

GENERAL SPECIFICATION

CORROSION

GS EP COR 355

**External protection of piping and equipment by
thermal spray coating**

02	10/2012	Update following the EP reorganization, March 2011
01	01/2011	General review - New paint Supplier
00	10/2009	First issue
Rev.	Date	Purpose of the revision

Owning entity: DEV/TEC

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1. Scope

This General Specification defines the technical requirements for the execution of Thermal spray works of new built offshore or coastal piping and equipment. The specification is based on high durability protection - more than 15 years.

This general specification does not cover protection systems for temporary equipment or equipment with design life less than 10 years.

Thermal spray coatings can be used as the protective coatings for atmospheric exposure, under thermal insulation, hot surface and all others conditions describe in particular specification approved by Company.

Thermal spray coatings use high heat, and aluminium dust can ignite and explode under certain conditions. Rigorous safety precautions shall be taken when thermal spray coatings are applied, particularly automated thermal spray aluminium coatings ([ISO 14713](#)).

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
ACQPA	"Association pour la Certification et la Qualification en Peinture Anticorrosion". Painting systems certified by ACQPA www.acqpa.com
ASTM D 4940	Standard test method for conductimetric analysis of water soluble ionic contamination of blasting abrasives
ISO 11124 (Parts 2; 3; 4)	Preparation of steel substrates before application of paints and related products. Specifications for metallic blast-cleaning abrasives - Parts 2; 3; 4
ISO 11125 (Parts 1; 2; 3; 4; 5; 6; 7)	Preparation of steel substrates before application of paints and related products. Methods for testing metallic blast-cleaning abrasives - Parts 1; 2; 3; 4; 5; 6; 7
ISO 11126 (Parts 7; 8; 10)	Preparation of steel substrates before application of paints and related products. Specifications for non-metallic blast-cleaning abrasives: fused aluminium oxide, olivine sand, and garnet - Parts 7; 8; 10
ISO 11127 (Parts 1; 2; 3; 4; 5; 6; 7)	Preparation of steel substrates before application of paints and related products. Methods for testing non-metallic blast-cleaning abrasives - Parts 1; 2; 3; 4; 5; 6; 7

Reference	Title
ISO 12944 (Parts 1; 2; 3; 4; 7; 8)	Paints and varnishes - Corrosion protection of steel structures by paint systems - Parts 1; 2; 3; 4; 7; 8
ISO 14713	Protection against corrosion of iron and steel in structures - zinc and aluminium coatings - Guidelines
ISO 14919	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 films on rough surfaces
ISO 2063	Metallic and other inorganic coatings - Thermal spraying - Zinc, aluminium and their alloys
ISO 209	Aluminium and aluminium alloys - Chemical composition
ISO 2808	Paints and varnishes. Determination of film thickness
ISO 4628 (Parts 1; 2; 3; 4; 5; 6)	Evaluation of paint and varnish defects. Designation of intensity, quantity and size of common types of defect - Parts 1; 2; 3; 4; 5; 6
ISO 8501 (Parts 1; 2; 3)	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness - Parts 1; 2; 3
ISO 8502 (Parts 1; 2; 3; 4; 6; 9)	Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness - Parts 1; 2; 3; 4; 6; 9
ISO 8503 (Parts 1; 2; 3; 4)	Preparation of steel substrates before application of paints and related products. Surface profile of abrasive blast-cleaned steel - Parts 1; 2; 3; 4
ISO 8504 (Parts 1; 2; 3)	Preparation of steel substrates before application of paints and related products. Methods for surface preparation - Parts 1; 2; 3

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
Not applicable	

3. Surfaces to be coated

The thermal spray coatings and sealers shall be applied in accordance with the principles of good workmanship described in [ISO 2063](#).

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Only sealers (tie coat) specified in appendix shall be applied.

The sealers based on epoxy resin shall be applied for operating temperature resistance less than 80°C, above sealer based on silicone shall be considered.

All surfaces shall be protected using the relevant specified process.

4. Items not to be coated

The following items shall not be coated:

- Valve stems, flange faces, instrumentation components (pressure gauges, etc.)

and any other machined contact surfaces.

- Surfaces within 5 cm of pipe joint ends or steel edges for welding operations
- Electrical wiring and cabling, plastics, rubber, and glass
- Nameplates, permanent labels, or instruction decals.

Suitable masking material shall be utilized on areas where Thermal Spray Coating is not required. The principal shall approve the locations and adequacy of masking prior to spray operations.

5. Choice of wires, rods and cords

The wires, rods and cords for flame and arc spraying shall be supplied in accordance with the [ISO 14919](#) ([ISO 209](#)).

Maximum operating temperature when zinc or alloys of zinc metal coating is used is 120°C.

6. Sealing

Sealer or Tie coat paint chosen in appendix is defined according to the following parameters:

- Type of substrate
- Atmosphere or environment
- Minimum and maximum Operating temperatures.

The nominal thicknesses of the sealer or tie coat are:

- Based on resin epoxy: 30/40 micrometers
- Based on silicone: 20/30 micrometers.

7. Certification of personnel

7.1 Operators

Operators shall be individually certified by an approved organization ([ACQPA](#), [FROSIO](#), etc.) according to the [ISO 2063](#).

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7.2 Inspectors

Inspectors shall be individually certified by an approved organization ([ACQPA](#), FROSIO, NACE International minimum level 3 with peer review, etc.).

8. Technical content of tenders

Tenders shall include the following information:

- Proposed thermal spray process
- Proposed type and characteristics of alloy wire
- Product data sheets
- Proposed qualification program
- List of derogations to the present General Specification, if any
- Terms and conditions of guarantee
- A statement showing that all parties involved (Contractor, Supplier, and Applicator) will be carrying out the work according to the present specification, or if relevant, to the project particular specification, including derogations duly agreed by TEC/COR before Contract award. This statement shall also show that the guarantee is jointly underwritten by all parties and specify the durations and performance levels of the guarantee. This statement can consist in a letter signed by the head office of each party involved
- Nominal thickness and tolerance
- Surface preparation and application procedure
- Inspection test plan with acceptance criteria and frequency of inspection
- A list of inspection and application equipment to be used
- Methods of protection of items to be painted against adverse weather conditions
- Certificates ([ACQPA](#), FROSIO, NACE, or equivalent) of Operators and Inspectors.

9. Surface preparation

9.1 Design and preparation before blasting of surfaces to be coated

All piping and equipment shall be designed according to [ISO 12944](#) international standard for high durability painting systems.

All sharp edges shall be rounded (minimum radius > 2 mm).

The design of the item to be treated shall be such that it creates no interstice and inaccessible area.

All oil or grease shall be removed by washing the item to be treated with appropriate solvents or any other suitable means before beginning of blast-cleaning operations. This includes bolt holes in piping assemblies.

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Weld spatter and remains of temporary welds, deposits or surface defects shall be eliminated by appropriate means; removal by deep grinding is subject to Company approval.

All mating surfaces of equipment subject to outdoor exposure shall be coated with the full coating system prior to assembly (saddles, skirts, base plates, oiled components, flanges, etc.).

Contractor shall protect all equipment that is not to be treated or may be affected by the presence of abrasives or paint. Special attention shall be paid to avoid splashes of zinc paint on equipment made of austenitic steels.

9.2 Quality of abrasives

Abrasives shall be sealed in watertight packaging. Any product delivered in defective packaging shall be rejected. Products must be stored sheltered from the elements.

Conductivity of abrasives shall be less than $150 \cdot 10^{-6}$ SIEMENS/cm as per [ASTM D 4940](#) ([ISO 11124/ISO 11125/ISO 11126/ISO 11127](#)).

The use of copper slag or silica sand is **strictly** prohibited.

9.3 Blast cleaning of carbon steel

All surfaces to be treated shall be blast-cleaned ([ISO 8504](#)) until degree of cleanliness Sa 3 according to [ISO 8501-1](#).

The surface profile shall be "G" medium according to [ISO 8503](#) with a minimum Ra equal to 10 micrometer.

After blast-cleaning, all dust must be removed using a vacuum cleaner before application of the Thermal spray coating in order to obtain a minimum dust level: less than 1 according to [ISO 8502-3](#).

Before thermal spray works commence surface contamination shall be checked and in particular the salts contamination according ([ISO 8502-6](#) & [ISO 8502-9](#)).

All blast-cleaned surfaces shall be coated before the deterioration of the degree of cleanliness. In any case, any surface that has been blast-cleaned shall be coated on the same day.

The blast cleaning procedure shall be submitted to Company for approval.

9.4 Blast cleaning of stainless steels

Stainless steels shall be segregated, carbon steel supports for storage shall be systematically painted, and lifting equipment shall prevent iron contamination.

Stainless steel surfaces to be coated shall be etched or degreased and blast-cleaned with a non-ferrous and chlorine-free abrasive.

The blast cleaning procedure to be submitted to Company shall include:

- Abrasive composition to obtain a surface roughness of $Ra = 10/13$ microns
- Dust level (maximum level 1 maximum according to [ISO 8502-3](#))
- Substrate contamination checks ferrous contamination/direct colorimetry method using Prussian blue (potassium ferricyanide) - no surface pollution is acceptable.

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10. Thermal Spray Coating application

10.1 Procurement and storage

The quantities of alloys wire, rods and paint required to perform the entire job shall be procured before the work commences.

Thinners, solvents, etc. shall be stored in a suitably ventilated fireproofed building, separate from other painting consumables.

The products shall be delivered in their original sealed packaging and stored in such conditions as to avoid their degradation (controlled temperature, etc.). The packaging shall be clearly marked with the product description, the batch number, the fabrication date and the expiry date.

10.2 Samples for QA/QC purposes

From each batch of products used during the work, the Contractor shall take two samples to be made available to Company.

10.3 Qualification of application procedure of thermal Spray Coating

One month before work commences, all the selected systems shall be applied on test plates representative of the structure to be coated. The products used shall be sampled from the same batches than these intended for the works.

The thermal spray coating shall be applied in the presence of the Company representative, in climatic conditions that are as similar as possible to worst case conditions that can be foreseen during the work on the construction site. Application shall be performed by the coater specialist who will be responsible for application during the work, using the same equipment that will be used during the work.

When the thermal spray coating is applied, visual inspection and adhesion testing shall be carried out to confirm that the performance of the thermal spray coating correspond to the value them indicated in particular specification, procedure and Inspection test plan.

Application of the sealer or tie coat on the thermal spray coating shall be performed during the qualification of application to validate the procedure to avoid the potential risk of pinholing and others defects.

10.4 Kick off meeting

A technical kick off meeting shall be organized by the Contractor in the presence of Company specialists (TEC/COR) and Supplier to review all the details regarding the work, application procedures, and inspection test plan. All the documentation shall be submitted to Company for review at least two (2) weeks prior to this meeting.

Supplier shall provide Contractor with technical assistance. All recommendations made by Supplier other than these outlined in datasheets or in the present specification shall be supported by a written statement from Supplier head office.

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10.5 Thermal Spray Coating application

10.5.1 General

Thermal spray coating shall always be applied to surfaces that are dry, clean and degreased, and grit blasted before the degradation of the surface preparation.

Thermal spray coating works shall not proceed if:

- Temperature of the substrate is less than 3°C above the dew point
- The relative humidity is more than 85% RH
- The weather is rainy or foggy, except under shelter, and subject to verification of the atmospheric conditions.

Contractor shall keep a daily record of the dew point, relative humidity, ambient atmosphere and substrate temperatures (all measured before the work commences and twice per shift and when ambient conditions are obviously changing) to ensure that conditions are acceptable. These records shall be kept and made available to Company.

Application shall be by flame or electrical arc.

The thickness of thermal spray coating, including frequency and tolerance shall be checked by the Contractor according to [ISO 2808](#). The values shall be recorded and made available to Company.

The thermal spray coating shall be firmly adherent. The surface after spraying shall be uniform and free of lumps, loosely adherent spattered metal, bubbles, ash formation, defects and uncoated spots.

Before application of any further coat, any damage to the previous coat shall be repaired.

10.6 Repairs

Any defect shall be repaired before the application of the tie coat. Subject to the agreement of Company, and after determining the type and size of the defects, the following methods of repair shall be applied.

In case of defect of the sealer or tie coat as pinholes or others a complementary coat could be applied.

10.6.1 Major defects

The Thermal spray coating shall be removed completely by abrasive blast-cleaning and the entire system shall be re-applied.

10.6.2 Minor defects (localized appearance, mechanical damage, scratches, etc.)

Subject to the agreement of the Company, the thermal spray coating shall be removed by localized blast-cleaning, the edges of the sound coating shall be feathered back to 50 mm minimum, and the full repair system shall be applied.

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11. Checks, inspection and acceptance

11.1 Checks

Throughout the duration of the work, Contractor's Quality Control department shall check the following points and record the results in its daily quality control report in accordance with the [ISO 2063](#).

- Construction quality:
 - Rounding of corners, sharp edges to 2 mm radius minimum
 - Form, quality and continuity of welds.
- Surface preparation quality:
 - Grade of cleanliness: Sa 3 (mandatory) according to [ISO 8501](#)
 - Cleanliness: no grease or oil, dust level 1 maximum according to [ISO 8502-3](#)
 - Anchoring profile: G medium according to [ISO 8502](#) for carbon steel substrate and by roughness measurement for another substrate as stainless steel.
- Contamination including chlorides: according to [ISO 8502-6](#) and [ISO 8502-9](#), 30 mg/m² maximum
- Climatic conditions for application all measured before the work commences and twice per shift and when the ambient conditions are obviously changing): temperature of substrate at least 3°C above dew point, maximum humidity 85% RH, ambient temperature (> 10°C for epoxy, weather conditions
- Dry Film Thicknesses of thermal spray coating according to [ISO 2808](#)
- Dry Film Thicknesses of sealer (tie coat) according to [ISO 19840](#)
- Adhesion according to [ISO 2063](#), Annex A1, Grid test
- Appearance and colour
- Visual inspection results: no defects such as cracking, bubbling, pinholes, runs and sags, blistering, etc.

11.2 Inspection test plan

An inspection test plan including all the points in section 9.1 shall be prepared and submitted to Company. The Inspection Test Plan shall clearly indicate frequency of testing for each check.

11.3 Company inspection

Company Inspector shall have free access to storage areas, workshops, yards where the works will be performed. Contractor shall also provide Company Inspector with all office facilities necessary for the execution of his work (telephone, fax, handling equipment, measuring instruments with valid calibration certificates, etc.).

Upon arrival of Company Inspector on site, Contractor shall supply him with all relevant documentation regarding the works to be carried out.

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11.4 Provisional acceptance

For provisional acceptance, Company shall check that all inspections set out in section 11.1 have been carried out and that all results are satisfactory.

11.5 Guarantee

The Work shall be covered by a specific guarantee given by Contractor to complete Guarantees and warranties defined in the Engineering, Procurement, Supply, Construction and Commissioning Contract (EPSCC 1113 - Article 20 "GUARANTEES AND WARRANTIES").

Contractor guarantees that the Work shall be covered by performance warranties in accordance with the following requirements of the Contract:

- The maximum degree of rust shall be Ri2 according to [ISO 4628](#).

Guarantee shall be provided for the duration of **10 years**.

Beginning of Warranty Period starts from the effective date of the PROVISIONAL ACCEPTANCE CERTIFICATE for painting works.

11.6 Final acceptance

At the end of the Warranty Period a joint inspection of Work by Company and Contractor shall be carried out before issuance of the FINAL ACCEPTANCE CERTIFICATE for painting works to determine if any claims are raised.

12. Technical file

Contractor shall hand over a technical file to Company at the end of the works which shall include:

- All inspection reports
- Provisional acceptance reports
- Guarantee certificates
- Insurance certificates for the guarantee.



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Bibliography

ISO 9223

Corrosion of metals and alloys. Atmospheres' corrosivity.
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Appendix 1

Appendix 1 List of approved Suppliers for the sealer (tie coat)

Supplier	Code	Phone No.	Fax No.	Remarks
CARBOLINE	C	+33 1 60 06 55 66	+33 1 60 06 55 70	Carboline.France @stoncor.com
CHUGOKU	Ch	+31 167 526 100	+31 167 522 059	x.hagenaars@cmpeurope.eu
HEMPEL	H	+33 3 44 08 28 90	+33 3 44 08 28 99	jmb@hempel.com dbo@hempel.com
INTERNATIONAL COATINGS	I	+33 2 35 22 13 72	+33 2 35 22 13 78	Frederic.coulon@akzonobel.com
JOTUN	J	+33 1 45 19 38 87	+33 1 45 19 38 94	Xavier.dubois@jotun.com
PPG	P	+33 1 70 03 11 11	+33 1 70 03 11 06	Pascal.digonnet@ppg.com

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Appendix 2

Appendix 2 List of approved sealers (tie coats)

Paint Supplier	Code	Sealer for operating temperature less than or equal 80°C	Sealer for operating temperature* above 80°C	Remarks
CARBOLINE	C	Carboguard 193 primer	Thermaline 4700	
CHUGOKU	Ch	Bannoh 500	Silicon HR Silver	
HEMPEL	H	Hempadur 1557	Silcone Alu 5691	
INTERNATIONAL COATINGS	I	Intergard 269	Intertherm 50	
JOTUN	J	Penguard Tie coat 100	Solvalitt	
PPG	P	SigmaCover 522	SigmaTherm 540	

* Less than 400°C