

Performance Requirements for Navy Ships Exterior Topside Coatings

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

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Foreword

This standard is intended for use by naval corrosion control personnel, coating applicators, and coating manufacturers. The purpose is to facilitate more effective corrosion protection of Navy ships, inter-operability requirement by presenting reliable information and providing guidelines for coating manufacturers and shipyards to develop more durable specifications.

Higher durability coatings provide the corrosion protection and durability required to meet these goals; however, proper application of the coatings is critical to achieve the maximum life expectancy of these coating products.

Scope

This standard provides guidelines for establishing minimum requirements for the protective coatings of ships exterior topsides and related structures exposed to the marine atmosphere. It covers coating materials, coating test protocol and acceptance criteria, surface preparation, coating application, quality assurance and control, and repair method.

Rationale

In the late nineties, the North Atlantic Treaty Organization (NATO)⁽¹⁾ navies were considering approaches to improve the durability and maintainability of major assets. The importance of surface preparation, application processes and qualified coatings was clear. There was also a confluence of enhanced operational capabilities (health, safety, security, etc.), environmental regulation compliance and increasing cost during ship life cycle (acquisition and maintenance). It was resolved that there was a need for internationally recognized performance standards and interest in standard documents such as NATO Allied Engineering Publications (AEP) to suit the unique requirements of military ships.

Navy ships represent large capital investments and are present worldwide. Moreover, control of corrosion on Navy ships is necessary to sustain operational availability and inter-operability, provide safe working and living areas, and limit total ownership cost during a ship's life cycle.

NATO established a working group comprised of experts from eleven countries to create international performance standards. Through contacts with various navies, shared objectives were established; in particular:

- Increasing the length of time between dry-dockings (up to 10 years),
- Reduction of maintenance, including reducing crew labor.

The working group used the period from 2002-2008 to complete four AEPs. In 2010, participating NATO member nations accepted the AEPs via an overarching Standardization Agreement (STANAG 4698).¹ The four AEPs developed under STANAG 4698 are:

- AEP 59: Application process for optimum paint and coatings system's performance
- AEP 60: Performance requirements for exterior topsides coatings
- AEP 61: Performance requirements for underwater hull paint systems
- AEP 63: Performance requirements for non-skid coating systems

In 2012, it was realized that the community of experts within NATO had diminished, and this limited NATO's ability to manage and update the AEPs. A plan was developed to transfer the documents to a Joint NATO/NACE International (NACE)/European Federation of Corrosion (EFC)⁽²⁾ working party. Under this plan, NATO maintains control of the STANAG and oversees the maintenance of the AEPs by the NACE/EFC working party. In 2021, NACE International became the Association for Materials Protection and Performance (AMPP).

This standard was prepared in 2023 by the joint working party of AMPP, EFC, and NATO representatives and referred to by NATO under STANAG 4698.

This standard replaces AEP 60.

⁽¹⁾ North Atlantic Treaty Organization (NATO), Boulevard Leopold III, Brussels, Belgium, www.nato.int.

⁽²⁾ European Federation of Corrosion (EFC), 1 Carlton House Terrace, London SW1Y 5DB, U.K. <https://efcw.org>.

Referenced Standards and Other Consensus Documents

The latest edition, revision, or amendment of the referenced standards in effect shall govern unless otherwise dated.

AMPP/NACE/SSPC, www.ampp.org:

NACE TM0104	Offshore Platform Ballast Water Tank Coating System Evaluation
SSPC-SP 1	Solvent Cleaning
SSPC-SP 16	Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

ASTM International, www.astm.org:

ASTM D2372	Standard Practice for Separation of Vehicle from Solvent-Reducible Paints
ASTM D3960	Standard Practice for Determining Volatile Organic Compound (VOC)
ASTM D2621	Standard Test Method for Infrared Identification of Vehicle Solids from Solvent-Reducible Paints

Australian Paint Approval Scheme (APAS), www.apas.gov.au:

AP-S0501	Low Solar Absorbing, Colour Stable Exterior Topside Paint for Navy Vessels
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International Organization for Standardization (ISO), www.iso.org:

ISO 1514	Paints and varnishes — Standard panels for testing
ISO 1517	Paints and varnishes – Surface-drying test – Ballotini method
ISO 2409	Paints and varnishes — Cross-cut test
ISO 2811	Paints and varnishes — Determination of density
ISO 2808	Paints and varnishes - Determination of film thickness
ISO 2810	Paints and varnishes - Natural weathering of coatings – exposure and assessment
ISO 2813	Paints and varnishes - Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°
ISO 3233	Paints and varnishes — Determination of percentage volume of non-volatile matter by measuring the density of a dried coating
ISO 2813	Paints and varnishes — Determination of percentage volume of non-volatile matter by measuring the density of a dried coating
ISO 3251	Paints and varnishes — Determination of non-volatile matter of paints, varnishes and binders for paints and varnishes”
ISO 3270	Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing
ISO 3679	Paints, varnishes, petroleum and related products — Determination of flashpoint — Rapid equilibrium method
ISO 3678	Paint and varnishes – Paint-free test
ISO 3679	Paints, varnishes, petroleum and related products — Determination of flashpoint — Rapid equilibrium method
ISO 4618	Paints and varnishes - Terms and definitions
ISO 4624	Paints and varnishes — Pull-off test for adhesion
ISO 4628-1	Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect — Part 1: General introduction and designation system
ISO 4628-2	Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect — Part 2: Assessment of degree of blistering

ISO 4628-3	Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect — Part 3: Assessment of degree of rusting
ISO 4628-4	Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect —Part 3: Assessment of degree of cracking
ISO 4628-5	Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect —Part 5: Assessment of degree of flaking
ISO 4628-6	Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect —Part 6: Rating of degree of chalking by tape method
ISO 4628-7	Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect — Part 7: Assessment of degree of chalking by velvet method
ISO 6270	Paints and varnishes - Determination of resistance to humidity (continuous condensation)
ISO 7724	Paints and varnishes – Colorimetry
ISO 8044	Corrosion of metals and alloys — Basic terms and definitions
ISO 8501-1	Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO 8501-3	Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 3: Preparation grades of welds, edges and other areas with surface imperfections
ISO 8501-4	Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 4: Initial surface conditions, preparation grades and flash rust grades in connection with high-pressure water jetting
ISO 8502-1	Preparation of steel substrates before application of paint and related products – Tests for the assessment of cleanliness — Part 1: Field test for soluble iron corrosion products
ISO 8502-3	Preparation of steel substrates before application of paint and related products – Tests for the assessment of cleanliness — Part 3: Assessment of dust on steel surfaces prepared for painting
ISO 8502-4	Preparation of steel substrates before application of paint and related products – Tests for the assessment of cleanliness — Part 4: Probability of condensation prior to paint
ISO 8502-6	Preparation of steel substrates before application of paint and related products – Tests for the assessment of cleanliness — Part 6: Extraction of soluble contaminant for analysis – Bresle method
ISO 8502-9	Preparation of steel substrates before application of paint and related products – Tests for the assessment of cleanliness — Part 9: Field method for conductometric determination of water-soluble salts
ISO 8503-1	Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces
ISO 8503-2	Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel — Comparator procedure
ISO 9117	Determination of through-dry state and through-dry time – Method of test
ISO 9223	Corrosion of metals and alloys – Corrosivity of atmospheres – Classification
ISO 9514	Paints and varnishes - Determination of the pot-life of liquid systems
ISO 11507	Paints and varnishes — Exposure of coatings to artificial weathering — Exposure to fluorescent UV and water
ISO 11890-1	Paints and varnishes - Determination of volatile organic compounds — Part 1: Difference method
ISO 11014-1	Safety data sheet for chemical products — Part 1: Content and order of section

ISO 11890-2	Paints and varnishes - Determination of volatile organic compounds — Part 2: Gas chromatographic method
ISO 12944-1	Paint and varnishes — Corrosion protection of steel structures by protective paint systems Part 1 — General Introduction
ISO 12944-2	Paint and varnishes — Corrosion protection of steel structures by protective paint systems Part 2 — Classification of Environments
ISO 12944-5	Paint and varnishes — Corrosion protection of steel structures by protective paint systems Part 5 — Protective paint systems
ISO 12944-6	Paint and varnishes — Corrosion protection of steel structures by protective paint systems Part 6 — Laboratory performance test methods
ISO 12944-7	Paint and varnishes — Corrosion protection of steel structures by protective paint systems Part 7 — Application of the paint and the execution and supervision of the paint work during the construction and installation of the structure
ISO 12944-8	Paint and varnishes — Corrosion protection of steel structures by protective paint systems Part 8 — Development of a specification
ISO 14680	Paints and varnishes — Determination of pigment content — Part 1: Centrifuge method
ISO 14680	Paints and varnishes — Determination of pigment content — Part 2: Ashing method
ISO 16474-2	Paints and varnishes - Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps
ISO 16701	Corrosion of metals and alloys - Corrosion in artificial atmosphere - Accelerated corrosion test involving exposure under controlled conditions of humidity cycling and intermittent spraying of a salt solution
ISO 19840	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces

SAE International, www.sae.org:

SAE-AMS-STD 595 Standard Colors Used in U.S. Government Procurement

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.

Section 1: General

Navy ships require specific attention in order to be able to withstand the severe corrosion stresses to which they are exposed during their service life, to minimize the risk of failures that would impact safety, operating costs or capital costs.

In order to establish sufficient corrosion protection, ensure optimum performance of the coating and have common functional specification, it is necessary to specify the requirements for the protection coating system(s) along with the relevant laboratory performance tests to assess its (their) likely durability and performance.

To achieve the same performance as indicated by testing, proper application of the paint is essential. Close attention needs to be given to the execution of the work.

In ISO 12944, relevant requirements are given for the following:

- Corrosivity categories for the atmosphere, water and soil (Part 2);
- Suitable design measures (Part 3);
- The surface and its preparation (Part 4);
- Application of the paint and the execution and supervision of the paint work during the construction and installation of the structure (Part 7);
- Development of a specification (Part 8).

Section 2: Scope

This standard provides guidelines for establishing minimum requirements for the protective coatings of ships exterior topsides and related structures exposed to the marine atmosphere.

It covers coating materials, coating prequalification test methods and the associated acceptance criteria, surface preparation, coating application, quality assurance and control and repair methods.

This standard emphasizes high corrosion durability paint systems, with the aim of minimizing maintenance, and hence reducing safety considerations and environmental impact. It includes the following:

- The test method to be used to determine the composition of the separate components of a coating system.
- The laboratory performance test methods for the assessment of the likely durability of the protective coating system.
- The criteria to be used to evaluate the results of performance tests.

This standard does not address corrosion protective coatings for equipment installed in topside areas.

Section 3: Definitions

For the purposes of this standard, the following terms and definitions apply. Some of the definitions have been taken from ISO 8044, ISO 12944-1 and ISO 4618, as indicated.

Cleaned Surface (Cleanliness): Surface from which the contaminants have been removed to a specified level.

Coat: A continuous layer of a coating material resulting from a single application (ISO 4618).

Corrosion: Physico-chemical interaction between a metal and its environment that results in changes in the properties of the metal and that may often lead to impairment of the function of the metal, the environment, or the technical system of which these form a part (ISO 8044).

C5: This is the very high marine corrosivity category, defined by standards ISO 12944-2, in terms of the mass or thickness loss of standard specimens made of low-carbon steel and/or zinc, after the first year of exposure. It corresponds to coastal and offshore areas with high salinity.

Dry Film Thickness (DFT): The thickness of a coating remaining on the surface when the coating has hardened.

Durability: The expected life of a protective paint system to the first major maintenance painting (ISO 12944-1). Durability in accordance with 12944-1 concerns only the anticorrosive performance of the paint system and not the cosmetic behavior of the topcoat.

Fire Risk: Risk due to flammable raw materials and application modes.

Maintainability: Ease with which a paint system can be repaired and maintained, including repair of anticorrosive paint and topcoat.

Safety Data Sheet (SDS): A document designed to provide information regarding the health and safety aspects of a paint product or thinner.

NOTE: The SDS typically includes information concerning generic material identification, hazardous ingredients, physical data, fire and explosion data, health hazards, reactivity data, spill or leak procedures, special protection requirements and other special precautions.

Nominal Dry Film Thickness (NDFT): The dry film thickness specified for each coat and the whole paint system to achieve the required durability (ISO 12944-5).

Paint: A pigmented coating material in liquid, in paste or powder form that, when applied to a substrate, forms an opaque film having protective, decorative or specific technical properties (ISO 4618).

Product Data Sheet (PDS): A document designed to provide information on a specific paint product.

NOTE 1: The type of information includes product uses, features, service properties, application properties, application instructions, packaging information, and information on storage and handling.

NOTE 2: See Paragraph 5.2 for specific required minimum information.

Protective Paint System: The sum of the coats of paints or related products that are to be applied or have been applied to a substrate to provide corrosion protection (ISO 12944-1).

Qualification: A process for the evaluation of protective paint systems using test criteria which allow the selection of suitable paint systems for distinct environmental exposure conditions.

Re-coatability: Property of paint dry film (generally topcoat) to receive a general coat, without compatibility failure.

Shelf Life: The period from the date of manufacture during which the paint can be transported and / or stored in undamaged and unopened packaging without any influence on its application or performance providing the ambient conditions are within the limits recommended by the paint manufacturer, or otherwise agreed.

NOTE: After exceeding this period, the paint is subject to re-inspection.

Substrate: The surface to which the coating material is applied or is to be applied (ISO 4618).

Toxicological Risk: Risks due to paint raw materials (pigments, binders, solvents, thinner).

VOC (Volatile organic compound): Fundamentally, any organic liquid and/or solid that evaporates spontaneously at the prevailing temperature and pressure with which it is in contact.

VOC Content (Volatile organic compound content): The mass of the volatile organic compounds present in a coating material, as determined under specific conditions.

NOTE 1: The properties and the amount of the compounds to be taken into account will depend on the field of application of the coating material. For each field of application, the limiting values and the methods of determination or calculation are stipulated by regulations or by agreement including exempted solvents.

NOTE 2: Under certain U.S. governmental legislation, the term "VOC" is restricted solely to those compounds that are photochemically active in the atmosphere (see ASTM D3960). Any other compound is then defined as being an exempt compound. (ISO 11890-16 adapted from ISO 4618).

Section 4: Field of Application

4.1 The field of application for which this standard is developed is characterized by:

- a) Type of structure
- b) Environment
- c) Substrate and surface preparation
- d) Type of paint

4.2 Type of structure

This standard deals with structural materials including carbon or low-alloy steels, as well as aluminum and composites for corrosion resistance and weathering performance.

The following are not covered by this standard:

- a) Steel cable structures
- b) Functional surfaces such as bearings
- c) Rubber components
- d) Type of environment

This standard deals with the atmospheric corrosivity representative of naval exterior topside structures, e.g., category CX or more severe as defined in ISO 9223.

4.3 Type of durability

The corrosion protection of the paint system is of high durability and must have a minimum life expectancy of 15 years (ISO 12944-1). During this period, localized repairs and general topcoat applications which are considered necessary for minor maintenance should be undertaken. The level of the coating failure before the first major maintenance painting shall not exceed 25% of each exterior topside area. The high durability classification does not concern the colorimetric and cosmetic properties of the topcoat.

4.4 Type of paint works

The applications covered by this document are new building application or equivalent (total removal of pre-existing coatings). Additional requirements may be necessary in-use for maintenance systems, e.g., reduced surface preparation.

The new building paint system must be adapted to maintenance procedures such as localized repairs (due to mechanical damages, weld burn, etc.) and general topcoat application.

Optional washing and soft sandpapering for surface preparation could be required for the general topcoat application.

4.5 Type of substrate and surface preparation

The major substrate of exterior topsides is steel, which may or may not have been protected by shop primer (e.g., zinc rich primer, zinc ethyl silicate) at construction.

If used, shop primers are not considered as the first coat of paint system.

The description of surface preparation covers cleanliness, levels of contamination and roughness. The surface preparations generally used for the different types of substrates are shown in Table 1.

Table 1
Surface Preparation

Nature of Substrate	Surface Preparation	Standardization
Steel	Sa 2½	ISO 8501-1
	WA 2 ½ - L	ISO 8501-4
Fiber reinforced composites	Sweep blast or mechanical sanding to remove gloss	
Other metallic materials (copper alloys, aluminum alloys, stainless steel)	Sweep blast and optional solvent wipe	SSPC-SP 16

For all types of substrate, the minimum level of cleanliness (contamination) before paint application must meet the criteria in Table 2.