

Continuous Measurements for Determination of Aerospace Coating Protective Properties

©2021 Association for Materials Protection and Performance (AMPP). All rights reserved. No part of this publication may be reproduced, stored in a retrieval systems, or transmitted, in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise) without the prior written permission of AMPP.

Continuous Measurements for Determination of Aerospace Coating Protective Properties

This AMPP standard represents a consensus of those individual members who have reviewed this document, its scope, and provisions. Its acceptance does not in any respect preclude anyone, whether he or she has adopted the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in conformance with this standard. Nothing contained in this AMPP standard is to be construed as granting any right, by implication or otherwise, to manufacture, sell, or use in connection with any method, apparatus, or product covered by Letters Patent, or as indemnifying or protecting anyone against liability for infringement of Letters Patent. This standard represents minimum requirements and should in no way be interpreted as a restriction on the use of better procedures or materials. Neither is this standard intended to apply in all cases relating to the subject. Unpredictable circumstances may negate the usefulness of this standard in specific instances. AMPP assumes no responsibility for the interpretation or use of this standard by other parties and accepts responsibility for only those official AMPP interpretations issued by AMPP in accordance with its governing procedures and policies which preclude the issuance of interpretations by individual volunteers.

Users of this AMPP standard are responsible for reviewing appropriate health, safety, environmental, and regulatory documents and for determining their applicability in relation to this standard prior to its use. This AMPP standard may not necessarily address all potential health and safety problems or environmental hazards associated with the use of materials, equipment, and/or operations detailed or referred to within this standard. Users of this AMPP standard are also responsible for establishing appropriate health, safety, and environmental protection practices, in consultation with appropriate regulatory authorities, if necessary, to achieve compliance with any existing applicable regulatory requirements prior to the use of this standard.

CAUTIONARY NOTICE: AMPP standards are subject to periodic review and may be revised or withdrawn at any time in accordance with AMPP technical committee procedures. AMPP requires that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of initial publication and subsequently from the date of each reaffirmation or revision. The user is cautioned to obtain the latest edition. Purchasers of AMPP standards may receive current information on all standards and other AMPP/NACE/SSPC publications by contacting the AMPP Customer Support Department, 15835 Parkway Place, Houston, Texas 77084-5145 (Tel: +1 281-228-6200, email: customersupport@ampp.org).

Document History

2021-09-02: Developed by AMPP Standards Committee (SC) 07, Defense & Aerospace.

AMPP values your input. To provide feedback on this standard, please contact: standards@ampp.org

AMPP TM21449-2021

©2021 Association for Materials Protection and Performance (AMPP). All rights reserved.

Continuous Measurements for Determination of Aerospace Coating Protective Properties

Scope and Rationale	5
Section 1 General	6
1.1 Overview	6
1.2 Limitations for Technical Use	6
1.3 Applicability	6
Section 2 Performance Parameters	7
2.1 Barrier Properties of Coatings	7
2.2 Protective Corrosion Properties of Coating at a Defect	7
2.3 Protective Properties for Resisting Environmental Cracking	7
Section 3 Coating Systems	8
3.1 Alloys	8
3.2 Coatings	8
3.3 Test Systems	8
Section 4 Coating Material	9
4.1 Corrosion Test Environment	9
4.2 Measurement of Environmental Test Conditions	9
Section 5 Surface Preparation of Pipe	9
5.1 Corrosion Test Environment	9
5.2 Measurement of Environmental Test Conditions	9
Section 6 Coating Application	10
6.1 Reporting	10
References	10
Appendix A Barrier Properties of Coating	11
A.1 Principle	11
A.2 Barrier Property Measurement Parameters	11
A.3 Barrier Property Measurement Instrumentation	11
A.4 Sensor Preparation and Coating	12
A.5 Exposure Method and Duration	13
A.6 Procedure	13
A.7 Test Data	13
A.8 Analysis and Expression of Results	13
A.9 Reporting	13
Appendix B Protective Corrosion Properties of Coating at a Defect	14
B.1 Principle	14

B.2	Free Corrosion Measurement	14
B.3	Galvanic Corrosion Measurement.....	14
B.4	Corrosion Protective Property Measurement Instrumentation	14
B.5	Sensor Preparation and Coating.....	16
B.6	Exposure Conditions and Duration	17
B.7	Procedure.....	17
B.8	Test Data	17
B.9	Analysis and Expression of Results	18
B.10	Reporting.....	18
Appendix C	Protective Properties for Resisting Environmental Cracking.....	19
C.1	Principle	19
C.2	Required Materials and Apparatus.....	19
C.3	Environmental Cracking Measurements	24
C.4	Sample Preparation and Coating.....	24
C.5	Test Material Preparation	25
C.6	Test Procedure	26
C.7	Test Completion	29
C.8	Test Data	29
C.9	Analysis and Expression of Results	29
C.10	Reporting.....	29

Figures

Figure A1	Equivalent Circuit Models for (a) an Organic Coating where One Electrode is in the Solution and the Other is the Metal Substrate and (b) for a Two-Electrode IDE Sensor where Both Electrodes are Covered by the Organic Coating, as is the Case for a Gold IDE Sensor.....	11
Figure A2	Gold IDE Used for Measurement of Coating Barrier Properties	12
Figure B1	Combined Free Corrosion and Galvanic Corrosion IDE Sensors.....	15
Figure B2	Multi-Sensor Panel Including Barrier Property, Free Corrosion, and Galvanic Corrosion IDE Sensors	15
Figure B3	Cutting Tool for Producing Coating Scribes	17
Figure B4	Scribe Width at the Coating and Substrate Interface (MIL-PRF-32239).....	17
Figure C1	Mechanical Drawing of Fracture Mechanics DCB Sample	21
Figure C2	DCB Sample Geometry and Loading and Gauge Section (with Expected Crack Growth Orientation).....	22
Figure C3	Compliance Curve for DCB Sample (Displacement at Sensor Position)	22
Figure C4	Plot of Crack Length as a Function of Compliance (Displacement at Sensor Position).....	23
Figure C5	DCB Load Frame with Spring Actuation.....	24
Figure C6	Schematic of DCB Sample with Compressive Load, Crack Initiation and Propagation Direction in Gauge Section, Uncoated Beam Areas and Coated Gauge Section Indicated	25
Figure C7	Fiberglass Mesh Installed on DCB Sample Gauge Area and Solution Application	27
Figure C8	Sample with Mesh and Alumina Pin.....	27
Figure C9	Crevice Former Installed, Showing O-ring Installation	28

Scope

This standard describes three Test Methods for conducting a coating evaluation for comparative performance testing, coating specification, and coating quality acceptance testing. The standard is organized to provide a general description of the Test Method (Sections 1 – 6) with three mandatory appendices that are arranged by coating protective properties and failure progression.

Appendix A (Mandatory), Barrier Properties of a Coating

Appendix B (Mandatory), Protective Corrosion Properties of a Coating at a Defect

Appendix C (Mandatory), Protective Properties of a Coating for Environmental Cracking Resistance

The Test Method describes the equipment required to conduct each type of performance test including the atmospheric corrosion test chamber, environmental monitoring, and coating performance property measurements. Materials, sensors, and test samples are detailed and guidance for materials preparation and coating application is given. The electrochemical measurements and sensors are applicable to liquid, polymer coatings applied by spray, brush, or dip processes. Atmospheric corrosion test cycles for protective property measurements are described. The method includes reporting requirements for documenting environment, materials, and sample conditions. Data collection for test records and data analysis to establish coating performance metrics are defined. The values stated in International System of Units (SI) are to be regarded as standard, although some U.S. customary units are used in this standard.

Rationale

This Test Method addresses the need for coating performance measurements that are relevant to the protection of aerospace structures.

In AMPP standards, the terms *shall* and *must* are used to state requirements that are considered mandatory. The term *should* is used to state something that is recommended, but is not considered mandatory. The term *may* is used to state something considered optional.