

Surface preparation and protective coating

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Foreword

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are, as far as possible, intended to replace oil company specifications and serve as references in the authorities' regulations.

The NORSOK standards are normally based on recognised international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant, NORSOK standards will be used to provide the Norwegian industry input to the international standardisation process. Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

The NORSOK standards are developed according to the consensus principle generally applicable for most standards work and according to established procedures defined in NORSOK A-001.

The NORSOK standards are prepared and published with support by The Norwegian Oil Industry Association (OLF), The Federation of Norwegian Industry, Norwegian Ship owners' Association and The Petroleum Safety Authority Norway.

NORSOK standards are administered and published by Standards Norway.

Introduction

The main changes included in this edition are that

- the content of a paint report and an example of such is included,
- additional requirements for surface protection of valves actuators, gearboxes, pumps and motors are implemented,
- requirements for reinforcement and anchoring of sprayed fire protecting with fibre mesh are given,
- requirements for subsea coatings at higher temperature than 50 °C is given,
- IMO MSC215(82) classification testing has been accepted as an alternative qualification method for ballast water tank coatings (coating system no. 3B),
- more detailed specification of what to include in the coating procedure specification is given,
- a time limit for the validity of the coating procedure test is specified,
- coating system numbering is made more detailed for system no. 6 and system no. 7,
- polyester based powder coating is included as an alternative on top of hot dipped galvanized steel and aluminium based structures,
- coating system for subsea is split into three categories.

1 Scope

This NORSOK standard gives the requirements for the selection of coating materials, surface preparation, application procedures and inspection for protective coatings to be applied during the construction and installation of offshore installations and associated facilities.

This NORSOK standard cover paints, metallic coatings and application of spray-on passive fire protective coatings.

The aim of this NORSOK standard is to obtain a coating system, which ensures

- optimal protection of the installation with a minimum need for maintenance,
- that the coating system is maintenance friendly,
- that the coating system is application friendly,
- that health, safety and environmental impacts are evaluated and documented.

This NORSOK standard is not applicable to pipelines and pipeline risers.

2 Normative and informative references

The following standards include provisions and guidelines which, through reference in this text, constitute provisions and guidelines of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet the requirements of the referenced standards.

2.1 Normative references

ASTM D4752,	Standard Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub
IMO MSC215(82),	Performance standard for protective coatings for dedicated seawater ballast tanks in all types of ships and double-sided skin spaces of bulk carriers
ISO 1461,	Metallic coatings – Hot-dip galvanised coating on fabricated ferrous products – Requirements
ISO 2814,	Paints and varnishes – Comparison of contrast ratio (hiding power) of paint of the same type and colour
ISO 4624,	Paints and varnishes – Pull-off test for adhesion
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 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. Informative supplement to part 1: Representative photographic examples of the change of appearance imparted to steel when blast-cleaned with different abrasives (ISO 8501-1:1988/Suppl:1994)
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 8502-3,	Preparation of steel substrates before application of paints and related products – Test for the assessment of surface cleanliness – Part 3: Assessment of dust on steel surfaces prepared for painting (pressure sensitive tape method)
ISO 8502-6,	Preparation of steel substrates before application of paints and related products – Test for the assessment of surface cleanliness – Part 6: Extraction of soluble contaminants for analysis – The Bresle method
ISO 8502-9,	Preparation of steel substrates before application of paints and related products – Test for the assessment of surface cleanliness – Part 9: Field method for the conductometric determination of water-soluble salts
ISO 8503,	Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast cleaned substrates
ISO 8504-2,	Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning
ISO 12944-4,	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 4: Types of surface and surface preparation
ISO 12944-5,	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 5: Protective paint systems
ISO 14919,	Thermal spraying — Wires, rods and cords for flame and arc spraying – Classification – Technical supply conditions
ISO 19840,	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Measurement of, and acceptance criteria for, the thickness of dry film on rough surfaces
ISO 20340,	Paints and varnishes – Performance requirements for protective paint systems for offshore and related structures
ISO 29601,	Paints and varnishes – Corrosion protection by protective paint systems - Assessment of porosity in a dry film
NORSOK M-001,	Materials selection
NORSOK R-004,	Piping and equipment insulation
NORSOK S-002,	Working environment
NS 476,	Paints and coatings – Approval and certification of surface treatment inspectors
SFS 8145,	Anticorrosive painting, surface preparation methods of blast cleaned and shop primer coated steel substrates and preparation grades for respective treatments

2.2 Informative references

None

3 Terms, definitions and abbreviations

For the purposes of this NORSOK standard, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

3.1.1

can

verbal form used for statements of possibility and capability, whether material, physical or casual

3.1.2

coat-back

continuation of passive fire protection along non fire critical steel work, from primary structural steel work, to reduce heat transfer

3.1.3

dry film thickness

DFT

thickness of a coat or a coating system remaining on the surface after hardening

NOTE The DFT is measured in accordance with ISO 19840.

3.1.3

feathered

gradual taper in thickness from a coated surface to an uncoated surface

3.1.5

holiday

discontinuity in a coating, which exhibits electrical conductivity, when exposed to a specific voltage

3.1.6

maximum operating temperature

maximum temperature including plant operation at unstable conditions

NOTE Unstable conditions include start-up/shutdown, control requirements and process upsets.

3.1.7

may

verbal form used to indicate a course of action permissible within the limits of this NORSOK standard

3.1.8

operating temperature

temperature during normal operation, including normal variations

3.1.9

shall

verbal form used to indicate requirements strictly to be followed in order to conform to this NORSOK standard and from which no deviation is permitted, unless accepted by all involved parties

3.1.10

shop primer

thin protective coating normally applied for protection during transport and storage

3.1.11**should**

verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required

3.1.12**stripe coat**

supplementary coat applied to ensure adequate protection of critical areas like edges, welds etc.

3.2 Abbreviations

ASTM	The American Society for Testing and Materials
CPS	coating procedure specification
CPT	coating procedure test
CSDS	coating system data sheet
DFT	dry film thickness
IMO	International Maritime Organization
ISO	International Organization for Standardization
ITP	inspection and test plan
MEK	methyl ethyl ketone
MSC	Maritime Safety Committee
NACE	National Association of Corrosion Engineers
NS	Norwegian Standard
OAR	Occupational Air Requirements
RAL	colour definitions issued by RAL (Deutsches Institut für Gütesicherung und Kennzeichnung e.V.)
RH	relative humidity
SCE	Standard Calomel Electrode
SFS	Finnish Standards Association
QC	quality control
VOC	volatile organic compound

4 General requirements**4.1 General**

Selection of coating systems and application procedures shall be made with due consideration to conditions during fabrication, installation and service of the installation.

Specific qualification requirements for products, personnel and companies are given in clause 10.

4.2 Planning

All activities shall be fully incorporated in the fabrication plan.

Details of management, inspectors, operators, facilities, equipment and qualified procedures shall be established and documented before commencing work.

Steel surfaces shall be blast cleaned and coated (i.e. metal sprayed or coated with primer and the succeeding coat of the applicable coating system) prior to installation.

4.3 Equipment protection and clean up

All equipment and structures shall be fully protected from mechanical damages, ingress of abrasives and dust from blast cleaning. Sags, droplets and paint over-spray (inclusive dry-spray) shall be avoided. Adjacent areas not to be painted or already finished shall be protected. On completion of the work in any area, all masking materials, spent abrasives, equipment etc. shall be removed.

4.4 Ambient conditions

No final blast cleaning or coating application shall be done if the relative humidity is more than 85 % and when the steel temperature is less than 3 °C above the dew point. Coating shall only be applied or cured at ambient and steel temperatures above 0 °C.

The coating manufacturer shall specify the maximum and minimum application and curing temperature and other relevant limitations regarding application and curing conditions for each product in any coating system.

4.5 Coating materials

The selected coating materials shall be suitable for the intended use and shall be selected after an evaluation of all relevant aspects such as

- corrosion protective properties,
- requirements to health, safety and environment,
- properties related to application conditions, equipment and personnel,
- experience with the coating materials and coating system,
- availability and economics of coating materials.

All coating materials and solvents shall be protected from ignition sources and shall remain within storage temperatures and storage conditions recommended by the coating manufacturer.

All coating materials and solvents shall be stored in the original container bearing the manufacturer's label and instructions. Each product shall have a batch number showing year and month of manufacture and giving full traceability of production. Shelf life shall be included in the technical data sheet.

Applicable coating systems are tabulated in Annex A.

Coating system no. 1, system no. 3B, system no. 4, system no. 5 and system no. 7 shall be pre-qualified in accordance with clause 10.

For those coating systems which are subject to pre-qualification, the specified coating systems are examples, and alternative coating systems may be used if the requirements of this NORSOK standard are fulfilled.

However, for coating system no. 1 and system no. 7 the number of coats and the coating film thicknesses given in Annex A are minimum requirements which shall apply for coating systems subject to pre-qualification testing.

Topcoat colours should be in accordance with Annex B. Light colours shall be used in ballast and fresh water tanks.

4.6 Steel materials

Steel subject to surface preparation on site shall as a minimum requirement be in accordance with rust-grade B according to ISO 8501-1. Shop primers shall be regarded as temporary corrosion protection and shall be removed prior to the application of the coating systems herein unless the requirements in 4.7 are fulfilled.

4.7 Shop primer

If a shop primer is considered left on the surface to form an integrated part of the final coating system, it shall be applied in accordance with the following:

- blast cleaning shall comply with ISO 8501-1 Sa 2½ and the surface shall remain at Sa 2½ until application of the primer. The primer shall consist of 1 coat zinc ethyl silicate primer with 15 µm thickness. Measured on a plane polished steel or glass test panel, the dry film thickness shall be maximum 25 µm.

Use of shop primer as an integrated part of the final coating system, can only be considered for coating system no. 1, system no. 3B, system no. 4, system no. 5, , system no. 7 and system no.8. For coating system 1, system no. 3B, system no. 4, system no. 5 and system no. 7, the pre-qualification requirements in 10.1 shall apply.

Areas with intact shop primer shall be sweep blasted to minimum lightly in accordance with SFS 8145; table 1, prior to application of the final coating system. All other areas shall be treated in accordance with the requirements for bare steel.

4.8 Unpainted surfaces

The following items shall not be coated unless otherwise specified:

- aluminium, titanium, uninsulated stainless steel, insulated stainless steel heating/ventilation/air-conditioning ducts, chrome plated, nickel plated, copper, brass, lead, plastic or similar;
- jacketing materials on insulated surfaces.

If stainless steel is connected to carbon steel, the stainless steel part shall be coated 50 mm beyond the weld zone onto the stainless steel. For piping and pressure vessels, the coating for the stainless steel part shall not contain metallic zinc.

4.9 Handling and shipping of coated items

Degreased, blast cleaned or coated items shall be carefully handled to avoid contaminations or damage to the surfaces. No handling shall be performed before the coating system is cured to an acceptable level.

Packing, handling and storage facilities shall be of non-metallic type.

4.10 Pre-qualification of products, personnel and procedures

Pre-qualification requirements as described in clause 10 shall be fulfilled and documented prior to commencement of any work in accordance with this NORSOK standard.

4.11 Metal coating

Hot-dip galvanising shall be in accordance with ISO 1461. Minimum coating thickness for structural items and outfitting steel shall be 125 µm and 900 g/m². Structural items shall be blast cleaned before hot-dip galvanising. When additional painting is specified, coating system no. 6 shall be used.

Metal spraying shall be in accordance with the requirements in this NORSOK standard.

4.12 Records and reports

All measurements and inspection results required by this NORSOK standard shall be recorded. The records shall provide traceability to the coated objects or associated parts of the coated objects and applied procedure (CPS) and qualification (CPT). All stages of the surface protection, pre-blasting operation, blasting and paint application shall be recorded in the painting report.

This includes

- all inspections and tests according to Table 3, including visual inspections and receive control at the paint shop,
- records of the thickness measurements, both average, minimum and maximum values and the number of measurements,
- percentage of thinner added to the paint,
- conditions during blasting, painting and curing,
- that the adhesion test shall be recorded according to ISO 4624,
- that the painting report shall include both required and obtained values,
- temperature during final curing when epoxy phenolic is used,
- curing test for zinc ethyl silicate, when used.

Defective work shall be reported and included in the records.

An example of painting report is given in Annex D.

Test reports shall be signed by the responsible inspector including title and inspector number.

4.13 Additional requirements to equipment

The following additional general requirements are applicable to surface protection of valves, actuators, gearboxes, pumps and motors:

- hand wheels and handles shall be in stainless steel or hot dip galvanised carbon steel according to ISO 1461;
- all bolt holes, not suitable for coating, shall as a minimum requirement, be preserved with wax. Unused threaded bolt holes, etc. shall be plugged or sealed.

Signs shall be fastened after painting operations are finished and the paint system is ready for handling.

Welds shall be continuous. Tack welding is not accepted.

Voids that cannot be blast cleaned and painted shall be closed.

All exposed surfaces on valves and flanges shall be blast cleaned and painted up to raised face or gasket area.

Care shall be made to prevent blasting or painting of any stem, valve stem tread, packing, packing nuts and bolts or other items which in normal operation are subject to frequent usage. Precautions shall be made to protect the bolts and nuts during the blasting and painting operations.

When coating system no. 2A or system no. 2B is required, equipment skids or other structures shall be designed in such a way that metalizing is possible.

5 Health, safety and environment

The following documentation shall be provided and used when evaluating coating systems:

- chemical name of organic solvent, occupational air requirements (OAR) number according to Norwegian regulations, and volatile organic components content (VOC) in g/l;
- percentage of low molecular epoxy (molecular weight < 700);
- content of hazardous substances, see NORSOK S-002;
- specification of hazardous thermal degradation components;
- combustibility;
- special handling precautions and personal protection.

All coating products shall as a minimum be in accordance with relevant Norwegian regulatory requirements regardless of where the coating operation takes place.

Content of silica and heavy metals in blast cleaning media (see ISO 8504-2) shall be given.

6 Surface preparation

6.1 Pre-blasting preparations

Sharp edges, fillets, corners and welds shall be rounded or smoothened by grinding to grade P3 as defined in ISO 8501-3 (minimum radius 2 mm).

Hard surface layers (e.g. resulting from flame cutting) shall be removed by grinding prior to blast cleaning.

The surfaces shall be free from any foreign matter such as weld flux, residue, slivers, oil, grease, salt etc. prior to blast cleaning. All surfaces should be washed with clean fresh water prior to blast cleaning.

All machined parts shall be cleaned with a solvent liquid suitable to remove any machining fluids.

Any oil and grease contamination shall be removed in accordance with ISO 12944-4, prior to blasting operations.

Any major surface defects, particularly surface laminations or scabs detrimental to the protective coating system shall be removed by suitable dressing. Where such defects have been revealed during blast cleaning, and dressing has been performed, the dressed area shall be re-blasted to the specified standard.

All welds shall be inspected and, if necessary, repaired prior to final blast cleaning of the area. Surface pores, cavities etc. shall be removed by suitable dressing or weld repair.

6.2 Blast cleaning

Blasting abrasives shall be dry, clean and free from contaminants, which will be detrimental to the performance of the coating.