REQUIREMENTS FOR CORROSION PROTECTIVE COATINGS

OSC-30-H004-Z-RA-00002

1107304 OCEAN SPACE CENTRE

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PROJECT OCEAN SPACE CENTRE

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1 Introduction

1.1 Scope of Work

The purpose of this document is to specify requirements for selection, application and inspection of corrosion protective coatings for carbon steel structures; including requirements for qualification of personnel and procedures, for the Ocean Space Center.

Original equipment, or systems that are delivered as a total delivery, where manufacturer/supplier can document the product's lifetime in the relevant corrosion class, either by testing or field service, is not regarded as part of scope for this specification.

1.2 Definitions and abbreviations

Definitions:

Company:	Statsbygg, which is the Norwegian government's key advisor in construction and property affairs, building commissioner, property manager and property developer.
Contractor:	Means the party named as such in the Form of Agreement
Subcontractor:	Means a Third Party who has entered into an agreement with the Contractor for the supply of goods or services in connection with the Work.
End-user:	SINTEF Ocean and NTNU
Work:	Means all work which Contractor shall perform or cause to be performed in accordance with the Contract
Company Materials:	Means equipment, systems, and/or materials supplied by Company, and which are to be incorporated in the Contract Object.

Abbreviations:

CSDS	-	Coating System Datasheet
CPS	-	Coating Procedure Specification
CPT	-	Coating Procedure Test
DFT	-	Dry Film Thickness
ISO	-	International Organization for Standardisation
ITP	-	Inspection and Test Plan
NACE	-	National Association of Corrosion Engineers
QC	-	Quality Control
RH	-	Relative Humidity

1.3 Standards and Regulations

The following standards/requirements and norms applies for the Work:

- ISO 2814:2006 - Paints and varnishes – Comparison of contrast ratio (hiding power) of paint of the same type and colour
- ISO 4624:2016 - Paints and varnishes – Pull-off test for adhesion
- ISO 8501-1:2007 - 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 8501-3:2006 - 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 8502-3:2017 - 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 (pressures sensitive tape method)
- ISO 8502-6:2006 - 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 Bressle method
- ISO 8502-9:2020 - 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 8503-1:2012 - Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast cleaned substrates – Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces
- ISO 8504-2:2019 - Preparation of steel substrates before application of paints and related products – Surface preparation methods – Part 2: Abrasive blast cleaning
- ISO 12944-5:2019 – Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 5: Protective paint systems
- ISO 19840:2012 - 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 29601:2011 - Paints and varnishes – Corrosion protection by protective paint systems – Assessment of porosity in a dry film
- NORSOK M-501:2012 – Surface preparation and protective coating

In addition, a document approved by EnergiNorge has been used: Paint specification for mechanical hydropower equipment, version 2020.

2 General requirements

2.1 Planning

All activities shall be fully incorporated in Supplier's fabrication plan.

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

2.1.1 Progress plan and Inspection and Test Plan (ITP)

The Supplier shall submit a detailed progress plan showing all stages of the painting process within the timeframes provided by the Buyer.

The Supplier shall also prepare an inspection and test plan (ITP) showing all planned inspections and tests.

All deviations from the progress plan related to the ITP shall be notified to the Buyer as soon as possible.

2.2 Equipment protection and clean up

All equipment 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.

Measures shall be taken so that there is no cross contamination between carbon and stainless steel materials.

2.3 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 deg. C above the dew point. Coating shall only be applied or cured at ambient and steel temperatures above 0 deg. C. Maximum steel temperature during application shall not exceed 35 deg. C.

Certain coating products may be applied or cured outside of the temperature limits specified above. In this event, the Supplier shall send a CR to Contractor for approval prior to commencement of coating work. The CR shall contain a recommendation from the coating manufacturer.

2.4 Coating materials

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 the year and month of manufacture and giving full traceability of production. Shelf life shall be included in the technical data sheet.

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.

2.5 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.

2.6 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/nickel plating
- Copper
- Brass
- Lead
- Plastic or similar

If stainless steel is connected to carbon steel, the stainless steel part shall be coated to 50 mm beyond the weld zone onto the stainless steel.

2.7 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 according to the coating manufacturer’s data sheet.

3 Surface preparation

3.1 Pre-blasting operations

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.

3.2 Blast cleaning

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

Size of abrasive particles for blast cleaning shall be such that the prepared surface profile height (anchor pattern profile) is in accordance with the requirements for the applicable coating system. The surface profile shall be graded in accordance with ISO 8503. Grit shall be used as blast medium. The grit shall be free from chlorides. In addition, the grit shall be non- metallic when used on stainless steel substrates.

The cleanliness of the blast cleaned surface shall be Sa 2 ½ per ISO 8501-1. Roughness shall be medium G, R_{y5} 50 – 85 µm per ISO 8503.

3.3 Final surface condition

The surface to be coated shall be clean, dry, free from oil/grease, and have the specified roughness and cleanliness until the first coat is applied.

Dust, blast abrasives etc. shall be removed from the surface after blast cleaning such that the particle quantity and particle size do not exceed rating 2 of ISO 8502-3.

The maximum content of soluble impurities on the blasted surface as sampled using ISO 8502-6 and distilled water, shall not exceed a conductivity measured in accordance with ISO 8502-9 corresponding to a NaCl content of 20 mg/m2.

4 Paint application

Contrasting colours shall be used for each coat of paint.

Hiding power of topcoat for specified colours shall be tested in accordance with ISO 2814. Contrast ratio shall not be less than 94 % at the specified topcoat thickness.

The coating manufacturer shall provide a TDS/CSDS for each coating system to be used, containing at least the following information for each product:

- surface pre-treatment requirements
- film thickness (maximum, minimum and specified)
- maximum and minimum re-coating intervals at relevant temperatures
- final curing time at relevant temperatures
- information on thinners to be used (quantities and type)
- coating repair system (qualified in accordance with Table 1)

4.1 Application equipment

The method of application shall be governed by the coating manufacturer's recommendation for the particular coating being applied.

Roller application of the first primer coat is not acceptable. When paints are applied by brush, the brush shall be of a style and quality acceptable to the coating manufacturer. Brush application shall be done so that a smooth coat, as uniform in thickness as possible, is obtained.

4.2 Application

For each coat, a stripe coat shall be applied by brush to all welds, corners, behind angles, edges of beams etc. and areas not fully reachable by spray in order to obtain the specified coverage and thickness.

Edges of existing coating shall be feathered towards the substrate prior to overcoating.

Each coat shall be applied uniformly over the entire surface. Skips, runs, sags and drips shall be avoided.

Each coat shall be free from pinholes, blisters and holidays.

Contamination of painted surfaces between coats shall be avoided. Any contamination shall be removed.

5 Inspection and Test Plan

The inspection and test plan below includes required quality control during all coating works. Surfaces shall be accessible until final inspection is carried out. The term “spot checks” shall be defined and agreed upon prior to start of work and included in the ITP in the coating procedure.

Table 1: Inspection and test plan

Test type	Method	Frequency	Acceptance criteria	Consequence
Environmental conditions	Ambient and steel temperature. Relative humidity. Dew point.	Before start of each shift + minimum twice per shift.	In accordance with specified requirements	No blasting or coating
Visual examination	Visual for sharp edges, weld spatter slivers, rust grade, etc. ISO 8501-3	100% of all surfaces	No defects, see specified requirements	Defects to be repaired
Cleanliness	a) ISO 8501-1 b) ISO 8502-3	a) 100 % visual of all surfaces b) Spot checks	a) In accordance with specified requirements b) Maximum quantity and size rating 2	a) Reblasting b) Recleaning and retesting until acceptable
Salt test	ISO 8502-6 and ISO8502-9	Spot checks	Maximum conductivity corresponding to 20 mg/m2 NaCl	Repeated washing with potable water and retesting until acceptable
Roughness	Comparator, stylus, instrument or testex tape (see ISO 8503)	Each component or once per 10 m2	Medium G, R_{y5}: 50-85 µm	Reblasting

Visual examination of coating	Visual to determine curing, contamination, solvent retention, pinholes/popping, sagging and surface defects	100% of surface after each coat	According to specified requirements	Repair of defects
Holiday detection	ISO 29601. Voltage see table 1	As per coating system specification	No holidays	Repair and retesting
Film thickness	ISO 19840. Calibration on a smooth surface	ISO 19840	ISO 19840, and coating system data sheet	Repair, additional coats or recoating as appropriate
Adhesion	ISO 4624, using equipment with an automatic centred pulling force, and carried out when coating system is fully cured	Spot checks	50% of the CPT value. Absolute minimum 5 MPa	Coating to be rejected

6 Documentation

The following documentation shall be compiled for all activities relating to painting. Documents shall be updated on a continuous basis and made available upon request.

6.1 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.

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

6.2 HSE plan

The Supplier shall submit an HSE plan to be implemented for the specific project. All personnel, including Subcontractors, must be familiar and comply with the HSE plan.

No coating work shall commence prior to Contractor’s approval of the HSE plan.

6.3 Records and reports

All measurements and inspection results required by this specification 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 1, 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
- defective work shall be reported and included in the records.

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

7 Qualification of companies and personnel

7.1 Companies

Companies performing work in accordance with this specification shall document experience in organizing, planning and execution of work with similar size and complexity.

Companies that can document former experience working with NORSOK M-501 requirements and a CPT not older than 3 years, are pre-qualified.

7.2 Qualification of paint operators

Operators shall be qualified to tradesman level as blast-cleaner, painter, applicator etc. The personnel shall have relevant knowledge of health and safety hazard, use of protection equipment, coating materials, mixing and thinning of coatings, coating pot-life, surface requirements etc.

Personnel not qualified to tradesman level, shall document training and experience to the same level as a formalized tradesman education.

7.3 Qualification of supervisors, foremen and QC personnel

Personnel carrying out inspection or verification shall be qualified in accordance with NS 476, Inspector level III, certified as NACE coating inspector level III or ICorr inspector level III.

Inspectors according to NS 476, Inspector level II, may carry out the inspection work under the supervision of an inspector level III.

Supervisors and foremen shall be qualified to tradesman level and should be qualified in accordance with NS 476, Inspector level II, or NACE level II.

7.4 Qualification of procedures

A detailed CPS based on the requirements of this specification shall be established. The CPS shall be prepared by the application contractor and contain the following:

- step by step information of the process (receive control, cleaning, blasting, coating and QC), including field welding where relevant
- identification of equipment for surface preparation and application
- information given on CSDS/TDS
- personal protective equipment to be used
- safety data sheets for each product
- product data sheets
- example of paint report
- repair procedure

The qualified CPS shall be followed during all coating work. No coating work shall commence before approval of the CPS by the Buyer.

The following changes in the coating application parameters require the CPS to be re-qualified:

- any change of coating material
- change of method and equipment for surface preparation and coating application.

The CPS shall be written in both English and in the first language for the paint operators. There shall only be one document.

7.5 Coating procedure test

A CPT shall be used to qualify all coating procedures. A test panel (minimum 1 m x 1 m) containing at least 1 pipe-end, 2 pipes, 1 angle and 1 flat bar shall be used.

The coating procedures shall be qualified under realistic conditions likely to be present during coating application.

Coating procedure tests approved within the last 3 years for previous projects or supplies and used within the last year may be used provided they comply with the above requirements.

8 Coating systems

8.1 Splash zone

Carbon and stainless steel in the splash zone shall be coated with minimum 2 coats of two component epoxy or polyester based coating. Minimum DFT shall be 600 µm.

8.2 Submerged components

Carbon steel submerged in water shall be coated with minimum 2 coats of two component epoxy or epoxy mastic. Minimum DFT shall be 500 µm.

8.3 Other components

Other carbon steel components shall be coated per ISO 12944-5, corrosivity category C3, durability very high, that comprises of the following coating system:

- 1st coat shall be a zinc rich primer with a DFT in the interval 60 – 80 µm.
- 2nd coat shall be a two-component epoxy.
- The total DFT of the system shall be 200 µm.

The zinc rich primer shall be in accordance with ISO 12944-5.

9 Repair

Minor coating damages in the top coat can be repaired by cleaning the area to remove oil, grease and other impurities followed by a roughening of the surface with sand paper. Dust is to be removed prior to application of the top coat.

Minor coating damages down to steel material shall be repaired by cleaning the area to remove oil, grease and other impurities followed by mechanical cleaning per ISO 8501-1 grade St3. Dust is to be removed prior to application of a full coating system.

For larger coating damages, the entire area shall be cleaned to remove oil, grease and other impurities followed by blast cleaning per ISO 8501-1 grade Sa 2 ½. Dust is to be removed prior to application of the full coating system.

What is regarded as minor or larger coating damage, as well as applicable products, shall be defined in the CPS per clause 7.4 of this document.