

Treatments for the Protection for Metal Parts of Service Stores and Equipment Against Corrosion

©2022 Association for Materials Protection and Performance (AMPP). All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise) without the prior written permission of AMPP. Ministry of Defence © Crown Copyright. Data is reproduced with permission of the Controller, His Majesty's Stationery Office." The phrases "DStan" and "Def Stan", and the DStan logo, are registered trade marks of the Ministry of Defence.

Treatments for the Protection for Metal Parts of Service Stores and Equipment Against Corrosion

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 AMPP Customer Support, 15835 Park Ten Place, Houston, Texas 77084-5145 (Tel: +1 281-228-6200, email: customersupport@ampp.org).

Document History

2022-03-11: Approved by AMPP Standards Committee (SC) 07, Defence and Aerospace

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

AMPP SP03-30-2022

©2022 Association for Materials Protection and Performance (AMPP). All rights reserved.
Ministry of Defence © Crown Copyright. Data is reproduced with permission of the Controller, His Majesty's Stationery Office.
The phrases "DStan" and "Def Stan", and the DStan logo, are registered trade marks of the Ministry of Defence.

Treatments for the Protection for Metal Parts of Service Stores and Equipment Against Corrosion

Foreword	5
Section 1 General Requirements	6
0 Introduction	6
1 Scope	6
2 Warning	6
3 Related Documents	6
Section 2 Basic Mechanisms of Aqueous Corrosion	7
4 Electrochemical Mechanism of Aqueous Corrosion	7
5 Electrode Potential	10
6 Polarisation of Electrode Reactions	12
7 Initial Consideration of the Different Types of Corrosion	13
Section 3 Different Types of Corrosion	14
8 General Surface Corrosion Section	14
9 Localized Corrosion	15
Section 4 Atmospheric Corrosion	23
10 Introduction	23
11 Relative Humidity	24
12 Atmospheric Conditions and Contaminants	24
13 Specific Corrosion Issues	26
Section 5: Corrosion Control	27
14 Introduction	27
15 Design	27
16 Corrosion Control: Material Performance	29
17 Cathodic Protection	32
18 Anodic Protection	33
19 Modification of the Environment	34
20 Protective Coatings: General	34
21 Hot-Dip Coating	36
22 Electrodeposition	37
23 Electroless Plating	38
24 Thermal-Spray Coating	38
25 Cladding	39
26 Diffusion Coating	39

AMPP SP03-30-2022

©2022 Association for Materials Protection and Performance (AMPP). All rights reserved.
Ministry of Defence © Crown Copyright. Data is reproduced with permission of the Controller, His Majesty's Stationery Office.
The phrases "DStan" and "Def Stan", and the DStan logo, are registered trade marks of the Ministry of Defence.

27	Mechanical Coating.....	39
28	Physical Vapour Deposition (PVD).....	39
29	Anodising	40
30	Phosphating	41
31	Chromium Conversion Coating.....	41
32	Other Conversion Coatings.....	41
33	Paint Coatings.....	41
Section 6	Recommendations for Protective Schemes.....	43
34	Selection of Materials.....	43
35	Design.....	43
36	Control of Environment	44
37	Selection of Protective Coatings.....	44
Figures		
Figure 1	Electrochemical Mechanism of Aqueous Corrosion in Bimetallic Cell.....	7
Figure 2	Electrochemical Mechanism of Corrosion of a Single Component.....	9
Figure 3	Potential Difference across Electrode Surface Associated with Electrode Reaction Represented by Equation 5.....	10
Figure 4	Measurement of Electrode Potential.....	10
Figure 5	Relationship between Electrode Potential and Direction of Spontaneous Electrode Reaction.....	12
Figure 6	Basic Classification of Corrosion Processes	13
Figure 7	Modes of Deterioration of Components under Combined Action of Corrosion and Stress.....	13
Figure 8	Some Types of Localised Corrosion	16
Figure 9	Pitting/Crevice Corrosion Propagation Involving a Macrocell between Pit or Crevice Interior (at relatively negative potential) and External Surface (at more positive potential).....	19
Figure 10	Poor (left) and Good (right) Design for Outdoor Inclined Members	28
Figure 11	The Basis of Cathodic Protection.....	32
Figure 12	Sacrificial Anode Method of Cathodic Protection.....	33
Figure 13	Sacrificial Protection of Steel Substrate by Zinc Coating at Defect or Damage in Coating.....	37
Figure 14	Schematic Representation of Structure of Anodised Coating on Aluminium.....	40
Tables		
Table 1	Standard Electrode Potentials (Electrochemical series).....	12
Table 2	Galvanic Series for Ambient-Temperature Seawater.....	17
Table 3	Classification of Protective Coatings Commonly Used for Protection Against Atmospheric Corrosion.....	35
Table 4	Coating Schemes for Carbon Steel.....	46
Table 5	Coating Schemes for Aluminium Alloys.....	47

Foreword

NOTICE

This document has been taken directly from the Ministry of Defence of the United Kingdom's Defence Standard (Def Stan) 03-30 Issue 3 dated 4 February 2005 (last reviewed on 2 November 2009), "Treatments for the Protection for Metal Parts of Service Stores and Equipment against Corrosion" and contains only minor editorial and format changes to conform with the publishing requirements of AMPP standards. This is a word-for-word conversion of the Def Stan to ensure technical equivalency. There are several instances where question marks "?" appear in the original Def Stan within Equation 4 and Clauses 21, 22, 23, 27, and 29 (including subparagraphs). AMPP believes these to be erroneous but will not be incorporating changes to the original document for this publication.

The original Def Stan was adopted as an AMPP standard under the provisions of the AMPP Standards Committee's Operating Manual Procedures for Conversion of Government Agency Standards.

- a. This standard is a guide to corrosion protection against atmospheric corrosion and covers all aspects from the basic mechanisms of aqueous corrosion, through a summary of the differing types to a detailed review of aspects of atmospheric corrosion. It concludes with a detailed survey of the methods of control against corrosion and a focused description of the particular methods of corrosion protection for different metal alloys.
- b. This standard was originally produced on behalf of the Standardization Advisory Group (SAG) by the Corrosion Prevention and Metallic Materials Standards Production Group (E3).
- c. This standard has been agreed by the authorities concerned with its use and is intended to be used whenever relevant in all future designs, contracts, orders etc. and whenever practicable by amendment to those already in existence. If any difficulty arises which prevents application of the Defence Standard, U.K. Defence Standardization (DStan) shall be informed so that a remedy may be sought.
- d. Any enquiries regarding this standard in relation to an invitation to tender or a contract in which it is incorporated are to be addressed to the responsible technical or supervising authority named in the invitation to tender or contract.
- e. Compliance with this Defence Standard shall not in itself relieve any person from any legal obligations imposed upon them.
- f. This standard has been devised solely for the use of the Ministry of Defence (MOD) and its contractors in the execution of contracts for the MOD. To the extent permitted by law, the MOD hereby excludes all liability whatsoever and howsoever arising (including, but without limitation, liability resulting from negligence) for any loss or damage however caused when the standard is used for any other purpose.

In AMPP standards, the terms *shall* and *must* are used to state requirements and 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.

AMPP SP03-30-2022

Section 1: General Requirements

0: Introduction

- 0.1** This standard has been written as a guide, it contains information assembled from various specifications for the protection of metals against atmospheric corrosion and its prevention. It aims to give advice to designers on corrosion and its prevention. It may be used in conjunction with existing design documents.
- 0.2** This standard covers the protection of ferrous and non-ferrous metals by metallic, conversion, paint, varnish and lacquer coatings, corrosion preventatives and electrochemical processes which assist in combating metal corrosion. It also discusses design factors which can also play an important part in preventing corrosion and makes reference to the cleaning and pre-treatment of metals prior to the application of a surface finish.
- 0.3** The advice and recommendations are primarily for the designer of equipment exposed to the atmosphere. Corrosion and protection problems in components immersed in aqueous streams are touched on but lightly; for these other specialised sources of information should be consulted.

1: Scope

This document is a guide to corrosion protection against atmospheric corrosion, and is written in several sections. It starts with a description of the basic mechanisms of aqueous corrosion since atmospheric attack on metallic components involves such mechanisms. It goes on to provide a summary of the different types of aqueous corrosion including those forms of deterioration where mechanical stress, as well as corrosion mechanisms, is involved. There is then a section that focuses on detailed aspects of atmospheric corrosion and includes a discussion of the crucial environmental factors that influence the phenomenon together with descriptions of some particular problems of atmospheric corrosion. This is followed by a detailed survey of all the methods of control against corrosion with emphasis on those approaches, materials performance, design and particularly protective coatings that are most relevant to the protection of components and equipment in atmospheric conditions. The final section provides a focused description of the particular methods of corrosion protection for different metals and alloys.

2: Warning

The Ministry of Defence (MOD), like its contractors, is subject to both United Kingdom and European laws regarding Health & Safety at Work, with full exemption. All Defence Standards either directly or indirectly invoke the use of processes and procedures that could be injurious to health if adequate precautions are not taken. Defence Standards or their use in no way absolves users from complying with statutory and legal requirements relating to Health & Safety at Work.

3: Related Documents

BS EN ISO 4042	Fasteners—Electroplated Coatings
BS EN ISO 12944-5	Paints and Varnishes—Corrosion Protection of Steel Structures by Protective Paint Systems—Part 5: Protective Paint Systems
BS EN ISO 14613	Protection against Corrosion of Iron and Steel in Structures – Zinc and Aluminium Coatings – Guidelines
ISO 9223	Corrosion of Metals and Alloys—Corrosivity of Atmospheres – Classification
ES PL 5484	Commentary on Corrosion of Bimetallic Contacts and its Alleviation
DEF STAN 81-41	Packaging of Defence Materiel (Parts 1 to 6)
DEF STAN 03-36	The Use of Cadmium Alternatives in the Protective Coating of Defence Equipment
DEF STAN 03-38	The Use of Chromium Alternatives in the Protective Coating of Defence Equipment

AMPP SP03-30-2022