and ASTM D 4752-95 were updated to ASTM D 3363-00 and ASTM D 4752-98, respectively.
- References to ASTM D 5139-96 were revised to ASTM D 5139-90 (1996) (no changes occurred in this ASTM revision).
- The approval date of ASTM G 85-98 (April 10, 1998) was added to the Table 3-4. References to ASTM G 85-87, Annex A4 were replaced by ASTM G 85-98, Annex A4.
- References to FED-STD-141C and FED-STD-595B were updated to show the full references (Change Notice 2, dated December 10, 1993 and Change Notice 1, dated January 11, 1994, respectively).
- References to MIL-A-8625 were changed to MIL-A-8625F, dated September 10, 1993.
- References to MIL-C-46168D, dated March 28, 1984, were changed to MIL-C-46168D, dated May 21, 1998.
- The date of MIL-C-53039A was added to Table 3-4 (May 19, 1993).
- The date of MIL-P-53030A was updated from March 9, 1992 to August 20, 1993.
- The title of MIL-PRF-22750F was revised from "High-Solids Epoxy Coating" to "Coating, Epoxy, High Solids".
- References to MIL-PRF-23377G, dated September 30, 1994 were updated to MIL-PRF-23377G Amendment 1, dated September 30, 1999.

- References to MIL-STD-810E (*Department of Defense Test Method Standard for Environmental Considerations and Laboratory Test*, dated July 14, 1989) were updated to MIL-STD-810F (*Environmental Engineering Considerations and Laboratory Tests*, January 1, 2000).

Additionally, the following technical changes were required by the NASA approval authority:

(a) **JTP Section 3.4.1, Tensile (Pull-Off) Adhesion** – Removed this test from the JTP; it is no longer required by NASA.
(b) **JTP Section 3.4.2, Abrasion Resistance** – Removed this test from the JTP; it is no longer required by NASA.
(c) **JTP Section 3.4.3, 18-Month Marine Environment** – Only St-2a coupons are required to be tested, instead of both St-2a and St-3.
(d) **JTP Section 3.4.16 – High-Temperature Resistance** – This test was added because it is required by NASA for validation of a primer/topcoat system.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

1. INTRODUCTION

The DOD AND NASA technical representatives tasked Science Applications International Corporation (SAIC) to develop a Joint Test Protocol (JTP) that would list testing requirements used to evaluate now-term protective coating systems for powered and non-powered SE. The task will be accomplished under the auspices of the Joint Group on Pollution Prevention (JG-PP) in order to coordinate joint service activities with respect to pollution prevention issues identified during a weapon system's acquisition process.

SAIC developed the SE JTP in a format to meet the primary objectives of the JG-PP:

- Reduce or eliminate the use of hazardous materials (HAZMATS) at manufacturing remanufacturing and sustainment locations.

- Avoid duplication of efforts in action required to reduce or eliminate HAZMAT through joint service/agency cooperation and technology sharing.

This JTP format is consistent with previous JTPs with respect to the extent of scope and test requirements. In the development of this JTP, SAIC has reviewed JTPs produced for the government including Boeing Company Aircraft & Missiles (BA&M) (formerly McDonnell Douglas Aerospace), Lockheed Martin Electronics & Missiles and Information Systems Companies and Raytheon Texas Instruments Systems, Inc. (RTIS). Additionally, SAIC reviewed a draft JTP currently under review by the Naval Air Warfare Center Aircraft Division in Patuxent River, MD. These JTPs provided in-depth information concerning past testing efforts in VOC reduction and chrome elimination. These reports and other project reports of interest may be viewed on the JG-PP web page http://www.jgpp.com.

This JTP document outlines the tests necessary to qualify potential coating alternatives that could be used on SE to replace the existing polyurethane and epoxy coating systems. The recommended tests were derived from engineering, performance, and operational impact (supportability) requirements defined by consensus of government and industry participants. This document will serve as a reference for future pollution prevention efforts by other DOD and commercial users to minimize duplication of effort.

The now-term coating processes identified herein are protective coating systems applied using wet-spray, thermal spray, electrostatic powder coating, or advanced film technology (e.g. 3M Applique®) that have potential uses on SE. Table 1-1 summarizes the target HAZMATs and hazardous air pollutants (HAPs), current processes, application to the equipment, current specifications, affected agencies, and candidate substrates.

Table 1-1 Target HAZMAT Summary

Target HAZMATs	Current Process	Applications	Current Specifications	Affected Agencies	Substrates
Hexavalent Chromium Lead HAPs (e.g., methyl ethyl ketone toluene xylene)	Wet-spray application of primers and topcoats by HVLP, airless, and electro-static methods	Exteriors and interiors of powered and non-powered SE	MIL-P-53022B, MIL-P-53030A, MIL-PRF-23377G, MIL-PRF-26915D, MIL-PRF-85582C, MIL-PRF-85285C, MIL-PRF-22750F, MIL-C-46168D, MIL-C-53039A, NASA System (CATH-COAT 304 inorganic zinc-rich primer, DEVRAN 201 epoxy primer, DEVTHANE 369 Aliphatic Urethane)	All participants in the Air Force, Army, Marine Corps, Navy and NASA	Aluminum, steel, and composites

2. PERFORMANCE AND TESTING REQUIREMENTS

The DOD and NASA technical representatives developed a consensus regarding the proposed coating test criteria to quantify and qualify potential technical and performance test requirements required by DOD and NASA. These requirements include procedures, methodologies, and acceptance criteria, which will provide the minimum requirements for a candidate technology to meet the stakeholders' needs.

Once the JTP test criterion is approved, testing will be performed in a manner that will optimize the use of each test panel. For example, where practical, more than one type of test will be performed on the coated test panels. The number and types of tests performed on a given panel will be determined by the destructive-nature of the tests in question, see Table 3-4, *Test Coupon Matrix Per Selected Coating System,* for required tests and test panels quantities.

All coating system candidates will be tested using the approved DOD and NASA standard SE coating system as an experimental control. The performance of the control coating will be evaluated against the alternate coating listed in this JTP. Coating technicians will follow all manufacturer application instructions and will document all relevant conditions at the time of application.

> **Note:** Tests specified in this JTP may involve the use of hazardous materials, operations, and equipment. This JTP does not address all safety issues associated with its implementation. It is the responsibility of each user of this JTP to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to its use.

The objective of this project is to compare candidate coating performance to the standard coating system, not to qualify the candidates under the specifications for the standard system. This project will compare coating performance of the proposed alternatives to existing coating systems or standards. The tests described in this JTP are in the following main categories: screening tests, common tests, field evaluations, and extended tests. Tables 2-1, 2-2, 2-3, and 2-4 summarize the test requirements for validating alternative coating candidates against existing approved SE coating systems.

Table 2-1 lists screening tests. Screening tests are preliminary tests performed on the candidate alternate coating systems. Candidate coatings that do not meet the requirements of the screening tests will be eliminated from further testing unless otherwise directed by the testing authority.

Table 2-2 lists the common tests required by participating services/agencies, such as adhesion, flexibility, ultraviolet (UV) light resistance, corrosion resistance, fluid resistance, removability and reparability. Candidate coatings that do not meet the requirements of the common tests will be eliminated from further testing unless otherwise directed by the testing authority.

Table 2-3 lists field evaluations that are intended to compare the performance of candidate test coatings with current coatings when applied to powered and non-powered SE in an operational environment. The field evaluations will be performed after laboratory tests are complete, using only those candidate coating systems that met acceptance criteria in the screening and common tests, unless directed by the testing authority. Coating evaluators will complete a written evaluation and documentation checklist to organize and quantify the observations of coating system performance under actual operating conditions.

Table 2-4 lists service/agency-specific extended tests that are required by one or more, but not all, of the services/agency. These tests may be unique to that particular service or agency mission profile rather than the entire DOD or NASA.

These tables include acceptance criteria and the reference specifications, if any, used to conduct the tests. Where "none" appears under *Test Method References*, the proposed test and evaluation are based on the aggregate knowledge and experience of the assigned technical project personnel and prior testing.

Table 2-1 Screening Test Requirements

Test	JTP Section	Test Specimen	Acceptance Criteria	Test Method References
Ease of Application	3.1.1	Coupon	Smooth coat, with acceptable appearance, no runs, bubbles or sags. Ability to cover the properly prepared/primed substrate with a single coat (one-coat hiding ability).	None
Surface Appearance	3.1.2	Coupon	No streaks, blistering, voids, air bubbles, cratering, lifting, blushing, or other surface defects/irregularities. No micro-cracks observable at 10X magnification. Gloss and color should match per FED-STD-595B color chips (either color 34094 or color 17925 is required to be tested).	ASTM D 523-89 (1999) ASTM D 2244--93
Pot Life (Viscosity)	3.1.3	Mixed Coating System	Procedure A High Solids Coatings Viscosity of both test batches shall not exceed 60 seconds after 4 hours of continuous mixing in a closed container maintained at 75 ± 5°F (Batch 1) and 95 ± 5°F (Batch 2). The admixed materials must still be sprayable 4 hours after mixing.	ASTM D 1200-94 (1999)
			Procedure B Waterborne Coatings Coating viscosity shall not exceed admix viscosity by more than 15 seconds after 4 hours, with no gelling of the admixed coating after 6 hours.	
Dry-To-Touch (Sanding)	3.1.4	Coupon	No rolling or scribing during sanding, and “easy” sanding (as evaluated by technician).	None
Cure Time (MEK Solvent Rub)	3.1.5	Coupon	No effect on surface or coating on the cloth (Resistance Rating 5).	ASTM D 4752-98

Table 2-2 Common Test Requirements

Test	JTP Section	Test Specimen	Acceptance Criteria	Test Method References
Removability	3.2.1	Coupon	Less than one minute to penetrate to substrate.	ASTM D 523-89 (1999) ASTM D 2244-93 ASTM G 26-96 Test Method 1
Reparability	3.2.2	Coupon	Ease of removal and replacement of damaged areas of the test coatings, color matching of aged versus new material. No streaks, blistering, voids, air bubbles, over-spray "halo", cratering, lifting, blushing, or other surface irregularities. No peel away of the repaired coating during the dry tape adhesion test.	ASTM D 523-89 (1999) ASTM D 2244-93 ASTM D 3359-97
Accelerated Weathering	3.2.3	Coupon	Color change performance < one unit (ΔE) @ 500 hrs.	ASTM G 26-96, Test Method 1 ASTM D 523-89 (1999) ASTM D 2244-93,
Filiform Corrosion Resistance	3.2.4	Coupon	No filiform corrosion extending beyond ¼-inch from the scribe lines with the majority of filaments less than $^1/_8$-inch long.	ASTM 2803-93, Procedure C
X-Cut Adhesion Test	3.2.5	Coupon	Candidate coating performs as well or better than control coatings and greater than or equal to 4a as specified in ASTM D 3359-97.	ASTM D 3359-97, Test Method A FED-STD-141C Method 6301.2
Mandrel Bend Flexibility	3.2.6	Coupon	No peeling or delamination from the substrate and no cracking greater than ¼-inch from the edges.	ASTM D 522-93a, Test Method B
Accelerated Storage Stability	3.2.7	Coupon	No skinning, grains, or lumps of the coating; no pressure buildup, corrosion on the container, odor of spoilage or cloudy appearance of catalyst.	ASTM D 1849-95

Table 2-3 Field Evaluation Requirements

Test	JTP Section	Test Specimen	Acceptance Criteria	Test Method References
Full Unit Operational Testing	3.3.1	SE-Type TBD	Performance equal to or better than DOD and NASA control coating system.	TBD

Table 2-4 Extended Test Requirements

Test	JTP Section	Service Agency	Test Specimen	Acceptance Criteria	Test Method References
Tensile (Pull-Off) Adhesion	3.4.1	NASA	N/A	*Requirement removed*	N/A
Abrasion Resistance	3.4.2	NASA	N/A	*Requirement removed*	N/A
18-Month Marine Environment Test	3.4.3	NASA	Coupon	Panel condition rated 9 or better per ASTM D 610-95.	ASTM D 610-95
Cyclic Corrosion Resistance	3.4.4	Air Force, NASA, Army	Coupon	Candidate coating performs as well or better than the control coatings. No significant blistering, softening, or lifting of coating.	GM 9540 P
SO_2 Corrosion Resistance	3.4.5	Navy	Coupon	No blistering or lifting after 500 hours. Slight substrate corrosion only. Slight substrate corrosion acceptable.	ASTM G 85-98, Annex A4 ASTM D 1654-92, Procedure A, Method 1
B 117 Salt Fog Corrosion Resistance Test	3.4.6	Navy	Coupon	No blistering or lifting after 2,000 hours. Slight substrate corrosion only.	ASTM B 117-97 ASTM D 1654-92, Procedure A, Method 1

Table 2-4 Extended Test Requirements (Continued)

Test	JTP Section	Service Agency	Test Specimen	Acceptance Criteria	Test Method References
Accelerated Weathering	3.4.7	Navy	Coupon	Color change performance < 2 units (ΔE) @ 1,000 hrs and 1,500 hrs.	ASTM G 26-96 Test Method 1, ASTM D 2244-93 ASTM D 523-89 (1999)
Fluid Resistance	3.4.8	Air Force, Army, Navy	Coupon	No objectionable discoloration, change in gloss, blistering, or swelling. Scratch hardness ≤ 2 pencil hardness units from the control finishes.	ASTM D 3363-00
Chemical Agent Resistance Test	3.4.9	Army	Coupon	Desorb a maximum 180 µg of HD agent and desorb a maximum of 40 µg GD agent	MIL-C-46168D
Decontamin-ating Agent, DS2 Resistance	3.4.10	Army	Coupon	No blistering, wrinkling, or softening.	MIL-C-46168D MIL-PRF-22750 MIL-D-50030H
Fungus Resistance	3.4.11	Army	Coupon	Topcoat does not support fungal growth.	MIL-STD-810F, Method 508
Infrared Reflectance	3.4.12	Army	Coupon	Field Green (34094): reflectance ≤ 8% reflectance in 450-500 and 600-2700 nm wavelength ranges and reflectance ≤ 10% in 500-600 nm wavelength range	MIL-C-46168D
Acid Resistance	3.4.13	Army	Coupon	No blistering or color change.	MIL-C-46168D

Table 2-4 Extended Test Requirements (Continued)

Test	JTP Section	Service Agency	Test Specimen	Acceptance Criteria	Test Method References
Specular Reflectance for All Camouflage Colors listed in Table 2-4 of MIL-C-46168	3.4.14	Army	Coupon	≤2.5 gloss units	MIL-C-46168D FED-STD-141C
Chromaticity	3.4.15	Army	Coupon	Color within 2.0 NBS units of chromaticity coordinates in Table 3-3.	MIL-C-46168D MIL-C-53039A, ASTM E 1164-91
High-Temperature Resistance	3.4.16	NASA	Coupons	No change in film integrity and adhesion	ASTM D 2197-98 ASTM D 4541-95e1

3. TEST DESCRIPTIONS

Test requirements identified in Tables 2-1, 2-2, 2-3, and 2-4 are further defined in this section to include the test description, rationale, and test methodology. The test methodology lists the major parameters, test coupon descriptions, number of trials per coupon, and acceptance (pass/fail) criteria. Any *Major or Unique Equipment* requirements and *Data Analysis and Reporting Criteria* are also included. In some cases no control coupons are required for a test, as the baseline coating performance is well documented.

Unless otherwise required by a specific test, test coupons will be at least 4 inches wide by 6 inches long and of suitable thickness (typically 0.032 inch). Metal coupons shall be prepared in accordance with ASTM D 5139-90 (1996) (*Standard Specification for Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants*, approved 1990, reaffirmed 1996). Coupon surfaces must be cleaned to "water-break-free" condition prior to coating. Water break tests shall be performed in accordance with the current version of ASTM F 22-65 (1998) (*Standard Test Method for Hydrophobic Surface Films by the Water-Break Test*, re-approved 1998). The surface conditioning for steel test coupons will be in accordance with the Society of Protective Coating Standards SSPC-SP-1 (*Solvent Cleaning*), -10 (*Near-White Blast Cleaning*), and -11 (*Power Tool Cleaning to Bare Metal*). Test coupons must be painted within one week of the application of the pretreatment (e.g., conversion coating, anodize, or seal). Each test will be performed on identical test panels prepared with the candidate alternative coating system and the DOD and NASA standard control coating(s) as the test control.

Each coating system will be prepared and applied according to instructions provided by the manufacturer. Coating systems should be applied by spraying, or, in the case of advanced film technology, by hand to the dry film thickness recommended by the coating manufacturer. Application should be conducted at a minimum temperature of 75 ± 5°F (21 ± 2°C) and 50% ± 10% relative humidity (RH), unless otherwise specified. The coating system may be applied in one or two coats if allowed by the manufacturer and provided that the manufacturer's instructions are carefully followed.

Unless otherwise specified, test panels with organic topcoats should be held at 75 ± 5°F (21 ± 2°C) and 50% ± 10% RH prior to testing. If a topcoat is to be applied over the primer, the topcoat should be applied within 24 hours of primer application. In many cases, the topcoat will be applied before the primer is fully cured; however, the topcoat should never be applied sooner than specified by the manufacturer or before the primer is dry to the touch (dry-to-handle). Unless otherwise specified, the topcoat should be applied to the total dry film thickness recommended by the coating manufacturer. Table 3-1 summarizes the test substrate codes and configurations.

The selected candidate coating systems will be tested on a variety of SE types to enhance the range of exposure conditions. This procedure will also increase the confidence of the approval authorities in the applicability of the test results to the SE units for which they are responsible.

Table 3-1 Coupon (Test Specimen) Codes and Substrate Descriptions

Test Coupon Code	Substrate Description
Al-1a	Aluminum alloy: 2024-T3 (Alclad) 4 inch x 6 inch x 0.032 inch; cleaned according to ASTM F 22-65 to provide a water-break-free surface; chromate conversion coated, conforming to MIL-C-5541E (*Chemical Conversion Coatings on Aluminum and Aluminum Alloys*, issued November 30, 1990), Class 1A; coated with the candidate coating system. Coatings applied per the coating manufacturer specifications.
Al-1b	Aluminum alloy: 2024-T3 (Alclad) 4 inch x 6 inch x 0.032 inch; cleaned according to ASTM F 22-65 to provide a water-break-free surface; anodized per MIL-A-8625F-93, *Anodic Coatings for Aluminum and Aluminum Alloys*, Type II *Sulfuric Acid Anodize*; coated with the candidate coating system. Coatings applied per the coating manufacturer specifications.
Al-1c	Aluminum alloy: 2024-T3 (Alclad) 4 inch x 6 inch x 0.032 inch; cleaned according to ASTM F 22-65 to provide a water-break-free surface; no conversion coating or other pretreatment; primed and topcoated coated with the candidate coating system. Coatings applied per the coating manufacturer specifications

Table 3-1 Coupon (Test Specimen) Codes and Substrate Descriptions (Continued)

Test Coupon Code	Substrate Description
Al-1d	Aluminum alloy: 2024-T3 (Alclad) 4 inch x 6 inch x 0.032 inch; cleaned according to ASTM F 22-65 to provide a water-break-free surface; nonchromate conversion coating applied according to the manufacturer specifications; primed and topcoated with the candidate coating system. Coatings applied per the coating manufacturer specifications.
Al-2	Aluminum alloy: 2024-T0 4 inch x 6 inch x 0.032 inch; cleaned according to ASTM F 22-65 to provide a water-break-free surface; anodized per MIL-A-8625F-93; coated with the candidate coating system. Coatings applied per the coating manufacturer specifications.
Al-3a	Aluminum alloy: 6061-T6 4 inch x 6 inch X 0.032 inch; cleaned according to ASTM F 22-65 to provide a water-break-free surface; chromate conversion coating applied to the coupon. Coatings applied per the coating manufacturer specifications.
Al-3b	Aluminum alloy: 6061-T6 4 inches x 6 inches x 0.032 inch; cleaned according to ASTM F 22-65 to provide a water-break-free surface; anodized per MIL-A-8625F-93; coated with the candidate coating system. Coatings applied per the coating manufacturer specifications.
St-1a	Steel alloy: 4340 4 inch x 6 inch x 0.032 inch; cleaned and prepared according to SSPC SP-10 (Blast clean to a near to white metal cleanliness, until 95 percent of the surface area is free of all visible residues); no pretreatment. Coatings applied per the coating manufacturer specifications.
St-1b	Steel alloy: 4340 4 inch x 6 inch x 0.032 inch; cleaned and prepared according to SSPC SP-11 (Complete removal of all rust, scale, and paint by power tools with resultant profile with no pretreatment). Coatings applied per the coating manufacturer specifications.
St-2a	Steel alloy: 1020 4 inch x 6 inch x 0.032 inch; cleaned and prepared according to SSPC SP-10 (Blast clean to a near to white metal cleanliness, until 95 percent of the surface area is free of all visible residues); no pretreatment. Coatings applied per the coating manufacturer specifications.

Table 3-1 Coupon (Test Specimen) Codes and Substrate Descriptions (Continued)

Test Coupon Code	Substrate Description
St-2b	Steel alloy: 1020 4 inch x 6 inch x 0.032 inch; cleaned and prepared according to SSPC SP-11 (Complete removal of all rust, scale, and paint by power tools with resultant profile; no pretreatment. Coatings applied per the coating manufacturer specifications.
St-3	Steel alloy 304 Corrosion Resistant Steel (CRES). 4 inch x 6 inch x 0.032 inch, cleaned and scuffed with either 280 grit sandpaper or stainless steel brush to a SSPC-SP1 finish.
St-4	Steel alloy: 4340 4 inch x 4 inch x 0.032 inch; cleaned and prepared according to SSPC SP-10. Coatings applied per the coating manufacturer specifications.
St-5	Steel Alloy: 4340 3 inch x 3 inch x 0.032 inch SSPC SP-10 (Blast clean to a near to white metal cleanliness, until 95 percent of the surface area is free of all visible residues); no pretreatment. Coatings applied per the coating manufacturer specifications.
St-6	Steel Alloy: 4340 4 inch x 12 inch x 0.032 inch SSPC SP-10 (Blast clean to a near to white metal cleanliness, until 95 percent of the surface area is free of all visible residues); no pretreatment. Candidate coating applied per the coating manufacturer specifications

3.1 Screening Test

Screening tests are preliminary tests performed on selected candidate coating systems. Candidate coating systems that do not meet the acceptance criteria of the screening tests will be eliminated from further testing. Coating systems that meet the requirements of the screening tests will be subjected to the additional tests listed in this JTP. Screening tests include ease of application, surface appearance, pot life, dry-to-touch time, and cure time evaluations. The initial screening of the coating candidates will compare the test candidates against the control coatings as described in each *Test Methodology*.

Table 3-2 DOD and NASA Control Coating Systems and Colors

Service/ Agency	Primer	Topcoat	Required Color FED-STD-595
Army	MIL-P-53022B	MIL-C-46168D or MIL-C-53039A	34094 (green 383)
NASA	Devoe Inorganic base primer, Zinc CATH-COAT 304 Devoe intermediate epoxy primer, DEVRAN 201	Devoe Aliphatic Urethane, DEVTHANE 369	17925 (white)[a]
Navy	MIL-P-53022B, Type II	MIL-PRF-85285C Type II	17925 (white)
USMC USAF	MIL-P-53022B, Type II[b]	MIL-PRF-85285C Type II	24052 (green)[c, d]

a. NASA also uses gloss gray, color number 16187
b. WR-ALC/LE, agreed that the Air Force will accept the test results obtained using MIL-P-53022B Type II and MIL-PRF-85285C Type II as the "worst case scenario" as compared to (MIL-P-23377, Class C and MIL-PRF-85285C).
c. USMC also utilizes camouflage green, color number 34094
d. The participants agreed one color, white topcoat color #17925 of the MIL-P-53022B/MIL-PRF-85285 system is sufficient for testing

3.1.1 Ease of Application

Test Description

This procedure is used to determine how easily a coating system may be applied.

Prepare the test coupons as described in Section 3, noting the appropriate coating application processes and equipment. This evaluation will be conducted while preparing "Control Coupons" for each coating described in this JTP.

Rationale

This screening test is conducted to identify and eliminate those candidate coating systems that are difficult to properly apply under normal maintenance operation conditions. All participants have agreed that *Ease of Application* is a performance requirement.

Test Methodology

Parameters	Coating manufacturer preparation instructions
Coupons Per Coating System	Three St-2a, Three St-2b
Trials Per Coupon	One per coating per test coupon
Control Coupons Required For Testing	None

Test Methodology (Continued)

Acceptance Criteria	Smooth coat, with acceptable appearance, no runs, bubbles or sags. Ability to cover the properly prepared/primed substrate with a single coat (one-coat hiding ability).

Unique Equipment and Instrumentation

- None

Data Analysis and Reporting

- Report applicator evaluation of the surface coating condition

3.1.2 Surface Appearance

Test Description

The purpose of this test is to evaluate and compare the surface appearance of the alternate and control coating systems.

Apply the primer and topcoat in accordance with Section 3. Examine the surface of each test coupon coated with the primer/topcoat system for coating defects with unaided eye and with 10X magnification. Micro-cracks extending no more than ¼-inch from the panel edge are acceptable. A slight orange peel appearance is acceptable. Color and gloss measurements shall be conducted on each coated coupon per ASTM D 2244-93, (*Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates,* approved September 15, 1993) and ASTM D 523-89 (1999), (*Standard Test Method for Specular Gloss*, approved March 31, 1989, reaffirmed 1999), respectively, to document the specular gloss of the original finish of the control test coupons.

Rationale

This test is conducted to provide critical detailed evaluation of coating appearance and integrity. All participants agreed the surface appearance evaluation is a performance requirement.

Test Methodology

Parameters	10x Magnification
Coupons Per Coating System	Three St-2a, Three St-2b (Use coupons from paragraph 3.1.1)
Trials Per Coupon	One
Control Coupons Required For Testing	None

Test Methodology (continued)

Acceptance Criteria	No streaks, blistering, voids, air bubbles, cratering, lifting, blushing, or other surface defects/irregularities. No micro-cracks observable at 10X magnification. Gloss and color should match FED-STD-595B color chips (either color 34094 or color 17925 is required to be tested).

Major or Unique Equipment

- 10X optical magnifier
- Hunter Lab "Miniscan" Spectrophotometer (using CIE L*a*b* Color Measurement System) or equivalent
- Hunter Lab "Progloss" Meter or equivalent

Data Analysis and Reporting

- Measure and report observation on any coating defects, original color readings, and gloss readings

3.1.3 Pot Life (Viscosity) Test

Test Description

This procedure is used to determine the viscosity increase of a mixed multi-component liquid coating system over a specified time. This test will be separated into two procedures. Procedure A is for solvent borne coatings and Procedure B is for waterborne coatings. All non-liquid coatings such as metal wire arc spray, powder coatings and dry film technology are exempt from this requirement.

Procedure A

Mix the coating components according to the manufacturer's directions.

Maintain a freshly mixed sample of the coating system in a closed container at 75 $\pm$ 5^{o}F (24 $\pm$ 3^{o}C) for four hours with continuous stirring. Measure and record the mixture's viscosity every 30 minutes in accordance with ASTM D 1200-94 (1999) (*Test Method for Viscosity by Ford Viscosity Cup,* approved August 15, 1994, reaffirmed 1999).

Maintain a second sample of the freshly mixed coating system in a closed container at 95 $\pm$ 5^{o}F for four hours with continuous mixing. Measure/record the mixture viscosity every 15 minutes with a #4 Ford viscosity cup. The test may be terminated when the viscosity exceeds 60 seconds. The admixed materials must still be sprayable 4 hours after mixing.

The samples mixed for this test should be used in coupon coating processes.

Procedure B

Mix coating per the manufacturers recommendations, thin to manufacturer's designation for admixed coating.

Allow coating to sit under agitation 75 ± 5°F for 4 hours.

Measure and record the coating viscosity with #4 Ford viscosity cup every 30 minutes in accordance with ASTM D 1200-94 (1999). Coating viscosity shall not exceed admix viscosity by more than 15 seconds after 4 hours, with no gelling of the admixed coating after 6 hours. If allowed by the coating manufacturer, the coating may be thinned with the appropriate amount of water if the viscosity is too high after 4 hours.

Rationale

All participants agreed the agitation history and temperature at which coating mixtures are maintained are important parameters in determining the pot life of the mixture. This test provides data to characterize the pot life envelope. Knowledge of initial viscosity and viscosity change, in relation to time and temperature, is important for determining the effective time frame for coating application. Different coating systems will exhibit different viscosity properties making some systems easier to handle than others; however, applicators can usually modify operating procedures to accommodate the range of mixture characteristics.

Test Methodology

Parameters	Temperature, viscosity
Amount Of Coating Per Test	One gallon of mixed coating per temperature condition
Control Coupons Required For Testing	None
Acceptance Criteria	Procedure A – High Solids Coatings Viscosity of both test batches shall not exceed 60 seconds after 4 hours of continuous mixing in a closed container maintained at 75 ± 5°F (Batch 1) and 95 ± 5°F (Batch 2). The admixed materials must still be sprayable 4 hours after mixing. Procedure B – Waterborne Coatings Coating viscosity shall not exceed admix viscosity by more than 15 seconds after 4 hours, with no gelling of the admixed coating after 6 hours.

Major or Unique Equipment

- # 4 Ford cup - Figure 1 in ASTM D 1200-94 (1999).

- Magnetic stirring unit, or equivalent, for one gallon containers
- Environmental chamber for temperature control
- Timer

Data Analysis and Reporting
- Report viscosity measurements every 30 minutes

3.1.4 Dry-To-Touch (Sanding)

Test Description

This procedure assists in determining the drying time (dry-to-touch) required for coating systems. Both liquid primers and liquid primer/topcoat systems are required to be tested against this requirement. All non-liquid coatings such as metal wire arc spray, powder coatings, and dry film technology are exempt from this requirement.

Coatings are applied to test coupons in accordance with manufacturer's directions/specifications and allowed to air dry for 12 hours at the conditions outlined in Section 3. After 12 hours, the coating is lightly abraded with very fine-grit nylon web pad to evaluate the ease of sanding.

Rationale

This test documents the time that a coating is "dry to the touch" so that the item can be handled without damaging the coating. All participants agreed it was important to know the drying time required before a succeeding coat may be applied.

Test Methodology

Parameters	Coating cure time
Coupons Per Coating System	Two St-2a
Trials Per Coupon	One
Control Coupons Required	None
Acceptance Criteria	No rolling or scribing during sanding, and "easy" sanding (as evaluated by technician).

Major or Unique Equipment
- Very fine grit nylon web abrasive pads (3M Co. Scotch Brite Type A or equivalent)

Data Analysis and Reporting
- Report technician evaluation for tests on candidate coating.

3.1.5 Cure Time (MEK Solvent Rub)

Test Description

This test determines how long an applied coating system requires to fully cure at room temperature up to a period of 14 days at 50±10% RH. Both liquid primers and liquid primer/topcoat systems are required to be tested against this requirement. Additionally, film technology and powder coating alternatives are required to be tested against this requirement. Metal wire arc spray coatings are exempt from this requirement.

Every two days, for a period of 14 days, perform fifty double-rubs (back and forth) on the coated panels with clean cheesecloth wetted with methyl ethyl ketone (MEK). Perform this test in accordance with ASTM D 4752-98, (*Standard Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub*, approved June 15, 1995). Each test should be conducted on a previously untested area of the coating. Visually examine the coating for substrate metal exposure. Pigment on the cheesecloth does not indicate failure.

Rationale

This test is outlined in ASTM D 4752-98 to determine the solvent resistance of a cured coating. Although MEK use is being phase out, the participants deemed the MEK solvent rub test as the test of choice as it is more stringent than an acetone rub test. This test is a commonly accepted industrial criterion for determining coating cure and only small amounts of MEK is consumed. Inspecting at two day intervals is required by participants to determine the actual cure time. All participants agreed the MEK rub test is a performance requirement.

Test Methodology

Parameters	MEK saturated terry cloth rag, 50 double rubs
Coupons Per Coating System	Two St-2a
Trials Per Coupon	Seven* (maximum)
Control Coupons Required	• One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A • One coupon coated with MIL-P-53022B, MIL-C-85285 Type II • One coupon coated with NASA system
Acceptance Criteria	No effect on surface or coating on the cloth (Resistance Rating 5)

(*) Perform succeeding trials on coupon areas that have not previously been rubbed.

Data Analysis and Reporting

- Report results of MEK rub test on candidate coating using rating system in ASTM D 4752-98,Table 1.
- Report dry film thickness of the coating
- Report elapsed time between the application of the coating and the running of the tests

3.2 Common Tests

Common tests are evaluations that all participants agree are required for validating a coating system for SE. Common tests are more in-depth tests performed on the coating systems surviving the initial Screening Tests. Candidate coating systems that do not meet the acceptance criteria of the common tests will be eliminated from further testing, unless otherwise directed by the lead government project manager. Coating systems that meet the requirements of the screening tests will be subjected to the additional tests listed in this JTP. Common tests include corrosion testing, coating weathering, removability, reparability, adhesion, accelerated storage stability and flexibility.

3.2.1 Removability

Test Description

This test determines the relative ease of removing coating on a 2 inch diameter area on a test coupon using Type V plastic media blast (PMB) process after artificial weathering.

Coated test panels shall be weathered for 504 hours (21 days) in accordance with ASTM G 26-96 (*Standard Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials),* Test Method 1 (*Continuous Exposure to Light and Intermittent Exposure to Water Spray,* approved 1996), prior to testing for removability. After exposure, color and gloss measurements shall be conducted on each coated coupon per ASTM D 2244-93 and ASTM D 523-89 (1999), respectively, to document the aged finish prior to removability tests.

The weathered panels shall be placed on a rack and tilted to a 60° angle to the horizontal. Record the dry film thickness of the coating. Adjust the PMB system air pressure to 100 psi. Use only virgin Type V abrasive plastic media for this test. Fix a ½-inch ventury abrasive blast nozzle parallel with the horizontal and set at a standoff distance of 8 inches from the coupon surface. Set the media flow in accordance with the media manufacturer's specifications. Direct the abrasive blast jet at the same area for 1 minute. Record the dry film thickness of the coating remaining in the abrasive blast area. Identical removal procedures shall be used for both the candidate and control coating systems.

Rationale

Coating systems applied to operating SE must typically be removed after prescribed periods of use. Evaluation of relative removal ease for candidate alternate coating systems after aging is necessary for predicting the

effectiveness of field maintenance operations. Participants agreed that PMB Type V media is representative of the media found in the depot and organizational maintenance levels.

Test Methodology

Parameters	Plastic media type V Blast pressure 100 psi Standoff distance of 8 inches ½-inch nozzle Dwell time 1 minute
Coupons Per Coating System	Three St-6
Trials Per Coupon	One
Control Coupons Required	• One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A • One coupon coated with MIL-P-53022B, MIL-C-85285 Type II • One coupon coated with NASA coating system
Acceptance Criteria	Less than one minute to penetrate to substrate.

Major or Unique Equipment

- PMB process equipment with stationary PMB head fixture.
- Hunter Lab "Miniscan" Spectrophotometer (using CIE L*a*b* Color Measurement System) or equivalent
- Hunter Lab "Progloss" Meter or equivalent
- Positest® 1,000 or equivalent ultrasonic dry film thickness gauge

Data Analysis and Reporting

- Report color and gloss changes
- Report coating dry film thickness before after abrasive blasting
- Report if the substrate is exposed after blasting

3.2.2 Reparability

Test Description

This test determines the relative ease of replacing and blending-in coatings that have been removed or otherwise damaged. The dry tape adhesion test provides a procedure for establishing acceptability of intercoat and surface adhesion of an organic coating by applying pressure-sensitive adhesive tape over a scribed area of the coating, then removing that tape.

Three procedures will be required for accomplishing this task; (A) Repair the baseline control coating with a baseline coating, (B) Repair the baseline control coating with each of the alternative coatings, and (C) Repair the alternative coating with alternative coating. Test panels from which coatings have been removed (Paragraph 3.2.1) shall be used for this evaluation. Replace the removed coating in accordance with the coating manufacturer's repair instructions. Examine the surface of each test panel to evaluate the appearance of the repair. The repaired area must be free of voids, over-spray "halo", air bubbles or other significant defects. The repaired area shall be inspected for coating quality and match to the original, aged coating on the top half of the test coupon. Conduct a dry tape adhesion test on the repaired areas after the prescribed cure times of test coating on the repaired area to ensure the coating adherence. Perform this test in accordance with Method A of ASTM D 3359-97 (*Standard Test Methods for Measuring Adhesion by Tape Test*, approved December 10, 1995, re-approved 1997), except use a 4.5 lb. roller instead of finger pressure for smoothing down the tape. In performing this test, scribe two "X" incisions through the coating so that the smaller angle of each "X" is 30 to 45**-** degrees, making sure that the coating has been scribed all the way to the substrate. The scribe must have a 45-degree bevel, and each line of each "X" should be approximately 1.5 inches long. Immediately place a piece of tape over the intersection of each "X" and smooth down by passing a 4.5 lb. roller over it once. Remove the tape rapidly at approximately a 180^{o} angle. Inspect the incision area for peel away.

Rationale

This test provides data to evaluate how effectively coatings can be replace/repaired in field maintenance environments. All participants have agreed that coating reparability is a performance requirement.

Test Methodology

Parameters	Manufacturer's instruction for coating repair
Coupons Per Coating System	Three St-6 (Use coupons from Paragraph 3.2.1)
Trials Per Coupon	One
Control Coupons Required	• One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A • One coupon coated with MIL-P-53022B, MIL-C-85285 Type II • One coupon coated with NASA coating system • No controls for procedures B and C

Test Methodology (Continued)

Acceptance Criteria	Ease of removal and replacement of damaged areas of the test coatings, color matching of aged versus new material. No streaks, blistering, voids, air bubbles, over-spray "halo", cratering, lifting, blushing, or other surface irregularities. No peel away of the repaired coating during the dry tape adhesion test.

Major or Unique Equipment

- 10X optical magnifier
- Hunter Lab "Miniscan" Spectrophotometer (using CIE L*a*b* Color Measurement System) or equivalent per ASTM D 2244-93
- Hunter Lab "Progloss" Meter or equivalent
- 1 inch masking tape, 3M Company Type 250 or equivalent
- 4.5 pound roller
- Carbide tip scribe

Data Analysis and Reporting

- One color photograph of a coupon coated with each candidate primer or primer/topcoat system shall be taken after recoating is completed. One color photograph of each tested coupon shall be taken after the tape test is completed.
- Report coating color measurements of repaired area and aged area per ASTM D 523-89 (1999).
- Report the adhesion rating as specified in ASTM D 3359-97, Section 7.

3.2.3 Accelerated Weathering

Test Description

This accelerated test evaluates the degree of coating color and gloss degradation when exposed to simulated outdoor weathering.

Prior to testing, record color and gloss measurements on each coated coupon per ASTM D 2244-93 and ASTM D 523-89 (1999), respectively. Test coupons are then exposed to UV, through a borosilicate inner and outer filter to simulate sunlight, and intermittent moisture for 500 hours in accordance with ASTM G 26-96, Test Method 1. At the conclusion of testing, measure color and gloss changes on each coated coupon. This test will continue as a Navy extended test as outlined in paragraph 3.4.7.

Test Methodology

Parameters	• 140 ± 5°F (60 ± 3°C) • 50 ± 5% RH • Borosilicate glass inner and outer filter • One cycle: 102 minutes of light only and 18 minutes of light and water spray • Spectral irradiance levels 0.35 W/m² incident at 340 nm • Operate for 500 hours (250 cycles)
Coupons Per Coating System	Three Al-1a, Al-1b, Al-1c, Al-1d, St-2a, St-2b (*)
Trials Per Coupon	One
Control Coupons Required	• One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A • One coupon coated with MIL-P-53022B, MIL-C-85285 Type II • One coupon coated with NASA coating system (steel panels only)
Acceptance Criteria	Color change performance < one unit (ΔE) @ 500 hrs.

(*) These coupons may be 2.75 inches by 4 inches by 0.032 inches if required by chamber size restraints.

Rationale

SE coating systems must withstand daily outdoor exposure to sunlight and wet/dry cycles. This procedure will document coating resistance to accelerated outdoor weather exposure conditions. All of the participants agreed accelerated weathering is a performance requirement.

Major or Unique Equipment

- Xenon light/moisture environmental exposure chamber per ASTM G26-96, with a borosilicate glass inner and outer filter
- Hunter Lab "Miniscan" Spectrophotometer (using CIE L*a*b* Color Measurement System) or equivalent
- Hunter Lab "Progloss" Meter or equivalent

Data Analysis and Reporting

- Report color/gloss change data for test coatings and compare to the control coating system.

3.2.4 Filiform Corrosion Resistance

Test Description

This test is used to evaluate the ability of a coating system to resist filiform corrosion.

Tests shall be conducted as specified in ASTM D 2803-93 (*Standard Guide for Testing Filiform Corrosion Resistance of Organic Coatings on Metal*, approved May 15, 1993), Procedure C.

Scribe an "X" incision through the coating so that the smaller angle of the "X" is 30 to 45 degrees, making sure that the coating has been scribed all the way to the substrate. The scribe must have a 45^{o} bevel, and each line of the "X" should be approximately 4 inches long. Place the scribed coupons in a desiccator containing 12 N hydrochloric acid for one hour at 75 ± 5^{o}F (24 ± 3^{o}C). Within 5 minutes of removal from the desiccator, place the coupon in a humidity cabinet maintained at 104 ± 3^{o}F (40 ± 1.7^{o} C) and 80% ± 5% RH for 1,000 hours. At the end of the 1,000 hour test, measure the length of any thread-like filaments.

Rationale

This test demonstrates the ability of a coating system to resist filiform corrosion. The filiform test, which determines the resistance of coated metals to filiform-type corrosion, is distinctly different from salt spray resistance test and is required to ensure the candidate coating(s) provide the necessary corrosion protection. This test is normally not required for a topcoating. However, as this test may include self priming, single coating systems we have included this test to ensure a full comparison of the coating system properties are examined.

This test is not required by NASA, but is required by the other project participants.

Test Methodology

Parameters	12N HCL for one hour/1,000 hours at 104^{o} ± 3^{o}F (40^{o} ± 1.7^{o}C) and 80% ± 5% RH
Coupons Per Coating System	Three of: Al-1a, Al-1d
Trials Per Coupon	One
Control Coupons Required	• One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A • One coupon coated with MIL-P-53022B, MIL-C-85285 Type II
Acceptance Criteria	No filiform corrosion extending beyond ¼-inch from the scribe lines with the majority of filaments less than $^{1}/_{8}$ –inch long.

Major or Unique Equipment

- Environmental (humidity) chamber

Data Analysis and Reporting

- Filiform corrosion is defined as threadlike corrosion filaments starting at the scribe lines and spreading underneath the coating film. Measure and report the presence, number, and length of corrosion filaments for the candidate coating systems and for the alternative and control coating systems.

3.2.5 X-Cut Adhesion By Tape Test

Test Description

This test method establishes the adequacy of intercoat and surface adhesion of an organic coating immersed in water by applying pressure sensitive tape over a scribed area of the coating. Perform this test in accordance with ASTM D 3359-97, Test Method A.

Immerse each test panel in distilled water at room temperature for 24 hours in accordance with FED-STD-141C, Method 6301.2. Remove each panel from the water and wipe dry with a soft cloth. Within one minute of removing a panel from the water, scribe two parallel lines one inch apart and scribe an "X" between the parallel lines (note that this is a modification of the scribing described in FED-STD-141C, Method 6301.2). Apply tape over the scribed area, smoothing it down by passing a 4.5 pound roller across the tape eight times. Quickly and smoothly pull the tape off the panel at a 45° angle to the surface. Visually examine the panel for blistering and loss of adhesion. Accomplish this test using only the top ½ of the test coupon. Retain the test coupon for further testing in Section 3.4.1, *Tensile Pull-Off Adhesion*.

Evaluate the adhesion of each coating system to the substrate as specified in ASTM D 3359-97, *Test Method A*. Inspect the X-cut and parallel lines-cut for removal of the coating from the substrate or previous coatings and rate the adhesion in accordance with the 0-5 scale outlined in ASTM D 3359-97, paragraph 7, *Procedure*, with the *0-A* rating, being *coating removal beyond the scribed area*, to *5-A*, *no peeling or removal*.

Rationale

The X-cut with parallel lines scribe procedure increases the severity of this test over a dry tape adhesion test using a single "X" scribe and provides quantitative data for the adhesion of a coating system to the underlying metal substrate. All participants have agreed that adhesion testing is a performance requirement.

Test Methodology

Parameters	ASTM D 3359-97 rating related to amount of coating removal
Coupons Per Coating System	Three Al-1a, Al-1b, Al-1c, Al-1d, St-1a, St-1b, St-2a, St-2b, St-3
Trials Per Coupon	One
Control Coupons Required	None
Acceptance Criteria	Candidate coating performs as well or better than control coatings and greater than or equal to 4a as specified in ASTM D 3359-97

Major or Unique Equipment

- One-inch (25mm) wide semitransparent pressure-sensitive tape 3M Code 250 or equivalent
- 4.5 pound rubber-covered roller, approximately 3.5 inches diameter by one-inch wide.
- Cutting tool
- Cutting guide

Data Analysis and Reporting

- Report the number of tests taken on each coupon
- Report the results of the test using the classification guide in ASTM D 3359-97, Test Method A, paragraph 7.7

3.2.6 Mandrel Bend Flexibility

Test Description

This test evaluates coating flexibility and adhesion to substrate limits when the test coupon is bent around a ¼-inch fixed diameter mandrel.

The bend test shall be conducted in accordance with the version of ASTM D 522-93a (*Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings*, approved September 15. 1993), *Test Method B*.

Rationale

This method will determine whether the coatings will provide the necessary flexibility when compared to the other more conventional coatings. All participants have agreed that the mandrel bend test is a performance requirement for the coatings.

Test Methodology

Parameters	¼-inch diameter mandrel
Coupons Per Coating System	Three Al-2 Three St-1a (MWAS only)
Trials Per Coupon	One
Control Coupons Required	• One coupon coated with MIL-P-53022B, MIL-C-85285 Type II • One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A • One coupon coated with NASA coating system
Acceptance Criteria	No peeling or delamination from the substrate and no cracking greater than ¼-inch from the edges.

Major or Unique Equipment

- Mandrel bend apparatus (¼-inch diameter mandrel)

Data Analysis and Reporting

- Record the minimum bend radius and corresponding percent elongation data for candidate and control systems.
- Report material characteristics during the test, including the amount of peeling and delamination.

3.2.7 Accelerated Storage Stability

Test Description

This test evaluates any changes in consistency and certain other properties that may take place when liquid coatings are stored at a temperature above 32^{o}F (0^{o}C). This test simulates some of the effects of storage for 6 months to 1 year at 73 ± 3.5^{o}F (23 ± 2^{o}C). This test is not applicable to MWAS coatings.

Obtain duplicate samples of the coating in the original unopened containers, preferably no larger than 1 quart for liquid coatings. As applicable, open one of the containers and note any skinning, corrosion on the interior of the can, odors of putrefaction, rancidity, or souring. Store the samples, undisturbed for one-month at 125 ± 2^{o}F(52 ± 1^{o}C). Bring the stored sample to 73 ± 3.5^{o}F (23 ± 2^{o}C). Open the containers (as applicable), and mix and apply the coatings to test coupons per ASTM D 1849-95.

Rationale

The stability of a coating system while in extended storage is an important parameter in determining an acceptable coating for depot and organizational maintenance activities. This tests simulates 6 months to a year of storage. All participants have agreed that storage stability of a coating is a performance

requirement for liquid coatings, as well as film technology and powder coating alternatives.

Test Methodology

Parameters	125 ± 2°F (52 ± 1°C) Quart containers (as applicable)
Coupons Per Coating System	One AL-1a
Trials Per Coupon	One
Control Coatings Required	None
Acceptance Criteria	No skinning, grains, lumps of the coating; no pressure buildup, or corrosion on the container, odor of spoilage or cloudy appearance of any catalyst (as applicable).

Major or Unique Equipment

- Heated storage capable of maintaining a 125 ± 2°F (52 ± 1°C) temperature

Data Analysis and Reporting

- Time of storage in days and the temperature of the storage
- Initial and final sample weights
- Any changes in the coating consistency or odors
- Any grains, lumps or streaks in the brushed film. Rate the finish per para 5.2.4 of ASTM D 1849-95 (*Standard Test Method for Package Stability of Paint*, approved August 15, 1995).

3.3 Field Evaluation

Field evaluations demonstrate comparative field performance of candidate coating systems with currently used coating systems when applied on operating SE. The field evaluations will be performed after laboratory tests are complete, using only those candidate coating systems that met acceptance criteria in the screening and common tests, unless directed by the testing authority.

3.3.1 Full Unit Operational Testing

Test Description

This test evaluates coating systems applied to a complete specified SE unit. One half of the SE unit shall be coated with the candidate coating system. The remaining half of the selected SE unit shall be coated with a selected control system.

Prepare the surfaces of the SE unit for painting in accordance with the requirements for that particular coating system. Apply the candidate test coating system and the control coating system to the respective designated surfaces in accordance with coating manufacturer's specifications.

Place the SE unit in service at locations selected by the appropriate DOD and NASA agency.

Conduct initial inspection during application of the SE coating systems. Conduct subsequent inspections/evaluations at the, six-month, and twelve-month intervals.

Rationale

Laboratory testing is useful in comparing the relative performance of candidate test coating systems when exposed to identical simulated environments; however, exposure to authentic field environments is necessary to establish high levels of confidence in coating performance in actual service. All participants have agreed that coating a fielded SE test article is a performance requirement.

Test Methodology

Operational Parameters	• Geographic Location • Corrosion Control • Coating Evaluation
Number of SE Units	TBD
Inspections	• Initial: Two weeks of field service after painting • Periodic: 6 month and 12 months (or after return from overseas deployment)
Acceptance Criteria	Performance equal to or better than DOD and NASA control coating system.

Major or Unique Equipment

Depending on the alternate coating being field tested, one or more of the following may be required.

- Conventional paint spray equipment (HVLP, airless, air-assisted airless, pressure feed or electrostatic)
- Powder coating application/cure equipment (if powder coating is required)
- Metallizing equipment (if portable metal wire arc spray is required)
- Designated SE units
- Digital camera
- Positest 1,000 ultrasonic thickness gauge or equivalent
- BYK Gardener Micro Tri-Gloss Glossmeter or equivalent

Data Analysis and Reporting

- Using the coating evaluation workbook (Attachment 1) document required information during application and after the coating cure cycle.

- Coating evaluation should include a descriptive narrative of each observed coating defect. Each test location will develop a silhouette of the equipment showing the sides, top, forward and aft section of the unit.
- The local coating evaluator will document:
  - defects by highlighting the area of damage on the silhouette.
  - severity of each defect to include a description of the defect, size of the damaged location, and extent of coating damage.
  - the dry film coating thickness and gloss.
- Visual assessment of the SE shall include photo/video documentation of the SE unit coating condition, especially with respect to the areas where coating defects have been identified. Repaired defects shall also be tracked and documented to evaluate the effectiveness of repair procedures.
- Interviews with squadron maintenance personnel shall be recorded to provide historical information regarding service conditions and coating maintenance experience.

3.4 Extended Test

Extended tests are tests that are specific to one or more, but not all, participants.

3.4.1 Tensile (Pull-Off) Adhesion {NASA Requirement} – *Removed requirement*

3.4.2 Abrasion Resistance {NASA Requirement} – *Removed requirement*

3.4.3 18-Month Marine Environment Test {NASA Requirement}

Test Description

This test evaluates the performance of the test and control coatings after an 18 month outdoor exposure in a marine environment. Coat all surfaces of the test panels with the prescribed coating. Install the test panels at the Kennedy Space Center (KSC) outdoor exposure rack 100 feet from the ocean high tide line. Follow all KSC test rack procedures for fasteners, exposure angle, and inspection interval. At the conclusion of the test, rate the test coupon condition per ASTM D 610-95 (*Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces*, approved September 15, 1995). Use the numerical grade scale in ASTM D 610-95, Table 1, *Scale and Description of Rust Grades*, where 0 indicates 100% surface rusting and 10 indicating less than 0.01% surface rusting.

Rationale

This test documents the actual exposure of the coatings to UV radiation, as well as different cycles of salt spray exposure. NASA requires this test for validation of alternative coating systems.

Test Methodology

Parameters	100 foot from the ocean high tide in Florida
Coupons Per Coating System	Four St-2a
Trials Per Test Coupon	One
Control Coupons Required	One coupon coated with NASA coating system
Acceptance Criteria	Panel condition rated 9 or better per ASTM D 610-95

Major or Unique Equipment

- Outdoor test rack located 100 feet from ocean high tide line
- BYK Gardener Micro Tri-Gloss Glossmeter or equivalent

Data Analysis and Reporting

- Report corrosion rating per ASTM D 610-95

3.4.4 Cyclic Corrosion Resistance {AF, NASA, Army Requirement}

Test Description

These tests evaluate the ability of coating systems to prevent corrosion when exposed to a simulated neutral pH corrosive environment.

Tests shall be conducted on all coupons in accordance with GM 9540P, (*Accelerated Corrosion Test* approved December 1997).

One test cycle is as follows:

Step 1. Expose the coupon to salt water solution (0.9% sodium chloride, 0.1% calcium chloride and 0.025% bicarbonate of soda) spray for one minute.

Step 2. Allow the coupon ambient atmospheric exposure for 89 minutes.

Step 3. Expose the coupon to salt water solution (0.9% sodium chloride, 0.1% calcium chloride and 0.025% bicarbonate of soda) spray for one minute.

Step 4. Allow the coupon ambient atmospheric exposure for 89 minutes.

Step 5. Expose the coupon to salt water solution (0.9% sodium chloride, 0.1% calcium chloride and 0.025% bicarbonate of soda) spray for one minute.

Step 6. Allow the coupon ambient atmospheric exposure for 89 minutes.

Step 7. Expose the coupon to salt water solution (0.9% sodium chloride, 0.1% calcium chloride and 0.025% bicarbonate of soda) spray for one minute.

Step 8. Allow the coupon ambient atmospheric exposure for 209 minutes.

Step 9. Expose the coupon to high humidity exposure (in accordance with GM 4465P at 120 ± 3°F (49 ± 2°C) and 1-2 ml/hr collection rate).

Step 10. Dry off exposure at 140 ± 3°F (60 ± 2°C) and < 30% RH.

Repeat for the appropriate number of cycles.

Perform inspections after 24, 48, 72, 96, and 168 hours of exposure. Perform subsequent inspections after a maximum of every 168 hours of exposure.

When removed for inspection, test coupons on which coating failure is detected shall be removed from further testing.

Rationale

The Air Force, NASA, and the Army participants have agreed that GM Accelerated Corrosion Test provides acceptable correlation between accelerated laboratory corrosion tests and actual corrosion experienced in the field. Data from these tests will be compared with the filiform test data obtained in Paragraph 3.2.5 to determine whether or not a correlation exists between the two test results.

Test Methodology

Parameters	• Exposure conditions include: • Electrolyte Solution: 0.9% sodium chloride, 0.1% calcium chloride and 0.025% bicarbonate of soda • Solution Acidity: pH between 6.0 and 8.0 Note One test cycle is equal to 24 hours One phase is equal to 8 test cycles Test Duration: 80 test cycles
Coupons Per Coating System	Three: Al-1a, Al-1b, Al-1c, Al-1d, Al-3a, Al-3b, St-1a, St-1b, St-2a, St-2b, St-3 (*)
Trials Per Coupon	One

Test Methodology (Continued)

Control Coupons Required	• One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A • One coupon coated with MIL-P-53022B, MIL-C-85285 Type II • One coupon coated with NASA coating system (steel panels only)
Acceptance Criteria	• Candidate coating performs as well or better than control coatings. • No significant blistering, softening, or lifting of coating.

(*) These coupons may be 3 inches by 6 inches by 0.032 inches if required by chamber size restraints.

Major or Unique Equipment

- Programmable salt spray (fog) chamber

Data Analysis and Reporting

- Collect coating condition and corrosion data for candidate coating system and the control coating system(s).
- Photograph test panels prior to test initiation, upon each removal for inspection and upon test termination.
- Compare test results with filiform test data to determine any correlation between the two tests.

3.4.5 SO_2 Corrosion Resistance {Navy Requirement}

Test Description

This test evaluates the ability of a coating system to prevent corrosion when exposed to corrosive conditions resulting from air pollutants (acidic environment). Following the guidance in ASTM G 85-98 (*Standard Practice for Modified Salt Spray (Fog) Testing*, approved April 10, 1998), Annex 4, scribe an "X" incision through the coating so that the smaller angle of the "X" is 30 to 45 degrees, making sure that the coating has been scribed all the way to the substrate. The scribe must have a 45 degree bevel, and each line of the "X" should be approximately 4 inches long. Cover the back and edges of the coupon with wax, paint, tape, or any other material that will prevent corrosion products from contaminating the chamber. Place the scribed coupons into a fog chamber. The coupons may not contact other surfaces in the chamber. Prepare a salt solution and the fog chamber as specified in *Test Methodology*. Adjust the nozzles in the fog chamber so that sprayed salt solution does not directly impinge on the coupon surfaces. Operate the fog chamber continuously for 500 hours.

After 500 hours total exposure time, remove the test panels from the salt spray chamber. Gently clean and dry each panel. Examine each panel visually for blistering, loss of adhesion, and corrosion on both the scribed and the unscribed

portions of the test panel. Slight corrosion in the scribe is generally acceptable, as long as it does not undercut the paint film. Corrosive salts or oxides running down the surface of the coupon are considered evidence of severe corrosion. Lab personnel shall evaluate and rate the panels in accordance with ASTM D 1654-92 (*Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments*, approved October 15, 1992), Procedure A, Method 1.

Rationale

This test evaluates corrosion protection when a coated substrate is exposed to an acidic corrosive environment such as acid rain. The Navy requires this test for validation of alternative coating systems.

Test Methodology

Parameters	• Test coupons placed at a 15 to 30^{o} angle. Temperature of the exposed salt spray zone = 95 ± 2-3^{o}F or (35 ± 1.1 – 1.7^{o}C) • Uniform SO_2 gas dispersion throughout salt fog chamber
Coupons Per Coating System	Three: Al-1a, Al-1b, Al-1c, Al-1d, Al-3a, Al-3b, St-1a, St-1b, St-2a, St-2b
Trials Per Coupon	One
Control Coupons Required	One coupon coated with MIL-P-53022B and MIL-PRF-85285C, Type II
Acceptance Criteria	No blistering or lifting after 500 hours. Slight substrate corrosion only. Slight substrate corrosion acceptable.

Major or Unique Equipment

- Salt spray (fog) chamber
- Salt solution reservoir
- Cylinder of SO_2 gas
- Compressed air supply
- Atomizing nozzles
- Heater for salt spray fog chambers
- Carbide tip scribe

Data Analysis and Reporting

- Report the extent of corrosion or loss of the coating extending from a scribe mark as prescribed in ASTM D 1654-92, Procedure A.
- Record the representative mean, maximum, and minimum creepage from the scribe and note whether or not the maximum is an isolated spot.

3.4.6 B 117 Salt Fog Corrosion Resistance Test {Navy Requirement}

Test Description

This test method evaluates a coating system's ability to prevent substrate corrosion and the effect that corrosion has on the adhesion of a coating system.

Operate the fog chamber for this test in accordance with ASTM B 117-97 *(Standard Practice for Operating Salt Spray (Fog) Apparatus,* approved 1997).

Scribe an "X" incision through the coating so that the smaller angle of the "X" is 30 to 45 degrees, making sure that the coating has been scribed all the way to the substrate. The scribe must have a 45 degree bevel, and each line of the "X" should be approximately four-inches. Cover the back and edges of the coupon with wax, paint, tape, or any other material that will prevent corrosion products from contaminating the chamber. Place the scribed coupons into a fog chamber. The coupons may not contact other surfaces in the chamber. Prepare a salt solution and the fog chamber as specified in *Test Methodology*. Adjust the nozzles in the fog chamber so that sprayed salt solution does not directly impinge on the coupon surfaces. Operate the fog chamber continuously for 2,000 hours. Evaluate coupons for surface corrosion and creepage from the scribe on a daily basis. Remove test coupons from the salt fog chamber if corrosion exceeds the acceptance criteria.

At the end of the test duration, carefully remove the coupons. Clean the coupons by gently flushing them with running water (water temperature less than 100°F [38^{o}C]), and dry them with a stream of clean, compressed air. Evaluate the adhesion of the primer/topcoat system in accordance with ASTM D 1654-92, *Procedure A, Method 1* (*Air Blow-Off*). Visually examine the coupons. Slight corrosion in the scribe is generally acceptable, as long as it does not undercut the paint film. Corrosive salts or oxides running down the surface of the coupon are considered evidence of severe corrosion.

Rationale

Navy participants require this test for validation of an alternative coating system.

Test Methodology

Parameters	• Test coupons at a 15 to 30 degree angle • Temperature of exposed salt spray zone = 95 + 2 - 3ºF (35 + 1.1 - 1.7ºC) • Every 80 cm^2 horizontal area, two collectors gather 1.0-2.0 ml fog/hr • 5% salt solution (5 ± 1 parts by weight of NaCl in 95 parts of water) • pH = 6.5-7.2 when atomized at 95°F (35°C) • 2,000 hours
Coupons Per Coating System	Three: Al-1a, Al-1b, Al-1c Al-1d, Al-3a, Al-3b, St-1a, St-1b, St-2a, St-2b (*)
Trials Per Coupon	One
Control Coupons Required	One coupon coated with MIL-P-53022 and MIL-PRF-85285C, Type II
Acceptance Criteria	No blistering or lifting after 2,000 hours. Slight substrate corrosion only.

(*) These coupons may be 3 inches by 6 inches by 0.032 inches if required by chamber size restraints.

Major or Unique Equipment

- Salt fog chamber
- Salt solution reservoir
- Compressed air supply
- Atomizing nozzles

Data Analysis and Reporting

- Report the condition of the scribed area of the test coupon at 2,000 hours of testing
- Photograph test coupons at 2,000 hours of testing

3.4.7 Accelerated Weathering {Navy Requirement}

Test Description

This test is a continuation of the *Accelerated Weathering* test in paragraph 3.2.3 to 1,500 hours of exposure. This accelerated test measures any coating color and gloss degradation occurring with exposure to simulated outdoor weathering.

Prior to testing, record color and gloss measurements for each coated coupon per ASTM D 2244-93 and ASTM D 523-89 (1999), respectively. Environmental chamber parameters should be maintained at 140 ± 5°F (60 ± 3°C) 50 ± 5% RH. A borosilicate glass inner and outer filter is required to simulate sunlight. The test will be conducted in cycles. One cycle is a total of two hours, 102 minutes of light only and 18 minutes of light and water spray. Expose the test coupons to UV, simulating sunlight, and intermittent moisture for a total of 1,500 hours (continuous). Inspect the test coupons at 1,000 and 1,500 hours intervals in accordance with ASTM G 26-96, Test Method 1. At the conclusion of testing, measure color on each coated coupon.

Test Methodology

Parameters	• 140 ± 5°F (60 ± 3°C) • 50 ± 5% RH • Borosilicate glass inner and outer filters • One cycle: 102 minutes of light only and 18 minutes of light and water spray • 0.35 W/m² incident at 340 nm • 1,500 hours duration
Coupons Per Coating System	Use test coupons from paragraph 3.2.3 (*)
Trials Per Coupon	One
Control Coupons Required	One coupon coated with MIL-P-53022B and MIL-PRF-85285C, Type II
Acceptance Criteria	Color change performance <2 units (ΔE) @ 1,000 hrs and 1,500 hrs.

(*) These coupons may be 2.75 inches by 4 inches by 0.032 inches if required by chamber size restraints.

Rationale

SE coating systems must withstand daily outdoor exposure to the UV radiation content of sunlight and to repeated wet/dry cycles. This procedure will document coating resistance to accelerated outdoor weather exposure conditions. Navy participants require this test for validation of an alternate coating system.

Major or Unique Equipment

- Xenon light/moisture environmental exposure chamber per ASTM G26-96, Test Method 1, with borosilicate glass inner and outer filters

- Hunter Lab "Miniscan" Spectrophotometer (using CIE L*a*b* Color Measurement System) or equivalent
- Hunter Lab "Progloss" Meter or equivalent

Data Analysis and Reporting

- Report color/gloss change data for alternative coatings control coating system at 1,000 and 1,500 hours.

3.4.8 Fluid Resistance {AF, Army, Navy Requirement}

Test Description

This procedure is used to determine the effect of fluid immersion on candidate coatings.

Determine the Scratch Hardness (Pencil Hardness) of the coating in accordance with ASTM D 3363-00 (*Standard Test Method for Film Hardness by Pencil Test*, approved November 15, 1992, re-approved 2000).

Immerse the test panels in the test fluids as specified in the *Test Methodology*. Remove the test panels from the immersion fluids and wipe dry with a clean cloth. Immediately determine the Scratch Hardness (Pencil Hardness) of the coating in accordance with ASTM D 3363-00.

Rationale

This test measures degradation of coating adhesion and hardness as a result of prolonged contact with specified common fluids.

Test Methodology

Parameters	Fluid	Temp	Duration	Test Coupons	Control Coupons	Reqmt	Acceptance Criteria
	Distilled Water	120°F (49°C)	4 days	1 each St-2a	1 coupon per control coating	AF, Navy	No objectionable discoloration, change in gloss, blistering, or swelling. Scratch hardness ≤ 2 pencil hardness units from the control finishes. .
	Fuel JP-5	Room Temp	7 days	1 each St-2a		AF, Army, Navy	
	Fuel JP-8	Room Temp	7 days	1 each St-2a		AF, Army, Navy	
	Diesel Fuel	Room Temp	30 days	1 each St-2a		AF, Army, Navy	
	Hydraulic Fluid (MIL-H-83282)	150°F (66°C)	24 hours	1 each St-2a		AF, Army, Navy	
	Hydraulic Fluid (SKY-DROL®)	Room Temp	7 days	1 each St-2a		AF, Army, Navy	
	Lube Oil (MIL-L-23699)	150°F (66°C)	24 hours	1 each St-2a		AF, Army, Navy	
	Solvent (PD-680, Type II)	Room Temp	7 days	1 each St-2a		AF, Army, Navy	

Major or Unique Equipment

- Hardness-graded pencil leads

Data Analysis and Reporting

- Collect and report coating scratch-hardness data for the candidate coating system and the baseline reference coating system(s).

3.4.9 CARC Tests For HD and GD Agents {Army Requirement}

Test Description

This test will measure the tendency of a primer/topcoat system to retain Agents HD and GD.

Spray three x three-inch steel panels, with primer conforming to MIL-P-53022B or MIL-P-53030A to a dry film thickness between 0.0009 and 0.0011 inch. Air dry two hours and spray the test coating to a dry film thickness between 0.0018 and 0.0022 inch. Air dry the panels four days, then bake for three days at 221 ± 2ºF (105 ± 2ºC). Mark a 5 cm^2 area in the center of the test panel and place the panel in a fume hood. Contaminate the marked area dropwise with a syringe. Keep the area wet with the designated Agent for 30 minutes and then clean with isopropyl alcohol. Place a stainless steel permeation cell over the contaminated area and sample through the bubbler. Agent vapors will be picked up in the

hexylene glycol in the bubbler. Continuously sample for 24 hours. Test the hexylene glycol for presence of the Agent by an appropriate colorimetric method.

Rationale

MIL-C-46168D (*Chemical Agent Resistant Aliphatic Polyurethane Coating*, dated May 21, 1998) requires the test for Agents HD and GD.

Test Methodology

		Agent	
Parameters	• Approved Agent test location • Bake for three days at 221 ± 2°F (105 ± 2°C)	**HD**	**GD**
		Bubbler apparatus, 77°F(25°C)	Bubbler apparatus, 77°F(25°C)
Coupons Per Coating System	Eight	Four of St-5	Four of St-5
Trials Per Test Coupon		One	One
Control Coupons Required	Two coupons coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A	One	One
Acceptance Criteria		Desorb 180 µg maximum	Desorb 40 µg maximum

Major or Unique Equipment

- Bubbler apparatus
- Colorimetric apparatus
- Stainless steel permeation cell
- Fume hood

Data Analysis and Reporting

- Report the amount of desorption of the chemical agent.

3.4.10 DS2 Decontaminant Resistance Test {Army Requirement}

Test Description

This test evaluates a coating system's resistance to degradation by DS2.

After coating, air dry the test coupon for four days and then bake for three days at 221 ± 5°F (105 ± 3°C). Allow the coupon to return to room temperature. Place two separate spots (approximately 0.5 milliliters each) of decontaminating solution DS2 conforming to MIL-D-50030H, (*Decontaminating Agent, DS2*, issued April 2, 1993) on the coupon. Let the coupon stand for 30 minutes

uncovered, then thoroughly rinse it with tap water. Visually inspect the specimen for blistering, wrinkling, or softening.

Rationale

The Army participants identified requirements for DS2 resistance as contained in MIL-PRF-22750F (*Coating, Epoxy, High Solids*, issued May 31, 1994) and MIL-C-46168D as a requirement for validation for an alternative coating system.

Test Methodology

Parameters	Two drops DS2, 30 minutes
Coupons Per Coating System	Three St-5
Trials Per Test Coupon	One
Control Coupons Required	One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A
Acceptance Criteria	No blistering, wrinkling, or softening

Major or Unique Equipment

- Oven capable of 221 ± 37^{o}F (105 ± 3°C) for three days.

Data Analysis and Reporting

- One color photograph of each test coupon shall be taken before and after the test.

3.4.11 Fungus Resistance Test {Army Requirement}

Test Description

This test will be performed to measure the extent to which a coating system will support fungal growth and how the fungal growth affects the adhesion of the topcoat.

Prepare subcultures of aspergillus niger, aspergillus flavus, aspergillus versicolor, and penicillium fungiculosum on an appropriate medium such as potato dextrose agar. Culture chaetomium globosum on strips of filter paper overlaid on the surface of a mineral salts agar that consists of agar and a mineral salts solution with the following composition:

Mineral Salt Solution	Quantity
Potassium dihydrogen orthophosphate	0.7 gram
Potassium monohydrogen orthophosphate	0.7 gram
Magnesium sulfate heptahydrate	0.7 gram
Ammonium nitrate	1.0 gram
Sodium chloride	0.005 gram
Ferrous sulfate heptahydrate	0.002 gram
Zinc sulfate monohydrate	0.002 gram
Distilled water	1,000 milliliters

Incubate subcultures at 86 ± 2.5°F (30 ± 1.4°C) for 14 to 21 days. Prepare a spore suspension by pouring 10 milliliters of an aqueous solution containing 0.05 grams per liter of a nontoxic wetting agent (e.g., sodium dioctyl sulfosuccinate or sodium lauryl sulfate) onto each agar culture, and then pouring the mixture into an Erlenmeyer flask that contains 45 milliliters of water and 50 to 75 glass beads that have a 5 millimeter diameter. Shake the flask. Filter the mixture with glass wool to remove the large mycelial fragments and clumps of agar. Resuspend the spores three additional times, filtering each time. After the final rinsing, suspend the spores in the mineral salts solution (composition previously described), so that the solution has 1,000,000 ± 200,000 spores per milliliter as determined with a counting chamber. Verify the viability of each spore suspension by incubating an inoculated potato dextrose agar plate at 75 to 88°F (24 to 31°C) for 7 to 10 days and checking for fungal growth. If fungal growth does not occur, the fungal suspensions must be prepared again.

Prepare the final mixed spore suspension by combining equal volumes of each fungal suspension. Prepare an environmental chamber that has 95 ± 5 % RH at 86 ± 2°F (30 ± 1°C), with an air velocity between 98 and 335 feet per minute (0.5 and 1.7 meters per second). Place the test coupons and cotton strips (used for a control) in the environmental chamber for at least four-hours immediately prior to inoculation. Inoculate the coupons with the final mixed spore suspension by spraying a mist of the suspension with an atomizer or nebulizer. After 7 days of inoculation, the cotton strips should be at least 90 percent covered with fungal growth; if not, repeat the entire test. After a total of 84 days, remove the test coupons. Visually inspect for fungal growth.

Rationale

This test was identified by the Army as a performance requirement. This fungus resistance test is performed in accordance with Method 508 of MIL-STD-810F (*Environmental Engineering Considerations and Laboratory Tests*, , issued January 1, 2000).

Method 508 of MIL-STD-810F recommends that the minimum test duration is 28 days, but suggests a longer test duration of 84 days to allow for fungal germination, breakdown of carbon molecules, and degradation of the material

being tested. The longer test duration was selected for location of the fungi, a narrative description of growth, and the length of the test period. Include a determination of the effect of fungi on performance.

Test Methodology

Parameters	Five types of fungus/84 days 95 ± 5% RH 30º C
Coupons Per Coating System	One Al-1a
Trials Per Test Coupons	One
Control Coupons Required	One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A
Acceptance Criteria	Topcoat does not support fungal growth

Major or Unique Equipment

- Environmental chamber capable of supporting a 95 ± 5 % RH at 86 ± 2°F (30 ± 1°C) environment, with an air velocity between 98 and 335 feet per minute (0.5 and 1.7 meters per second).

Data Analysis and Reporting

- One color photograph of each test coupon shall be taken before and after the test.

3.4.12 Infrared Reflectance Test {Army Requirement}

Test Description

This testing method measures the infrared (IR) reflectance of a candidate topcoat.

Measure the total reflectance (specular and diffuse) of the test coupon within the specified wavelength range (refer to *Test Methodology*) relative to barium sulfate using a Perkin-Elmer *LAMBDA 9* spectrophotometer or equivalent.

Rationale

IR reflectance is critical for some topcoats, such as those used in special operational missions to increase the equipment's survivability.

The Army organizations identified requirements for IR reflectance as contained in MIL-C-46168D and MIL-C-53039A as performance requirements for alternate coatings. Test procedures are also described in FED-STD-141C (*Paint, Varnish, Lacquer and Related Materials: Methods of Inspection, Sampling and Testing*, issued January 24, 1986, Change Notice 2 dated December 10, 1993), Method 6242. Reflectance values are based on the military specifications and colors. The requirement stated in this document for Field Green (34094) is based on MIL-PRF-85285C and MIL-PRF-22750F.

Test Methodology

Parameters	Refer to MIL-C-46168D, Table 8 for selected wavelengths for determining IR reflectance values.
Number and Type of Test Coupons	Two of Al-1a
Trials Per Test Coupon	One
Control Coupons Required	One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A
Acceptance Criteria (*)	Field Green (34094): reflectance ≤8% reflectance in 450-500 and 600-2700 nm wavelength ranges and reflectance ≤10% in 500-600 nm wavelength range.

(*) Individual weapon systems may have acceptance criteria that can not be listed in this JTP; these needs will take preference over the above acceptance criteria and will be considered when reviewing the results from this test.

Major or Unique Equipment

- Perkin-Elmer LAMBDA 9 spectrophotometer or equivalent

Data Analysis and Reporting

- Report infrared reflectance measurements

3.4.13 Acid Resistance {Army Requirement}

Test Description

This testing method measures the acid resistance of a candidate topcoat.

Place a 3 to 5 ml spot of 10 percent by volume acetic acid solution on the surface of the coating. Cover with an appropriate size watch glass and allow to stand for one-hour. Rinse with water thoroughly, allow to dry, and examine for blistering and color change. For Green 383, 34094 and Dark Green 34082, a film of the coating tested as specified in MIL-C-46168D, paragraph 4.3.21 shall have no blistering and show no change from the original color.

Test Methodology

Parameters	Three to five ml spot of 10 percent by volume acetic acid solution
Coupons Per Coating System	One Al-1a and St-1a

Test Methodology (continued)

Trials Per Test Coupon	One
Control Coupons Required	One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A
Acceptance Criteria	No blistering or color change.

Major or Unique Equipment

- None

Data Analysis and Reporting

- Report signs of blistering and color change.

3.4.14 Specular Reflectance for All Camouflage Colors listed in Table 2-4 of MIL-C-46168D {Army Requirement}

Test Description

This testing method measures the spectral reflectance properties in the visible light range (380-700 namometer) and the near infrared range (700-900 namometers).

Perform this test in accordance with ASTM D 523-89 (1999). Also, refer to MIL-C-46168D paragraph 3.3 and related amendments for Tan 686A along with the tables associated with colors to include table VIII for gloss. Calibrate a glossmeter capable using a NIST traceable standard. Measure the gloss at three different places on the coupon and record the average. After every thirty specular gloss measurements, check calibration and recalibrate if necessary.

Rationale

This test is required by the Army and documents the specular reflectance of Army camouflage coatings. The test procedure and the acceptance criteria in this JTP were derived from detailed specification MIL-C-46168D.

Test Methodology

Parameters	None
Number and Type of Test Coupons	Three Al-1a
Trials Per Test Coupon	Three
Control Coupons Required	One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A
Acceptance Criteria (*)	≤ 2.5 gloss units

(*) Individual weapon systems may have acceptance criteria that cannot be listed in this JTP; these needs will take preference over the above acceptance criteria and will be considered when reviewing the results from this test.

Major or Unique Equipment

- BYK Gardner Micro Tri-Gloss Glossmeter or equivalent using the 85 degree geometry settings

Data Analysis and Reporting

- Report the mean specular gloss.

3.4.15 Chromaticity Test {Army Requirement}

Test Description

This test will measure whether or not the candidate topcoats meet color matching requirements.

Perform this test in accordance with ASTM E 1164-91. Use a color spectrophotometer to calculate the color difference in National Bureau of Standards (NBS) units. CARC shall fall within 2.0 NBS units of the values listed in Table 3-2 of this document when calculated using the average brightness of the range specified in the same table. Figures 4 through 16 of MIL-C-53039A may be used as approximate guidelines for chromaticity limits. All other colors tested must match the appropriate color chip specified by FED-STD-595B.

Rationale

The Army organizations identified the need for chromaticity testing for the topcoats listed in Tables 3-2 of this JTP. Color requirements for standard camouflage must match the performance requirements of MIL-C-46168D or MIL-C-53039A. Acceptance criteria are the same in these standards, except for Field Drab (33105), in which the requirement of MIL-C-46168D (0.389 for the Chromaticity y-value) was selected over the requirement for MIL-C-53039A (0.383 for the Chromaticity y-value).

Test Methodology

Parameters	None
Coupons Per Coating System	Three Al-1a
Trials Per Test Coupon	One
Control Coupons Required	One coupon coated with MIL-P-53022B and MIL-C-46168D or MIL-P-53022B and MIL-C-53039A
Acceptance Criteria	Color within 2.0 NBS units of chromaticity coordinates in Table 3-3

Note: only one color to be tested

Major or Unique Equipment

- Spectrophotometer

Data Analysis and Reporting

- Report chromaticity values

Table 3-3 Chromaticity Acceptance Criteria for CARC Topcoat Colors

Color	Color Number *	Use		Affected Military Branch			Chromaticity		Average Brightness
		Air-craft	Camou-flage	AF	Army	Navy	x	y	(Y)
Brown 383	30051		X		X		0.357	0.342	0.060-0.080
Field Drab	33105		X		X		0.390	0.389	0.093-0.117
Earth Yellow	33245		X		X		0.420	0.395	0.228-0.263
Sand	33303		X				0.360	0.366	0.284-0.323
Tan 686	33446		X		X		0.368	0.364	0.360-0.400
Dark Green	34082	X	X				0.339	0.390	0.071-0.091
Green 383	34094	X	X		X	X	0.328	0.365	0.063-0.083
Black	37030		X		X	X	0.310	0.315	0.030-0.041

*Refers to FED-STD-595B (Colors Used in Government Procurement, issued December 15, 1989; Change Notice 1, dated January 11, 1994).
Note: Only one color will be tested, the alternative coating color must meet the requirements in the above table.

3.4.16 High-Temperature Resistance Test {NASA Requirement}

Test Description

This procedure is used to determine the heat resistance of a coating system.

Measure the film integrity and adhesion with ASTM D 2197-98 (*Standard Test Method for Adhesion of Organic Coatings by Scrape Adhesion*, approved 1968, revised 1998) and ASTM D 4541-95e1 (*Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers*, approved 1993, revised 1995). Place coupons in the oven as specified in Test Methodology. At the completion of the test, remove the coupons from the oven, allow them to cool to room temperature, and measure the film integrity and adhesion.

Rationale

NASA requires this test for validation of alternative coating systems.

Test Methodology

Parameters	24 hours at 750 ± 5°F
Coupons Per Coating System	Two St-2a
Trials Per Coupon	One per coating per test coupon
Control Coupons Required For Testing	None
Acceptance Criteria	No change in film integrity and adhesion

Unique Equipment and Instrumentation

- Oven capable of maintaining 750 ± 5°F.

Data Analysis and Reporting

- Report the initial and final film integrity and adhesion of the coating system.

Table 3-4 Summarized Test and Evaluation Reference Listing

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
ASTM D 523-89 (1999)	Standard Test Method for Specular Gloss	March 31, 1989; reaffirmed 1999	All	Surface Appearance	3.1.2
				Removability	3.2.1
				Reparability	3.2.2
				Accelerated Weathering (Common Test)	3.2.3
				Accelerated Weathering (Extended Test)	3.4.7
				Specular Reflectance (Extended Test)	3.4.14
ASTM D 522-93a	Standard Test Method For Mandrel Bend Test of Attached Organic Coatings	September 15, 1993	Test Method B	Mandrel Bend Flexibility	3.2.6
ASTM D 610-95	Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces	September 15, 1995	All	18-Month Marine Environment Test	3.4.3
ASTM D 1200-94 (1999)	Standard Test Method for Viscosity by Ford Viscosity Cup	August 15, 1994; reaffirmed 1999	All	Pot Life	3.1.3
ASTM D 1654–92	Standard Test Method of Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments	October 15, 1992	Test Procedure A	SO_2 Corrosion Resistance	3.4.5
				B-117 Salt Fog Corrosion Resistance Test	3.4.6

Table 3-4 Summarized Test and Evaluation Reference Listing (Continued)

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
ASTM D 2197-98	Standard Test Method for Adhesion of Organic Coatings by Scrape Adhesion	1968, revised 1998	All	High-Temperature Resistance	3.4.16
ASTM D 2244-93	Standard Test Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates	September 15, 1993	All	Surface Appearance	3.1.2
				Removability	3.2.1
				Repairability	3.2.2
				Accelerated Weathering	3.2.3
ASTM D 2803-93	Standard Guide for Testing Filiform Corrosion Resistance of Organic Coatings on Metal	May 15, 1993	Test Procedure C	Filiform Corrosion Resistance	3.2.4
ASTM D 3359-97	Standard Test Methods for Measuring Adhesion by Tape Test	December 10, 1995; re-approved 1997	Test Method A	X-Cut Adhesion Tape Test	3.2.5
ASTM D 3363-00	Standard Test Method for Film Hardness by Pencil Test	November 15, 1992	All	Fluid Resistance	3.4.8

Table 3-4 Summarized Test and Evaluation Reference Listing (Continued)

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
ASTM D 4541-95e1	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers	February 15, 1995	All	High-Temperature Resistance	3.4.16
ASTM D 4752-98	Standard Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub	1998	All	Cure Time	3.1.5
ASTM D 5139-90 (1996)	Standard Specification for Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants	Approved 1990; Reaffirmed 1996	All	Panel Preparation	3
ASTM F 22-65 (1998)	Standard Test Method for Hydrophobic Surface Films by the Water-Break Test	Reapproved 1998	All	Panel Preparation	Table 3-1 Coupon (Test Specimen) Codes and Substrate Descriptions

Table 3-4 Summarized Test and Evaluation Reference Listing (Continued)

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
ASTM G 26-96	Standard Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials	January 1, 1996	Test Method 1	Removability	3.2.1
				Accelerated Weathering	3.4.7
ASTM G 85-98	Standard Practice for Modified Salt Spray (Fog) Testing	April 10, 1998	Annex A4	SO_2 Corrosion Resistance	3.4.5
FED-STD-595B	Colors Used in Government Procurement	December 15, 1989; Change Notice 1, dated January 11, 1994	All	Surface Appearance	3.1.2
				Chromaticity Test	3.4.15
FED-STD-141C	Paint, Varnish, Lacquer and Related Materials: Methods of Inspection, Sampling and Testing	January 24, 1986; Change Notice 2, dated December 10, 1993	Method 6242	Infrared Reflectance Test	3.4.12
GM 9540P	Standard Practice for Modified Salt Spray (Fog) Testing	December 1997	All	Cyclic Corrosion Resistance	3.4.4

Table 3-4 Summarized Test and Evaluation Reference Listing (Continued)

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
JTP Environmental Security Technology Certification Program (ESTCP)	Validation of Alternatives to Topcoats Containing Volatile Organic Compounds (VOCs) for Military Aerospace Applications	30 October 1998 (Draft)	All	Reference Data	1
JTP LM-P-1-1	Validation of Alternatives to High Volatile Organic Compound (VOC) Topcoats and Primers	June 16, 1997, (Rev. November 19, 1998)	All	Reference Data	1
JTP MD-P-1-1	Validation of Alternatives to Chromate-Containing Primer Coatings for Aircraft Exterior Mold Line Skins	December 23, 1997	All	Reference Data	1
JTP TI-P-1-1	Alternatives to High Volatile Organic Compounds (VOCs) Primers and Topcoats containing: Methyl Ethyl Ketone (MEK), Toluene, and Xylene	June 20, 1996, (Rev. May 11, 1998)	All	Reference Data	1

Table 3-4 Summarized Test and Evaluation Reference Listing (Continued)

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
MIL-A-8625F	Anodic Coatings for Aluminum and Aluminum Alloys	September 10, 1993	Type II – Sulfuric Acid Anodize	Panel Preparation	Table 3-1 Coupon (Test Specimen) Codes and Substrate Descriptio ns
MIL-C-46168D	Coating, Aliphatic Polyurethane, Chemical Agent Resistant	Amendment 3, dated May 21, 1998	All	Chemical Agent Resistance	3.4.9
				DS2 Decontaminant Resistance	3.4.10
				Fungus Resistance	3.4.11
				Infrared Reflectance	3.4.12
				Acid Resistance	3.4.13
				Specular Reflectance	3.4.14
				Chromaticity	3.4.15
MIL-C-53039A	Coating, Aliphatic Polyurethane, Single Component, Chemical Agent Resistant	Amendment 2, dated May 19, 1993	All	Chemical Agent Resistance	3.4.9
				DS2 Decontaminant Resistance	3.4.10
				Fungus Resistance	3.4.11
				Infrared Reflectance	3.4.12
				Acid Resistance	3.4.13
				Specular Reflectance	3.4.14
				Chromaticity	3.4.15
MIL-D-50030H	Decontamin-ating Agent, DS2	Notice 1, April 2, 1993	All	DS2 Decontaminant Resistance	3.4.10
MIL-P-53022B	Primer, Epoxy Coating, Corrosion Inhibiting, Lead And Chromate Free	June 1, 1988	All	Cure Time	3.1.5
				Removability	3.2.1
				Reparability	3.2.2

Table 3-4 Summarized Test and Evaluation Reference Listing (Continued)

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
MIL-P-53022B (continued)	Primer, Epoxy Coating, Corrosion Inhibiting, Lead And Chromate Free	June 1, 1988	All	Accelerated Weathering	3.2.3
				Filiform Corrosion Resistance	3.2.4
				Mandrel Bend Flexibility	3.2.6
				Cyclic Corrosion Resistance	3.4.4
				SO_2 Corrosion Resistance	3.4.5
				B117 Salt Fog Corrosion Resistance	3.4.6
				Accelerated Weathering	3.4.7
				Fluid Resistance	3.4.8
				Chemical Agent Resistance	3.4.9
				DS2 Resistance	3.4.10
				Fungus Resistance	3.4.11
				Infrared Reflectance	3.4.12
				Acid Resistance	3.4.13
				Specular Reflectance	3.4.14
				Chromaticity	3.4.15
MIL-P-53030A	Primer Coating, Epoxy, Water Reducible, Lead And Chromate Free	Amendment 2, dated August 20, 1993	All	CARC Tests for HD and GD Agents	3.4.9

Table 3-4 Summarized Test and Evaluation Reference Listing (Continued)

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
MIL-PRF-22750F	Coating, Epoxy, High Solids	May 31, 1994	All	DS2 Decontaminant Resistance	3.4.10
				Infrared Reflectance	3.4.12
MIL-PRF-23377G	Primer Coating, Epoxy, High Solids	Amendment 1, September 30, 1999	All	DS2 Decontaminant Resistance	3.4.10
MIL-PRF-85285C	Coating, Polyurethane, High Solids	April 30, 1997	All	Cure Time	3.1.5
				Removability	3.2.1
				Reparability	3.2.2
				Accelerated Weathering	3.2.3
				Filiform Corrosion Resistance	3.2.4
				Mandrel Bend Flexibility	3.2.6
				Cyclic Corrosion Resistance	3.4.4
				SO_2 Corrosion Resistance	3.4.5
				B117 Salt Fog Corrosion Resistance	3.4.6
				Accelerated Weathering	3.4.7
				Fluid Resistance	3.4.8
				Chemical Agent Resistance	3.4.9
				DS2 Decontaminant Resistance	3.4.10
				Fungus Resistance	3.4.11
				Infrared Reflectance	3.4.12

Table 3-4 Summarized Test and Evaluation Reference Listing (Continued)

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
MIL-PRF-85285C (continued)	Coating, Polyurethane, High Solids	April 30, 1997	All	Acid Resistance	3.4.13
				Specular Reflectance	3.4.14
				Chromaticity	3.4.15
MIL-STD 810F	Environmental Engineering Considerations and Laboratory Tests	January 1, 2000	Method 508	Fungus Resistance	3.4.11
None	Subjective Evaluations	Not Applicable	Not Applicable	Ease of Application	3.1.1
				Dry-To-Touch	3.1.4
				Full Unit Operational Testing	3.3.1
SSPC SP-1	Steel Structures Painting Manual, Systems and Specifications, Vol. 2, Solvent Cleaning	September 1991	All	Test Coupon Preparation	Table 3-1
SSPC SP-10	Steel Structures Painting Manual, Systems and Specifications, Vol. 2, Near-White Blast Cleaning				

Table 3-4 Summarized Test and Evaluation Reference Listing (Continued)

Reference Document	Title	Date	Applicable Section Of Referenced Document	JTP Test	JTP Section
SSPC SP-11	Steel Structures Painting Manual, Systems and Specifications, Vol. 2, Power Tool Cleaning to Bare Metal	September 1991	All	Test Coupon Preparation	Table 3-1