Engineering and Technical Services for Joint Group on Acquisition Pollution Prevention (JG-APP) Pilot Projects

Joint Test Protocol
TI-P-1-1

for Alternatives to High Volatile Organic Compounds (VOCs) Primers and Topcoats Containing: Methyl Ethyl Ketone (MEK), Toluene, and Xylene

June 20, 1996
(Revised May 11, 1998)

Contract No. DAAA21-93-C-0046
Task No. N.072
CDRL No. A005

Prepared by
National Defense Center for Environmental Excellence (NDCEE)

Operated by Concurrent Technologies Corporation

Joint Group on Acquisition Pollution Prevention (JG-APP)

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Submitted by:

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PREFACE

This report was prepared by Concurrent Technologies Corporation (*CTC*) through the National Defense Center for Environmental Excellence (NDCEE) under Contract Number DAAA21-93-C-0046. This report was prepared on behalf of, and under guidance provided by the Joint Group on Acquisition Pollution Prevention (JG-APP) through the Joint Pollution Prevention Advisory Board (JPPAB). The structure, format, and depth of technical content of the report was determined by the JPPAB, Government contractors, and other Government technical representatives.

THIS REVISED JOINT TEST PROTOCOL (JTP) REFLECTS AMENDMENTS TO THE PREVIOUS JTP DATED JUNE 20, 1996, AS FOLLOWS:

- A CORRECTION TO THE PASS/FAIL CRITERIA (THAT WAS MISTYPED IN THE FINAL VERSION OF THE ORIGINAL DOCUMENT) FOR TEST 3.2.13 IN TABLE 3A OF SECTION 2.2.1, PAGE 6, TO READ 180 MICROGRAMS MAXIMUM FOR AGENT HD, AND 40 MICROGRAMS MAXIMUM FOR AGENT GD
- A CLARIFICATION TO THE EXECUTION OF THE TESTING PROCEDURES, AS DISCUSSED ON PAGE 8 OF THIS DOCUMENT
- A CORRECTION TO THE ACCEPTANCE CRITERIA (THAT WAS MISTYPED IN THE FINAL VERSION OF THE ORIGINAL DOCUMENT) IN SECTION 3.2.13, PAGE 21, UNDER "TEST METHODOLOGY," TO READ 180 MICROGRAMS MAXIMUM FOR AGENT HD, AND 40 MICROGRAMS MAXIMUM FOR AGENT GD.

THE ABOVE CHANGES ARE HIGHLIGHTED BY REVISION MARKS IN THE BORDER OF THE MODIFIED PAGES. NO OTHER CHANGES HAVE BEEN MADE.

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1.0. INTRODUCTION

On 15 September 1994, the Joint Logistics Commanders (JLCs) chartered the Joint Group on Acquisition Pollution Prevention (JG-APP) to coordinate joint service activities affecting pollution prevention issues identified during a weapon system's acquisition process. To avoid duplication of efforts in reducing hazardous material (HazMat) procurement and use, JG-APP will facilitate the Joint Implementation of the Department of Defense Comprehensive Pollution Prevention Strategy dated 11 August 1994. The primary objectives of the JG-APP are to:

- Reduce or eliminate Hazardous Materials (HazMats) by fostering joint service cooperation
- Avoid duplication of efforts in actions required to reduce or eliminate HazMats and share technology

The focus of the JG-APP is on contractor design, manufacturing, and remanufacturing locations with technology transfer to the sustainment community.

This JTP contains the critical requirements and tests necessary to qualify potential alternatives to a selected target HazMat and process for the particular application.

A Joint Test Report (JTR) will document the data and results of the testing and will be made available as a reference for future pollution prevention and other DOD and commercial users to minimize duplication of effort.

Environmental, Safety, and Occupational Health (ESOH) activities will be performed and included with the JTR.

At the Texas Instruments–Defense Systems & Electronics (TI-DS&E) JG-APP pilot site, the target HazMats identified were VOCs. Individual VOCs were identified as Methyl Ethyl Ketone (MEK), toluene, and xylene which are contained in current primer and topcoat formulations. The identified process was conventional, wet-spray coating of primer, ground support topcoat, and airborne topcoat applications. Table 1 summarizes the target HazMats, process and material, applications, current specifications, and the affected programs.

Table 1. Target HazMat Summary

Target HazMats	Process/ Material	Application	Current Specification	Affected Programs
VOCs: MEK - 9,000 lb/yr Toluene - 22,000 lb/yr Xylene - 4,000 lb/yr	Conventional, wet-spray coating process High VOC primers and topcoats	Primer	MIL-P-23377	Navy: P3, HARM, JSOW, F/A-18 Air Force: PVWY III, F3, F-16, Lantirn Army: Avenger
		Ground Support Topcoat	MIL-C-22750	Navy: none Air Force: none Army: M1A2 CITV/ HTEU
		Airborne Topcoat	MIL-C-22750	Navy: P3, F/A-18 Air Force: PVWY III, F3, Lantirn Army: none
			MIL-C-83286	Navy: P3, JSOW, F/A-18 Air Force: PVWY III, F3, F-16, Lantirn Army: none
		CARC Camouflage	MIL-C-46168 Type II	Navy: none Air Force: none Army: Avenger, M1A2 CITV/HTEU

2.0. TESTING REQUIREMENTS

A joint group led by the JG-APP and consisting of technical representatives from TI-DS&E, the affected DOD Program Managers, representatives of the Sustainment Community, and other government technical representatives identified and reached technical consensus on application, performance, and operational impact (supportability) requirements for primers and topcoats. The group identified and defined critical tests with descriptions, methodologies, and pass/fail criteria to qualify alternatives against these technical requirements.

Tables 2 and 3 detail a common set of requirements and tests agreed upon by technical representatives from TI-DS&E and the affected programs. Tables 2A and 3A include additional requirements and tests, identified by at least one of the affected programs, that may need to be performed on an as needed basis.

Tests will be conducted in a manner that will eliminate duplication and maximize use of each test coupon. For example, where possible, more than one test will be performed on each panel. The amount of tests and type that can be run on any one panel will be determined by the destructiveness of the test.

2.1. Primer Application

2.1.1. Test Requirements

The test requirements are located in Tables 2 and 2A for the Primer Application.

Table 2. Common Primer Test Requirements

JTP Section	Requirement	Test	Pass/Fail Criteria
3.1.1		Salt Spray (Scribed)	No blistering or lifting
3.1.2		Wet Tape Adhesion	No peel away
3.1.3	Full Cure Test	Recoatability	No lifting of topcoat
3.1.4		Solvent (MEK) Rub	No substrate show-through
3.1.5	Impact/Flexibility Resistance	GE Impact	10% elongation, no cracks

Table 2A. Extended Primer Test Requirements

JTP Section	Requirement	Test	Pass/Fail Criteria
3.1.6		SO_2 Salt Spray (scribed)	>= 500 hours
3.1.7		Infrared Reflectance	600-2700=10
3.1.8		Filiform Corrosion	All filaments </= 1/4” Majority < 1/8” filaments
3.1.9	Fluid Immersion (Film Change)	Hydraulic Fluid Lubricating Oil Deionized (DI) Water	No blistering, whitening, or dulling

2.1.2. Primer Application Test Flow Diagram

The relationships among the groups of tests identified Tables 2 and 2A are detailed below in Figure 1.

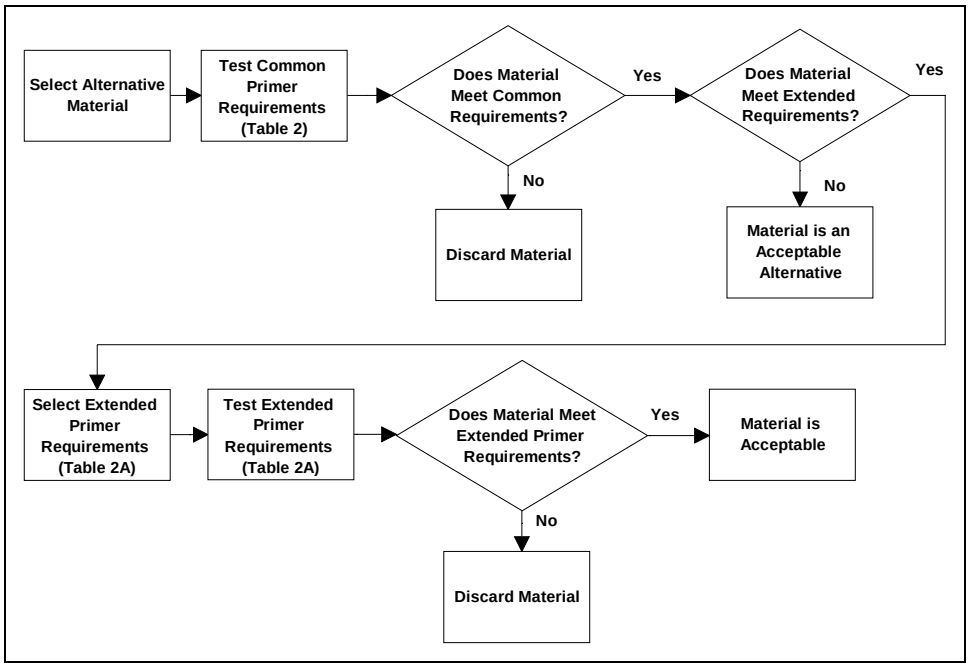

Figure 1. Primer Application Test Flow Diagram

2.2. Topcoat Application

2.2.1. Test Requirements

The test requirements for Topcoat Applications are located in Tables 3 and 3A.

Table 3. Common Topcoat Test Requirements

JTP Section	Requirement	Test	Pass/Fail Criteria
3.2.1	Gloss	Gloss (High)	>=90 units
		Gloss (Semi)	15 - 45 units
		Gloss (Low)	<= 5 units
3.2.2		Wet Tape Adhesion	No peel away
3.2.3		Solvent (MEK) Rub	No substrate show-through
3.2.4		Hiding Power (white only)	>= 0.95
3.2.5		Humidity	No film defects
3.2.6		Heat Resistance	color change <=1.0 Delta E
3.2.7		Accelerated Weather	color change <=2.0 Delta E
3.2.8		Tape Resistance	No Marring
3.2.9		Color	Visual Match
3.2.10	Fluid Immersion (Film Change)	Hydraulic Fluid Lubricating Oil	No blisters, dark stains, soften to scratch

Table 3A. Extended Topcoat Test Requirements

JTP Section	Requirement	Test	Pass/Fail Criteria
3.2.7	Extended Environment	Special accelerated weathering	Color change<=1.0 Delta E
3.2.11	Low Observability	Infrared reflectance	600-2700=8
3.2.1		Very Low Gloss	<= 1.0 units
3.2.12		DS_2 resistance	No blisters, wrinkles, soften to scratch
3.2.13	Chemical Agent Resistant Coating (CARC)	Standard Chemical Agents: Agent HD	180 micrograms maximum
		Standard Chemical Agents: Agent GD	40 micrograms maximum
		Special Chemical Agent: Agent VX	Program requirement
3.2.14		Temperature Shock	Visual (no film defects)
3.2.15		Fungus	Visual (no film defects)
3.2.16		High Temperature	Visual (no film defects)
3.2.17		Low Temperature	Visual (no film defects)
3.2.18		Rain	Visual (no film defects)
3.2.19		Salt Fog (cyclical)	Visual (no film defects)
3.2.20		Humidity (water soak)	Visual (no film defects)
3.2.21		Specialized wet tape adhesion	5-15% lattice removal
3.2.22		Recoatability Test	No lifting
3.2.23	Specialized Fluid Resistance	Hydrocarbon Skydrol JP4 JP6 JP8 JP10 RJ4	No blisters, dark stains, soften to scratch
3.2.24	Increased Flexibility	Impact flexibility	No adhesion loss
		Low temp flexibility	No adhesion loss

2.2.2. Test Flow Diagram

The relationships among the groups of tests identified in Tables 3 and 3A are detailed below in Figure 2.

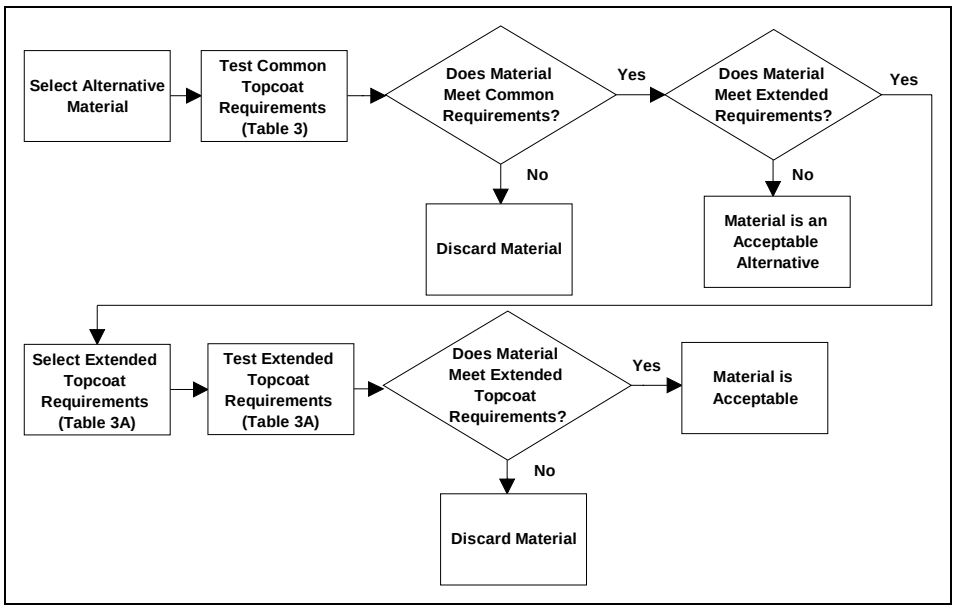

Figure 2. Topcoat Application Test Flow Diagram

3.0. TEST DESCRIPTIONS

Tests identified in each application requirement/test matrix are defined to include description, test methodology, any unique equipment and instrumentation and data analysis, as needed. Test methodology includes the substrates/types of samples, the number of test runs, testing parameters and conditions, and pass/fail criteria. Test coupons will be at least 3" x 6" unless otherwise required by a specific test.

Coating process parameters, including application method and cure schedule will be documented. Verification of the coating process shall be established through analysis and/or demonstration of the life-cycle effect on the substrate mechanical properties.

Actual execution of the tests may vary from that described in this JTP. Any deviations will be justified by the technical stakeholders, and documented and discussed in the project's JTR. Therefore, users of this document should check the JTR for modifications that may have been necessary in the execution of testing.

Below is a listing of substrate types that will be used for testing (test specimen code):

AL1 Aluminum alloy 2024-T0, clad, cleaned using alcoholic-phosphoric acid cleaner in accordance with procedures for non-anodized aluminum panels, then chemical conversion coated (chromate), and primed with epoxy, waterborne primer (Sterling U-4800 or equivalent) to a dry film thickness of 0.0006-0.0009 inches, and then topcoated per specified material process and dry film thickness.

AL2 Aluminum alloy 2024-T0, clad, cleaned using alcoholic-phosphoric acid cleaner in accordance with procedures for non-anodized aluminum, then primed with epoxy, waterborne primer (Sterling U-4800 or equivalent) to a dry film thickness of 0.0006-0.0009 inches, and then topcoated per specified material process and dry film thickness.

AL3 Aluminum alloy 2024-T3, clad, cleaned using alcoholic-phosphoric acid cleaner in accordance with procedures for non-anodized aluminum panels, then chemical conversion coated (chromate), and primed with epoxy, waterborne primer (Sterling U-4800 or equivalent) to a dry film thickness of 0.0006-0.0009 inches, and then topcoated per specified material process and dry film thickness.

AL4 Aluminum alloy A356-T6, casting (representing typical electronics housing) conforming to AMS 4218, cleaned using alcoholic-phosphoric acid cleaner in accordance with procedures for non-anodized aluminum panels, then chemical conversion coated (chromate), and primed with epoxy, waterborne primer (Sterling U-4800 or equivalent) to a dry film thickness of 0.0006-0.0009 inches, and then topcoated per specified material process and dry film thickness.

AL5 Aluminum alloy 7075-T7, bare, cleaned using alcoholic-phosphoric acid cleaner in accordance with procedures for non-anodized aluminum panels, then chemical conversion coated (chromate), and primed with epoxy, waterborne primer (Sterling U-4800 or equivalent) to a dry film thickness of 0.0006-0.0009 inches, and then topcoated per specified material process and dry film thickness.

ST Steel alloy 1018 (or other similar low carbon steel), pretreated with zinc phosphate (150 mg/sq ft min – 500 mg/sq ft max), and primed with epoxy, waterborne primer (Sterling U-4800 or equivalent) to a dry film thickness of 0.0006-0.0009 inches, and then topcoated per specified material process and dry film thickness.

SS Type 17-4PH corrosion resisting steel conforming to AMS 5643, heat treated by heating to 1400° F +/- 25°, and holding for two hours, air cooling below 90° F, and then aging for 4 hours at 1150° F +/- 25°, passivated, wash primed, primed with epoxy, waterborne primer (Sterling U-4800 or equivalent) to a dry film thickness of 0.0006-0.0009 inches, and then topcoated per specified material process and dry film thickness.

T Titanium alloy 6Al-4V, cleaned, wash primed, primed with epoxy, waterborne primer (Sterling U-4800 or equivalent) to a dry film thickness of 0.0006-0.0009 inches, and then topcoated per specified material process and dry film thickness.

3.1. Primer Application Tests

3.1.1. Salt Spray Test

Test Description

This method covers the establishment of the required conditions of the salt spray test in which test specimens are placed in a controlled corrosive heated environment for a specified length of time. A coated panel is scribed with an "x" and the back and edges of the panel are covered with wax, paint, tape, or any other material that will prevent corrosion products from contaminating the chamber. The panels are placed in the salt spray chamber at a 15° to 30° angle from the vertical. The salt solution is verified to be 5% +/- 1% and pH is verified to be 6.5 to 7.2 at 35° C. The chamber is closed and the specimens are evaluated for surface corrosion and creepage from scribe on a daily basis. Acceptable criteria is no blistering or lifting after 2,000 hours.

Test Methodology

Parameters	5% salt solution/2,000 hours
Type and Number of Panels	Al 3/5 Al 4/1 Al 5/5 SS/5
Trials Per Panels	1
Acceptance Criteria	No blistering or lifting

3.1.2. Wet Tape Adhesion Test

Test Description

This test method covers a procedure for establishing acceptability of intercoat and surface adhesion of an organic coating immersed in water by applying pressure sensitive taped over a scribed area of the coating. A coated specimen is soaked in distilled water for 24 hour. An "x" is scribed into the specimen so that the smaller angle is about 35° to 45°, making sure the coating has been scribed all the way to the substrate. A piece of tape is placed over the incision and smoothed out. The tape is then removed rapidly at a 180° angle. The incision area is inspected for peel away. Acceptable criteria is no peel away.

Test Methodology

Parameters	24 hours distilled water
Type and Number of Panels	Al 3/3
Trials Per Panel	1
Acceptance Criteria	No peel away

Unique Equipment and Instrumentation

- 1” masking tape code 250 or equivalent
- 4.5 lb roller

3.1.3. Recoatability Test

Test Description

Panels coated with the test material will be recoated with material to test compatibility with field operations. Recoat material will be specified by program and could include topcoats, touch-up materials, adhesives, and sealants.

Test Methodology

Parameters	Coated panels
Type and Number of Panels	Al 3/2
Trials Per Panel	3
Acceptance Criteria	No lifting

3.1.4. Solvent Rub (MEK) Test

Test Description

This test method determines the effect of MEK on a coated panel. A test panel is allowed to cure according to manufacturers specifications. Cheese cloth is then saturated with MEK. The cheese cloth is then double rubbed 50 times. The panel is then examined to determine if the coating has been worn through exposing the substrate.

Test Methodology

Parameters	MEK saturated cheese cloth, 50 double rubs
Type and Number of Panels	Al 3/2
Trials Per Panel	3
Acceptance Criteria	No substrate show through

3.1.5. GE Impact Test

Test Description

This test method covers the procedure for rapidly deforming a coating and its substrate by the impact of a weighted ball. A coated panel is placed coated side down in the testing apparatus. A GE impact indentor is dropped from a measured height such that the full impression of the indentor is obtained. The full impression of the indentor must be made in the panel in order for the test to be valid. The panel is then inspected for cracks where the impact occurred. Low temperature flexibility is determined by use of a conical mandrel. A coated panel is placed over a pre-specified diameter conical mandrel and bent. The panel is then inspected for adhesion loss.

Test Methodology

Parameters	Indirect at room temperature
Type and Number of Panels	Al 1/3
Trials Per Panel	1
Acceptance Criteria	10% elongation, no cracks

Unique Equipment and Instrumentation

- Paul N. Gardner Impact Tester or equivalent

3.1.6. Sulfur Dioxide (SO_2) Salt Spray Test

Test Description

A test item is subjected to 5% salt solution with one hour SO_2 at four hour intervals. The cycles are repeated until failure or 500 hours.

Test Methodology

Parameters	5% salt with 1 hr SO_2 at 4 hour intervals
Type and Number of Panels	Al 3/5 Al 5/5 SS/5
Trials Per Panels	1
Acceptance Criteria	>/= 500 hours

3.1.7. Infrared Reflectance Test

Test Description

A Perkin-Elmer Lambda 9 or equivalent spectrophotometer is calibrated with a barium sulfate standard. The sample is then tested to determine if the spectral properties are within the wavelengths specified for the designated color.

Test Methodology

Parameters	Lambda 9 Spectrophotometer or equivalent with barium sulfate
Type and Number of Panels	Al 3/2
Trials Per Panel	1
Acceptance Criteria	600-2700 = 10

Data Analysis

- Total reflectance will be reported relative to barium sulfate

3.1.8. Filiform Corrosion Test

Test Description

Coated test panels will be scribed with an "x" so that the substrate is exposed. The panels will then be placed vertically in a dessicator containing 12 N hydrochloric acid for one hour. The panels will be placed within 5 minutes in a humidity cabinet maintained at 104° +/-3° F, and 80% +/- 5% humidity for 1,000 hours.

Test Methodology

Parameters	12 N HCl for 1 hour, 104° F, 80% humidity for 1,000 hours
Type and Number of Panels	Al 3/3
Trials Per Panel	1
Acceptance Criteria	All filaments </= 1/4" Majority < 1/8" filaments

3.1.9. Fluid Immersion Tests (Hydraulic Fluid, Lubricating Oil, Deionized (DI) Water)

Test Description

This test method covers the determination of the effects of certain fluids on organic finishes resulting in any objectionable alteration in the surface such as discoloration, change in gloss, blistering, softening, swelling, loss of adhesion, or other special conditions. Test panels will be separately immersed for the specified period of time in aircraft turbine engine lubricating oil such as Mobil Jet Oil or equivalent and in fire-resistant hydraulic fluid such as Shell Aeroshell or equivalent. Other fluids may be substituted based on program requirements. Four hours after removal the panels will be examined for blistering, softening, dark staining, or other film defects.

Test Methodology

	Hydraulic Fluid	**Lubricating Oil**	**DI Water**
Parameters	24 hour immersion, 150° F+/- 5° F	24 hour immersion, 250° F +/- 5° F	4 days immersion, 120° F +/-5° F
Type and Number of Panels	Al 3/6	Al 1/6	Al 3/3
Trials Per Panel	1	1	1
Acceptance Criteria	No blisters, dark stains or softening	No blisters, dark stains or softening	No blisters, dark stains or softening

3.2. Topcoat Application Tests

3.2.1. Gloss Tests (High, Semi, Low, and Very Low)

Test Description

This test covers the measurement of the specular gloss of nonmetallic specimens for glossmeter geometries of 60°. A glossmeter capable reading at 60° is calibrated using a National Institute of Standards and Technology (NIST) traceable standard. The instrument is then placed on the sample. A reading is taken on three different places on the sample and an average is given. One batch or ten samples will be analyzed. Calibration is then rechecked, if it does not verify, that the instrument is recalibrated and the samples are done over. For high gloss paints the acceptance criteria is greater than or equal to 90. For semi-gloss paints the acceptance criteria is 15 to 45. For low gloss paint the acceptance criteria is less than or equal to 5.

Test Methodology

	Gloss - High	**Gloss - Semi**	**Gloss - Low**	**Gloss - Very Low**
Parameters				
Type and Number of Panels	Al 3/1	Al 3/1	Al 3/1	Al 3/1
Trials Per Panel	3	3	3	3
Acceptance Criteria	>/= 90	15 - 45	</= 5	</= 1

3.2.2. Wet Tape Adhesion Test

Test Description

This test method covers a procedure for establishing acceptability of intercoat and surface adhesion of an organic coating immersed in water by applying pressure sensitive taped over a scribed area of the coating. A coated specimen is soaked in distilled water for 24 hours. An “x” is scribed into the specimen so that the smaller angle is about 35° to 45°, making sure the coating has been scribed all the way to the substrate. A piece of tape is placed over the incision and smoothed out. The tape is then removed rapidly at a 180° angle. The incision area is inspected for peel away. Acceptable criteria is no peel away.

Test Methodology

Parameters	24 hours distilled water
Type and Number of Panels	Al 3/3
Trials Per Panel	1
Acceptance Criteria	No peel away

Unique Equipment and Instrumentation

- 1” masking tape code 250 or equivalent
- 4.5 lb roller

3.2.3. Solvent (MEK) Rub Test

Test Description

This test method determines the effect of MEK on a coated panel. A test panel is allowed to cure according to manufacturers specifications. Cheese cloth is then saturated with MEK. The cheese cloth is then double rubbed 50 times. The panel is then examined to determine if the coating has been worn through exposing the substrate.

Test Methodology

Parameters	MEK saturated cheese cloth, 50 double rubs
Type and Number of Panels	Al 3/2
Trials Per Panel	3
Acceptance Criteria	No substrate show through

3.2.4. Hiding Power Test

Test Description

This test method covers the determination of the hiding power of air dry coatings with Y tristimulus values greater than 15%. Cardboard Leneta charts, or equivalent, will be coated with the test material. For powder coatings, enamel-coated metal charts are available for hiding power tests from Leneta.

Test Methodology

Parameters	Daylight
Type and Number of Panels	Charts
Trials Per Panel	3
Acceptance Criteria	>= 0.95

Data Analysis

- Report Hiding power as calculated from Leneta chart

3.2.5. Humidity Test

Test Description

This test method covers the procedure for exposing organically coated films to a moisture-saturated atmosphere at a controlled temperature and with a continuous condensation on the test film. Coated specimens are placed at a 15° angle in an enclosed chamber at 100% humidity and 120° F. Droplets of condensation should be visible on the specimens at all times. At the end of the exposure period, the panels are wiped dry and rated for changes in color, blistering, etc. The panels are rated from 5 to 10 minutes after being out of the chamber. The panels may also be rated again after 24 hours (especially for changes in gloss and color). Acceptable criteria is not effect after 30 days exposure.

Test Methodology

Parameters	30 days, 100% humidity, 120° F
Type and Number of Panels	Al 3/3
Trials Per Panel	1
Acceptance Criteria	No softening or blistering

3.2.6. Heat Resistance Test

Test Description

This test method covers the procedure for determining the resistance to heat of certain organic materials.

Test Methodology

Parameters	250° F oven for 1 hour
Type and Number of Panels	Al 1/3
Trials Per Panel	1
Acceptance Criteria	Color change ΔE <= 1

Unique Equipment and Instrumentation

- Thermolyne Muffle Furnace or equivalent
- Digital Colorimeter

3.2.7. Accelerated Weather Test

Test Description

This test method covers the ability of a coated sample to withstand accelerated weathering in a weatherometer chamber. The samples will be checked for a color and/or gloss difference.

Test Methodology

	Common	**Extended**
Parameters	0.35 Watts/m^2 Incident for 500 hours	0.35 Watts/m^2 Incident for 500 hours
Type and Number of Panels	Al 1/3	Al 1/3
Trials Per Panel	1	1
Acceptance Criteria	Color change <= 2ΔE	Color change <= 1ΔE

Unique Equipment and Instrumentation

- Xenon Arc Weatherometer

Data Analysis

- Results will be reported as visual inspections, color differences, and gloss changes

3.2.8. Tape Resistance Test

Test Description

This test uses standard masking tape (not type 250) applied to the coating film to determine if it will affect the coating's adhesion in any way during masking and subsequent painting or stenciling operations.

Test Methodology

Parameters	4.5 lb roller, #250 tape, 1 hour tape contact
Type and Number of Panels	Al 3/1
Trials Per Panel	3
Acceptance Criteria	No marring

Unique Equipment and Instrumentation

- 4.5 lb roller
- Standard masking tape

3.2.9. Color Test

Test Description

This test method covers the visual determination of color matching based on daylight illumination of painted panels. Panels coated with the test material are visually compared with panels of standard colors.

Test Methodology

Parameters	Color compared to a standard
Type and Number of Panels	Al 3/1
Trials Per Panel	1
Acceptance Criteria	Visual Match

3.2.10. Fluid Immersion Tests (Hydraulic Fluid, Lubricating Oil)

Test Description

This test method covers the determination of the effects of certain fluids on organic finishes resulting in any objectionable alteration in the surface such as discoloration, change in gloss, blistering, softening, swelling, loss of adhesion, or other special conditions. Test panels shall be separately

immersed for 24 hours in aircraft turbine engine lubricating oil such as Mobil Jet Oil or equivalent and in fire-resistant hydraulic fluid such as Shell Aeroshell or equivalent. Other fluids may be substituted based on program requirements. Four hours after removal the panels will be examined for blistering, softening, dark staining, or other film defects.

Test Methodology

	Hydraulic Fluid	Lubricating Oil
Parameters	24 hour immersion, 150° F +/- 5° F	24 hour immersion, 250° F +/- 5° F
Type and Number of Panels	Al 3/6	Al 1/6
Trials Per Panel	1	1
Acceptance Criteria	No blisters, dark stains or softening	No blisters, dark stains, or softening

3.2.11. Infrared Reflectance Test

Test Description

A Perkin-Elmer Lambda 9 or equivalent spectrophotometer is calibrated with a barium sulfate standard. The sample is then tested to determine if the spectral properties are within the wavelengths specified for the designated color.

Test Methodology

Parameters	Lambda 9 Spectrophotometer or equivalent with barium sulfate
Type and Number of Panels	Al 3/2
Trials Per Panel	1
Acceptance Criteria	600-2,700 = 8

Data Analysis

- Total reflectance will be reported relative to barium sulfate

3.2.12. DS_2 Decontaminant Resistance Test

Test Description

A steel panel is baked for one day at 105°. The panel is then allowed to return to room temperature. Two spots (approximately 0.5 ml) of DS_2 are placed on the panel. The sample is left to stand for 30 minutes uncovered, then is thoroughly washed with water. The specimen shall show no blistering, wrinkles, or softening.

Test Methodology

Parameters	2 drops DS_2, 30 minutes
Type and Number of Panels	ST/3
Trials Per Panel	1
Acceptance Criteria	No blistering, wrinkling, softening

3.2.13. Chemical Agent Resistance Tests (Agent HD, Agent GD, Agent VX)

Test Description

A five square centimeter area is marked in the center of the test panel and placed in a fume hood. The area is completely contaminated dropwise with a syringe. The area is kept wet for 30 minutes then cleaned with isopropyl alcohol. A stainless steel permeation cell is placed over the contaminated area and sampled through the bubbler. Agent vapor are picked up in the diethyl phthalate in the bubbler. Sampling is continuos for 24 hours. The diethyl phthalate is then tested for presence of agent by an appropriate gas chromatography method.

Test Methodology

	Agent HD	**Agent GD**	**Agent VX**
Parameters	Bubbler apparatus, 25° C	Bubbler apparatus, 25° C	
Type and Number of Panels	ST/3	ST/3	ST/3
Trials Per Panel	1	1	1
Acceptance Criteria	180 micrograms maximum	40 micrograms maximum	As required by program

Unique Equipment and Instrumentation

- Bubbler apparatus
- Gas Chromatograph

Data Analysis

- Report out agent recovered in micrograms

3.2.14. Temperature Shock Test

Test Description

This is a test method for determining the effects of extreme temperatures on test items. Temperature range is defined as +85° C to -62° C with extended requirements up to +95°.

Test Methodology

	Standard	Optional
Parameters	+85° C to -62° C	+95° C to -62° C
Type and Number of Panels	Al 3/1 SS/1 ST/1 T/1	Al 3/1 SS/1 ST/1 T/1
Trials Per Panel	1	1
Acceptance Criteria	No loss of adhesion	No loss of adhesion

Unique Equipment and Instrumentation

- Environmental chamber capable of maintaining -62° C
- Environmental chamber capable of maintaining +85° C, +95° C

Data Analysis

- Report visual examination and loss of adhesion after testing period

3.2.15. Fungus Test

Test Description

A test specimen is inoculated with at least five different types of fungi and incubated for at least 28 days in an environmental chamber capable of maintaining a viable environment for the fungi.

Test Methodology

Parameters	5 types of fungi/28 days
Type and Number of Panels	Al 3/1 SS/1 ST/1 T/1
Trials Per Panel	1
Acceptance Criteria	No loss of adhesion

Unique Equipment and Instrumentation

- Environmental chamber capable of maintaining 95% +/- 5% humidity and temperature of 30° +/- 1° C

Data Analysis

- The report shall include the test item identification, the presence/absence of fungal growth at a seven day check and at the end of the test, the location of the fungi, a narrative description of growth, and the length of the test period. A determination of the effect of fungi on performance shall also be included.

3.2.16. High Temperature Test

Test Description

This test method determines the effect of extreme heat on a test specimen.

Test Methodology

	Standard	Optional
Parameters	+85° C	+95° C
Type of Number Per Panels	Al 3/1 SS/1 ST/1 T/1	Al 3/1 SS/1 ST/1 T/1
Trials Per Panels	1	1
Acceptance Criteria	No loss of adhesion	No loss of adhesion

Unique Equipment and Instrumentation

- Environmental chamber capable of maintaining 85° C and controlling humidity if necessary

Data Analysis

- Report visual examinations and loss of adhesion after specified testing period

3.2.17. Low Temperature Test

Test Description

Adjust the environmental chamber to the temperature and humidity desired. Expose the test item to -62° C temperature for at lest three cycles. Conduct a visual examination.

Test Methodology

Parameters	-62° C
Type and Number of Panels	Al 3/1 SS/1 ST/1 T/1
Trials Per Panel	1
Acceptance Criteria	No loss of adhesion

Unique Equipment and Instrumentation

- Environmental chamber capable maintaining -62° C temperature

3.2.18. Rain Test

Test Description

For a blowing rain test, the finished product/item is exposed to rain produced by a water distribution device so that the water emitted in the form of droplets will have a diameter range of 0.5 to 4.5 millimeters. The rain is dispersed completely over the test item by wind velocity equal to and exceeding 18 m/s. After the rainfall rate is adjusted and the velocity set, the test item remains in the chamber for 30 minutes. The finished product/item is rotated and the test performed over again until all variations have taken place.

Test Methodology

Parameters	0.5 – 4.5 mm; 18 m/sec wind
Type and Number of Panels	Al 3/1 SS/1 ST/1 T/1
Trials Per Panel	1
Acceptance Criteria	No loss of adhesion

Unique Equipment and Instrumentation

- Environmental chamber capable of producing rain and wind

Data Analysis

- Visual examination of any corrosion or loss of adhesion

3.2.19. Salt Fog (Cyclical) Test

Test Description

This test method exposes a test item to a corrosive environment (5% NaCl, 35° C) for 24 hours, then a dry cycle for 24 hours. The cycling is repeated until test duration is over.

Test Methodology

Parameters	35° C/5% salt/cycling periods 24 hours wet/dry
Type and Number of Panels	Al 3/1 SS/1 ST/1 T/1
Trials Per Panel	1
Acceptance Criteria	No loss of adhesion

Unique Equipment and Instrumentation

- Salt Spray Chamber

3.2.20. Humidity (Water Soak) Test

Test Description

With the test item in the chamber, adjust the chamber conditions to be 31° C and 88% humidity. Perform a 24 hour cycle with the time-temperature-humidity values in the appropriate cycle. Perform a check during a convenient time during the 24 hour period. Operational checkouts will be performed at least once every five cycles. After all the cycles are completed, adjust the chamber to ambient conditions and maintain at least 24 hours. At the end of the 24 hour wait, conduct a visual examination of the test item(s).

Test Methodology

Parameters	31° C, 88% RH/ambient
Type and Number of Panels	Al 3/1 SS/1 ST/1 T/1
Trials Per Panel	1
Acceptance Criteria	No loss of adhesion

Unique Equipment and Instrumentation

- Humidity cabinet

Data Analysis

- Report procedure used, results of visual examinations, operational check outs, exposure durations, time versus temperature and humidity.

3.2.21. Specialized Wet Tape Adhesion Test

Test Description

This test method covers a procedure for establishing acceptability of intercoat and surface adhesion of an organic coating immersed in water by applying pressure sensitive tape over a scribed area of the coating. A coated specimen is soaked in distilled water. An "x" is scribed into the specimen so that the smaller angle is about 35° to 45°, making sure the coating has been scribed all the way to the substrate. A piece of tape is placed over the incision and smoothed out. The tape is then removed rapidly at a 180° angle. The incision area is inspected for peel away. Acceptable criteria is no peel away.

Test Methodology

Parameters	24 hours at 23° C; 96 hours at 49° C; 168 hours at 65° C
Type and Number of Panels	Al 3/9 (3 each)
Trials Per Panel	1
Acceptance Criteria	5 – 15% lattice removal

3.2.22. Recoatability Test

Test Description

Panels coated with the test material will be recoated with material to test compatibility with field operations. Recoat material will be specified by program and could include topcoats, touch-up materials, adhesives, and sealants.

Test Methodology

Parameters	Coated panels
Type and Number of Panels	Al 3/2
Trials Per Panel	3
Acceptance Criteria	No lifting

3.2.23. Specialized Fluid Resistance Tests (Hydrocarbon, Skydrol, JP4, JP6, JP8, RJ4, JP10)

Test Description

This test method covers the determination of the effects of certain fluids on organic finishes resulting in any objectionable alteration in the surface such as discoloration, change in gloss, blistering, softening, swelling, loss of adhesion, or other special conditions. Test panels will be separately immersed for seven days. Four hours after removal the panels will be examined for blistering, softening, dark staining, or other film defects.

Test Methodology

Parameters	Hydrocarbon, Skydrol, JP4, JP6, JP8, JP10, RJ4
Type and Number of Panels	Al 3/15
Trials Per Panel	1
Acceptance Criteria	No blisters, dark stains or softening

3.2.24. Flexibility Tests (Impact, Low Temperature)

Test Description

IMPACT:

This test method covers the procedure for rapidly deforming a coating and its substrate by the impact of a weighted ball. A coated panel is placed coating side up (direct) or coated side down (reverse) in the testing apparatus. A two pound weight with either a 0.625 inch diameter indentor is dropped from a measured height. The panel is then inspected for cracks where the impact occurred.

LOW TEMPERATURE:

Low temperature flexibility is determined by use of a conical mandrel. A coated panel is placed over a prespecified diameter conical mandrel and bent. The panel is then inspected for adhesion loss.

Test Methodology

	Impact	Low Temperature
Parameters	At 60 inch pounds	At -60° F High and semi at 1” Low at 2”
Type and Number of Panels	Al 1/3	Al 2/3
Trials Per Panel	1	1
Acceptance Criteria	No adhesion loss	No adhesion loss

Unique Equipment and Instrumentation

- Paul N. Gardner Impact Tester or equivalent

4.0. REFERENCE DOCUMENTS

The following documents in Table 4 were referenced in the development of the JTP.

Table 4. Reference Documents

Document	Name	Section	Date
MIL-C-22750	Coating, Epoxy, High-Solids	All	1994
MIL-C-46168	Coating, Aliphatic Polyurethane, Chemical Agent Resistant	All	1993
MIL-C-81706	Chemical Conversion Materials for Coating Aluminum and Aluminum Alloys	Class 1A	1979
MIL-C-83286B	Coating, Polyurethane	All	1995
MIL-P-8514	Wash Primer		
MIL-P-85582	Primer Coating: Epoxy, Waterborne	All	1994
MIL-C-85285	Coating, Polyurethane, High-Solids	All	1990
MIL-L-23699	Lubricating Oil, Aircraft	All	1994
MIL-H-6875	Heat Treatment of Steel Process	Class D, 17-4PH, H1150	1993
MIL-H-83282	Hydraulic Fluid, Fire-Resistant, Aircraft	All	1986
MIL-P-23377	Primer Coating: Epoxy, High-Solids	All	1994
MIL-T-81772	Thinner, Aircraft Coatings	Types I and II	1991
MIL-C-53072	Chemical Agent Resistant Coating (CARC), Systems Application Procedures	All	1992
MIL-R-81294	Remover, Paint, Epoxy, Polysulfide, Polyurethane Systems	Type 1, Class 1	1990
ASTM D-2794	Rapid Deformation (Impact)	All	1992
ASTM B-117	Salt Spray (Fog) Testing	All	1990
ASTM D-522	Low Temperature Flexibility	All	1992
ASTM D-523	Gloss Test	All	1989
ASTM D-2803	Filiform Corrosion Test	All	1993
ASTM D-1308	Fluid Immersion Test	All	1993
ASTM D-2247	Humidity Test	All	1994
ASTM D-3359	Tape Adhesion	All	1992
ASTM D-2805	Hiding Power Test	All	1988
ASTM G-26	Accelerated Weathering Test	All	1990
ASTM G-85.A4	SO2 Salt Spray	All	1990

Table 4. Reference Documents (continued)

Document	Name	Section	Date
FED-STD-141	Wet Tape Test	Method 6301.2	1986
FED-STD-141	Humidity Test	Method 6201	1986
FED-STD-141	Heat Resistance Test	Method 6051	1986
FED-STD-141	Color Test	Method 4250.1	1986
FED-STD-141	Gloss Test	Method 6101.1	1986
FED-STD-141	Infrared Reflectance from Spectrophotometric Data	Method 6241.1	1986
FED-STD-141	Infrared Reflectance from Reflectometer	Method 6242.1	1986
FED-STD-141	Knife Test	Method 6304.1	1986
FED-STD-141	Preparation of Aluminum Alloy Panels	Method 2013.1	1986
FED-STD-595B	Color Standards	All	1989
MIL-STD-810	High Temperature Test	M501	1989
MIL-STD-810	Low Temperature Test	M502	1989
MIL-STD-810	Temperature Shock	M503	1989
MIL-STD-810	Rain Test	M506	1989
MIL-STD-810	Humidity Test	M507	1989
MIL-STD-810	Fungus Test	M508	1989
MIL-STD-810	Salt Fog Test	M509	1989
TT-C-490	Pretreatments for Organic Coatings	Type I	1994
QQ-A-225	Aluminum and Aluminum Alloy Bar, Rod, Wire, or Special Shapes: Rolled, Drawn, or Cold Finished: General Specification	225/9	1990
QQ-A-250	Aluminum and Aluminum Alloy Plate and Sheet: General Specification	250/5	1978
QQ-P-35	Passiviation Treatments for Corrosion-Resistant Steel	All	1988
JTR	Joint Test Report for Alternatives to High-VOC Primers and Topcoats	All	1996