NOT MEASUREMENT SENSITIVE

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George C. Marshall Space Flight Center
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EM30

MULTIPROGRAM/PROJECT COMMON-USE DOCUMENT
OR PROGRAM/PROJECT NAME

GUIDELINES FOR EVALUATION OF CORROSION INHIBITING PRESERVATIVES

Materials and Processes Laboratory
Metals Engineering Branch

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DOCUMENT HISTORY LOG

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FOREWORD

MSFC-SPEC-1870 sets forth the criteria to be used in the evaluation of corrosion inhibiting preservatives for space vehicles, associated equipment, and facilities. It presents the test methods, environments, examination procedures, and pass/fail criteria.

Request for information, corrections, or additions to this document shall be directed to The Materials and Processes Laboratory, Metals Engineering Branch, EM30, Marshall Space Flight Center, Huntsville, Al 35812.

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1 SCOPE

1.1 Purpose

This document sets forth the criteria to be used in the evaluation of corrosion inhibiting preservatives for space vehicles, associated equipment, and facilities.

1.2 Applicability

This specification describes the requirements for evaluation of corrosion inhibiting preservatives for use on space vehicles, structural components, and associated flight equipment. Unless otherwise specifically referred to in the end item specification, this specification does not apply to Government furnished items.

2 APPLICABLE DOCUMENTS

The following documents, of the issue in effect on the date of invitation for bids, form a part of this specification to the extent specified herein.

2.1 Government Documents

MSFC-SPEC-250, Protective Finishes for Space Vehicle Structures and Associated Flight Equipment

TT-C-490, Chemical Conversion Coatings and Pretreatments for Ferrous Surfaces (Base for Organic Coatings)

Federal-STD-791, Lubricants, Liquid Fuels, and Related Products: Methods of Testing

MIL-PRF-16173, Corrosion Preventative Compound, Solvent Cutback, Cold Application

DOD-L-25681, Lubricant, Molybdenum Disulfide, Silicone

MIL-C-81302, Cleaning, Compound Solvent Trichlorotrifluoroethane

MIL-STD-810, Environmental Test Methods and Engineering Guidelines

2.2 American Society for Testing and Materials (ASTM) Documents

ASTM-G1, Preparing, Cleaning, and Evaluating Corrosion

ASTM-G46, Examination and Evaluation of Pitting Corrosion

ASTM-G44, Alternate Immersion Stress Corrosion Testing in 3.5% Sodium Chloride Solution

ASTM-B117, Salt Spray (Fog) Testing

ASTM-D1193, Specification for Reagent Water

ASTM-D1748, Method of Test for Rust Protection by Metal Preservatives in Humidity Cabinet

ASTM-G50, Conducting Atmospheric Corrosion Tests on Metals

2.3 Order of Precedence

In case of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. The content of this document, however, does not supersede applicable laws and regulations unless a specific exemption has been obtained. The latest issue in effect of this document shall be used.

3 DEFINITIONS

3.1 Corrosion Inhibiting Preservatives

Temporary applied nonmetallic coatings other than chemical conversion or paint. They are used to protect bare metal surfaces from the corrosive effects of an aggressive environment.

4 REQUIREMENTS

4.1 Material Usage Agreement

This document does not purport to be all inclusive of factors and criteria necessary for the total control of corrosion by inhibiting preservatives. It is recognized that for many applications involving corrosion inhibiting preservatives, unusual combinations of exposure periods and environments during in process flow are experienced. To ensure adequate testing at minimal cost, it will be necessary to conduct a detail evaluation when these situations occur. The proposed test environment must be submitted to Marshall Space Flight Center (MSFC) for review, and MSFC approval will be required before the test environment can be used or incorporated in a design under the circumstances in question. The medium for submittal will be the Material Usage Agreement (MUA), which is described in MSFC-Form-551. In addition, all materials applications other than those explicitly approved according to the criteria set forth in this document will be predicated on MSFC approval of an MUA submitted either by a prime contractor or by a subcontractor through the prime. The MUA will contain information deemed necessary for the accurate assessment of the proposed test environment. Appendix A shows an MUA form tailored for corrosion inhibiting preservative materials. Detailed information to be submitted is presented in Appendix B.

4.2 Classification of Corrosion Inhibiting Preservatives

Levels of corrosion inhibiting preservatives shall be as follows. The contract or the detail finishing specification or both shall identify the applicable class (or classes) of protection.

Class I – Used for protection against severely corrosive environments such as exposure to seawater.

Class IIA – Used for protection against moderately corrosive environments such as extended exposure to seacoast.

Class IIB – Used for protection against moderately corrosive environments such as extended industrial exposure.

Class III – Used for protection against mildly corrosive environments such as inland and non-industrial environments.

4.3 Classification of Test Methods

Levels of testing shall be in accordance with the following methods.

Method I – Outdoor Exposure (seacoast or industrial)

Method II – Salt Spray Exposure

Method III – Alternate Immersion Exposure

Method IV – Humidity Exposure

Method V – Simulated Industrial Exposure

4.4 Test Methods for Each Class Environment

Test methods for a given class environment shall be in accordance with the following requirements.

Class I Environment – Requires methods I, II, and III

Class IIA Environment – Requires methods I, II, IV, and optional III.

Class IIB Environment – Requires methods I, IV, and optional V.

Class III Environment – Requires method IV.

4.5 Material

All material used shall be as specified herein, on the drawings, or of a quality consistent with good commercial practice.

4.6 Test Panels

Test panels shall be prepared from stock material purchased to the same procurement specification as the actual service hardware. Test panels shall not be less than 4 in by 6 in by 1/16 in in size and need not be identical. Test panels shall be stamped, etched, or otherwise indelibly marked for identification as a test panel. Test panels shall be handled using clean surgical gloves at all times.

4.7 Surface Preparation

Surface preparation of test panels shall be in accordance with Federal Specification TT-C-490 (latest revision). All test panels shall have a commercial surface, closely resembling the one to be used in service.

4.8 Application of Preservative

A uniform film of preservative shall be applied to one half of each prepared surface. Each variety of preservative shall be applied in the same manner, and to the same thickness. Coating thickness shall be indicative of that used on actual hardware.

Note 4-1: During preservative application, the contractor may exercise the option of using fully coated panels with representative uncoated panels.

4.9 Test Panel Holders

Panel holders shall be designed to electrically insulate the specimens from each other and from any other bare metal. When this is not possible, the bare metal contacting the panel shall be isolated from the corrodent by a suitable coating. Protective coatings shall be of a type that will not leach inhibiting or accelerating ions or protective oils over the uncoated portions of the panels. Coatings containing chromates are to be particularly avoided. The shape and form of panel supports and holders shall be such that:

a. Drainage from one panel does not directly contact any other panel.

b. They do not retain a pool of solution in contact with the panel after the immersion period (applicable in test method III alternate immersion only).

c. They do not obstruct air flow over the panel, thereby retarding the drying process (applicable in test method III alternate immersion only).

4.10 Safety

All hazardous materials and processes required in compliance with provisions of this specification are subject to applicable federal, state, and local safety codes, standards, and regulations. Appropriate personnel protection shall be used in all hazardous processes.

5 QUALITY ASSURANCE PROVISIONS

5.1 Responsibility for Inspections

Unless otherwise specified in the contract, the contractor is responsible for the performance of all testing and inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other NASA approved facilities suitable for the performance of the testing and inspection requirements specified herein. NASA reserves the

right to perform any test and inspection set forth in the document as deemed necessary to assure conformance to prescribed requirements.

6 TEST METHODS

Testing shall be conducted as required in this document. A quick reference chart of these methods is presented in Appendix C.

6.1 Method I – Outdoor Environmental Exposure

6.1.1 Summary of Practice

Test panels shall be exposed to outdoor environmental conditions for the specified time period. Both coastal and industrial effects shall be evaluated. The following sections set forth the conditions for outdoor environmental exposure testing (See ASTM-G50, entitled, "Standard Practice for Conducting Atmospheric Corrosion Tests on Metals").

6.1.2 Test Sites

Test sites shall be locations representative of natural seawater environments, and natural industrial environments where the metal or alloy to be tested may be used. Ideally, a natural seawater test site should have clean, uncontaminated seawater, and be in a protected location. Test site shall be approximately 100 to 200 feet from the ocean. Industrial sites shall be located in an area free of dirt and debris, and protected from unauthorized personnel. Reference shall be made to tropical versus other conditions, and seasonal variations in temperature.

6.1.3 Construction of Exposure Racks

Test racks shall be constructed of a material that will remain intact for the entire proposed period of exposure. Monel nickel copper alloy 400 has been found to be an excellent material, but it is not recommended for holding aluminum panels. Coated aluminum racks (6061-T6 or 5086-H32) also have given satisfactory service when used with strip insulators (such as polyethylene) and nylon bolts and nuts to mount panels. Coatings shall be of a type that will not leach inhibiting or accelerating ions, or protective oils over the uncoated portions of the panels. Non-metallic racks made from reinforced plastic or treated wood may also be used.

6.1.4 Spacing of Panels

Spacing of the mounted panels can be important. It is desirable to have sufficient space between surfaces of test panels to ensure that with long exposures, any accumulated fouling will not block off the surface to the presence of the given environment.

6.1.5 Orientation of Panels

Exposure racks should be suspended so that attached panels will be oriented 30 degrees to the vertical and subjected to the full effects of the environment, but free of galvanic contact with other panels and with minimal sedimentation of silt and debris on the panel. Test panels shall face the source of contamination such as the ocean in seacoast environment, and the industrial source in the industrial environment. Racks may be suspended by such materials as nylon, polyester, or polypropylene rope, depending on prevailing conditions. Steel wire rope should be avoided.

6.1.6 Test Duration

Outdoor environmental tests shall be run for a minimum period of six months, and a maximum period of 24 months. Periodic observations (biweekly) shall be conducted and corrosive attack of each panel documented.

6.2 Method II – Salt Fog Exposure

6.2.1 Summary of Practice

The salt spray test subjects test panels to a 5-percent salt fog environment at 35 degrees C (95 degrees F), for the specified time period. The following sections set forth the conditions required for salt spray testing.

6.2.2 Salt Spray Apparatus

The apparatus required for salt spray (fog) testing consists of a fog chamber, a salt solution reservoir, a supply of suitably conditioned compressed air, one or more atomizing nozzles, specimen supports, a provision for heating the chamber, and necessary means of control. The size and detailed construction of the apparatus are optional, provided the conditions obtained meet the requirements of this method (See MIL-STD-810, latest revision, section entitled “Salt Fog Apparatus”, or ASTM-B117).

6.2.3 Orientation of Panels in the Salt Spray Chamber

The position of the panels in the salt spray chamber during the test shall be such that the following conditions are met:

a. Unless otherwise specified, the panels shall be supported or suspended between 15 and 30 degrees from the vertical, and preferably parallel to the principal direction of horizontal flow of fog through the chamber, based upon the dominant surface being tested.

b. The panels shall not contact each other or any metallic material capable of acting as a wick.

c. Each panel shall be positioned to permit free settling of fog on all panels.

d. Salt solution from one panel shall not drip on any other panel.

6.2.4 Preparation of Salt Solution

The salt solution referred to in the salt fog test shall meet the requirements of ASTM-B117. This solution shall be prepared by dissolving 5 +/- 1 parts by weight of sodium chloride (NaCl) in 95 parts of water conforming to Type IV of ASTM-D1193. The salt used shall be sodium chloride substantially free of nickel and copper, and containing on the dry basis, not more than 0.1 percent of sodium iodide and not more than 0.3 percent of total impurities. Some salts contain additives that may act as corrosion inhibitors, therefore, careful attention should be given to the chemical content of the salt. Upon agreement between purchaser and seller, analysis may be required, and limits established for elements or compounds not specified in the chemical composition given above.

6.2.5 pH of Collected Solution

The pH of the salt solution shall be such that when atomized at 35 degrees C (95 degrees F), the collected solution will be in the pH range of 6.4 to 7.2. Before the solution is atomized, it shall be free of suspended solids. The pH measurement shall be made by one of the following techniques:

a. Electrochemically at 25 degrees C (77 degrees F) using a glass electrode with a saturated potassium chloride bridge

b. Calorimetrically using bromthymol blue as indicator

c. Short range pH paper which reads in 0.2 or 0.3 of a pH unit

6.2.6 Air Supply

The compressed air supply to the nozzle or nozzles for atomizing the salt solution shall be free of oil and dirt, and maintained between 69 and 172 KN/m^2 (10 and 25 psi).

6.2.7 Temperature Inside the Salt Spray Chamber

The exposure zone of the salt spray chamber shall be maintained at 35 +/- 2 degrees C (95 +/-5 degrees F).

6.2.8 Nozzles

The nozzle or nozzles shall be so directed or baffled that none of the spray can impinge directly on the test specimens.

6.2.9 Continuity of Test

Unless otherwise specified in the specification covering the material or product being tested, the test shall be continuous for the duration of the entire test period. Continuous operation implies that the chamber be closed and the spray operating continuously except for the short interruptions necessary to inspect, rearrange, or remove test panels, and to make necessary recordings. Operations shall be so scheduled that these interruptions are held to a minimum.

6.2.10 Test Duration

a. For Class I Environment test panels shall be exposed for 30 days.

b. For Class II Environment test panels shall be exposed for seven days.

6.3 Method III – Alternate Immersion

6.3.1 Summary of Practice

The alternate immersion test per ASTM-G44 utilizes a one-hour cycle that includes a 10-minute period in an aqueous solution of 3.5-percent sodium chloride, followed by a 50-minute period out of the solution, during which the panels are allowed to dry. This one-hour cycle is continued 24 hours per day for the total numbers of days specified. The following sections set forth the conditions required for alternate immersion testing.

6.3.2 Alternate Immersion Apparatus

The apparatus used in the alternate immersion test meets the requirements of ASTM-G44. Any suitable mechanism may be used to accomplish the immersion portion of the cycle, provided that:

a. It achieves the specified rate of immersion and removal, and

b. The apparatus is constructed of suitable inert materials

6.3.3 Methods of Immersion

The usual methods of cycling immersion are:

a. Movable Rack – The panels are placed on a movable rack that is periodically lowered into a stationary tank containing the solution.

b. Hexagonal Ferris Wheel – The panels are placed on a hexagonal Ferris wheel arrangement which rotates 60 degrees every 10 minutes, thereby passing the panels through a stationary tank of solution. (The use of a Ferris wheel continuously rotating at a rate of one revolution per hour is not recommended for very large panels for which the rate of immersion would be slower than that specified.)

6.3.4 Rate of Immersion

The rate of immersion and removal of the panels from the solution should be as rapid as possible without jarring them. No more than two minutes shall elapse from the time the first portion of any panel is covered (or uncovered) until it is fully covered (or uncovered) by solution.

6.3.5 Reagents

Reagent grade sodium chloride shall be used conforming to the following requirements: Free of nickel and copper, and containing, an a dry basis, not more than 0.1 percent of sodium iodide, and not more than 0.3 percent total impurities.

6.3.6 Solution Condition

The salt solution used in the alternate immersion test shall meet the requirements of ASTM-G44. The salt solution shall be prepared by dissolving 3.5 +/- 0.1 parts by weight of sodium chloride in 96.5 parts of water. The solution shall be prepared using distilled or deionized water conforming to the purity requirements of ASTM-D1193 Type IV reagent water. The pH of the salt solution, when freshly prepared, shall be within the range from 6.4 to 7.2. Only diluted reagent grade hydrochloric acid (HCl), or reagent grade sodium hydroxide (NaOH) solution shall be used to adjust the pH. For a new testing facility, it is recommended that daily pH measurements be made for one week to verify stable operation and adjustments made if required. If the solution is used longer than the recommended interval, a pH measurement, together with any necessary adjustments, should be made periodically, preferably on a weekly basis.

6.3.7 Temperature

A freshly prepared solution should be allowed to come to within 3 degrees C (5 degrees F) of the specified room temperature before being used. Thereafter, no control is required on the solution temperature. Instead, the room air temperature shall be controlled and the solution allowed to reach temperature equilibrium.

6.3.8 Minimum Volume

The volume of the test solution shall be large enough to avoid any appreciable change in its corrosiveness, either through exhaustion of corrosive constituents, or the accumulation of corrosion products or other constituents that might significantly affect further corrosion.

6.3.9 Replenishment of Water Lost by Evaporation

Evaporation losses shall be made up by daily additions of water of the required purity. Evaporation losses must not be replenished with the salt solution because that will increase the salt concentration in the tank.

6.3.10 Replacement of solution

The frequency of solution change can be based on the severity of corrosion that occurs, visual appearance of the solution, and ratio of surface area of samples to volume of solution. If a large number of samples are tested in a small amount of solution, then the solution will deteriorate more rapidly. If, on the other hand, a small number of samples are tested in a large volume of solution, then the solution will last longer. Alloys such as low alloy steels produce a significant amount of rust and the solution deteriorates more rapidly. The solution last longer when testing alloys such as stainless steels. Observing the condition of the solution daily over a period of time will help determine how frequent the solution should be changed for the particular test being performed. Generally, the solution last, at least one week. When testing corrosion resistant materials, the solution may last two or more weeks. However, to insure that the properties of the solution have not significantly changed over time and its corrosiveness has not been diminished, the solution can be changed more frequently than needed. When the solution is changed the portions of the apparatus that contact the solution should be cleansed by flushing with water.

6.3.11 Room Parameters

The air temperature shall be maintained at 27 +/- 3 degrees C (80 +/- 5 degrees F) throughout the entire test cycle. The percent relative humidity of the air shall be controlled at 45 +/- 10. A mild circulation of air is recommended with the following two precautionary considerations:

a. Drying by forced air blasts on the specimens is not recommended because of difficulty in maintaining uniform drying of large groups of panels.

b. Stagnant air conditions should be avoided.

6.3.12 Period of Cycle

Totally immerse panels in the salt solution for ten minutes of each hour, and then remove them from the solution and allow them to dry for minutes. Continue the cycle 24 hours per day for the specified period, with interruptions only for changing the solution or for examining samples.
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6.3.13 Test Duration in Alternate Immersion

a. 30 days for Class I Environment

b. 8 days for Class II Environment

6.4 Method IV – Humidity Exposure

6.4.1 Summary of Practice

This test method exposes test panels continuously to a high humidity environment that ranges from 85 to 100 percent relative at 35 +/- 3 degrees C (95 +/- 5 degrees F) for the specified time period. The following sections set forth the conditions required for humidity exposure testing.

6.4.2 Apparatus

The apparatus used in the humidity exposure test shall meet the requirements of MIL-STD-810. The apparatus consists of a chamber or cabinet, and auxiliary instrumentation capable of maintaining and continuously monitoring the required conditions of temperature and relative humidity throughout an envelope of air surrounding the test item.

6.4.3 Chamber

Unless otherwise specified, the test volume of the chamber or cabinet and the accessories contained therein shall be constructed and arranged in such a manner as to prevent condensate from dripping on the test item (s). The test volume shall be vented to the atmosphere to prevent the build-up of total pressure and to prevent contamination from entering the chamber. Relative humidity shall be determined by employing either solid state sensors whose calibration is not affected by water condensation or by an equivalent method, such as fast reacting wet bulb/dry bulb sensors or dew point indicators. Sensors that are sensitive to condensation, such as the lithium chloride type, are not recommended for tests with high relative humidity levels.

6.4.4 Data Collection

A data collection system separate from the chamber controllers shall be employed to measure test volume conditions. A recording device shall be mandatory for the data collection system. If charts are used, they shall be readable to within +/- 0.6 degrees C (+/- 1.0 degree F). The wet-wick control method may also be used. Water used in wet-wick systems shall be of the same quality as that used to produce the humidity. The components making up relative humidity measuring systems shall be visually examined periodically during the test, and parts changed or repaired as needed.

6.4.5 Velocity of Air

It is recommended that the velocity of the air flowing across the wet bulb sensor not be less than 4.5 m/s (14.7 ft/sec), and the wet wick be on the suction side of the fan to eliminate the effect of fan heat. It is also recommended that the flow of air anywhere within the envelope of air surrounding the test item be maintained between 0.5 and 2 m/s (1.6 and 6 ft/sec).

6.4.6 Methods to Produce Relative Humidity

The relative humidity within the envelope of air surrounding the test item shall be created by steam or water injection. If water injection is used to humidify the envelope of air, the water shall be temperature conditioned before its injection to prevent upset of the test conditions and shall not be injected directly into the test section.

6.4.7 Water Used

In either method used, the water shall be distilled, demineralized, or deionized, and should have a resistance of not less than 500,000 ohms.

6.4.8 Cautions

a. No material other than water, conforming to ASTM-D1193, shall be brought into physical contact with the test item(s) that will cause the test item(s) to deteriorate, or that will affect the test results. No rust or corrosive contaminants or any material other than water conforming to ASTM-D1193 shall be introduced into the chamber test volume.

b. Dehumidification, humidification, heating, and cooling of the air envelope surrounding the test item shall be achieved by methods that do not change the chemical composition of the air, water, or water vapor within that volume of air.

6.4.9 Test Duration

a. For Class II environments the exposure period shall be a minimum of 180 days, and up to two years for maximum confidence.

b. For Class III environments the exposure period shall be 30 days.

6.5 Method V – Simulated Industrial Exposure (SO_2)

6.5.1 Summary of Practice

The simulated industrial exposure consists of exposing tests panels to a sulfur dioxide environment with high relative humidity. The environmental temperature is maintained at 23 +/- 3 degrees C (73 +/- 5 degrees F) throughout the test duration.

Note 6.5-1: The concentration of SO_2 to be used during preservative testing shall be the responsibility of the contractor. The reagent concentrations utilized in this specification procedure produce a 10 percent SO_2 environment in a 10-liter chamber. Lower concentrations of SO_2 may be obtained by reducing the concentration of the appropriate reagent (Stock Solution A, described later).

6.5.2 Safety Precautions

The SO_2 test shall be carried out under a chemical fume hood since the gases released are toxic. Particular care shall be exercised when the reaction vessel is opened at the end of each test. Small amounts of SO_2 may also be released from the vessel during test as pressure builds up inside. Caution must be used when performing the test to insure that drafts often found in the hoods do not cause significant cooling of the chamber walls.

6.5.3 Apparatus

The apparatus used in the simulated industrial exposure shall meet the requirements of ASTM-B583.

6.5.4 Test Chamber

The test chamber required for industrial exposure consists of any convenient size glass or acrylic resin vessel having a gas tight lid, such as a glass desiccator. The volume of SO_2-generating solution shall not be less than 1/40 the volume of the chamber and the ratio of chamber volume in cubic centimeters to generating solution surface area in square centimeters shall not be greater than 50/1.

6.5.5 Test Panel Holder

Panel holders or supports may be made of glass, acrylic resin, or other inert materials. It is essential that the panels be arranged so as not to impede circulation of the gas.

Panels shall be at least, 1.3 cm, (1/2 inch) from any other surface being evaluated, and at least, 7.6 cm, (3 inches) from the solution surface.

6.5.6 Reagents

a. Stock Solution A : Sodium Thiosulfate Solution – Dissolve 200 grams of sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$) in 800 ml of distilled or deionized water.

b. Stock Solution B: Sulfuric Acid (19.6N) – Mix equal volumes of concentrated sulfuric acid (H_2SO4, specific gravity 1.84) and distilled or deionized water. Prepare in advance and allow solution to cool to room temperature.

6.5.7 Humidity

The H_2O content of the atmosphere in the chamber at equilibrium shall be between 86 and 95 percent relative humidity. This level is attained in about two hours for a 10-liter vessel.

6.5.8 Temperature

The ambient temperature and temperature of the panels and solution shall be 23 +/- 3 degrees C (73 +/- 5 degrees F) during the test period.

6.5.9 Procedure

Prior to testing, a beaker of deionized water heated to 93 degrees C (200 degrees F) shall be placed inside of the vessel. The vessel shall be partially sealed leaving only a gap large enough to accommodate an air hose. The water shall be oxygenated for 30 minutes, at which time the beaker shall be removed. (This is carried out for maximum humid conditions.) Prepare the $S0_2$-H_2O generating mixture by adding, (for a 9 to l0 liter vessel), 50 ml of dilute sulfuric acid (Stock Solution B) to 200 ml of sodium thiosulfate (Stock Solution A). A convenient method is to initially place the sodium thiosulfate solution in the vessel, add the dilute sulfuric acid, and mix by swirling. Insert the panels as rapidly as possible after mixing and immediately seal the vessel.

6.5.10 Test Duration

Test duration shall be relative to actual anticipated exposure of hardware with a minimum exposure of 30 days. Test panels may be viewed periodically through the transparent chamber without disturbing the environment. At the end of the exposure, the panels shall be removed and the corrosion products allowed to dry by waiting a few minutes before surface inspection. Discard the gas generating solution after test.

7.0 EXAMINATION

After completion of all exposure, remove the panels from test. Using a soft tissue, solvent wipe each panel until all traces of the preservative have been removed (Any solvent which is non-reactive to rust or steel at room temperature shall be used.). Each test surface shall be visually examined, photographed, and rated on a pass or fail basis.

Pass: A test surface shall pass if it contains:

a. No more than three dots of rust, 1 mm or less in diameter (Spots that are easily removed by rubbing lightly with soft tissue (alone or wetted with solvent) shall not be considered as corrosion in the rating) and

b. No evidence of pitting or etching.

Fail: A test surface shall fail if it contains:

a. One or more dots of rust larger than 1 mm in diameter, or

b. Four or more dots of any diameter, or

c. Pitting or etching.

APPENDIX A: THE CORROSION INHIBITING PRESERVATIVE MATERIAL USAGE AGREEMENT FORM (PMUA)

PRESERVATIVE MATERIAL USAGE AGREEMENT	C	USAGE AGREEMENT NUMBER:	REV	PAGE OF

PROJECT:	SYSTEM:	SUBSYSTEM:	ORIGINATOR (PERSON'S NAME):	ORGANIZATION/CONTRACTOR:

PART NUMBER (S):	USING ASSEMBLY (S):	ITEM DESCRIPTION:	ISSUE:

BASE MATERIAL:	COATING SYSTEM:	COATING MANUFACTURER:	COATING SPECIFICATION:	PROPOSED EFFECTIVITY:

LOCATION	ENVIRONMENT		
HABITABLE ☐	PRESSURE, PSIA	TEMPERATURE, DEG F	MEDIA
NONHABITABLE ☐			

APPLICATION:

RATIONALE:

ORIGINATOR:	PROGRAM MANAGER:	DATE:

PRESERVATIVE MATERIAL APPLICATION EVALUATION BOARD (PMAEB) DISPOSITION					
CHIEF, EM03	DATE	APPROVE	REJECT	DEFER	PMAEB MEMO NUMBER:
SECRETARY:					EFFECTIVITY:

REMARKS:

APPENDIX B: DETAILED INFORMATION FOR THE EVALUATION OF CORROSION INHIBITING PRESERVATIVES

1. MUA Number, Originator, Organization, Address, and Phone Number
2. Project, System and Subsystem
3. Part Name, Number, and Using Assembly
4. Part Description and function
5. Part Fabricator
6. Is part subjected to tensile stresses? If yes, indicate magnitude, direction with respect to grain orientation, and the source (residual, assembly, or design)
7. Is part welded? If yes, provide welding process and filler wire, if applicable. Was the weld bead removed? Was the part subjected to a stress relief or any post-weld thermal treatment?
8. Base Material (Include temper, size and raw material form (bar, plate, sheet, extrusion, forgings, etc.)).
9. Corrosion Rating of Base Material in MAPTIS (Materials and Processes Technical Information System)
10. Special Processing of the Material not Mentioned Above
11. Coating System, Manufacturer, and Specification
12. Location on Spacecraft (habitable or nonhabitable)
13. Fracture Critical Component? (Yes or no)
14. Environment
15. Pressure
16. Temperature
17. Duration of exposure
18. Rationale
19. Possible Effect of Coating Failure (Effect on all function or mission of the major assembly involved. Indicate whether the part or assembly is a fracture critical component (a part or assembly whose failure can lead to personal injury, loss of life, loss of a flight vehicle, hardware, ground structures, loss of property, etc.)).
20. Remarks. Include any additional information or explanatory notes.

APPENDIX C: QUICK REFERENCE CHART FOR THE TEST ENVIRONMENTS

Method I: Outdoor Environmental Exposure
I-A Seacoast
Equipment: Shall meet the requirements of ASTM-G50
Site: Ocean front setting (100-200 feet from ocean front)
Orientation of Panels: 30 degrees to the vertical and facing the ocean
Observation: Biweekly
Duration: 6-24 months

I-B Industrial
Site: Industrial setting
Orientation of Panels: 30 degrees to the vertical and facing industrial air flow
Observation: Biweekly
Duration: 6-24 months

Method II: Salt Fog Exposure
Equipment: Shall meet the requirements of MIL-STD-810
Orientation of Panels: 15-30 degrees to the vertical and parallel to the principal direction of horizontal flow of the fog
Salt Solution: 95 parts deionized water and 5 +/- 1 parts of sodium chloride conforming to ASTM-B117
pH: 6.5-7.2
Air Pressure: 69-172 KN/m^2 (10-25 psi)
Temperature: 35 +/- 2degrees C (95 +/- 5 degrees F)
Observation: Daily (except weekends and holidays)
Test Duration: Class I – 30 days, Class II – 7 days

Method III: Alternate Immersion
Equipment: Shall meet the requirements of ASTM-G44
Salt Solution: 3.5 +/- 0.1 parts by weight NaCl and 96.5 parts deionized water. Solution conforms to the requirements of ASTM-G44.
pH: 6.4-7.2
Temperature: Room temperature 27 +/- 3 degrees C (80 +/- 5 degrees F)
Solution Replacement: In general, biweekly, however, more frequent or less frequent replacement may be required for certain steels and aluminum alloys depending on the severity of rusting and corrosion that occurs.
Observation: Daily
Test Duration: Class I – 30 days, Class II – 8 days

Method IV: Humidity Exposure
Equipment: Shall meet the requirements of MIL-STD-810

Orientation of Panels: 15-30 degrees to the vertical
Solution: Water shall meet the requirements of ASTM-D1193
Relative Humidity Inside Cabinet: 85-100 percent
Temperature: 38 +/- 3 degrees C (95 +/- 5 degrees F)
Observation: Daily (except weekends and holidays)
Test Duration: Class II – 6 months up to 2 years, Class III – 30 days

Method V: Simulated Industrial Exposure (SO_2)
Equipment: Shall meet the requirements of ASTM-B583
Orientation of Panels: 15 degrees to the vertical
Solution: Mixture of Stock Solution A [1] and B [2]
Relative Humidity Inside Cabinet: 86-95 percent
Temperature: Room 27 degrees C (80 degrees F)
Observation: Daily
Test Duration: Indicative of actual anticipated exposure of hardware with a 30-day minimum exposure

[1] Stock Solution A : Sodium Thiosulfate Solution – Dissolve 200 grams of sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$) in 800 ml of distilled or deionized water.

[2] Stock Solution B: Sulfuric Acid (19.6N) – Mix equal volumes of concentrated sulfuric acid (H_2SO4, specific gravity 1.84) and distilled or deionized water. Prepare in advance and allow solution to cool to room temperature.

PACKAGE NO. 10443R

DOCUMENTATION RELEASE LIST
GEORGE C. MARSHALL SPACE FLIGHT CENTER

MSFC CODE IDENT 14981/339B2
ISSUE DATE FEB 22 2007

C H	DOCUMENT NUMBER	DRL DSH	DRL REV	TITLE	CCBD NO.	PCN	PC	EFFECTIVITY
*	MSFC-SPEC-1870	202	-	GUIDELINES FOR EVALUATION OF CORROSION INHIBITING PRESERVATIVES	000-00-0000	0000000	ZA	NONE

CHG NO.	CHG REV	CHG NOTICE	RESPONSIBLE ENGINEER	RESPONSIBLE ORGANIZATION	ACTION DATE	DESCRIPTION
	A	SCN001	V. MCMILLAN	EH24	03/02/94	REVISION 'A' RELEASED 03/16/92.
* 1	A	SCN000	EUGENA GOGGANS	EO03	02/22/07	DOCUMENT RELEASED THRU PDS. NO LONGER TRACKED IN ICMS.

CHECKER

N/A
02/15/07

(FINAL)

PACKAGE NO: 10443R

PROGRAM/PROJECT: MULTI LAST UPDATED: 02/22/07

NOMENCLATURE: MSFC-STD- GOING TO NONE EFFECTIVITY

ECR NO:	PCN:	CCBD NO:	DATE PREPARED:
E003-0000	0000000	000-00-0000 SB3-00-0000	02/22/07

DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-HDBK-1453		202	-			
			MSFC-HDBK-1674		202	-			
			MSFC-HDBK-2221		203	-			
			MSFC-HDBK-505		202	-			
			MSFC-HDBK-670		202	-			
			MSFC-MNL-1951		209	-			
			MSFC-PROC-1301		202	-			
			MSFC-PROC-1721		202	-			
			MSFC-PROC-1831		202	-			
			MSFC-PROC-1832		202	-			
			MSFC-PROC-404		202	-			
			MSFC-PROC-547		202	-			
			MSFC-QPL-1918		204	-			
			MSFC-RQMT-1282		202	-			
			MSFC-SPEC-1198		202	-			
			MSFC-SPEC-1238		202	-			
			MSFC-SPEC-1443		202	-			
			MSFC-SPEC-164		202	-			
			MSFC-SPEC-1870		202	-			
			MSFC-SPEC-1918		203	-			
			MSFC-SPEC-1919		206	-			
			MSFC-SPEC-2083		202	-			
			MSFC-SPEC-2223		202	-			
			MSFC-SPEC-2489		206	-			
			MSFC-SPEC-2490		205	-			
			MSFC-SPEC-2491		203	-			
			MSFC-SPEC-2492		203	-			
			MSFC-SPEC-2497		211	-			
			MSFC-SPEC-250		202	-			
			MSFC-SPEC-445		202	-			
			MSFC-SPEC-504		202	-			
			MSFC-SPEC-521		202	-			
			MSFC-SPEC-548		202	-			
			MSFC-SPEC-560		202	-			
			MSFC-SPEC-626		202	-			
			MSFC-SPEC-684		202	-			
			MSFC-SPEC-708		202	-			
			MSFC-SPEC-766		202	-			
			MSFC-STD-1249		202	-			
			MSFC-STD-1800		202	-			
			MSFC-STD-246		202	-			
			MSFC-STD-2594		203	-			

PACKAGE NO: 10443R

DWG SIZE	DRAWING NUMBER	DWG REV	EPL/DRL/DDS NUMBER	DWG REV	EPL DSH	EPL REV	EO DASH NUMBER	EO REV	PART NUMBER
			MSFC-STD-2903		202	-			
			MSFC-STD-2904		202	-			
			MSFC-STD-2905		202	-			
			MSFC-STD-2906		202	-			
			MSFC-STD-2907		202	-			
			MSFC-STD-366		202	-			
			MSFC-STD-383		202	-			
			MSFC-STD-486		202	-			
			MSFC-STD-506		203	-			
			MSFC-STD-531		202	-			
			MSFC-STD-557		202	-			
			MSFC-STD-561		203	-			
			MSFC-STD-781		202	-			

SUBMITTED BY ENGINEERING AREA:	BASIC	CHANGE	PARTIAL	COMPLETE	CLOSES ACTION
E003		X		X	E003

PREPARED BY:
EUGENA GOGGANS
12/19/06

SUBMITTED BY:

CONCURRENCE:

TRANSMITTAL DATES
TO RELEASE DESK 02/22/07 10:00
TO MSFC DOC REP 02/22/07 00:00

REMARKS:

2007 FEB 22 AM 11:22

DOCUMENT INPUT RECORD - MSFC DOCUMENTATION REPOSITORY

I. GENERAL INFORMATION

1. APPROVED PROJECT:	2. DOCUMENT/ DRAWING NUMBER:	3. CONTROL NUMBER:	4. RELEASE DATE:	5. SUBMITTAL DATE:
Multiprogram/Project Common-Use Document	MSFC-SPEC-1870A		10/26/2005	10/27/2005

6. DOCUMENT/DRAWING TITLE:	7. REPORT TYPE:
GUIDELINES FOR EVALUATION OF CORROSION INHIBITING PRESERVATIVES	Specification

8. CONTRACT NUMBER / PERFORMING ACTIVITY:	9. DRD NUMBER:	10. DPD / DRL / IDRD NUMBER:

11. DISPOSITION AUTHORITY (Check One):	12. SUBMITTAL AUTHORITY:	13. RELEASING AUTHORITY:
☒ Official Record - NRRS 8/12/A ☐ Reference Copy - NRRS 8/5/A/3 (destroy when no longer needed)	MSFC Multiprogram/Project Common Use Document Control Board (DCB)	

14. SPECIAL INSTRUCTIONS:

15. CONTRACTOR/SUBMITTING ORGANIZATION, ADDRESS AND PHONE NUMBER:	16. ORIGINATING NASA CENTER:
	MSFC
	17. OFFICE OF PRIMARY RESPONSIBILITY: Pablo Torres

18. PROJECT CODE: 29710	19. NUMBER OF PAGES: 23

II. ENGINEERING DRAWINGS

20. REVISION:	21. ENGINEERING ORDER:	22. PARTS LIST:	23. CCBD:

III. REPORTS, SPECIFICATIONS, ETC.

24. REVISION:	25. CHANGE:	26. VOLUME:	27. BOOK:	28. PART:	29. SECTION:
A					

30. ISSUE:	31. ANNEX:	32. SCN:	33. DCN:	34. AMENDMENT:

35. APPENDIX:	36. ADDENDUM:	37. CCBD:	38. CODE ID:	39. IRN:

IV. EXPORT AND DISTRIBUTION RESTRICTIONS

- ☐ Privacy Act (see MWI 1382.1)
- ☐ Proprietary (see MPD 2210.1, MPR 7120.3)
- ☐ Patent (see MPR 2220.1)
- ☐ ITAR (see MPR 2220.1, MPD 2190.1)
- ☐ EAR (see MPR 2220.1, MPD 2190.1)
- ☐ Other ACI (see NPR 1600.1, MPR 1600.1) _____
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V. DOCUMENTATION SUBMITTER (NASA OR CONTRACTOR)

40. ORG. CODE:	41. PHONE NUMBER:	42. NAME:	43. SIGNATURE/DATE:
EM30	(256) 544-2616	Pablo Torres	Pablo D. Torres 10/27/05

VI. TO BE COMPLETED BY MSFC DOCUMENTATION REPOSITORY

44. RECEIVED BY:	45. DATE RECEIVED:	46. WORK ORDER:
Kim Miller	11/2/05	02-00099-6