



GENERAL SPECIFICATION

CORROSION

GS EP COR 225

**Polyethylene and Polypropylene coatings for bends
and fittings**

04	10/2009	Chemical conversion treatments
03	10/2008	Changes in epoxy adhesion tests
02	10/2006	General updating, especially for selection of epoxy primer
01	10/2005	Transformation in Corporate General Specification and general review
00	10/0204	First issue
Rev.	Date	Notes

Contents

1. Scope	4
1.1 Definitions of main parties involved	4
2. Reference documents.....	4
3. Obligations of APPPLICATORS and MANUFACTURERS	6
3.1 COMPANY requirements regarding coating products	6
3.2 Qualification of APPLICATOR's plant and coating system	7
3.3 Notification prior starting coating work.....	8
3.4 Acceptance certificates.....	8
4. Coating system and characteristics of the raw materials and repair products.....	8
4.1 Coating System	8
4.2 Marking and identification	9
4.3 Characteristics of epoxy primer	9
4.4 Characteristics of the top coat material	10
5. Application of the coating	12
5.1 Surface preparation	12
5.2 Coating	13
6. Characteristics of applied coating.....	14
6.1 Aspect.....	14
6.2 Thickness.....	14
6.3 Electrical porosity.....	14
6.4 Cut-backs.....	14
6.5 Other characteristics.....	15
7. Inspection	16
7.1 Inspection of coating materials and repair product conformity	16
7.2 Inspection of the various application parameters of the coating materials	16
7.3 Systematic inspection of each bend or fitting	18
7.4 Inspection of coating or test samples taken from coating.....	19
8. Handling, transport and storage rules	21



8.1	Handling.....	21
8.2	Transfer to storage yard	21
8.3	Storage yard of the APPLICATOR	21
8.4	Bends and fittings loading for shipment.....	21
9.	Reporting	21
Appendix 1	Summary of Qualification and Fabrication tests	22

1. Scope

This specification covers the manufacturing of multi layers PE and PP external anti corrosion coatings for bends and fittings for onshore and offshore pipelines.

It is limited to raw materials used in powder form.

PE top coat will be used for service temperature between -40°C and +80°C (depending on the type of epoxy primer used).

PP top coat will be used for service temperature between -20°C and +110°C (depending on the type of epoxy primer used).

Preferably, the choice of coating type for bends and fittings will relate to the coating of the corresponding line-pipe:

- PE for three layers PE coating of line-pipe as per **GS EP COR 220**
- PP for three layers PP coating of line-pipe as per **GS EP COR 221**.

All other choices or combinations will be submitted to COMPANY for approval.

1.1 Definitions of main parties involved

For the purposes of this specification, the following terms and definitions apply.

1.1.1 MANUFACTURER

The COMPANY which produces and sells the products used for the coating shall be referred to herein as the "MANUFACTURER".

1.1.2 APPLICATOR

The COMPANY in charge of the plant coating application and quality control which is eventually sub-contracted by the CONTRACTOR shall be referred to herein as the "APPLICATOR".

1.1.3 INSPECTOR

The COMPANY's representatives or members from COMPANY elected Inspection Bodies for the time being or from time to time duly appointed in writing by the COMPANY to act as its representatives for the purpose of the contract shall be referred to herein as the "INSPECTOR".

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
ASTM D 570	Standard Test Method for Water Absorption of Plastics
ASTM D 4940	Standard test method for conductimetric analysis of water soluble ionic contamination of blasting abrasives
CAN/CSA Z245-20	External fusion bond epoxy coating for steel pipe

Reference	Title
ISO 306	Plastics - Thermoplastic materials - Determination of Vicat softening temperature
ISO 527-1	Plastics - Determination of tensile properties - Part 1: General principles
ISO 527-2	Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics
ISO 868	Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)
ISO 1133	Plastics - Determination of the melt-mass flow rate (MFR) and melt-volume flow rate (MVR) of thermoplastics
ISO 2808	Paints and varnishes - Determination of film thickness
ISO 2811-1	Paints and varnishes - Determination of density - Part 1: Pycnometer method
ISO 6964	Polyolefine pipes and fittings: Determination of carbon black content by calcinations and pyrolysis: Test method and basic principles
ISO 8130-6	Coating powders - Part 6: Determination of gel time of thermosetting coating powders at a given temperature
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 8502-3	Preparation of steel substrates before application of paints and related products - Tests 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 - Tests 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. Tests for the assessment of surface cleanliness: Field method for conductometric determination of water-soluble salts
ISO 8503-4	Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates - Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile - Stylus instrument procedure

Reference	Title
ISO TR 10837	Determination of the thermal stability of Polyethylene for use in gas pipes and fittings
NF A49-710	External three layer polyethylene based coating

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP COR 220	Three layer polyethylene external coating for pipelines
GS EP COR 221	Three layer polypropylene external coating for pipelines
GS EP COR 420	External field joint coatings of pipelines

3. Obligations of APPLICATORS and MANUFACTURERS

3.1 COMPANY requirements regarding coating products

The APPLICATOR shall, in his tender, submit the data sheets of its selected products concerning the epoxy primer material and the top coat product for approval.

The APPLICATOR shall inform by writing the MANUFACTURERS of the epoxy and the top coat of the COMPANY requirements related to:

- Test certificates, properties requirements and conformity certificates as detailed in the present document. A copy of this written notice shall be sent to COMPANY
- The packaging of the epoxy powder: The MANUFACTURER shall deliver the product in waterproof plastic bags to prevent water contamination and absorption of humidity during storage and transportation.

Once approved the epoxy primer material and top coat product shall not be changed by the APPLICATOR.

Approval of the products by the COMPANY shall not, under any circumstances, be considered as a guarantee from the COMPANY with respect to coating materials and repair products but simply as an authorisation for use.

3.2 Qualification of APPLICATOR's plant and coating system

Qualification of the proposed application plant, personnel, coating method and products shall be carried out in due time through a Procedure Qualification Trial (PQT). Qualification shall be organised jointly by the CONTRACTOR and the APPLICATOR, and witnessed by a COMPANY representative. Qualification testing shall be organised at least 2 months before the works start in order to ensure that a suitable solution can be implemented in case of test results fail to meet the requirements of this specification.

Qualification shall consist of the following step:

- Raw materials (epoxy, PE or PP top coat):
 - Conformity certificates (see § 4) and tests results for materials requirements (see § 4) shall be submitted to COMPANY for approval prior to the start of qualification process of the coating
 - Certificate of analysis (see § 4) for each batch of product used for qualification process shall be submitted to COMPANY.

Note:

- Coating process: Witnessed by COMPANY representative and in accordance with § 5. Coating process parameters shall be fully recorded during PQT. Same parameters shall be used for production, with a maximum discrepancy of 5% for each parameter.
- Coating properties: Witnessed by COMPANY representative and in accordance with § 6.

A summary of Qualification tests as well as acceptance criteria and frequency is given in Appendix 1. The CONTRACTOR and APPLICATOR shall submit a complete joint report of the Qualification test results to the COMPANY for approval.

Once approved, the system (considered as all individual components as a whole) will be considered as qualified in the corresponding coating plant. Any change in the components of the system shall lead to a new qualification process. The qualification of the system is valid for a duration of three years. Renewal of the qualification is based on a technical visit and/or track record. A new PQT can be requested in case of quality issues noted on the line during the three years duration.

- At start of production a PPT (Pre Production Test) shall be carried out, consisting mainly of reinforced test frequency over the first pipes of the first shift of production, as

described in Appendix 1 (typically five pipes, but can be more, subject to COMPANY decision).

3.3 Notification prior starting coating work

The CONTRACTOR shall notify the COMPANY, at least eight working days before production start up, for the dates of starting coating process to allow mobilisation of the COMPANY designated Inspector.

The Inspector shall have free access to the workshops, storage yards and laboratory of the APPLICATOR who shall also provide him with all the facilities necessary for the proper execution of his work (i.e. office, telephone and fax, handling equipment, measuring instruments with calibration certificates, etc.).

Upon arrival at the coating plant, the Inspector shall receive from the main CONTRACTOR the documents supplied by the APPLICATOR.

3.4 Acceptance certificates

The CONTRACTOR and the APPLICATOR shall sign jointly with the Inspector the coated bends and fittings acceptance certificate including the results of all tests and inspection as set forth in this specification.

The acceptance certificate of coated bends and fittings shall certify that all tests and inspections have been performed by the APPLICATOR under the responsibility of the CONTRACTOR for all COMPANY ordered bends and fittings and have been witnessed by the Inspector.

One copy of the acceptance certificates shall be transmitted to COMPANY and one copy to the Inspector.

4. Coating system and characteristics of the raw materials and repair products

For each raw material (epoxy, PE or PP top coat), the requirements are as follow:

- Nature and type of raw material
- Technical requirements
- Content of conformity certificate
- Content of certificate of analysis.

4.1 Coating System

It shall consist of:

- One epoxy primer
- One chemically modified PE or PP top coat.

Both products shall be applied in powder form.

4.2 Marking and identification

Raw materials shall be clearly identified with the following markings (whatever the packaging of the product):

- Name of MANUFACTURER
- Production plant
- Name of product
- Batch number
- Date of manufacture (epoxy only)
- Shelf life (epoxy only). For PE and PP top coat, a shelf life of one year (starting at reception of material by APPLICATOR) shall be considered, provided the product is stored according to MANUFACTURER's recommendation (To be found in Materials Safety Data Sheets).

4.3 Characteristics of epoxy primer

4.3.1 Nature and type

The epoxy primer shall be 100% solid powder form. The use of a liquid epoxy is not allowed.

4.3.2 Technical requirements

The epoxy primer shall meet the technical requirements specified in Table 1.

Table 1 - Technical requirements for epoxy primer

Characteristic	Methods	Units	Acceptable Values
Moisture content	Powder: 20 g Temperature: 105°C Time: 30 min	%	0.5 (max.)
Glass transition temperature *	Differential Scanning Calorimeter (DSC)	°C	no less than 100°C for fully cured material
Bend test	CAN/CSA Z245-20 , Clause 12.11 2.5° at minimum temperature		No holiday
Water absorption (demineralised water)	ASTM D 570 on a free film of 500 microns ± 50 thickness	%wt	Less than 15% of weight uptake after 28 days at 80°C

* Tg shall be understood here as inflection point on the DSC spectra.

4.3.3 Content of conformity certificate

The conformity certificate is a document issued by the raw material MANUFACTURER (specific to each raw material). It is a list of physical or chemical characteristics controlled for every production batches. For each of these characteristics, a conformity range is reported by the MANUFACTURER.

The conformity certificate shall include the following information (as a minimum, but not limited to):

- Name of MANUFACTURER
- Name of product
- Manufacturing plant
- Date of issue
- Name, function and signature of the person issuing the document.

Characteristics	Methods	Units	Conformity range
Gel time	ISO 8130-6	seconds	MANUFACTURER specification
Density	ISO 2811-1	g/ml	MANUFACTURER specification
Glass transition T°			
First heating		°C	MANUFACTURER specification
Second heating		°C	MANUFACTURER specification and as per Table 1
Enthalpie		J/g	MANUFACTURER specification
IR Spectra			MANUFACTURER specification
Particle size analysis	MANUFACTURER		MANUFACTURER specification
Moisture content	MANUFACTURER		MANUFACTURER specification and as per Table 1

Conformity certificate shall be considered valid for one year, provided there is no change of any kind for the product for that period.

When submitted to COMPANY for approval during qualification, COMPANY reserves the right to ask for changes with regards to MANUFACTURER's specification ranges for each characteristic.

4.3.4 Content of certificate of analysis

The certificate of analysis is issued by raw material MANUFACTURER with every batch of product. It reports all characteristics controlled on the corresponding batch.

The content of certificate of analysis shall be equivalent to the conformity certificate, except that measured values shall be reported instead of conformity range or MANUFACTURER specification.

4.4 Characteristics of the top coat material

4.4.1 Nature and type

4.4.1.1 PE top coat

It shall be based on linear type (i.e. low pressure manufacturing process) PE with grafted reactive sites to react on the epoxy primer. It shall be applied in powder form, stabilized with carbon black for UV resistance and anti oxidant for thermal stability.

4.4.1.2 PP top coat

It shall be based on copolymers with grafted reactive sites. It shall be applied in powder form, and stabilized with titanium dioxide and anti oxidant for thermal stability and UV resistance.

4.4.2 Technical requirements

The COMPANY requirements are given in Table 2.

Table 2 - Technical requirements for top coat

Characteristics	Standards	Units	Acceptable values PE	Acceptable values PP
Carbon black content	ISO 6964	%	≥ 2.5	N/A
OIT	ISO TR 10837	min	> 20 at 200°C	> 20 at 220°C
VICAT Softening point (9.8 N)	ISO 306	°C	≥ 80	≥ 120
Melt Flow Rate	ISO 1133	g/10 min	> 5 (190°C; 2.16kg)	> 5 (230°C; 2.16kg)

In addition:

- A full DSC spectra shall be provided once for each product, from - 40°C up to 250°C Heating rate 20°C/min, cooling rate 10°C/min (first and second heating)
- DMTA spectra shall be provided once at a frequency of one Hertz from - 40°C up to 250°C.

4.4.3 Content of conformity certificate

The conformity certificate is a document issued by the raw material MANUFACTURER (specific to each raw material). It is a list of physical or chemical characteristics controlled for every production batches. For each of these characteristics, a conformity range is reported by the MANUFACTURER.

The conformity certificate shall include the following information (as a minimum, but not limited to):

- Name of MANUFACTURER
- Name of product
- Manufacturing plant
- Date of issue
- Name, function and signature of the person issuing the document.

Characteristics	Methods	Units	Conformity range
Melt Flow Index	ISO 1133	g/10 min	MANUFACTURER specification and as per Table 2
OIT	ISO TR 10837	min	MANUFACTURER specification and as per Table 2
Reactive site content	MANUFACTURER		MANUFACTURER specification
Particle size analysis	MANUFACTURER		MANUFACTURER specification

Conformity certificate shall be considered valid for one year, provided there is no change of any kind for the product for that period.

When submitted to COMPANY for approval during qualification, COMPANY reserves the right to ask for changes with regards to MANUFACTURER's specification ranges for each characteristic.

4.4.4 Content of certificate of analysis

The certificate of analysis is issued by raw material MANUFACTURER with every batch of product. It reports all characteristics controlled on the corresponding batch.

The content of certificate of analysis shall be equivalent to the conformity certificate, except that measured values shall be reported instead of conformity range or MANUFACTURER specification.

5. Application of the coating

5.1 Surface preparation

- Before abrasive blasting, the bends or fittings surface shall be inspected and cleaned to remove all traces of oil, grease and loose deposits. Any visible trace of oil or grease shall be removed using an appropriate non-oily and non-toxic product.
- Salt contamination shall be checked before abrasive cleaning and shall be lower than 2 micrograms per square cm as per ISO 8502-6 and ISO 8502-9.
- All bends or fittings shall be preheated (40 to 70°C) before abrasive blasting. Temperature shall be checked continuously with infra red camera.
- The surface shall be blast cleaned to Sa3 as per ISO 8501-1.
- The grit shall be selected so that the average roughness Ry5 (as per ISO 8503-4) obtained ranges from 60 to 90 microns (as per ISO 8503-4). The use of replica tape to assess the roughness is not allowed. At start of production, cleanliness and salt contamination of abrasives shall be checked as per ASTM D 4940: Conductivity shall be lower than 1000 microSiemens/cm and no oil visible after 30 minutes. No Silica grit is allowed.
- Immediately after abrasive blasting, all dust and traces of abrasives shall be removed from the pipe surface by brushing and vacuum cleaning. Maximum acceptable level shall be 2 according to ISO 8502-3.
- Each cleaned bend or fitting shall be inspected for surface defects. Any defect shall be removed.

- h) Cleaned bends or fittings shall then be coated before degradation of surface preparation. They shall not be left in a moist and/or salt contaminated atmosphere. The metal temperature shall be 3°C above the ambient dew point temperature. Any bends or fittings which have not been coated before degradation of their surface preparation shall be completely re-blasted before coating.

5.2 Coating

Conversion chemical treatment of the surface of steel (e.g. using chromates/phosphate/Acid wash or any kind of treatment) to improve adhesion or durability is subject to COMPANY approval. In all cases, the required adhesion and CD test in this specification shall be obtained only by using suitable powder epoxy primer and surface preparation process. This shall be demonstrated during PQT by coating some linepipes with and without conversion chemical treatment, in order to show that required adhesion and CD properties of the present specification are obtained without treatment. The opportunity to implement a surface chemical treatment shall be based on specific requirements such as high temperature and/or high durability in hot/wet environment. In that case, additional specific tests to assess the durability of such treatment will be required.

All the process parameters shall be recorded during PQT. For PPT and production, these parameters shall strictly remain within a 5% error margin (especially line speed).

5.2.1 Powder epoxy primer application

The bends or fittings shall be heated by induction electrical oven, whichever is the most adapted. The temperature of the pipe and the intercoat time (between primer and top coat) shall be set according to the gel time of the epoxy primer and following the epoxy MANUFACTURER recommendation, in order to obtain, as a minimum, adhesion values required in Table 5 (and within 5% of recorded value during PQT). Heterogeneity of temperature over the whole bend or fitting shall be 10°C maximum.

The powder epoxy primer is sprayed using electrostatic spray guns. The thickness of the coat shall be at least 150 microns (as per [ISO 2808](#), method 10). The proposed value shall be documented by the APPLICATOR. Care should be taken as to avoid any contamination of the primer layer by subsequent powder top coat.

5.2.2 Top coat application

The PE or PP top coat shall be applied as follows:

- The first layer shall be applied immediately after primer application and within the gel time of the epoxy at considered steel temperature. **Any failure to do so shall result in rejection of the coated piece with no further examination. It shall be within 5% of recorded value during PQT.**
- Subsequently, to build the correct thickness, several methods can be used to melt the layer over which a new powder layer is applied (Amongst them are flame spray or oven melting).

5.2.3 Cooling

Temperature shall be such that handling of the coated bend or fitting leaves no marking or degradation on the coating.

6. Characteristics of applied coating

The coating shall meet the characteristics below according to the following methods and acceptance values.

6.1 Aspect

The coating shall be of a uniform colour and aspect, and free of any surface defect detrimental to its quality. It shall not show any crack, blister, lamination, wrinkle or disbonding.

6.2 Thickness

As agreed between COMPANY and APPLICATOR during qualification.

6.3 Electrical porosity

The finished coating shall be free of porosity. It shall be demonstrated using a holiday detector set to 10 kV per mm of coating thickness (25 kV maximum).

6.4 Cut-backs

As a minimum, a 150 mm + 20/-0 mm cut-back shall be provided at each end unless otherwise specified. In any case the cut back length shall be determined by the pipe laying CONTRACTOR in relation with the coating APPLICATOR(s) to take into account the coating yard requirements and the welding process heat input effect on the coating.

The coating shall be cut just after cooling and removed manually or mechanically with power brushes. The stripped steel ends shall be brushed clean. Epoxy primer shall be visible for a few millimeters at cut back to avoid any disbonding during storage.

The ends of the PE or PP coating shall be bevelled in order to ensure a satisfactory bonding of field joint material on site. The bevel angle shall be approximately 30 to 45°.

The cut backs shall be protected by peeling varnish in order to avoid rusting of the bare metal during storage/transportation.

6.5 Other characteristics

Table 5 - Characteristics of applied coating

Characteristics	Methods	Units	Acceptable values for PE coating	Acceptable values for PP coating
Impact resistance at 23°C ± 2°C	NF A49-710	Joules/mm	≥ 5	≥ 7
Shore D hardness	ISO 868	Shore D	≥ 45	≥ 55
Resistance to peeling	NF A49-710 at max service temperature ± 2°C	N/50 mm	> 150 Cohesive failure within top coat No Peeling between steel and epoxy	> 200 Cohesive failure within top coat No peeling between steel and epoxy
Elongation at break at 23°C ± 2°C for top coat	ISO 527	%	>10	> 40
Peeling speed	5 cm strip	mm/min	No peeling for 15 kg weight at max service temperature	No peeling for 20 kg weight at max service temperature
OIT	ISO TR 10837	min	>20 (200°C)	>20 (220°C)
Homogeneity of the coating in the thickness	Visual		No microvoids or bubbles within the layers	No microvoids or bubbles within the layers
Cathodic disbonding	Appendix 8 of GS EP COR 220 Rev.06 after 28 days at 23 ± 2°C* after 48hr at 65°C ± 2°C after 28 days at maximum operating temperature*	mm	< 5 < 3 < 15	< 5 < 3 < 15

* Cathodic disbonding tests at 28 days are mandatory during **qualification process** described in chapter 3.2. Test result shall be known before start of production.

7. Inspection

Coating inspection shall be carried out by the APPLICATOR in the presence of the Inspector from the beginning of the work and throughout production. It shall include the following four operations:

- Inspection of the epoxy powder and top coat deliveries and conformity with the requirements
- Verification of the various application parameters of the epoxy primer and the top coat
- Systematic inspection of coating or test samples taken from bend or fitting end
- Inspection of coated bends or fittings.

The Inspector may take samples of the coating materials and test specimens of coated bends or fittings for testing in laboratories selected by the COMPANY in order to check the quality of the tested products. These tests will be at COMPANY cost if their results are satisfactory but they will be back charged to the CONTRACTOR/APPLICATOR if the coating material are not in accordance with this specification requirements.

7.1 Inspection of coating materials and repair product conformity

Inspection shall be performed upon delivery of the coating materials and repair product in order to check packaging, markings and ensure that certificates of analysis for all materials fall within certificate of conformity.

Packaging and storage shall be in accordance with the MANUFACTURER's instructions and this specification and markings shall be in conformity with this specification.

Non-conformity with any of the specified requirements shall cause the immediate rejection of the delivery.

In order to cater for any dispute arising at a later stage, three 50 g samples of each raw coating material shall be taken from each production batch. One shall be reserved for the APPLICATOR, one shall be transmitted to the COMPANY and one shall be kept as a check sample in the APPLICATOR's laboratory for six months, away from humidity at a temperature below and close to 20°C.

7.2 Inspection of the various application parameters of the coating materials

Inspection shall be performed during coating application in order to check the following parameters:

- Climatic conditions (Air and steel temperature, dew point)
- Preheating temperature
- Finish of prepared surface
- Dust level of prepared surface
- Roughness (Ry5) of prepared surface
- Steel temperature before epoxy application
- Intercoat time
- Temperature after cooling.

7.2.1 Climatic conditions, surface cleanliness and preheating temperature

Bends before grit blasting shall be checked for oil, grease and loose deposit contaminations. Pre heating temperature shall be checked by IR camera. After grit blasting, bends shall be checked for storage conditions and temperature.

Frequency:

Continuously and/or 100% of surface of the bends and fittings.

Specification requirements:

No contamination of bend surface before grit blasting.

Pre heating temperature: 40 to 70°C.

Salt contamination lower than 2 micrograms per square cm as per [ISO 8502-6](#) and [ISO 8502-9](#) before sand blasting and temperature 3°C above dew point for bends after grit blasting.

7.2.2 Finish of prepared surface

Frequency:

100% of the prepared surface of each bend shall be inspected.

Specification requirements:

Surface preparation shall be Sa3 as per [ISO 8501-1](#).

7.2.3 Dust level of grit blasted surface

Frequency:

100% of the prepared surface shall be checked.

Specification requirements:

Maximum acceptable level shall be 2 according to [ISO 8502-3](#).

7.2.4 Average roughness Ry5 of grit blasted surface

Surface profile roughness required -Ry5- shall be measured with electronic apparatus according to [ISO 8503-4](#).

Frequency:

All bends and fittings shall be checked.

Specification requirements:

Ry5 values shall be between 60 and 90 microns.

7.2.5 Bend temperature before epoxy application

Control of temperature shall be made with optical pyrometer (Infra red camera) and temperature recorder. Other apparatus can be used after approval by COMPANY. Homogeneity of temperature over the whole bend shall also be checked.

Frequency:

All bends and fittings.

Specification requirements:

Temperature shall be in accordance with § 5.2.1.

7.2.6 Application of top coat**Frequency:**

All bends and fittings.

Specification requirements:

The application process shall be in accordance with § 5.2.2.

7.3 Systematic inspection of each bend or fitting

The following inspection shall be performed after coating application on each bend and fitting cooled down to ambient temperature:

- Visual aspect, homogeneous colour
- Thickness with electromagnetic gauges (individual thickness print and general histogram / one per shift)
- Cut-backs length with ruler or specific gauge
- Electrical porosity.

7.3.1 Thickness**Frequency:**

All bend and fitting.

Specification requirement:

As per § 6.2.

7.3.2 Cut-back**Frequency:**

Each bend and fitting.

Specification requirement:

As per § 6.4.

7.3.3 Electrical porosity**Frequency:**

Each bend and fitting.

Specification requirement:

As per § 6.3.

The holiday detector shall be calibrated once per shift.

7.4 Inspection of coating or test samples taken from coating

The inspection shall be performed upon completion of coating application on dry coated bends cooled down to ambient temperature in order to check the following characteristics:

- Epoxy layer thickness
- Top coat layer thickness
- Impact resistance
- Shore D hardness
- Peeling force/speed
- OIT
- Elongation at break
- Visual inspection of homogeneity of the coating within its thickness (samples used for peeling tests can be used for that purpose)
- Cathodic disbondment.

The corresponding standards for each property are reported in Table 5.

7.4.1 Epoxy layer thickness

Frequency:

PQT, PPT and production: All bends.

Specification requirements:

Results shall be in accordance with § 5.2.a.

7.4.2 Impact resistance

Frequency:

PQT and PPT: One bend. Production: One test per shift.

Specification requirements:

Energy shall be equal or more than 5 Joules per mm of specified nominal coating thickness for PE and 7 Joules per mm for PP.

The coating shall be examined with a holiday detector, over the points of impact, at a voltage of 10 kV per mm of coating thickness (maximum 25 kV).

7.4.3 Shore D hardness

Frequency:

PQT and PPT: One bend. Production: One test per shift.

Specification requirements:

Average equal or more than 45 (Shore D) for PE and 55 for PP after 15 seconds.

7.4.4 Resistance to peeling / Peeling force:

Frequency:

PQT and PPT: One bend. Production: Once per shift.

Specification requirements:

For PE: Peel strength higher than 150N/5 cm at service temperature (with cohesive failure) or alternatively no peeling with a weight of 15 kg at service temperature for 5 cm strip.

For PP: Peel strength higher than 200N/5 cm at service temperature (with cohesive failure) or alternatively no peeling with a weight of 20 kg at service temperature for 5 cm strip.

No peeling allowed between steel and epoxy.

7.4.5 OIT

Frequency:

PQT and PPT: One bend. Production: Once per shift.

Specification requirement:

For PE: Higher than 20 min at 200°C as per [ISO TR 10837](#).

For PP: Higher than 20 min at 220°C as per [ISO TR 10837](#).

7.4.6 Elongation at break

Frequency:

PQT and PPT: One bend. Production: Once per shift.

Specification requirement:

See Table 5.

7.4.7 Homogeneity of the coating

Frequency:

PQT, PPT and production: All bends.

Specification requirements:

Samples used can be from peeling tests. Within the thickness of the layer, there shall be no microvoids and/or microbubbles. The inspection is visual.

7.4.8 Cathodic disbonding

Equipment:

As per [GS EP COR 220](#) Rev.06, appendix 8.

Frequency:

PQT and PPT: One bend. Production: One test every 2 shifts at $65 \pm 2^\circ\text{C}$ during 48 hours.

Specification requirements:

See Table 5.

8. Handling, transport and storage rules

The APPLICATOR shall be responsible for any damage occurring to the bends and fittings from unloading at reception of the bare pieces to loading of the coated pieces for shipment.

The APPLICATOR shall consequently:

- Inspect the bare pieces upon delivery to check that they have not suffered previous damage
- Take all necessary precautionary measures to prevent any deterioration during the following operations:
 - Handling
 - Transfer to storage yard
 - Storage
 - Loading of bends and fittings for shipment.

All repairs and inspection shall be at the APPLICATOR's expense.

8.1 Handling

The bends and fittings shall be handled without causing damage to the bevels and coating.

8.2 Transfer to storage yard

During transport to a storage yard, the APPLICATOR shall take all the required actions to avoid damages to the bends and fittings.

8.3 Storage yard of the APPLICATOR

Stockpiling of coated bends or fittings is not allowed. If coated bends or fittings are to be stored for more than 6 months, they shall be protected against ultraviolet rays.

8.4 Bends and fittings loading for shipment

During loading for shipment, the APPLICATOR shall take all necessary actions to avoid the deterioration of pieces and coating during handling and transport.

9. Reporting

The coating APPLICATOR shall deliver, at the end of the coating application, a report containing all the coating material certificates, inspection results including bend or fitting reference number, the list of all rejected coated pieces reference numbers, the reason for rejection and what was eventually the corrective action for these pieces.

Appendix 1 Summary of Qualification and Fabrication tests

Tests / Checks	Requirements	PQT	PPT	Fabrication
1. Preheating	40 to 70°C	All pieces	All bends	IR camera monitoring - All
2. Surface preparation				
• Degree of cleanliness	A or B Sa 2 ½ or C SA 3 No oil, grease contaminations	All	All	All
• Salt contamination	Lower than 2 micrograms per square cm	All	All	All
• Dust level	Equal or less than 2	All	All	All
• Roughness	60 ≤ Ry5 ≤ 90 μm	All	All	All
• Steel temperature	+ 3°C above dew point	All	All	All
3. Coating application				
• Pipe temperature	See § 5.2.1	All	All	All
• Intercoat time	See § 5.2.1 and 5.2.2	All	All	All
• Top coat application	See § 5.2.2	All	All	All
• Cooling	See § 5.2.3	All	All	All
4. Raw materials				
Conformity certificate	See § 4.3.3 and 4.4.3	Each Raw materials	Each raw material	N/A
<u>Tests results</u>		Each raw materials	Each raw material	N/A
• Epoxy primer	See § 4.3.2			
• Top coat	See § 4.4.2			
Certificate of analysis	See § 4.3.4 and 4.4.4	Every batch	Every batch	Every batch

Tests / Checks	Requirements	PQT	PPT	Fabrication
5. Coating	Visual aspect: Homogeneous colour	All	All	All
• Thickness	See § 6.2	All	All	All
• Epoxy thickness	See § 5.2.1	All	All	All
• Holiday detection	See § 6.3	All	All	All
• Cut-back	See § 6.4	All at both ends	All	All at both ends
• Impact resistance	See Table 5	All	One bend	One per shift
• Shore D hardness	See Table 5	All	One bend	One per shift
• Peeling force	See Table 5	All	One bend	One per shift as per § 7.4.4
• OIT	See Table 5	All	One bend	One per shift
• Homogeneity of the coating	Visual inspection. No micro voids or micro bubbles	All	All	One per shift
• Elongation at break	See Table 5	All	One bend	One per shift
• Cathodic disbonding	See Table 5	One bend as per Table 5*	One bend	One every two shift as per § 7.4.8

* Cathodic disbonding tests at 28 days are mandatory during **qualification process** described in chapter 3.2. Test result shall be known before start of production.