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TECHNICAL SPECIFICATION

Doc No: DSF-SPC-MEC-010

Rev. 1

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HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

CORROSION PROTECTION OF HOT BENDS

JUNE 2021

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1. INTRODUCTION

2. SCOPE AND OBJECTIVES

2.1 ITEM

This specification specifies the minimum requirements for the surface preparation, coating application, inspection and testing of a two component polyurethane coating of buried hot bends of gas pipeline to be executed in shop.

2.2 SERVICE TEMPERATURE

The service temperature of the pipeline will be from -15° C to +50° C. However, coated hot bends may be stored at ambient temperatures down to -20° C and with a surface temperature up to 80° C under the sun.

3. REFERENCES

3.1 Reference Documents

- Job Specification DSF-SPC-PIP-031 [HotBends]

3.2 Reference Codes and Standards

- **EN 10288** - Steel tubes and fittings for onshore and offshore pipelines - External two layer extruded polyethylene based coatings
- **EN 10289** - Steel tubes and fittings for onshore and offshore pipelines - external two layer extruded polyethylene based coatings
- **ISO 2409** [Paints and Varnishes - Cross-cut Test]
- **ISO 4624** [Paints and Varnishes - Pull-off Test for Adhesion]
- **ISO 4587** [Adhesives - Determination of Tensile Lap-Shear Strength of Rigid-to-Rigid Bonded Assemblies]
- **EN 10290** [Steel tubes and fittings for onshore and offshore pipelines - External liquid applied polyurethane and polyurethane-modified coatings]
- **EN ISO 8501-1** [Preparation of steel substrates before application of paints and related



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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]

- **EN ISO 8502-2** [Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface cleanliness - Part 2: Laboratory determination of chloride on cleaned surfaces]
- **EN 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]
- **EN ISO 8504-2** [Preparation of steel substrates before application of paints and related products - Surface preparation methods - Part 2: Abrasive blast-cleaning]
- **EN ISO 2808** [Paints and varnishes - Determination of film thickness]

All standards or codes mentioned in this specification are valid in their latest version or by the relative superseded edition.

4. ACRONYMS

5. GENERAL REQUIREMENTS

5.1 GENERAL

All coating materials, production and repair procedures as well as test methods shall be approved by the Owner or his Representative before coating starts.

Coating application procedures shall be documented and monitored by the Contractor. Written records shall be maintained by qualified personnel.

The procedures shall include:

- Complete details of the coating materials, together with quality control and Contractor's certification sheets, and of materials storage, which shall be in accordance with the Contractor's recommendations;



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- Surface preparation, including number, type and size of cleaning machines, grades and types of abrasive, removal of steel defects, cleanliness, surface profile and methods of measurement;
- Application of coating, including details of application temperatures, curing times and methods, cutback and beveling methods and acceptable prevailing working conditions (humidity, dust and temperature);
- Inspection and testing, including instrument and equipment types, makes and uses;
- Details of instrument and equipment calibration methods, including relevant standards and examples of calibration certificates;
- Coating defect repair methods and materials.
- Storage, handling and transport procedures.

A record of hot bends serial numbers shall be kept for Owner's information. This record shall contain all information on the delivered hot bends, i.e. types, damages, repairs, transfer of serial numbers.

These records shall be available at all times for Owner's Representative review. At the completion of coating operations, the Contractor shall satisfactorily account for all materials or shall reimburse the Owner for the full cost of any materials not balanced.

6. MATERIALS

6.1 The coating material and cured coating film shall be two-component polyurethane and shall meet the requirements of **EN 10290**. The Contractor shall provide all information described in paragraph 13.

6.2 Prior to the commencement of the coating works the Contractor shall carry qualification tests to demonstrate that the polyurethane coating is in accordance with requirements of this specification.

The test program, which shall be witnessed by the Owner, shall be based on the application of the coating to two hot bends and to three test panels.

The test requirements are specified in Table 1 and shall be submitted to the Owner for approval.



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7. SURFACE PREPARATION

All preparation and coating works shall be carried out in a fully enclosed weatherproof workshop.

Hot bends, which have not been coated within three hours, shall be re-blasted.

Blast cleaning shall be suspended if the pipe surface temperature drops 3° C below the dew point.

The hot bends surface shall be dried before blast cleaning.

All weld spatter, grease, oil, etc. shall be removed prior to blasting.

The ends of the hot bends shall be protected with plugs in order to prevent entry of the abrasive into the pipe during the blast cleaning.

Unless otherwise agreed, surfaces shall be cleaned by abrasive blasting to at least degree SA 2 1/2 according to **EN ISO 8501-1**. Angular sharp grit or a mixture of grit and shot shall be used. Shot applied alone is not be accepted. Blast cleaning abrasives shall be agreed with the Owner.

The use of sand is not permitted. After blast cleaning, the surface profile shall have an average peak to trough height of 50 µm and a maximum of 90 µm. This shall be measured in accordance to **EN ISO 8503-2**, or other method approved by the Owner. Dust on the hot bend exterior shall be removed directly before coating by a method which is approved by the Owner, for example compressed dry air followed by vacuum cleaning.

Abrasive materials shall be employed in accordance with **EN ISO 8504-2**.

Blasting abrasives shall be kept dry, clean and free from contamination. Airlines shall be filtered to remove oil and moisture. Blasting abrasive shall be cleaned by a dust extraction system, which removes fine particles the size of which will be determined after the initial site testing.

When recovered metallic grit systems are used, a stabilized working mix of blast cleaning material shall be established and maintained throughout the entire course of the production by frequent small additions from fresh or cleaned stock at a rate sufficient to replenish consumption. Large additions of new material shall be avoided. Report verifications of the mix quality shall be submitted to Owner by the Contractor.

Blasting and other dust producing areas shall be kept separate from coating application areas.



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The blast-cleaned surface shall not be contaminated with dirt, dust, metal particles, hydrocarbons, water, or any other foreign matter, which are detrimental to the coating.

8. COATING APPLICATION

The coating will be applied with hot airless spray from a machine where the material components are mixed within the spray head.

The machine shall be equipped with adequate filters to avoid intuition of foreign substances or other particles.

The wet film will be monitored using suitable metal comb gages to ensure that the required dry film thickness will be achieved. The number of over coats shall be such to obtain a total thickness of 1500 microns.

The coating works shall proceed when ambient temperature is above 5°C, the relative humidity is under 85% and the surface to be coated is at temperature at least 3° C above the dew point of the surrounding atmosphere during all the time of the coating operation.

The finished coating shall be left off at hot bend ends at a length of 150 mm ± 15 mm, in order the welding of the hot bend to the pipeline to be performed without damage to the coating.

9. INSPECTION AND TESTING

9.1 GENERAL

An office and all necessary facilities required for the performance of his work shall be made available to the Owner's Representative by the Contractor.

Inspection and testing shall be carried out by the Contractor and, unless otherwise agreed, in the presence of the Owner's Representative.

Inspection activities shall be as follows:

- Inspection of surface cleaning.
- Visual inspection.
- Inspection of coating thickness.
- Inspection of coating adhesion.
- Holiday testing.

Inspection and testing requirements are specified in Table 2.



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9.2 SURFACE CLEANING

All surfaces shall be free from dust or chloride contamination. Three items shall be tested at random per shift for surface contamination in accordance to **EN ISO 8501-1** and **EN ISO 8502-2**. No surface shall have in excess of 2µg/cm² chloride.

9.3 VISUAL INSPECTION

Every hot bend shall be visually inspected. The coating shall be continuous and free of blisters, pinholes, scratches or any other irregularities and shall be of uniform color and gloss.

9.4 COATING THICKNESS

Coating thickness shall be measured using non-destructive instrument approved by the Owner and in accordance with **EN ISO 2808**. Instruments shall be calibrated at least once per 8 hour period or work shift, whichever is the shortest period.

Wet film thickness checks shall be carried out as spraying progresses in accordance with **EN ISO 2808** Method 7B. Dry film thickness checks shall be carried out on the cured coating in accordance with **EN ISO 2808** Method 6. Three sets of thickness measurements shall be made on each hot bend.

Each set of measurements will consist of four readings at equidistant points around the hot bend. The average value of each set of four measurements shall comply with the specified minimum coating thickness and no individual reading shall be less than 75% of the minimum thickness.

9.5 COATING ADHESION

One hot bend from each shift or per 5 hot bends, whichever is the more frequent, shall be tested for adhesion of the coating. The coating adhesion at a randomly selected location on the item shall be determined by the following method.

Using a heavy-duty short-bladed knife two incisions of approximately 15mm in length shall be made in the coating. The incisions shall fully penetrate the coating through to the steel surface and shall cross through each other to form an "X" with an angle of intersection of



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approximately 30 degrees. Commencing at the intersection, an attempt shall be made to lift the coating from the steel substrate using the blade of the knife.

Peel-away from the point of intersection of more than the critical dimension or brittle breakaway of flakes of more than the critical dimension in size, shall be deemed a failure. The critical dimension shall be 2 mm unless specified otherwise by the Owner. Cohesive failures, caused by voids leaving a honeycomb structure on the surface, shall be deemed a failure.

9.6 HOLIDAY TESTING

The Contractor shall (holiday) detect porosity 100% of the coated surface in accordance with **EN 10290**. The testing shall be carried out by means of a high voltage holiday detector supplied by the Contractor of a type approved by the Owner.

According to **EN 10290** the test voltage shall be set at 8 kV/mm of measured thickness but the maximum allowable test voltage is 20 kV.

10. REPAIRS

All damages to polyurethane coating shall be repaired. Hot bends with coating defect greater than 50 cm² (in total) shall be rejected to complete stripping and recoating. All repairs to the coated hot bends shall be made at Contractor's expenses. A coating system compatible with the original and having identical characteristics shall be used.

10.1 CLEANING

The damaged area shall be cleaned of foreign bodies and loose bits of polyurethane material.

The surface shall be cleaned by abrasion of the exposed metal substrate until equivalent to SA2 1/2 grade **EN ISO 8501-1** and roughening of the surrounding coating will be achieved.



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10.2 APPLICATION OF COATING

The appropriate number of coats shall be applied in order to achieve the specified coating thickness, using material and procedures approved by the Owner. If required, Contractor shall perform a procedure test in the presence of the Owner's Representative.

10.3 INSPECTION OF THE REPAIRED AREA

The repaired area shall be holiday tested according the requirements of paragraph 9.6 in order to verify the successful coating work.

11. MARKING

11.1 Each package of coating materials shall include the following marking:

- Contractor's name.
- Premises of Contractor.
- Production batch number
- Time limit for use.
- Any special safety or storage instructions relevant to the batches.
- Condition of application of any repair product.

11.2 Marking of the hot bend shall be made at the length of 100 mm from the ends.

12. HANDLING. STORAGE AND TRANSPORT

Instruction regarding handling, storage and transportation of hot bends are referred in Job Specifications listed in "Reference Documents"

When handling the hot bends non-metallic slings spreader bars or protected hooks shall be used.

The coated hot bends shall be transported in such a manner that the existing coating is not in contact with a hard surface, which may damage the coating.

Storage of coated hot bends shall be executed in such a manner to avoid any damage of the polyurethane coating.



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13. TECHNICAL DOCUMENTATION

13.1 WITH TENDER

Contractor shall submit the following:

- Request for deviations, if any, from the specified requirements.
- Raw material Contractors' data sheets, including health and safety data, viscosity relative density, mixing ratio, pot life and flash point.
- Written quality assurance procedures, standard operating procedures, and repair procedures.
- Request for approval of coating materials, production and repair procedures as well as test methods not elsewhere defined.

13.2 AFTER AWARD OF CONTRACT

Contractor shall submit the results of all test of the coating material as defined in this specification. The tests shall be in accordance with the requirements of **EN 10290** and shall include the following:

- a) Impact strength.
- b) Indentation resistance.
- c) Flexibility.
- d) Elongation at break.
- e) Coating resistivity.
- f) Heat reversion.
- g) Cathodic disbonding.

13.3 ON DELIVERY

Contractor shall submit Contractor's Certified Test Report containing the results of performed prequalification and production testing and other requirements in this specification.

The manufacturer in the certificate declares that the materials supplied are in compliance with the requirements of the order and the test results are submitted with the certificate.



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The certificate is validated by the Manufacturer's authorized Representative, independent from the manufacturing department.

However, the following tests shall have been witnessed by the Owner's Representative: Surface profile, coating thickness, holiday detection, and adhesion tests.

Raw material certificates for each batch of materials used.

TABLE 1
INSPECTION SUMMARY FOR PROCEDURE QUALIFICATION TEST

Work Stage	Relevant Paragraph	Acceptable Values	No. of Tests
Before Cleaning			
• Oil Contamination	7	No indication of oil contamination	All hot bends
After Cleaning			
• Cleanliness	7	Sa 2 1/2	All hot bends
• Profile	7	50 - 90 µm	All hot bends
• Chloride	7	2 µg/cm ²	All hot bends
• Dust and Oil	7	No indication of dust or oil contamination	All hot bends
Finished Coating			
• Coating Thickness	8	1500 Mm (min)	All hot bends
• Coating Adhesion	9.5	2mm max, no honeycombing	(2x4 per hot bend)
• Holidays	9.6	No holidays	All hot bends
• Visual Examination	9.3	Continuous, uniform color, free from blisters, pinholes,	All hot bends



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• Cut Backs	8	scratches and irregularities 150 ± 15mm	All hot bends
Finished Coating on Test Panels			
• Impact Strength	6		3 test panels
• Indentation Resistance	6		
• Flexibility	6	As per coating material data	Each test panel may
• Elongation at break	6	sheets	be used for more
• Coating Resistivity	6		than one test
• Heat Reversion	6		As per EN 10290
• Cathodic Disbanding	6		
• CO ₂	6		
• Heat reversion/ageing	6		

TABLE 2

INSPECTION SUMMARY FOR PRODUCTION TESTING

Work Stage	Relevant Paragraph	Acceptable Values	No. of Tests
Before Cleaning			
• Oil Contamination	7	No indication of oil contamination	All hot bends
After Cleaning			
• Cleanliness	7	Sa 2 1/2	All hot bends
• Profile	7	50 - 90 µm	All hot bends
• Chloride	7	2 µg/cm ²	3 per Shift
• Dust and Oil	7	No indication of dust or oil contamination	All hot bends
Finished Coating			
• Coating Thickness	8	1500 pm (min)	All hot bends
• Coating Adhesion	9.5	2mm max, no honeycombing	(2x4 per hot bend)
• Holidays	9.6	No holidays	All hot bends



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• Visual Examination	9.3	Continuous, uniform colour, free from blisters, pinholes, scratches and irregularities	All hot bends
• Cut Backs	8	150 ± 15mm	All hot bends