



Exploration & Production

GENERAL SPECIFICATION

CORROSION

GS COR 420

External field joint coatings of pipelines

02	10/04	General review, abrasive blast cleaning for onshore applications of heat shrinkable sleeves
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1. Scope

This specification covers the external field joint coatings applied for ensuring the continuity of anticorrosion to the steel surface which is left bare when plant coated seamless or welded pipes are joined by welding to constitute pipelines used for onshore or offshore oil, gas or water transportation.

Pipelines coated with these types of coatings are protected by means of cathodic protection.

As requested in [ISO 13623](#), field joints shall be protected with a coating system which is compatible with the line pipe coating and allow satisfactory application under the predicted field conditions. The performance of field joint coating should ideally meet or exceed the factory applied coating on line pipes.

This specification defines the possible different types of coatings for buried and immersed pipelines as described in Table 1 as a function of the plant coating existing on the pipes as defined in Table 2.

The type(s) of field joint coating(s) accepted for a given project is/are specified in a Project Specification in reference with the codification given in the present document.

For examples:

- Polyethylene based heat shrinkable sleeves applied on liquid epoxy primer: Field joint coating type 1B
- Flame sprayed polypropylene applied on a FBE primer: Field joint coating type 3A.

In absence of a Project Specification or specific requirement in the tender or order, the field joint coating type(s) accepted are given in Table 2 as a function of the plant coating of tubes.

Except when otherwise stated in the present document, requirements of [NF A49-716](#) fully apply for the different types of field joint coatings.

For each of the field joint coating type, the present document specifies the minimum requirements for the following:

- Applicator's obligations
- Nature, description and composition of coatings
- Application of coatings
- Characteristics of coatings
- Qualification testing
- Pre-production and production testing and inspection

Repairs of plant and field joint coatings are also addressed in the present document.

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
NF A 49-716	Steel tube - External constitution of tube and fitting coating for welded joint
EN 12068	Cathodic protection - External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection - Tapes and shrinkable materials.
NF A49-710	Steel pipes: External coating with three layer polyethylene based coating: application by extrusion.
NF A49-711	Steel pipes: External coating with three layer polypropylene based coating: application by extrusion.
DIN 30670	Polyethylene coating of steel pipes and components
DIN 30678	Polypropylene coating of steel pipes and components
ISO 13623	Petroleum and natural gas industries – Pipeline transportation system
ISO 11124-2 to 4	Preparation of steel substrates before application of paints and related products. Specifications for metallic blast-cleaning abrasives
ISO 11125-1 to 7	Preparation of steel substrates before application of paints and related products. Methods for testing metallic blast-cleaning abrasives
ISO 11126-7	Preparation of steel substrates before application of paints and related products. Specifications for non-metallic blast-cleaning abrasives: fused aluminium oxide
ISO 11127-1 to 7	Preparation of steel substrates before application of paints and related products. Methods for testing non-metallic blast-cleaning abrasives
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 8501-2	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 2: Visual assessment of surface cleanliness
ISO 8502-1 to 4	Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness
ISO 8502-6	Preparation of steel substrates before application of paints and related products. Tests for the assessment of surface cleanliness: extraction of soluble contaminants for analysis - the Bresle method

Reference	Title
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 8503-1 to 4	Preparation of steel substrates before application of paints and related products. Surface profile of abrasive blast-cleaned steel
ISO 306	Plastics - Thermoplastic materials - Determination of Vicat softening temperature (VST)
ISO 527-3	Plastics -Determination of tensile properties - Part 3: Test conditions for films and sheets
ISO 1133	Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics
ISO 868	Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)
ISO 1183	Plastics - Methods for determining the density and relative density of non-cellular plastics
ISO 4287	Geometrical Product Specifications (GPS) - Surface texture : profile method - Terms, definitions and surface texture parameters
ISO 11357-2	Plastics - Differential scanning calorimetry (DSC) - Part 2: Determination of glass transition temperature
DIN 53151	Testing of paints, varnishes and similar coating materials, cross-cut test on paint coatings and similar coatings
DIN 53153	Testing of paints, varnishes and similar coating materials; Buchholz indentation test on paint coatings and similar coating
EN 10204	Metallic products - Types of inspection documents
BS 3900 - E1 (70)	Bend test (Cylindrical Mandrel)

Professional Documents

Reference	Title
NACE RP 0402	Field-applied fusion-bonded epoxy (FBE) pipe coating systems for girth weld joints: Application, performance, and quality control
NACE RP 0190	External protective coatings for joints, fittings, and valves on metallic underground or submerged pipelines and piping systems
NACE RP 0394	Application, performance, and quality control of plant-applied, fusion-bonded epoxy external pipe coating



Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS COR 220	Three layer polyethylene external coating for pipelines
GS COR 221	Three layer polypropylene external coating for pipelines

3. Definitions of main parties involved

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

3.1 COMPANY

Total or its subsidiary or agent acting on its behalf shall be referred to herein as the "COMPANY".

3.2 CONTRACTOR

The COMPANY, or their agents, designated in the Contract as being the selected main CONTRACTOR for the job to be performed, i.e. pipelines laying operations, shall be referred to herein as the "CONTRACTOR".

3.3 MANUFACTURER

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

3.4 APPLICATOR

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

3.5 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".

4. Information to be supplied by the COMPANY

The COMPANY or his representative will state in his inquiry and order, by a Project Specification, the following information:

- maximum operating temperature, minimum temperature if relevant;
- joints coated in accordance with this specification designated by reference to the temperature class;
- type(s) of coating(s) accepted in accordance with codification of Table 1 and requirements of Table 2;
- more specific information on the type of coating material and application process, including approved MANUFACTURER and trade of product if needed;
- acceptability of repairs;
- maximum number and dimensions of repairs (if allowed);
- repair procedure;
- type of test certificate when different from requirements of the present document;
- minimum thickness of the coating when different from requirements of the present document.
- overlap of the factory applied coating.

5. APPLICATOR's Obligations

5.1 Approval of coating method and products

The CONTRACTOR shall, in his tender, submit the method of application and data sheets of all the coating materials selected by him for COMPANY approval (field joint coating and coatings repair), in accordance with the present General Specification and the specific requirements given in the Project Specification, the tender or the order.

Once approved, the coating products and method shall not be changed by the Applicator without prior written authorisation of the COMPANY.

The approval decision shall not in any case be considered as a guarantee from the COMPANY with respect to the coating material but as most as an authorisation for use.

The time necessary for the various operations related to surface preparation, heating, coating application and testing shall be defined by APPLICATOR and checked and approved by CONTRACTOR in order to suit with the pipeline laying operations.

5.2 Supply of coating products

The CONTRACTOR shall obtain through the Applicator from the MANUFACTURER(s) and submit to COMPANY:

- The guarantee that the coating products delivered shall meet the required coating characteristics as set forth according to the specified methods
- Production test certificates for the coating products
- In case epoxy powder is used, one test certificate per 20 tons batch approximately, including respectively the test results as defined in the present document which shall be in conformity with the specified methods and acceptable values
- Standard Infra Red Scan of epoxy powder for each production batch
- Conditions of application of the coating products (field joint and repair of plant coating and field joint coating)
- Packaging and storage requirements of coating materials
- Marking on each packing of coating materials with mention of the following information:
 - MANUFACTURER's name
 - Name and complete identification of product including factory of origin
 - Reference to applicable coating standards
 - Production batch or cast number
 - Date of production
 - Limit date of use.

5.3 Qualification of the coating systems

Except if a written derogation is given by COMPANY (for field proven coating systems as per the COMPANY's experience), the coating system, products, application process, equipment to be used for surface preparation and application of the coating system and personnel which execute the job (for type 3A, 3B or 3C coatings) shall be qualified, in the presence of a COMPANY representative, based on a Procedure for Qualification Trial (PQT). These tests should be carried out either independently of a specific job or two months before production start up at the latest for a given job, and shall be organised jointly by the CONTRACTOR, the APPLICATOR or the MANUFACTURER. Tests and acceptable results are those specified in the present document in the chapters related to the different field joint coating systems.

When necessary, MANUFACTURER(s) should assist APPLICATOR for ensuring the right use of the coating product(s) and train the personnel.

- The procedure to be used shall be submitted to COMPANY for approval before PQT
- Operators should be already familiar with the field joint coating type application
- PQT shall be carried out on pipes having the same diameter and the same thickness that the actual pipes
- Tests shall be carried out on test zones distributed along an actual pipe coated with the same process as the other pipes. The length of the test zones should be equivalent to the field joint coating length

- A girth cap weld shall be added at the centre of each of the test zones in order to mimic the field weld
- All equipment (induction heating, abrasive blasting, coating application equipment and also inspection equipment and tools) used for PQT shall be the same as the equipment which will be used for the actual field joint coating
- For type 3A, 3B or 3C coatings, each operator shall coat at least three test zones. If any of them is not acceptable then the same applicator will coat three other test zones
- The time for coating application on a test zone shall not exceed the estimated field joint coating time on yard or on the barge
- If PQT is related to the field joint coating type 3A, coating samples shall be collected to measure the Oxygen Induction Time

The CONTRACTOR, APPLICATOR or MANUFACTURER shall submit a complete report of the PQT results to the COMPANY for approval at least one month before production start up.

5.4 Qualification of operators

The personnel who will apply the field joint coating system and the repair products have to individually qualified, either through a Certification scheme or by demonstration to the Inspector of their competence at the start up of the coating operations. Technical assistance from the MANUFACTURER should be ensured for training of personnel and verification of their qualification for a correct application of their product.

For technologically advanced systems requiring a high level of competence (e.g. coating types 3A, 3B and 3C), qualification of operators who will do actually the job is requested during PQT.

CONTRACTOR or APPLICATOR shall not replace the qualified applicators without informing COMPANY. A new qualification test shall be organised for the new applicators and at the CONTRACTOR's expense.

5.5 Notification prior starting coating work

The CONTRACTOR shall notify the COMPANY, at least eight working days before coating application, of the dates of coating execution to permit mobilisation of the COMPANY designated Inspector.

Upon arrival at the field joint coating facilities, the Inspector shall receive from the CONTRACTOR/ APPLICATOR the documents supplied by the MANUFACTURER as specified in § 5.2

5.6 Other requirements

The CONTRACTOR/APPLICATOR shall supply all personnel, coating material and repair products, equipment, application material and inspection apparatuses.

The APPLICATOR shall store the coating materials and repair products, perform coating application and inspection in conformity with the present document and all the relevant rules of practice.

The INSPECTOR shall have free access to the field coating site. The CONTRACTOR shall provide the INSPECTOR with all the facilities necessary for the proper execution of his mission. He will provide accommodation to him in case of offshore or remote locations.

5.7 Acceptance certificates

The CONTRACTOR and the APPLICATOR shall sign jointly with the Inspector the field joint coating acceptance certificates including the results of all tests and inspection as set forth in this specification.

The acceptance certificates shall certify that all tests and inspections have been performed by the APPLICATOR under the responsibility of the CONTRACTOR and have been witnessed by the INSPECTOR.

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

6. Choice of field joint coatings

6.1 Types of field joint coatings

The coatings of joints concerned by this document are classified into major types according to Table 1 which gives a code for each of them. Any other coating system may be subjected to COMPANY's approval based on a documented file containing results of qualification tests carried out by third party laboratories.

Table 1 - Types of coating

Code	Type of coating
1A	Heat-shrinkable materials, polyethylene based
1B	Heat-shrinkable materials, polyethylene based, applied over a liquid epoxy primer
1C	Heat-shrinkable materials, polyethylene based, applied over a fusion bonded epoxy primer
1D	Heat-shrinkable materials, polypropylene based, applied over a fusion bonded epoxy primer
2	Cold-applied polyethylene or polyvinylchloride plastic tapes
3A	Flame-sprayed polypropylene applied over an epoxy primer
3B	Chemically modified polypropylene tapes hot- applied over a fusion-bonded epoxy powder primer
3C	Injection applied polypropylene
4	Fusion-bonded epoxy powder
5 ^a	Liquid epoxy resin
6 ^a	Liquid polyurethane
^a The epoxy resins and polyurethanes cover the tar-epoxy and the polyurethane bituminous or other modifications.	

6.2 Possible choices of field joint coatings depending on plant applied tube coatings

The nature and the characteristics of the plant applied coating shall be known to the APPLICATOR.

In absence of particular requirements concerning the accepted coating(s) type(s) for a given project specified in a Project Specification, in the tender or in the order, the accepted type(s) of field joint coating(s) are given in Table 2 under the symbol ▲. Any other solution shall be submitted to the written approval of COMPANY and should belong to combinations given in Table 2 with the symbol X.

Table 2 -Types of field joint coatings as a function of plant applied coatings used on pipes

Type of plant applied coating	PE Shrinkable sleeves (1A)	Liquid epoxy + PE Shrinkable sleeves (1B)	FBE+ PE Shrinkable sleeves (1C)	FBE + PP Shrinkable sleeves (1D)	Cold-applied PE or PVC plastic tapes (2)	Polypropylene based coatings (3A, 3B, 3C)	Epoxy powder (4)	Liquid epoxy resin (5)	Liquid polyurethane (6)
3-layer polyethylene coating (onshore application)	X	▲	▲		X			X	X
3-layer polyethylene coating (offshore application)	▲	X	▲		X			X	X
3-layer polypropylene coating	X	X	▲	▲	X	▲		X	X
Bituminous coatings	▲				▲				
Epoxy powder	X	X	X	X	X		▲	X	X

6.3 Documents

6.3.1 Information for the Applicator

Information concerning the coating materials is given by MANUFACTURER's data sheets. In case of tapes and shrinkable materials the information has to be in accordance with [EN 12068](#) (Tables 3 to 7, typical data).

The minimum content of a data sheet required is indicated in the chapters related to the different field joint coating systems.

6.3.2 Test certificates for the coating

Inspection operations shall be carried out as agreed between COMPANY and APPLICATOR at the time of enquiry and order. The inspection documents should be in accordance with [EN 10204](#).

7. Common requirements for application of field joint coatings

7.1 Preparation of the steel surface before coating

7.1.1 General

Surface preparation shall be carried out in accordance with the recommendations of the MANUFACTURER and the present specification.

The surface to be coated shall be, at the time of application of the coating, dry and free of any contamination (such as former coating, paint and non adhering particles, grease and oil, salt, etc.) detrimental to surface preparation or to adhesion of the coating on the steel.

If appropriate, cleaning shall be carried out to remove the following in particular:

- greasy substances (using a totally volatile solvent, as required) or other contamination such as soluble salts;
- weld spot, slag, burrs that can pierce the coating (by grinding or filing); areas of rust or scaling shall be treated in the same way.

7.1.2 Brush cleaning

Oxidation and rust are removed by mechanically using rotary steel brushes or any other appropriate means, which do not affect the quality of the item to be coated. The dust created by this operation shall be removed efficiently.

After cleaning, the appearance of the steel shall comply with surface condition St 3 of [ISO 8501-1](#). The surface shall have a roughness as specified by the MANUFACTURER. It is measured according to a method given in the coating application and repair procedure.

7.1.3 Abrasive blast cleaning

Abrasive blast cleaning is carried out to obtain a surface condition which corresponds at least to the quality of surface preparation Sa 2 1/2 defined in [ISO 8501-1](#).

The cleaned surface shall have a roughness as specified by the MANUFACTURER. It is measured according to a method given in the coating application and repair procedure.

After abrasive blast cleaning, the surface of the joints shall be inspected. All slivers, laminations, weld spot and other surface imperfections made visible by the cleaning and which are detrimental to the quality of coating are removed, by agreement with the COMPANY.

After removal of these imperfections, the residual thickness of the steel shall satisfy the minimum tolerance requirements of the tube standard.

7.1.4 Reconditioning

If, after preparation of the surface of the joint to be coated, it is contaminated or covered in rust, the joint shall undergo further partial or total surface preparation in order to be able to apply the coating that corresponds to all aspects of the provisions of this document.

7.2 Preparation of the close plant applied coating

The plant coating area close to the field joint to be coated shall be prepared to facilitate the adhesion of the field joint coating. The method is described in the chapters treating the different coating systems.

7.3 Provisions before field coating application

The temperature of the joint shall be at least 3°C above the dew point.

Before applying the coating, the surface of the joint shall be cleaned of any residual dust by a method given in the coating application and repair procedure.

Any chemical pre-treatment of the steel to supplement the surface preparation is forbidden.

The coating of the joint is applied by qualified personnel, in accordance with the specified procedure qualified by the COMPANY.

The joint shall not be exposed to high temperature conditions which could result in oxidation of its surface, detrimental to the quality and adhesion of the coating.

At the time of application, the temperature at the surface of the joint shall be within the temperature range specified by the MANUFACTURER. The temperature of the joint shall be monitored using suitable means in order to make sure that the application conditions are fully satisfied (steel substrate and plant applied coating).

During bad weather (rain, wind, etc.) cleaning operations may only continue if effective protective awnings are installed.

7.4 Appearance of the coating

During the visual inspection, the appearance of the coating applied shall be homogenous across the entire surface, in particular no surface defects detrimental to the quality of the coating (grit, foreign particles, pitting, blisters, etc) shall be observed.

7.5 Inspection and testing

For each field joint coating project, a Pre-Production Trial (PPT) shall be carried out on site in actual conditions of pipe, plant-coating, equipment, material and personnel before commencement of the job. In addition, a Production Testing programme shall be implemented to verify the conformity of quality during execution of the job.

Procedures, frequency and acceptable results of testing and inspections during PPT and Production Testing are indicated in the chapters related to the different field joint coating systems.

7.6 Additional mechanical protection

Additional mechanical protection may be used as required in the Project Specification (e.g. rockshield or infill of concrete coated pipes). It is not covered in this document.

7.7 Repair of field joint coating

The acceptability of field joint coating repair and the repair procedure is subject to agreement between the COMPANY and the Applicator.

7.8 Preliminary quality inspection

The APPLICATOR shall make sure that:

- the products comply with the specification ;
- the storage instructions are followed.

8. Coatings from cold applied adhesive polymeric tapes or heat-shrinkable materials

8.1 General

All coatings made by cold applied adhesive polyethylene (PE) or polyvinylchloride (PVC) polymeric tapes or polyethylene (PE) or polypropylene (PP) based heat-shrinkable materials shall meet as a minimum the requirements of [EN 12068](#) and shall be at minimum Class C of this standard.

Information concerning the coating materials is given by the MANUFACTURER. The information has to be in accordance with [EN 12068](#) (Tables 3 to 7) in data sheets.

Application of the coatings shall be carried out in accordance with the recommendations of the MANUFACTURER (see MANUFACTURER's information, as required in Table 7 of [EN 12068](#)).

The minimum overlap of tapes and shrinkable materials on factory coating is given by the MANUFACTURER in Table 7 of [EN 12068](#). For all materials this overlap shall be at least 50 mm.

8.2 Definition of the types of coating systems

Type 1 of field joint coatings: Coatings from polyolefin-based heat-shrinkable materials include either a polyethylene (**Types 1A, 1B, 1C**) or polypropylene (**Type 1D**) based backing with an adhesion coating on one side.

The heat-shrinkable materials come in one of the forms of the following:

- tubular sleeve ;
- wrap around sleeve ;
- pre-formed material (assembly for complex configuration parts).

Heat-shrinkable materials are applied without a primer (**Type 1A**) or with a liquid epoxy primer (**Type 1B**) or a fusion bonded epoxy primer (**Types 1C and 1D**), depending on the nature of adhesive, the use and the practical possibilities (see table 2).

Type 2 of field joint coatings: Cold applied adhesive polymeric tape coatings generally include a bonding primer and one or several plastics tapes made of polyethylene or PVC. They are generally composed of a layer of anti-corrosion tape and a layer of mechanical protection tape.

8.3 Surface preparation

Surface preparation shall be carried out in accordance with the recommendations of the MANUFACTURER (see MANUFACTURER's information, as required in Table 7 of [EN 12068](#)). The minimum requirement is that the area to be coated has to be cleaned with a powered or manual wire brush until a degree of cleanliness St 3 is achieved. The edges of the wrapping shall be bevelled with a fine file and a length of 50 mm (± 5 mm) of the plant applied coating shall be roughened to guaranty a good adhesion of the field joint coating.

Abrasive blast cleaning to a quality of surface preparation Sa 2 1/2 as defined in [ISO 8501-1](#) is mandatory for coatings Types 1B, 1C and 1D and for high operating temperature (> 50 °C), whatever the coating type.

8.4 Application of the coating

8.4.1 Application of the primer

Application of the (eventual) primer shall be carried out in accordance with the recommendations of the MANUFACTURER (see MANUFACTURER's information, as required in Table 7 of [EN 12068](#)).

When FBE is used, the epoxy primer is applied on the steel surface by spraying of the powder with a semi automatic electrostatic coating machine or special spray guns applying, by rotation around the pipe, 120 to 200 microns of fusion bonded epoxy powder coat. FBE thickness should not exceed 200 microns. No FBE shall be applied on the pipe plant coating.

8.4.2 Application of heat-shrinkable sleeves

As a general guide, the following procedure shall be adhered to:

- Before welding, position an adhesive polyethylene shrinkable sleeve just beside the weld or use an open type shrinkable sleeve
- After welding, clean the area with the approved cleaning method.
- Preheat the area to be coated to a temperature adapted to the material (about 70°C for Types 1A and 1B, about 200°C for Types 1C and 1D)
- Position the sleeve so as to provide a 10 cm overlap, on both sides, on the sound coating when shrinking is completed
- By external side heat sleeve to a surface temperature adapted to the specific product to be applied (from 90 to 240°C) with a hot air ring unit or a gas torch. Heat progressively and regularly, starting from the middle of the sleeve and going towards the ends to avoid forming air pockets

8.4.3 Application of cold applied tapes

As a general guide, the following procedure shall be adhered to:

- After welding, clean the area with the approved cleaning method.
- Apply a thin coat of compatible primer (if any), allow the primer to dry enough
- Spirally wrap the area with tapes of an adequate width, employing the right overlap and using sufficient tension to ensure a complete conformability of the coating. A manual application tool shall be used to achieve these goals. Cigarette wrapping may be used in certain circumstances (in particular for offshore laying on a conventional barge).

The minimum overlap from tape to tape while spiral wrapping the tape is given in Table 3. The Applicator shall always respect the overlap given by the MANUFACTURER if it results in overlap greater than that given below.

The width of the material used depends on the diameter of the tubes. For all types of manual application, an appropriate width should be chosen to avoid folding the material which would occur if the material was too wide.

Table 3 - Overlap of tapes

Tape width	Overlap
< 50 mm	≥ 50%
≥ 50 mm	≥ 25 mm

8.5 Characteristics of the coatings applied

The tests detailed below shall be carried out, either for qualification (PQT) or during Pre-production trial (PPT) or for Production testing. They are summarised in Table 4. Other tests like impact resistance, indentation at ambient and maximum operating temperature, electrical insulation resistance, lap shear strength, resistance to thermal ageing and to UV radiation, etc have also to be carried out for Qualification. For these tests, methods and acceptable values are those of [EN 12068](#) for Class C.

8.5.1 Thickness

The minimum value of the thickness of the coating measured on the body shall be not less than 90% of the nominal thickness agreed by the COMPANY. The nominal thickness is the calculated sum of the thickness of all the layers of the coating before application.

The minimum value measured on top of the weld bead shall be not less than 75 % of the nominal thickness.

NOTE: The thickness on the weld bead is normally less than the thickness on the body because part of the polymeric adhesive flows during and after the application from the weld bead to the body. This effect is necessary in order to avoid voids and it is not detrimental for the corrosion protection.

Table 4 - Testing of tapes or shrinkable materials

Properties	§	Method of testing	Frequency	
			PQT and PPT ^a	Production
Visual inspection of the cleaned surface	7.1	ISO 8501-1	3 joints	Each joint
Temperature of the surface to be coated	7.3	-	3 joints	Each joint
Visual inspection of the coating	7.4	-	3 joints	Each joint
Inspection of thickness	8.5.1	NF A49-716 Annex A	3 joints	Once per shift
Holiday detection test	8.5.2	NF A49-716 Annex B	3 joints	Each joint
Peel strength test at ambient temperature	8.5.3	NF A49-716 Annex K	3 joints (K2 or K3)	Once per shift (K3 or K4)
Peel strength test at maximum operating temperature	8.5.3	NF A49-716 Annex K	3 joints (K2 or K3)	
Cathodic disbonding at ambient temperature	8.5.4	NF A49-716 Annex E	3 joints	
Cathodic disbonding at maximum operating temperature	8.5.4	NF A49-716 Annex E	3 joints (PQT)	
^a All the tests in this column should be carried out every three years for every type of coating (see Table 1) and technical process.				

8.5.2 Holiday detection

The absence of holidays on the entire surface of field joint coating is checked at a voltage of 5 kV/mm + 5 kV at a maximum of 15 kV. No holidays are allowed unless otherwise agreed between COMPANY and CONTRACTOR/Applicator.

8.5.3 Peel strength

The minimal waiting period between application of the coating and the peel force test is 48hr for heat-shrinkable materials and 72 hr for cold applied tapes.

The test shall be carried out according to the method K2 or K3 (qualification) and K3 or K4 (production) defined in Annex K of NF A49-716.

The peel strength on the steel of the coated joint shall be greater than the values given in Table 5 for ambient temperature and maximum operating temperature.

The peel strength on the plant coating and the peel strength between the different coats of tapes shall be greater than 75 N/50mm at ambient temperature and greater than 10 N/50mm at maximum operating temperature.

Table 5 - Minimum values for peel strength and cathodic disbonding tests

Coating type	Peel resistance (N / 50 mm)	Peel resistance (N / 50 mm)	Cathodic disbonding (radius mm)	Cathodic disbonding (radius mm)
	Ambient T	Max. T	Ambient T	Max. T
Coatings from heat shrinkable materials (Type 1A)	> 100	> 20	< 10 (28 days) < 7 (48hr at 65°C)	< 15 (28 days)
Coatings from heat shrinkable materials on liquid epoxy primer (Type 1B)	> 250	> 30	< 8 (28 days) < 5 (48hr at 65°C)	< 12 (28 days)
Coatings from heat shrinkable materials on FBE (Types 1C and 1D)	> 400	> 80	< 7 (28 days) < 5 (48hr at 65°C)	< 10 (28 days)
Coatings from polymeric tapes (Type 2)	> 50	> 15	< 12 (28 days) < 10 (48hr at 65°C)	< 20 (28 days)

8.5.4 Cathodic disbonding

The test shall be carried out according to the method defined in Annex E of [NF A49-716](#). Duration of 48hr instead of 28 days may be used for PPT if temperature is increased to 65°C. Duration of 28 days is mandatory for PQT.

The cathodic disbonding radius on the steel of the coated joint shall be less than the values given in Table 5 for ambient temperature (28 days), 65°C (48hr) and maximum operating temperature (28 days).

9. Polypropylene based coatings

The technical data sheets shall contain at least the information given in Table 6.

9.1 Definition of the types of coatings

9.1.1 Coatings from flame spray polypropylene (Field joint coating type 3A)

It consists of the application of an epoxy resin primer coat, in the form of powder by dusting or by electrostatic spray, covered with a coat of modified polypropylene powder applied by spraying or flame spraying and then the coating thickness is obtained applying modified polypropylene powder by flame spraying.

9.1.2 Coatings from hot applied chemically modified polypropylene tapes (Field joint coating type 3B)

It consists of the application of an epoxy resin primer coat, in the form of powder by dusting or by electrostatic spray, covered with a coat of chemically modified polypropylene powder applied by spraying and then the coating thickness is obtained by wrapping hot polypropylene tape either in a spiral way or in cigarette way.

9.1.3 Coatings from injection moulded polypropylene (Field joint coating type 3C)

It consists of the application of an epoxy resin primer coat, in the form of powder by dusting or by electrostatic spray, covered with a coat of modified polypropylene powder applied by spraying and then the coating thickness is obtained injecting polypropylene in a proper mould.

Table 6 - Technical data sheet of polypropylene coating materials

Items	Testing standards	Epoxy Powder primer	Modified PP powder	PP product
Date of issue		+	+	+
Name of MANUFACTURER		+	+	+
Commercial name of the product		+	+	+
Shelf life		+		
Storage conditions		+	+	+
Colour		+	+	+
Density	ISO 1183	+	+	+
Sieve analysis		+	+	
Viscosity				
Melt index	ISO 1133		+	(+)
Application methods and conditions (ambient conditions)		+	+	+
Minimum and maximum temperature of the steel during application		+	+	+
Maximum operating temperature		+	+	+
Elongation at break	ISO 527-3		+	+
Infrared analysis		+		
Gel time		+		
Time between coats		+	+	
Vicat softening point at 9,8 N	ISO 306 A50		+	+
ΔT_g	NF A49-716 Annex D	+		

9.2 Surface preparation

The areas to be coated are prepared by abrasive blast cleaning only (see 7.1.3).

The close plant coating area is dulled and cleaned in order to obtain the surface profile defined in 7.2 At least 5 cm of the adjoining factory applied coating has to be cleaned and abraded to expose a fresh surface.

9.3 Application of the coating

The method of application should be in accordance with the recommendations of the MANUFACTURER.

9.3.1 Heating of the area to be coated

The area to be coated is heated immediately after surface preparation up to the temperature required (approximately 240°C), by induction heating.

The holding time and the temperature shall not:

- result in oxidation of the surface of steel and of the coating detrimental to the quality of the coating of the joint ;
- damage the factory applied coating.

9.3.2 Application of the epoxy primer

The epoxy primer is applied on the steel surface by spraying of the powder with a semi automatic electrostatic coating machine or special spray guns applying, by rotation around the pipe, 120 to 200 microns of fusion bonded epoxy powder coat. FBE thickness should not exceed 200 microns. No FBE shall be applied on the pipe plant coating.

9.3.3 Application of the polypropylene top coat

The overlap on the factory applied coating, excluding bevels, shall not be less than 10 mm, unless otherwise specified in the tender specifications and the order.

It shall be applied according to the system used:

- Type 3A: by flame spray in a controlled gaseous atmosphere; the chemically modified polypropylene powder is sprayed onto the surface to be coated preferably during the primer gel time, but in any case before the primer is fully cured, to get a 2 to 2.5 mm thickness coat. The Applicator shall provide COMPANY with the test results showing that they are able to meet the COMPANY requirement related to the Oxygen Induction Time for the applied polypropylene which is 22 minutes $\pm$ 2 minutes at 220°C for 1 gram of sample under 350 mbar of oxygen. An adequate distribution of the polypropylene particles size is an important parameter for preventing heavy oxidation of the powder during application. The Applicator shall control the powder quality. Additional heat may be added during application of the polypropylene via low pressure hot air or gas flame heated guns.
- Type 3B: by wrapping a hot tape, either spiral wrap or cigarette wrap; a proper heating system has to be used to obtain a good welding on the factory applied coating and between the tape overlapping; Preheat the tape in an oven for one hour at 120-140°C, then the field joint area temperature shall be raised to approximately 240°C by induction heating. The pipe coating shall be protected by masking tapes during induction heating. Following the FBE application and before the gel time of the FBE has elapsed, the chemically modified polypropylene layer shall be applied. The thickness shall be 100 to 200 microns. The thickness along the longitudinal weld (if any) can be up to 400 microns. Wrap the field joint area with the preheated PP tape by means of a manually operated semi-automatic machine. The overlap between two successive layers shall be at least 66 %. Sufficient runs of tape shall be applied to reach around 2.5 mm thick coating. The tape shall be wrapped with enough tension to avoid any fold or any trapping of air between tapes. The tape shall be heated with a torch. The green adhesive layer should be visible at the tape overlaps. The temperature control at this stage is essential for the adequate coating adhesion. With a hand held roller, gently apply pressure to the tape along the toe of the longitudinal weld (if any) at the intersection of the girth weld.
- Type 3C: by injection of molten polypropylene; a proper heating system has to be used to obtain a good welding on the factory applied coating.

9.4 Characteristics of the coatings applied

The tests detailed below shall be carried out after curing. They are summarised in table 7.

Table 7 -Testing of polypropylene based coatings

Properties	§	Method of testing	Frequency	
			PQT and PPT ^a	Production
Visual inspection of the blast cleaned surface	9.3	ISO 8501-1	3 joints	Each joint
Roughness of the blast cleaned surface of the joint	7.1.3	ISO 8503-1	3 joints	3 times per shift
Examination of the dulled factory applied coating	9.3	Visual	3 joints	Each joint
Temperature of the surface to be coated	9.4.1	-	3 joints	Each joint
Application criteria	9.4		3 joints	Continuously
Visual inspection of the coating	7.4	-	3 joints	Each joint
Inspection of the thickness	9.5.1	NF A49-716 Annex A	3 joints	Each joint
Holiday detection test	9.5.2	NF A49-716 Annex B	3 joints	Each joint
Peel strength test at 90 °C or maximum operating temperature if > 100 °C	9.5.3	NF A49-716 Annex K	3 joints (K2, K3)	-
Peel strength test at 90 °C	9.5.3	NF A49-716 Annex K	-	One per shift (K3, K4)
Degree of cure	9.5.4	NF A49-716 Annex D	3 joints	-
Cathodic disbonding at ambient temperature	9.5.5	NF A49-716 Annex E	3 joints	-
Cathodic disbonding at maximum operating temperature	9.5.5	NF A49-716 Annex E	3 joints (PQT)	-
Impact resistance test	9.5.6	NF A49-716 Annex F	3 joints	-
Indentation resistance test at ambient temperature and 90 °C	9.5.7	NF A49-716 Annex L	3 joints	-
Oxygen Induction Time (for type 3A)	9.4.3		3 joints	-

^a All the tests in this column should be carried out every three years for every type of coating (see Table 1) and technical process.

9.4.1 Thickness

The minimum thickness of the coating is defined by agreement between COMPANY and CONTRACTOR/APPLICATOR and taking into consideration the thickness of the existing factory applied coating.

9.4.2 Holiday detection

The voltage is defined according to the nominal thickness chosen. The entire surface is monitored at a voltage of 10 kV/mm with a maximum of 25 kV, according to the method defined in [NF A49-716](#) Annex B.

No holidays are allowed unless otherwise agreed between COMPANY and APPLICATOR.

9.4.3 Peel strength

The peel strength is measured at 90°C or at maximum operating temperature if it is higher than 100°C, in accordance with the methods K2 or K3 defined in [NF A49-716](#) Annex K. The acceptable value is 200 N/50mm at 90°C and 100N/50mm at maximum operating temperature if it is higher than 100°C

9.4.4 Degree of cure

The degree of cure of the primer in powder is determined by differential thermal analysis of a sample of primer taken from the joint.

The test is carried out according to the method defined in Annex D of [NF A49-716](#).

The acceptance criterion is the value of ΔT_g given by the MANUFACTURER.

9.4.5 Cathodic disbonding

The test is carried out in accordance with the method defined in Annex E of [NF A49-716](#). Duration of 48hr instead of 28 days may be used for PPT if temperature is increased to 65°C. Duration of 28 days is mandatory for PQT.

The average disbanding shall not be more than:

- 7 mm after a period of 28 days at $23 \pm 2^\circ\text{C}$ (mandatory for PQT)
- 5 mm after a period of 48 hr at $60 \pm 2^\circ\text{C}$.
- 10 mm after a period of 28 days at maximum operating temperature.

9.4.6 Impact resistance

The minimum impact energy, determined according to the method defined in Annex F of [NF A49-716](#) shall correspond to 7 J per mm of measured thickness of the coating.

This test shall be carried out at $20 \pm 5^\circ\text{C}$ and for diameters ≥ 100 mm.

After the impact test no holidays are allowed.

9.4.7 Indentation resistance

Indentation resistance shall be determined by testing in accordance with the method defined in Annex L of [NF A49-716](#). The maximum indentation is given in Table 8.

Table 8 - Indentation for polypropylene coating

Testing temperature	Indentation
23 ± 2°C	≤ 0,1 mm
90 ± 2°C	≤ 0,6 mm

10. Fusion-bonded epoxy powder coating (FBE)

The fusion-bonded epoxy powder coating shall meet the qualification requirements defined in [NACE RP 0402](#) except when otherwise specified.

The technical data sheet shall contain at least the information given in Table 9.

10.1 Surface preparation

The areas to be coated are prepared by abrasive blast cleaning (see 7.1.3).

The coating area is dulled and cleaned in order to obtain the surface profile defined in 7.2.

At least 5 cm of the adjoining factory applied coating has to be cleaned and dulled by brushing or blasting.

10.2 Application of the coating

The method of application should be in accordance with the recommendations of the MANUFACTURER.

Table 9 - Technical data FBE

Items	Testing standards	Technical data sheet
Date of issue		+
Name of MANUFACTURER		+
Commercial name of the product		+
Storage conditions		+
Application methods and conditions		+
Minimum and maximum temperature of the steel during application		+
Maximum operating temperature		+
Granulometry		+
Specific gravity		+
Colour		+
IR spectrogram		+
Buchholtz hardness of reticulated film	DIN 53163	+
Maximum thickness per coat		+
Gel time		+
Maximum ΔT_g of the reticulated film		+
Impact resistance of the reticulated film at ambient temperature		+
Flexibility of the reticulated film at 0°C and 23 °C		+
^a Method given by the MANUFACTURER.		

10.2.1 Heating of the area to be coated

The area to be coated is heated if necessary immediately after cleaning by induction heating or by flame up to the temperature given by the MANUFACTURER.

The holding time and the temperature shall not:

- result in oxidation of the surface of steel and of the coating detrimental to the quality of the coating of the joint ;
- damage the factory applied coating.

10.2.2 Application of the epoxy powder

The overlap on the factory applied coating, excluding bevels, shall be not less than 50 mm, unless otherwise specified in the tender specifications and the order.

10.3 Characteristics of the coatings applied

The tests detailed below shall be carried out after curing of the material. They are summarised in Table 10.

Table 10 - Testing of FBE

Properties	§	Method of testing	Frequency	
			PQT and PPT ^a	Production
Visual inspection of the blast cleaned surface	10.1	ISO 8501-1	3 joints	Each joint
Roughness of the blast cleaned surface of the joint	7.1.3	ISO 4287	3 joints	3 times per shift
Examination of the dulled factory applied coating	10.1	Visual	3 joints	Each joint
Temperature of the surface to be coated	10.2.1	-	3 joints	Each joint
Visual inspection of the coating	7.4	-	3 joints	Each joint
Inspection of the thickness	10.3.1	NF A49-716 Annex A	3 joints	Each joint
Holiday detection test	10.3.2	NF A49-716 Annex B	3 joints	Each joint
Adhesion test	10.3.3	NF A49-716 Annex C	3 joints	Once per shift
Cathodic disbonding at ambient temperature	10.3.4	NF A49-716 Annex E	3 joints	-
Cathodic disbonding at maximum operating temperature	10.3.4	NF A49-716 Annex E	3 joints (PQT)	-
^a All the tests in this column should be carried out every three years for every type of coating (see Table 1) and technical process.				

10.3.1 Thickness

The minimum thickness of the coating is defined by agreement between the COMPANY and the Applicator. As a general rule, the minimum value shall be 325 microns and the maximum value 600 microns, except in case of reel barge laying when it is 500 microns; this value applies in particular to the overlap between the plant and field coatings.

The thickness is checked according to method defined in NACE RP 0402.

10.3.2 Holiday detection

The voltage is defined according to the nominal thickness. The entire surface is monitored at a voltage of 5 V/μm with a maximum of 5 kV, according to the method defined in annex B of NF A49-716.

No holidays are allowed unless otherwise agreed between COMPANY and Applicator.

10.3.3 Adhesion

Adhesion on the steel surface is monitored in accordance with the method C4 defined in annex C of [NF A49-716](#). Results shall be level 1.

10.3.4 Cathodic disbonding

The test is carried out in accordance with the method defined in Annex E of [NF A49-716](#). Duration of 48hr instead of 28 days may be used for PPT if temperature is increased to 65°C. Duration of 28 days is mandatory for PQT.

The average disbonding shall not be more than:

- 5 mm after a period of 28 days at $23 \pm 2^{\circ}\text{C}$ (mandatory for prequalification)
- 3 mm after a period of 48 hr at $60 \pm 2^{\circ}\text{C}$.
- 10 mm after a period of 28 days at maximum operating temperature.

11. Coatings from liquid epoxy (EP) or polyurethane (PUR) resins

The technical data sheet shall contain at least the information given in Table 11.

11.1 Definition of the coatings

The coating of joints consists in the application of one or more layers of liquid epoxy resin or liquid polyurethane, whether modified or not. These materials are applied with or without primer.

A coating from EP or PUR can be used at different maximum operating temperatures and at different thickness classes. The combinations of these classes are given in Table 12.

Table 11 - Technical data sheet for liquid epoxy resin or liquid polyurethane

Items	Testing standards	Technical data sheet
Date of issue		+
Name of MANUFACTURER		+
Commercial name of the product		+
Type of product		+
Storage conditions		+
Density of component A and B	a	+
Density of mixture		+
Dose ratio in weight and volume		+
Application methods and conditions (ambient conditions)		+
Minimum and maximum temperature of the steel during application		+
Maximum operating temperature		+
Type of solvent		+
Solids by weight	a	+
Solids by volume	a	+
Time between coats		+
Shore D hardness	ISO 868	+
Maximum thickness per coat		+
Curing time		+
Colour		+
^a Method given by the MANUFACTURER.		

Table 12 - Combinations of thickness and maximum operating temperatures

		class A	class B	class C
EP	Thickness	400 µm	800 µm	1500 µm
	Maximum operating temperature	- 20 to 40°C	- 20 to 40°C - 20 to 60°C	- 20 to 40°C - 20 to 60°C - 20 to 80°C
PUR	Thickness	1000 µm	1500 µm	-
	Maximum operating temperature	- 20 to 40°C	- 20 to 40°C - 20 to 60°C - 20 to 80°C	-

Other temperatures can be agreed. In this case, tests shall be carried out at the required temperature.

11.2 Surface preparation

The areas to be coated are prepared by abrasive blast cleaning (see 7.1.3).

At least 5 cm of the adjoining factory applied coating to be covered by field joint coating shall be dulled and cleaned by brushing or blasting in order to obtain the surface profile defined in 7.2. When necessary (PE or PP factory coatings), a specific treatment (e.g. oxidising flame treatment) shall be applied to achieve the right level of bonding.

11.3 Application of the coating

The method of application should be in accordance with the recommendations of the MANUFACTURER.

11.3.1 Heating of the area to be coated

The area to be coated is heated if necessary immediately after cleaning by induction heating or by flame up to the temperature given by the MANUFACTURER.

The holding time and the temperature shall not:

- result in oxidation of the surface of steel and of the coating detrimental to the quality of the coating of the joint ;
- damage the factory applied coating.

11.3.2 Application of the primer

The primer if necessary is applied manually or with a machine by spraying of the liquid.

11.3.3 Application of the liquid epoxy resin or liquid polyurethane

The liquid epoxy resin or liquid polyurethane is applied in accordance with the recommendations of the MANUFACTURER.

The overlap on the factory applied coating, excluding bevels, shall be not less than 50 mm, unless otherwise specified in the tender specifications and the order.

11.4 Characteristics of the coatings applied

The tests detailed below shall be carried out after curing of the material. They are summarised in Table 13.

11.4.1 Thickness

The minimum thickness of the coating is defined by agreement between COMPANY and Applicator and shall be at least in accordance with Table 11.

The thickness is checked according to method defined in [NF A49-716](#) Annex A.

11.4.2 Holiday detection

The voltage is defined according to the nominal thickness. The entire surface is monitored at a voltage of 8 V/μm with a maximum of 20 kV, according to the method defined in [NF A49-716](#) Annex B.

No holidays are allowed unless otherwise agreed between COMPANY and APPLICATOR.

Table 13 - Testing of coatings from liquid epoxy resin or liquid polyurethane

Properties	§	Method of testing	Frequency	
			PQT and PPT ^a	Production
Visual inspection of the blast cleaned surface	11.2	ISO 8501-1	3 joints	Each joint
Roughness of the blast cleaned surface of the joint	7.1.3	ISO 4287	3 joints	3 times per shift
Examination of the dulled factory applied coating	11.2	Visual	3 joints	Each joint
Temperature of the surface to be coated	11.3.1	-	3 joints	Each joint
Visual inspection of the coating	7.4	-	3 joints	Each joint
Inspection of the thickness	11.4.1	NF A49-716 Annex A	3 joints	Each joint
Holiday detection test	11.4.2	NF A49-716 Annex B	3 joints	Each joint
Adhesion test	11.4.3	NF A49-716 Annex C	3 joints	Once per shift
Shore D hardness		ISO 868	3 joints	-
Cathodic disbondment test at ambient temperature	11.4.4	NF A49-716 Annex E	3 joints	-
Cathodic disbondment test at maximum operating temperature	11.4.4	NF A49-716 Annex E	3 joints (PQT)	-

^a All the tests in this column should be carried out every three years for every type of coating (see Table 1) and technical process.

11.4.3 Adhesion

Adhesion on the steel surface is monitored in accordance with the method C4 defined in [NF A49-716](#) Annex C. Results shall be level 1.

11.4.4 Cathodic disbonding

The test is carried out in accordance with the method defined in Annex E of [NF A49-716](#). Duration of 48hr instead of 28 days may be used for PPT if temperature is increased to 65°C. Duration of 28 days is mandatory for PQT.

The average disbonding shall not be more than:

- 8 mm after a period of 28 days at $23 \pm 2^{\circ}\text{C}$ (mandatory for PQT)
- 5 mm after a period of 48 hr at $60 \pm 2^{\circ}\text{C}$.
- 12 mm after a period of 28 days at maximum operating temperature.

12. Coating repairs on job site

The eventual repairs to be done on job site shall be implemented as agreed between COMPANY and Applicator if the damaged area is less than 100 cm².

If the damaged area is more than 100 cm² heat shrinkable sleeves or tapes approved by COMPANY should be used.