BRITISH STANDARD

BS EN
10329:2006

Steel tubes and fittings for onshore and offshore pipelines — External field joint coatings

The European Standard EN 10329:2006 has the status of a British Standard

ICS 23.040.01

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 10329:2006.

The UK participation in its preparation was entrusted by Technical Committee ISE/16, Protective coatings and linings of metal pipes and fittings, to Subcommittee ISE/16/-/11, External coatings for steel tubes and fittings, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 10329

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ICS 23.040.01

English Version

Steel tubes and fittings for onshore and offshore pipelines - External field joint coatings

Tubes et raccords en acier pour canalisations enterrées et immergées - Revêtements externes des assemblages réalisés sur site

Stahlrohre und -formstücke für erd- und wasserverlegte Rohrleitungen - Umhüllungen für Schweißverbindungen

This European Standard was approved by CEN on 9 December 2005.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This European Standard (EN 10329:2006) has been prepared by Technical Committee ECISS/TC 29 “Steel tubes and fittings for steel tubes”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2006, and conflicting national standards shall be withdrawn at the latest by July 2006.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies the application and related testing of the corrosion protection coatings applied to steel surfaces left bare after the tubes and fittings (components) are joined by welding.

It defines the different types of coatings for buried and immersed pipelines defined in Table 1.

This European Standard applies to seamless or welded steel tubes used in the construction of pipelines for the conveyance of fluids.

Components coated with this type of coating may be further protected by means of cathodic protection.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10204, *Metallic products — Types of inspection documents*

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 liquid applied epoxy and epoxy-modified coatings*

EN 10290, *Steel tubes and fittings for onshore and offshore pipelines — External liquid applied polyurethane and polyurethane-modified coatings*

EN 10310, *Steel tubes and fittings for onshore and offshore pipelines — Internal and external polyamide powder based coatings*

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*

EN ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST) (ISO 306:2004)*

EN ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets (ISO 527-3:1995)*

EN ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness) (ISO 868:2003)*

EN ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics (ISO 1133:2005)*

EN ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pyknometer method and titration method (ISO 1183-1:2004)*

EN ISO 2808, *Paints and varnishes — Determination of film thickness (ISO 2808:1997)*

EN ISO 2811-1, *Paints and varnishes — Determination of density — Part 1: Pyknometer method (ISO 2811-1:1997)*

EN ISO 2815, *Paints and varnishes — Buchholz indentation test (ISO 2815:2003)*

EN 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 8501-1:1988)*

ISO 11357-2, *Plastics — Differential scanning calorimetry (DSC) — Part 2: Determination of glass transition temperature*

3 Terms and definitions

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

3.1
manufacturer
supplier of the coating material in a condition suitable for application to the product to be coated

3.2
coater
company that applies the coating material to the components to be coated in accordance with the provisions of this European Standard or the special requirements given in the tender specification and in the order

3.3
purchaser
company that buys the applied coating and/or coated pipeline

3.4
maximum operating temperature
maximum service temperature of the medium being carried by the buried or submersed coated pipeline

4 Information to be supplied by the purchaser

4.1 Mandatory

The purchaser shall state in the inquiry and order the following information:

— joints coated in accordance with this European Standard shall be designated by reference to this European Standard followed by the temperature class and the mechanical resistance class if applicable;

EXAMPLE 5 000 m of tube – EN 10224 of 406, 4-4,0 – coating of the joints EN 10329;

— type of coating material in accordance with Table 1;

— acceptability of repairs (see 6.6);

— maximum number and dimensions of repairs (if allowed – see 6.6);

— maximum operating temperature.

4.2 Options to be indicated by the purchaser

— type of test certificate when different from 5.3.2;

— repair procedure (see 6.6);

— minimum thickness of the coating (see 7.1.6.2 and 7.3.6.2);

— overlap of the factory applied coating (see 7.1.6.4, 7.2.6.4 and 7.3.6.4);

— qualification of the personnel applying the coating;

— conditions for testing the cathodic disbondment resistance.

5 Choice of coatings

5.1 Types of coating

The coatings of joints covered by this European Standard are classified into eight types in accordance with Table 1.

Table 1 — Types of coating

Item	Type of coating
1	Bituminous tape
2 [a]	Liquid epoxy resin
3 [a]	Liquid polyurethane
4	Petrolatum tapes
5	Plastic tapes
6	Heat shrinkable materials
7	Polypropylene
8	Epoxy powder

[a] The liquid epoxy resin and liquid polyurethane categories cover also modifications of these materials.

NOTE It is intended for polyamide and polyethylene materials to be included in Table 1 in the next 5-year revision, when more experience with these coatings will be available.

5.2 Types of joint coatings depending on factory applied tube coating

The combinations of the joint coating materials with different factory applied coatings are given for information in Table 2. In each case, the products used shall be compatible and suitable for the service temperature of the pipeline. The tests to be carried out on the joint coating are described in the following subclauses.

The nature and the characteristics of the factory applied coating shall be known to the coater.

Table 2 — Types of joint coating(s) depending on factory applied coating

Factory applied coatings		Types of coating for the welded joint							
European Standard	Type of factory applied coating	Bituminous tape	Liquid epoxy resin	Liquid polyurethane	Petrolatum tapes	Plastic tape	Heat shrinkable materials	Polypropylene	Epoxy powder
EN 10310	Polyamide coating	X	X	X	X	X	X		
	Polyethylene coating	X	X	X	X	X	X		
	Polypropylene coating	X	X	X	X	X	X	X	
	Bitumen	X			X	X	X		
	Epoxy powder	X	X	X	X	X	X		X
EN 10288	Extruded polyethylene (2-layer)	X	X	X	X	X	X		
	Fusion bonded powder polyethylene	X	X	X	X	X	X		
EN 10289	Liquid epoxy and epoxy-modified coatings	X	X	X	X	X	X		
EN 10290	Liquid polyurethane and polyurethane-modified coatings	X	X	X	X	X	X		

5.3 Documents

5.3.1 Information for the coater

Specific information on the coating materials will be given in the manufacturer's product data sheets.

An indication of the minimum amount of information required for a product data sheet is indicated in the chapter on the different coating materials.

5.3.2 Test certificate for the coating

In case inspection operations are carried out as agreed by the purchaser and the coater at the time of enquiry and order, the inspection documents shall be according to EN 10204.

6 Application of the coating and general requirements

6.1 Preparation of the surface before coating

6.1.1 General

Surface preparation shall be carried out in accordance with the recommendations of the manufacturer.

6.1.2 Preparation of the steel surface

6.1.2.1 General

At the time of application, the surface to be coated shall be dry and free from any contamination (such as earlier coatings, non-adherent particles, grease, oil, salt etc.) that could be detrimental to surface preparation or the adhesion of the coating to the steel.

The surface shall be cleaned to remove any greasy substances and salt. Filing or grinding shall be used to remove any weld spots, slag or burrs that could pierce the coating.

The preparation of the surface can be made either by brush cleaning or abrasive blast cleaning.

6.1.2.2 Brush cleaning

Rust and scale shall be removed, manually or mechanically, using wire brushes or any other suitable method that does not affect the quality of the surface to be coated; all dust and debris produced shall be removed correctly.

After brush cleaning, the steel surface shall correspond to grade St 3 as defined in EN ISO 8501-1 or better. The roughness of the cleaned surface shall be specified by the manufacturer and shall be measured using a method given in the coating application and repair procedure.

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

6.1.2.3 Abrasive blast cleaning

Rust and scale shall be removed by blast cleaning with a suitable abrasive to produce a surface that corresponds to Grade Sa 2½ as defined in EN ISO 8501-1 or better. The roughness of the cleaned surface, and the choice of abrasive, shall be specified by the manufacturer and shall be measured using a method given in the coating application and repair procedure.

After abrasive blast cleaning, the steel surface shall be inspected. By agreement with the customer, all slivers, laminations, weld spots or other imperfections exposed by the cleaning that may be detrimental to the quality of the coating shall be removed. After these imperfections have been removed, the residual thickness of the steel shall meet the minimum tolerance requirements of the tube standard.

6.1.2.4 Reconditioning

If the joint to be coated becomes contaminated or rusted after surface preparation, this area shall be subjected to further cleaning according to the requirements of this European Standard to give a suitable surface for the application of the coating.

6.1.3 Preparation of the adjoining factory applied coating

The factory coating adjacent to the joint area shall also be prepared to provide a suitable surface for the joint coating to adhere to. The methods for preparing this area are given in the clause covering the different joint coating materials.

6.2 Conditions before application

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

Before the coating is applied, all residual abrasive dust and debris shall be removed from the surface of the joint by a method given in the coating application and repair procedure. By agreement with the purchaser, chemical pre-treatment may be used to supplement the surface preparation.

Qualified personnel shall apply the coating according to the specified procedure that may have been qualified by the purchaser.

The joint shall not be exposed to conditions, such as high temperature, that would cause oxidation of the surface sufficient to be detrimental to the quality and adhesion of the coating.

At the time of application, the surface temperature of the joint shall be within the temperature range specified by the manufacturer. The temperature of the joint shall be monitored, using a suitable technique, to ensure that the application conditions on the steel substrate and factory applied coating are being met fully.

During bad weather, such as wind and rain, cleaning operations may only be carried out if suitable protective awnings, possibly heated depending on the type of the applied coating are installed.

6.3 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...) shall be observed.

6.4 Testing

During production, there should be regular inspections of surface preparation and coating application; procedures are given in Annex I.

6.5 Additional mechanical protection

Additional mechanical protection (e.g. rockshield) is not covered in this European Standard.

6.6 Repair

The acceptability of coating repair and the repair procedure is subject to agreement between the purchaser and the coater.

6.7 Qualification of the application procedure and the coater

Details of the application procedure and the coating material shall be supplied to the purchaser upon request. If requested, qualification testing to demonstrate the characteristics of the coating shall be carried out. This test shall use the coating materials, the procedure, equipment and personnel that will be used on site and will take into account specific application conditions found on site; recommendations for the procedure are given in Annex I.

6.8 Preliminary quality inspection

The coater shall ensure that:

— the products comply with the specification;

— the storage instructions are followed.

7 Coatings

7.1 Bituminous tapes, petrolatum tapes, plastic tapes or heat shrinkable materials

7.1.1 General

All coatings made by tapes or heat shrinkable materials shall meet the requirements of EN 12068.

7.1.2 Definition of the coating

7.1.2.1 Bituminous tapes

Bituminous tape coatings consist of a bonding primer and a single layer or multiple layers of fusible bituminous tape.

7.1.2.2 Petrolatum tapes

Petrolatum tape coatings may consist of a single layer or multiple layers of tape.

7.1.2.3 Plastic tapes

Plastic tape coatings may consists of a bonding primer and multiple layers of one or several plastics tapes.

7.1.2.4 Heat shrinkable materials

Heat shrinkable coatings consist of a polyolefin based backing with an adhesive on one side.

The heat shrinkable materials come in the form of the following:

— tubular sleeve;

— wrap around sleeve;

— pre-formed material (assembly for complex configuration parts).

Heat shrinkable materials may be applied with or without primer, depending on the nature of adhesive.

7.1.3 Information for the coater

The manufacturer shall supply data sheets giving information on the coating material that meets EN 12068.

7.1.4 Surface preparation

Surface preparation shall be carried out according to the provisions of this European Standard and the recommendations of the manufacturer (see the information required from the manufacturer according to EN 12068).

7.1.5 Application of the coating

7.1.5.1 General

Application of the coating shall be carried out in accordance with the recommendations of the manufacturer (see manufacturer's information, as required in EN 12068).

7.1.5.2 Application of the primer

Where applicable application of the primer shall be carried out in accordance with the recommendations of the manufacturer (see manufacturer's information, as required in EN 12068).

For petrolatum tapes normally there is no primer necessary.

7.1.5.3 Application of the tape or the heat shrinkable material

Application of the material shall be carried out in accordance with the recommendations of the manufacturer (see manufacturer's information, as required in EN 12068).

7.1.5.4 Overlap

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

The overlap of tapes and heat shrinkable materials on factory coating is given by the manufacturer in EN 12068. For all materials this overlap shall be at least 50 mm.

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

7.1.6 Characteristics of the coating applied

7.1.6.1 General

The tests below shall be carried out.

7.1.6.2 Thickness

The nominal thickness is the sum of the thickness of the individual layers before application.

Unless agreed otherwise with the purchaser, the minimum thickness of the coating on the body of the joint shall be not less than 90 % of the nominal value given in EN 12068.

Unless agreed otherwise with the purchaser, the minimum thickness on the top of the weld bead shall be not less that 0.6 mm.

NOTE The thickness on the weld bead is normally less than on the body because some of the polymeric adhesive will flow from the bead to the body, both during and after application. This is necessary to prevent voids in the coating and is not detrimental to the corrosion protection.

The thickness should be measured using the method given in Annex A.

7.1.6.3 Holiday detection

The whole surface of the coated joint shall be checked for holidays or other discontinuities at a voltage of 5 kV per mm of coating thickness +5 kV, with a maximum of 15 kV, in accordance with the method given in Annex B. No holidays or other discontinuities are allowed.

7.1.6.4 Peel strength

The minimal waiting period between application of the coating and the peel force test is given in Table 4. The test shall be carried out in accordance with the method defined in Annex D.

The peel strength on the joint shall meet the requirements given in EN 12068.

Table 4 — Waiting period before peel strength test

Material	Waiting period
Bituminous tapes	≥ 24 h
Petrolatum tapes	≥ 30 min
Plastic tapes [a]	≥ 120 h
Heat shrinkable materials [a]	≥ 48 h
[a] The waiting period may be reduced by agreement with the manufacturer.	

7.2 Liquid epoxy resin or liquid polyurethane

7.2.1 General

The liquid epoxy resin (EP) and the liquid polyurethane (PUR) shall meet the qualification requirements defined in EN 10289 and EN 10290 except infrared scan and cut back at the end.

7.2.2 Definition of the coating

The coating on the joints consists of the application of one or more coats of the liquid epoxy resin or liquid polyurethane, which may be modified. These materials may be applied with or without a primer coat.

The thickness classes and maximum operating temperatures of epoxy and polyurethane coatings are given in EN 10289 and EN 10290. However, all classes of both coating types are suitable for use at temperatures down to - 20 °C. The different combinations of coating thickness and maximum operating temperature are given in Table 5.

Table 5 — Coating thickness and maximum operating temperatures

		class A	class B	class C
EP	Thickness	400 µm	800 µm	1 500 µm
	Maximum operating temperature	40 °C	40 °C 60 °C	40 °C 60 °C 80 °C
PUR	Thickness	1 000 µm	1 500 µm	-
	Maximum operating temperature	40 °C	40 °C 60 °C 80 °C	-

Other temperatures may be agreed between the interested parties, but full testing of the coating shall be carried out at the required temperature.

7.2.3 Information for the coater

The technical data sheet drawn up by the product manufacturer shall contain as a minimum the information detailed in Table 6.

7.2.4 Surface preparation

7.2.4.1 On steel

The areas to be coated shall be prepared by abrasive blast cleaning (see 6.1.2.3) or another suitable method recommended by the manufacturer to give the surface profile defined in 6.1.2.

Table 6 — Technical data sheet liquid epoxy resin or liquid polyurethane

Items	References to 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	EN ISO 868	+
Maximum thickness per coat		+
Curing time and temperature		+
Colour		+
[a] Method given by the manufacturer.		

7.2.4.2 On factory applied coating

At least 50 mm of he factory applied coating adjacent to the joint shall also be prepared by mechanical or abrasive blast cleaning.

7.2.5 Application of the coating

7.2.5.1 General

The method of application shall be in accordance with the recommendations of the manufacturer.

7.2.5.2 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.

7.2.5.3 Application of the primer coat

If required, the primer coat shall be applied using a brush or spray equipment.

7.2.5.4 Application of the liquid epoxy resin or liquid polyurethane

The liquid epoxy resin or liquid polyurethane shall be 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.

7.2.6 Characteristics of the coating applied

7.2.6.1 General

The tests below shall be carried out on the cured coating (curing time and temperature see Table 6).

7.2.6.2 Thickness

The minimum thickness of the coating is defined by agreement between the purchaser and the coater and shall be at least in accordance with Table 5.

The thickness is measured in accordance with the method defined in Annex A.

7.2.6.3 Holiday detection

The whole surface of the coated joint shall be checked for holidays or other discontinuities at a voltage of 8 kV per mm of the nominal coating thickness, with a maximum of 20 kV, in accordance with the method given in Annex B. No holidays or other discontinuities are allowed.

7.2.6.4 Adhesion

The adhesion of the coating to the steel substrate shall be measured using the method given in Annex C. The acceptance criteria are given in Table 7.

Table 7 — Adhesion

Material	Acceptance criteria
EP	rating 2
PUR	rating 3

7.2.6.5 Shore D hardness

The shore D hardness shall be measured according to EN ISO 868. The shore D hardness shall be in accordance with the technical data sheet.

7.3 Polypropylene

7.3.1 General

Polypropylene coating shall meet the qualification requirements defined in 7.3.7.

7.3.2 Definition of the coating

7.3.2.1 Flame sprayed polypropylene

The coating shall consist of an epoxy primer coat; either a powder applied by dusting or electrostatic spray or a spray applied liquid coating. The primer shall be over coated with modified polypropylene powder applied by spray or by flame spray and the required thickness achieved by further flame spray application of the modified polypropylene powder.

7.3.2.2 Polypropylene tape

The coating shall consist of an epoxy primer coat; either a powder applied by dusting or electrostatic spray or a spray applied liquid coating. The primer shall be over coated with modified polypropylene powder applied by spray and the required thickness achieved by wrapping the joint with polypropylene tape; either in a spiral or a single piece large enough to cover the required area.

7.3.2.3 Injected polypropylene

The coating shall consist of an epoxy primer coat; either a powder applied by dusting or electrostatic spray or a spray applied liquid coating. The primer shall be over coated with modified polypropylene powder applied by spray and the required thickness achieved by injecting polypropylene into a proper mould around the joint.

7.3.3 Information for the coater

The technical data sheet drawn up by the product manufacturer shall contain as a minimum the information detailed in Table 8.

7.3.4 Surface preparation

7.3.4.1 On steel

The areas to be coated shall be prepared by abrasive blast cleaning only (see 6.1.2.3) to give the surface profile defined in 6.1.2.

Table 8 — Technical data sheet polypropylene coating materials

Items	References to testing standards	Powder primer	Liquid primer	Modified PP powder	PP
Date of issue		+	+	+	+
Name of manufacturer		+	+	+	+
Commercial name of the product		+	+	+	+
Shelf life		+	+		
Storage conditions		+	+	+	+
Colour		+	+	+	+
Density	EN ISO 1183-1	+		+	+
Density	EN ISO 2811-1		+		
Sieve analysis		+		+	
Viscosity			+		
Melt index	EN ISO 1133			+	+
Application methods and conditions (ambient conditions)		+	+	+	+
Minimum and maximum temperature of the steel during application		+	+	+	+
Maximum operating temperature		+	+	+	+
Elongation at break	EN ISO 527-3			+	+
Infrared analysis		+	+		
Gel time		+			
Time between coats		+	+	+	
Vicat softening point at 9,8 N	EN ISO 306 A50			+	+
ΔTg	Annex E	+			

7.3.4.2 On factory applied coating

At least 50 mm of he factory applied coating adjacent to the joint must also be prepared by mechanical or abrasive blast cleaning.

7.3.5 Application of the coating

7.3.5.1 General

The method of application shall be in accordance with the recommendations of the manufacturer.

7.3.5.2 Heating of the area to be coated

Immediately after surface preparation the area to be coated is heated to the required temperature by induction.

The holding time and the temperature shall not:

— cause oxidation on the steel surface or the coating that would be detrimental to the quality of the coating of the joint;

— damage the factory applied coating.

7.3.5.3 Application of the primer coat

The primer coat shall be applied by manual or automatic spray.

7.3.5.4 Application of the modified polypropylene powder

Unless agreed otherwise in the tender specification and the order, the overlap onto the factory applied coating shall be not less than 10 mm. The polypropylene shall be applied before the primer coat has cured and preferably during the gel time of the primer material.

7.3.5.5 Application of the polypropylene topcoat

Depending on the system being used (see 7.3.2.1, 7.3.2.2 and 7.3.2.3), the top shall be applied as follows:

— by flame spray in a controlled gaseous atmosphere;

— by wrapping with tape; a proper heating system is required to ensure a good weld between the tape and the factory applied coating;

— by injection of melted polypropylene into a suitable mould; a proper heating system is required to ensure a good weld between the melted polypropylene and the factory applied coating.

7.3.6 Characteristics of the coating applied

7.3.6.1 General

The tests below shall be carried out on the cured coating (application conditions see Table 8).

7.3.6.2 Thickness

The minimum thickness of the coating is defined by agreement between the purchaser and the coater, taking into consideration the thickness of the existing factory applied coating.

The thickness is measured in accordance with method defined in Annex A.

7.3.6.3 Holiday detection

The whole surface of the coated joint shall be checked for holidays or other discontinuities at a voltage of 10 kV per mm of the nominal coating thickness, with a maximum of 25 kV, in accordance with the method given in Annex B. No holidays or other discontinuities are allowed.

7.3.6.4 Peel strength

If the thickness of the field joint coating is greater than 3 mm, the thickness may be reduced before testing. The peel strength of the polypropylene coating shall be measured at a temperature of (90 ± 2) °C according to the method given in Annex D; the minimum required value shall be 4 N/mm.

7.3.6.5 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 in accordance with the method defined in Annex E.

The acceptance criterion is the value of ΔTg given by the manufacturer.

7.3.6.6 Cathodic disbondment

The test is carried out in accordance with the method defined in Annex F.

The average disbondment shall not be more than 7 mm after a period of:

— 28 days at (23 ± 2) °C; or

— 7 days at (40 ± 2) °C; or

— 2 days at (60 ± 2) °C.

The test condition is subject to an agreement between coater and purchaser.

7.3.6.7 Impact resistance

When tested according to the method given in Annex G, the coating shall be able to withstand an impact energy of 7 J per mm of measured thickness (see 7.3.6.2). Testing shall be carried out at (20 ± 5) °C and shall only be carried out on pipes with diameters of 100 mm or more.

After the impact test no holidays are allowed.

7.3.6.8 Indentation resistance

Indentation resistance shall be determined by testing in accordance with the method given in Annex H.

The maximum indentation is given in Table 9.

Table 9 — Indentation for polypropylene coating

Testing temperature	Indentation
(23 ± 2) °C	≤ 0,1 mm
(90 ± 2) °C	≤ 0,9 mm

7.4 Epoxy powder

7.4.1 General

The coating from epoxid powder shall meet the qualification requirements defined in 7.4.6.

7.4.2 Definition of the coating

The coating on the joints consists of an epoxy powder applied to a pre-heated surface.

7.4.3 Information for the coater

The technical data sheet drawn up by the product manufacturer shall contain as a minimum the information detailed in Table 10.

7.4.4 Surface preparation

7.4.4.1 On steel

The areas to be coated shall be prepared by abrasive blast cleaning only (see 6.1.2.3) to give the surface profile defined in 6.1.2.

Table 10 — Technical data sheet epoxy powder coating materials

Items	References to testing standards	Technical data sheet
Date of issue		+
Name of manufacturer		+
Commercial name of the product		+
Type of product		+
Packaging		+
Storage conditions		+
Colour		+
Density	EN ISO 1183-1	+
Sieve analysis		+
Application methods and conditions (ambient conditions)		+
Minimum and maximum temperature of the steel during application		+
Maximum operating temperature		+
Gel time		
Time between coats		+
Bucholz hardness of the cured film	EN ISO 2815	+
ΔTg	Annex E	+
Impact resistance	Annex G	+
Maximum moisture content		+

7.4.4.2 On factory applied coating

At least 50 mm of the factory applied coating adjacent to the joint shall also be prepared by mechanical or abrasive blast cleaning.

7.4.5 Application of the coating

7.4.5.1 General

The method of application shall be in accordance with the recommendations of the manufacturer.

7.4.5.2 Heating of the area to be coated

Immediately after surface preparation, the area to be coated is heated up to the temperature required by induction heating.

The holding time and the temperature shall not:

— cause oxidation of the surface of steel or the coating that would be detrimental to the quality of the coating of the joint;

— damage the factory applied coating.

7.4.5.3 Application of the epoxy powder

Unless agreed otherwise in the tender specification and the order, the overlap onto the factory applied coating shall be not less than 10 mm.

7.4.6 Characteristics of the coating applied

7.4.6.1 General

The tests below shall be carried out on the cured coating (application conditions see table 10).

7.4.6.2 Thickness

The minimum and maximum thickness of the coating are defined by agreement between the purchaser and the coater, taking into consideration the thickness of the existing factory applied coating.

The thickness is measured in accordance with method defined in Annex A.

7.4.6.3 Holiday detection

The whole surface of the coated joint shall be checked for holidays or other discontinuities at a voltage of 5 kV per mm of the nominal coating thickness, with a maximum of 5 kV, in accordance with the method given in Annex B. No holidays or other discontinuities are allowed.

7.4.6.4 Adhesion

The adhesion of the coating to the steel substrate shall be measured using the method given in Annex C. The acceptance criterion is: rating 3.

7.4.6.5 Degree of cure

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

The test is carried out in accordance with the method defined in Annex E.

The acceptance criterion is the value of ΔTg given by the manufacturer.

7.4.6.6 Cathodic disbondment

The test is carried out in accordance with the method defined in Annex F.

The average disbondment shall not be more than 8 mm after a period of:

— 28 days at (23 ± 2) °C; or

— 7 days at (40 ± 2) °C; or

— 2 days at (60 ± 2) °C.

The test condition is subject to an agreement between coater and purchaser.

7.4.6.7 Impact resistance

When tested according to the method given in Annex G, the coating shall be able to withstand an impact energy of 3 J. Testing shall be carried out at (20 ± 5) °C and shall only be carried out on pipes with diameters of 100 mm or more.

After the impact test no holidays are allowed.

7.4.6.8 Adhesion after immersion in water

The test samples are fully immersed in demineralized water at (80 ± 2) °C for 4 days. The adhesion of the coating is tested in accordance with Annex C.

The acceptance criterion is: rating 4.

7.4.6.9 Electrical insulation resistance

The specific electrical resistance of the coating R_s has to be measured in accordance with the method defined in EN 10289: 2002, Annex F1. After 100 days immersion in a 0,1 N solution of NaCl, the specific electrical insulation resistance shall meet with the following criterion:

R_s (100 days) > 1 X 10^8 Ωm^2

Furthermore, if the value of R_s after 70 days remains only one power of ten above the permissible 100 days value then the ratio α shall be met.

$$\alpha = \frac{Rs(100days)}{Rs(70days)} \geq 0{,}8$$

7.4.6.10 Buchholz hardness

The Buchholz hardness of the coating shall be measured in accordance with EN ISO 2815. The Buchholz hardness shall be complied with the technical data sheet.

Annex A
(normative)

Inspection of thickness

A.1 General

The test consists of measuring the thickness of the applied coating.

A.2 Apparatus

A magnetic, electromagnetic or ultrasonic measuring instrument with ± 10 % reading accuracy shall be used.

A.3 Procedure

For measuring thickness of less than 1 mm, the surface profile of the joint is relevant. In this case, the measurement shall be carried out according to EN ISO 2808, method no. 10.

On each coating to be tested, a total of 8 measurements shall be carried out on the body.

The measurement points shall be distributed along four equally spaced longitudinal circumferential lines on both sides of the weld bead.

Four additional measurements shall be carried out on a circumferential line on top of the weld bead.

A.4 Results

The minimum value for the body and for the weld bead shall be reported.

Annex B
(normative)

Holiday detection test

B.1 General

The test consists of detecting any porosity of the coating using a scanning electrode energised by a high-arc-voltage.

Defects shall be detected by a spark occurring between the steel and the electrode at the defect, accompanied by a sound and/or light signal.

B.2 Apparatus

The apparatus shall consist of:

— adjustable high-voltage holiday detector with ± 10 % reading accuracy, equipped with a sound and/or light signal;

— scanning electrode in the form of a metal brush, coiled spring with continuous spirals or conductive rubber conforming to the shape of the joints;

— conductors which are used to connect the joint to an earth electrode.

B.3 Procedure

The test shall only be done on a coating that is free from surface moisture.

The instrument and earth shall be connected to the coated component. The scanning electrode passes over the surface of the coating to be inspected with a continuous movement. The rate of the relative movement of the electrode shall not be greater than 300 mm/s.

At the time of the test, the voltage shall be set at the value depending on the material and the thickness of the coating.

B.4 Results

The number of holidays shall be reported.

Annex C
(normative)

Adhesion test – Resistance to removal

C.1 General

The test consists of determining the adhesion of the coating by a destructive process.

C.2 Apparatus

The apparatus shall consist of:

— a utility knife (e.g. with a stiff straight blade);

— a steel rule, if required;

— a steel rod, if required.

C.3 Procedure

The adhesion test shall be done at (20 ± 5) °C on the body.

The test area shall consist of any coated area on the component or test piece that is free from all defects and with the correct dry film thickness.

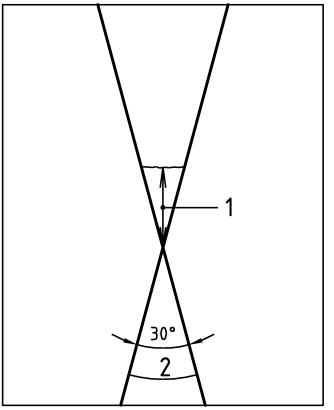
Using a sharp-bladed utility knife against a steel rule if necessary, straight 30 mm to 50 mm cuts shall be made in the coating through to the metal surface to form an X with an angle of approximately 30° at the intersection point.

The point of the utility knife shall be inserted horizontally (i.e. the flat of the blade) under the coating at the point of intersection of the cuts such that the blade point is at the metal surface.

A levering action against a fulcrum (such as a steel rod) shall be used to force the flat point of the blade up from the metal surface describing a single, vertical (i.e. at 90° to the surface) motion in an attempt to prise the coating off.

C.4 Results

The adhesion of the coating shall be determined by the following rating system, see Figure C.1.



Key

1 Adhesive loss of coating (rating 1 to 5)

- Rating 1: No removal of coating other than that caused by insertion of the flat point of the knife blade at the intersection point (nominally less than 1 mm).
- Rating 2: Not more than 2 mm of adhesive loss of coating from the metal surface.
- Rating 3: Not more than 3 mm of adhesive loss of coating from the metal surface.
- Rating 4: Not more than 5 mm of adhesive loss of coating from the metal surface.
- Rating 5: More than 5 mm of adhesive loss of coating from the metal surface.

2 Cuts

Figure C.1 — Adhesive loss of coating (rating 1 to 5)

The rating of the coating adhesion is determined by adhesive failure. Limited cohesive rupture within the coating shall be considered a pass, if there is satisfactory adhesion.

Cohesive rupture caused by excessive interface or cross-section porosity leaving a noticeable "honeycomb" structure on the specimen surface shall constitute a fail.

The rating shall be reported.

Annex D
(normative)

Peel strength test

D.1 Measurement of the peel strength on a coated sample

D.1.1 General

The method consists of measuring the force required for peeling the coating from the metal substrate of the joint at a constant rate of pull (see Figure D.1).

D.1.2 Apparatus

The apparatus shall consist of:

— a tensile testing machine with which it is possible to record the peel force with ± 5 % reading accuracy and which operates at a rate of pull of (10 ± 1) mm/min;

— a cutting tool (e.g. knife);

— a test piece holder with which it is possible to rotate the joint without friction about its axis and which can be fitted in the jaws of the tensile testing machine.

D.1.3 Procedure

The test shall be performed at temperatures of (23 ± 2) °C and (maximum operating temperature ± 2) °C if > 30 °C on the body. If provision has been made to perform this test outside this temperature range, the method described shall be adapted, after agreement, if necessary, between the coater and purchaser.

The temperature shall be measured by means of an adapted probe, on the external surface of the joint at the root of the peeled strip (evaluation on 100 mm).

A sample of minimum length of 100 mm shall be cut from the coated joint. From this sample, a strip of coating 50 mm wide perpendicular to the axis of the joint shall be cut. When the peel force of the coating is higher than the capacity of the testing machine, the width of the coating strip may be reduced.

The strip shall be separated over a circumferential length of approximately 20 mm.

The joint shall be arranged on its support and shall be secured to one of the gripping jaws of the testing machine. The separated strip of the coating shall be held in the other jaw and it shall be verified that the tensile force is applied in the plane passing through the axis of rotation of the support.

The peel force shall be graphically recorded over the agreed length of 200 mm using a constant peeling rate set to 10 mm/min.

D.1.4 Results

Calculate the mean value of the peel strength in Newton per millimetre width using at least 20 points at regular intervals. Disregard the first and last 50 mm of the peeling length. If any values are less than 75 % of the specified peel strength, test a further three test specimens. No further failure is allowed.

D.2 Measurement of the peel strength on large diameter joint

D.2.1 General

The method consists of measuring the force required for peeling the coating from the metal substrate of the joint at a constant rate of pull (see Figure D.2).

D.2.2 Apparatus

The apparatus shall consist of:

— a parallel tensile test machine, which shall be fixed directly on the joint which makes it possible to record the peel force with ± 5 % reading accuracy, on a minimum strip length of 100 mm and which operates at a rate of pull of (10 ± 1) mm/min;

— a cutting tool (e.g. knife).

D.2.3 Procedure

The test shall be performed at temperatures of (23 ± 2) °C and (maximum operating temperature ± 2) °C if > 30 °C on the body. If provision has been made to perform this test outside this temperature range, the method described shall be adapted, after agreement, if necessary, between the coater and purchaser.

The temperature shall be measured by means of an adapted probe, on the external surface of the joint at the root of the peeled strip (evaluation on 100 mm).

A sample with a length appropriated to the testing machine shall be cut from the coated joint. From this sample, a strip of coating 50 mm wide perpendicular to the axis of the joint shall be cut. When the strength of the coating is higher than the capacity of the testing machine, the width of the coating strip may be reduced.

The strip shall be separated over a circumferential length of approximately 20 mm.

The separated strip of the coating shall be secured in the jaw of the testing machine. The coating shall be peeled off with a peeling rate of 10 mm/min perpendicular to the surface of the pipe.

The peel force shall be graphically recorded over a length of 200 mm.

D.2.4 Results

See D.1.4.

D.3 Measurement of the peel strength with a spring balance

D.3.1 General

The method consists of measuring the force required for peeling the coating from the metal substrate of the joint with a spring balance at a constant rate of pull (see Figure D.3).

D.3.2 Apparatus

The apparatus shall consist of:

— a spring balance with an accuracy of ± 10 % with a clamp;

— a cutting tool (e.g. knife).

D.3.3 Procedure

The test shall be performed at a temperature of (20 ± 5) °C on the body. If provision has been made to perform this test outside this temperature range, the method described shall be adapted, after agreement, if necessary, between the coater and purchaser.

The temperature shall be measured by means of an adapted probe, on the external surface of the joint at the root of the peeled strip (evaluation on 100 mm).

From the joint, a strip of coating 50 mm wide perpendicular to the axis of the joint shall be cut. When the peel force of the coating is too high, the width of the coating strip may be reduced.

The strip shall be separated over a circumferential length of approximately 20 mm.

The separated part of the coating shall be secured in the clamp of the spring balance.

The coating shall be peeled off with a peeling rate of 10 mm/min perpendicular to the surface of the pipe. Over a distance of 10 mm every 6 s the peel force shall be recorded.

D.3.4 Results

The peel strength, in Newton per mm, shall be calculated as the arithmetic mean taken over the 10 recorded peel forces.

The peel strength in N/mm shall be reported.

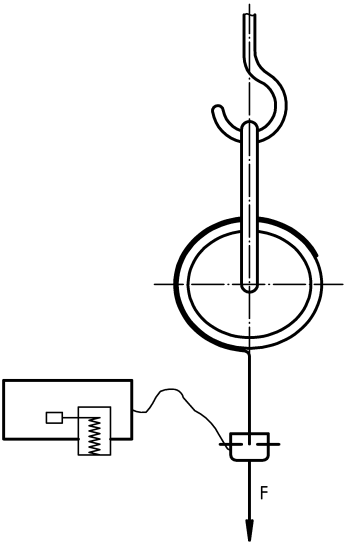


Figure D.1 — Peel strength test on a small diameter joint

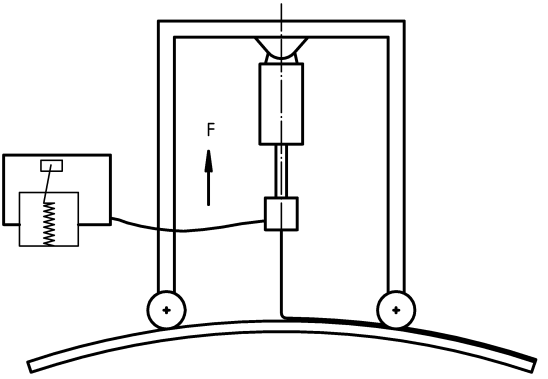
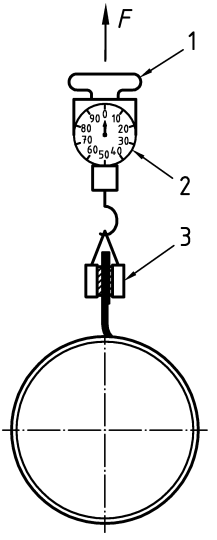


Figure D.2 — Peel strength test on a large diameter joint



Key

1 Handle
2 Spring balance
3 Clamp

Figure D.3 — Peel strength test with a spring balance

Annex E
(normative)

Test for assessing the degree of cure of the epoxy coating by thermal analysis

E.1 General

The purpose of the test is to assess the degree of cure of the epoxy film by the measurement of the glass transition temperature by means of a differential scanning calorimeter.

The test shall be performed on a test specimen taken from the coated component previously subjected to the holiday detection inspection in accordance with Annex C. It may be agreed that the test may be carried out on the coated component without cutting the test specimen.

E.2 Principle

The method consists of raising the temperature of a sample of epoxy coating at a constant rate in a differential scanning calorimeter in accordance with ISO 11357-2.

The samples shall be pre-treated to remove moisture and to provide a uniform thermal state in accordance with the recommendations of the manufacturer.

The first plot records the thermal changes in the sample between room temperature and a point located beyond the glass transition temperature. Then the sample shall be cooled down to room temperature. A second heating cycle identical to the first cycle shall then be carried out.

E.3 Sampling

Immediately after application, a sample of the epoxy film shall be taken from the coated component without adhesive by using a sharp tool to provide flakes of the coating. Care shall be taken to remove the sample from the whole thickness of the film while, at the same time, the inclusion of steel fragments shall be avoided. The flakes of the coating shall be placed in a box sealed and identified. The sample may be taken at various points along the length or around the circumference of the component. The flakes shall be broken into small pieces.

E.4 Procedure

The test procedure shall be in accordance with ISO 11357-2.

E.5 Results

A completely polymerised coating will give characteristic glass temperatures during two successive tests. On the other hand, an incompletely polymerised coating shall give a difference in glass transition temperature. This difference ($\Delta Tg = Tg_2 - Tg_1$) shall be less than that communicated by the manufacturer (see Table 8).

The difference ΔTg shall be reported.

Annex F
(normative)

Cathodic disbondment test

F.1 General

The test consists of assessing the resistance to disbondment of damage to the coatings when exposed to cathodic polarisation.

The test shall be performed on test specimen taken from the coated components previously subjected to holiday-detection (Annex B), and in which an artificial defect of a defined size has been drilled. The test may be performed on the coated component without cutting test specimens.

F.2 Apparatus

F.2.1 Electrical source

The source for the voltage and the current shall consist of a stabilised DC power unit[1)]. A cathodic polarisation potential of U_H = - 1 260 mV (where U_H means the potential of the standard hydrogen electrode) shall be maintained.

— "*E*" is the potential of the "working electrode" with regards to the "reference electrode".

— "*V*" is the difference of potential between the “working electrode” and the "auxiliary electrode".

F.2.2 Electrolytic cell

For tests, typical test cell configurations are shown in Figure F.1 for large diameter components and in Figure F.2 for small diameter components.

The electrolytic cell shall comprise of:

— a rigid plastic tube of an internal diameter of minimum 50 mm. The height shall be such that the total volume of the electrolyte is equal or greater than 150 ml with a minimum height of the electrolyte of 70 mm;

— a rigid plastic cover in which holes shall be drilled to allow the passage of the electrodes and any other measuring instruments deemed necessary, and to allow the escape of hydrogen.

F.2.3 Electrodes

F.2.3.1 Reference electrode

A suitable type of reference electrode to give a potential (see F.2.1) shall be placed in an electrode holder situated in a glass tube with a porous end diaphragm. The end of this assembly shall be placed approximately 10 mm from the surface of the coating and approximately 20 mm from the coating defect.

The reference electrode used shall be suitable for the test temperature required.

---

1) The current source should be capable of supplying 20 mA to each test area simultaneously.

F.2.3.2 Auxiliary electrode

The auxiliary electrode shall consist of an inert material, e.g. platinum wire of 0,8 mm to 1,0 mm diameter. It shall be immersed in the electrolyte[2)].

The ratio of the surface area of the anode and the cathode shall be greater than 1.

F.2.3.3 Working electrode (cathode)

The working electrode is represented by the artificial defect which shall be 6 mm in diameter, with a maximum depth of 0,5 mm in the steel substrate (see F.3.5 and Figure F.3).

F.2.4 Electrolyte

The electrolyte shall consist of a solution of 3 % NaCl concentration in distilled or de-ionized water. The solution shall be made from annalar grade sodium chloride.

The pH at the (23 ± 2) °C during the test shall be in the range of 6 to 9.

The height of the electrolyte in the cell shall be (75 ± 5) mm.

F.2.5 Heating equipment

Suitable heating equipment shall be used to establish and to maintain the test temperature of the sample.

If not heated in an oven the temperature shall be checked on the artificial defect by an appropriate means e.g. a temperature sensor.

F.3 Sampling

The test specimen shall be cold cut from a coated component and shall have a minimum size of 80 mm x 80 mm, unless the test is performed on the body of the coated component.

Tests samples shall not be taken from the weld area.

For each sample the thickness of the area of the coating subject to the test shall be measured and recorded.

The integrity of the coating on all test samples shall be checked by holiday detection (see Annex B).

A 6 mm diameter hole (see Figure F.3) shall be drilled on the body through the coating in the centre of the test specimen using a standard drill bit. The depth of the drilled hole in the steel substrate shall not exceed 0,5 mm. At the initiation of the test the total surface area subject to the test shall be free from residual coating.

The test area shall be degreased using a suitable solvent and then rinsed with potable water and subsequently dried.

F.4 Procedure

The plastic tube forming the electrolytic cell shall be sealed using a suitable sealant, e.g. a chemically inert adhesive. The artificial defect shall be in the centre of the cell.

The cell shall be filled with the NaCl electrolyte (see F.2.4).

---

2) Approximately within 10 mm over the coating defect.

A negative cathodic potential shall be applied between the reference and working electrodes (see Figure F.1 or F.2), with an accuracy of ± 10 mV. If a saturated calomel electrode is used the potential shall be – 1 500 mV.

The test shall be performed for the test period required. The level of the electrolyte shall be readjusted with distilled or de-ionized water, if necessary.

F.5 Investigation procedure

After the test, the cell with the electrolyte shall be removed. The test specimen shall be rinsed with water and dried.

After drying, the area of the coating subjected to the test shall be examined in accordance with the following method.

Inspect and assess each coating immediately after the test period. Detach the plastic tube from the test site. Using a lint-free paper towel, wipe along the surface of the coating and cathode area to remove moisture.

Make 12 radial incisions using a sharp knife through the coating to the substrate extending outwards from the holiday for a distance of at least 40 mm. Make these incisions at an angle of approximately 30° from each other.

Insert the knife point into the centre portion of the holiday down to the metal substrate. Using a gentle levering action, peel away slowly a radial section of coating continuing until firm adhesion is encountered. As loss of adhesion is not always obvious, carefully examine the substrate for sign of residual coatings, which indicates that disbonding has not occurred.

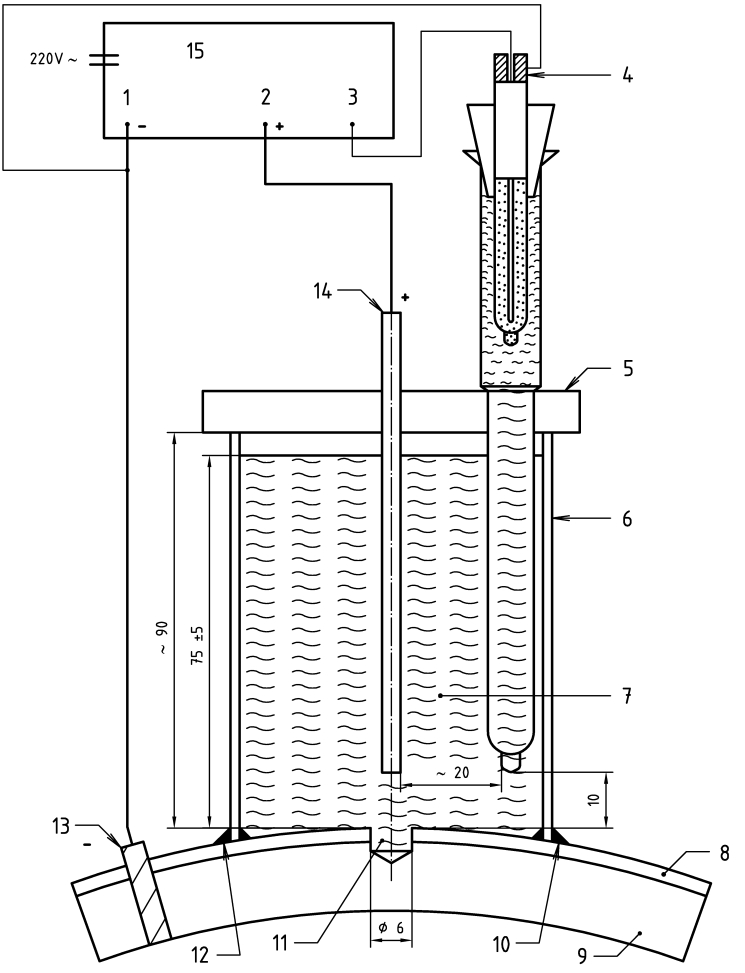
Repeat with each radial segment.

F.6 Results

The result of the cathodic disbondment test is defined as the arithmetic mean value of the 12 single values.

The mean value shall be reported.

Dimensions in millimetres

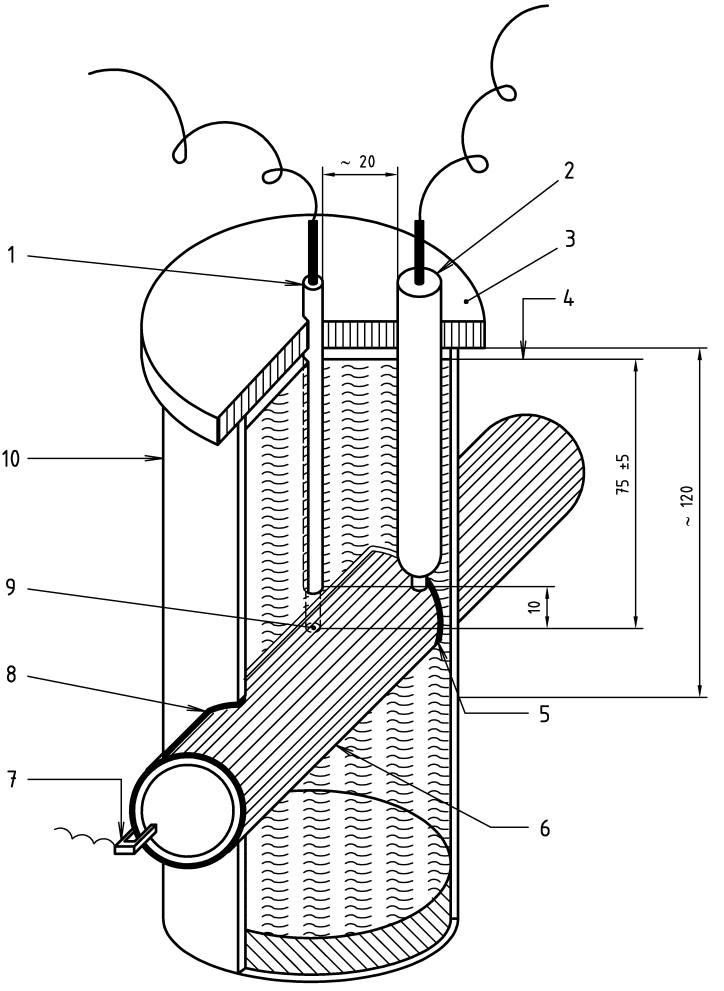


Key

1 Working electrode
2 Electrode (anode)
3 Electrode (reference)
4 Reference electrode
5 Plastic cover
6 Plastic tube, minimum internal ∅ 50 mm
7 Electrolyte volume ≥ 150 ml
8 Coating
9 Steel test piece
10 Sealing material
11 Artificial defect
12 Sealing material
13 Electrode (cathode)
14 Platinium electrode ∅ 0,8 mm to 1,0 mm (anode)
15 Potentiostat

Figure F.1 — Electrolytic cell for large diameter tubes

Dimensions in millimetres

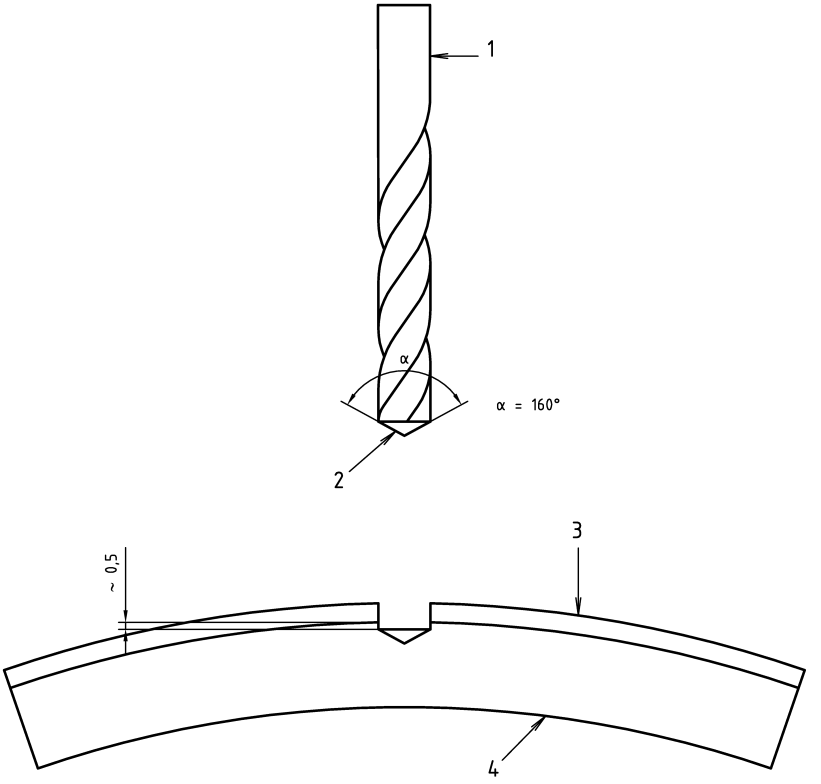


Key

1 Platinum electrode ∅ 0,8 mm to 1,0 mm (anode)
2 Saturated calomel reference electrode
3 Plastic cover
4 Electrolyte level
5 Sealing material
6 Coated tube
7 Working electrode (cathode)
8 Sealing material
9 Artificial defect ∅ 6 mm
10 Plastic tube, minimum internal ∅ 50 mm

Figure F.2 — Electrolytic cell for small diameter tubes

Dimensions in millimetres



Key

1 Fluted and mill face mill ∅ 6 mm
2 Conic end
3 Coating
4 Steel

Figure F.3 — Production of artificial defect

Annex G
(normative)

Impact test

G.1 General

The test consists of verifying the strength of the coating by the impact of a punch of defined shape falling directly onto the coating from a fixed height and at a fixed temperature.

G.2 Apparatus

The apparatus shall consist of a drop weight testing machine comprising:

— a straight guide made of steel, aluminium or plastic, rigid and non-deformable, of inside diameter between 40 mm to 60 mm, of length at least 1,30 m and incorporating a smooth and even inside surface. The guide shall be provided with:

  — a support and levelling device (for example, two spirit levels for the horizontal plane and a plumb line for the vertical plane);

  — a graduated rod which makes it possible to determine the drop height to an accuracy of 5 mm;

— a hard steel punch, with a hemispherical head, free from notches, porosity or other surface irregularities and with a diameter of 25 mm. A small metal rod of diameter 6 mm shall be fixed perpendicular to the flat face of the head and in its centre, where this rod shall be long enough to hold the additional weights required for the tests. The punch shall be equipped with a suitable system for raising to the required height, the accuracy of the mass of this assembly shall be (0,4 ± 0,005) kg;

— a sufficient number of additional weights, formed by metal discs (preferably made of stainless steel) of outside diameter approximately 24 mm and incorporating a central hole of diameter 6,5 mm, the mass of each disc shall be known with an accuracy of ± 5 g.

Other guides may be used by agreement.

G.3 Procedure

The test shall be carried out at a temperature of (20 ± 5) °C. If provision has been made to perform this test outside this temperature range, the method described shall be adapted, after agreement, if necessary, between the coater and purchaser.

The coated component shall be placed on a rigid, and stable, horizontal support, and the component interior shall be supported to reduce its elastic response.

Before carrying out an impact test, the holiday detection test shall be undertaken (see Annex B) to identify the defective points and to avoid making the impact at these locations. If the number of faults found is too high, another coated test piece shall be taken.

For each point of impact, the drop weight testing machine shall be arranged perpendicular to the coating surface so that the loaded punch can fall freely without friction or resistance.

The drop height is 1 m. Ten impacts shall be carried out with the required energy. The points of impact shall be at least 50 mm beside the weld bead and/or the pipe end and at least 50 mm between the axes of the impacts.

The holiday detection test shall then be undertaken at each location (see Annex B).

The hard steel punch shall be checked every 30 impacts. If damaged, it shall be changed.

G.4 Results

The impact energy and the actual coating thickness shall be reported.

Annex H
(normative)

Indentation test

H.1 General

The test consists of measuring the indentation of a punch into the coating under fixed conditions of temperature and load.

H.2 Apparatus

The apparatus shall consist of:

— a chamber or a bath thermostatically controlled to ± 2 °C;

— a penetrometer comprising:

  — a cylindrical punch of diameter 1,8 mm (cross-sectional area 2,5 mm²) on the top of which is mounted a weight. The assembly, punch plus weight, shall produce a force of 25 N;

  — a dial gauge or any other measurement system accurate to ± 10^{-2} mm.

H.3 Procedure

The test shall be performed three times on one coating sample.

The test piece, held within the penetrometer assembly, shall be placed in the thermostatically controlled chamber and set to the test temperature. The test piece shall be allowed to stand for 1 h. The reading on the dial gauge shall be recorded.

The shock resistant punch with the mass giving 2,5 kg in total shall be loaded to the apparatus. The test shall be allowed to stand for 24 h. The reading of the dial gauge shall be recorded.

When sampling of the test piece is unpractical (e.g. in the case of large diameter components), the test shall be carried out directly on the coated component in air provided that the surface temperature of the coating is (20 ± 5)°C and the experimental assembly (component + apparatus) shall not be exposed to any heat radiation or any vibration during testing.

H.4 Results

The indentation shall be the difference between the dial gauge reading before and after the 24 h test duration. The arithmetic mean of the three indentation measurements shall be calculated and reported.

Annex I
(informative)

Qualification of the application procedure and the coater

I.1 General

This European Standard contains the conditions for the evaluation of conformity of any single coating of a joint. However, in order to make an assessment of conformity of a full range of coatings of joints, more elements may be needed such as a factory production control system or quality system, a type-testing scheme, a qualification scheme and/or a certification scheme. These systems are independent from the strict evaluation of conformity of a single coating of a pipe joint, and may be required either by legislation or regulation, or by contractual agreements.

Unless there is a qualification scheme of the coater and a factory production control system in place, ECISS/TC 29/SC 4 is of the opinion that the following clauses represent the best way to assess the conformity of a range of coatings of pipe joints to this European Standard.

I.2 Qualification of the procedure and the coater

The inspections to be carried out during the qualification operation are given in Tables I.1 to I.4.

I.3 Frequency of inspections

The inspections to be carried out during the production are given in Tables I.1 to I.4.

I.4 Retest

In case of failure of one of the tests the test shall be repeated. No further failure is allowed.

Table I.1 — Testing of coatings from bituminous tapes, petrolatum tapes, plastic tapes or heat shrinkable material

Properties	Subclause	Method of testing	Frequency	
			Qualification [a]	Production
Surface condition of the component before preparation	7.1.4	Visual	3 joints	Each joint
Visual inspection of the cleaned surface	7.1.4	EN ISO 8501-1	3 joints	Each joint
Temperature of the surface to be coated	7.1.5	-	3 joints	Each joint
Visual inspection of the coating	6.3	-	3 joints	Each joint
Inspection of thickness	7.1.6.2	Annex A	3 joints	By agreement
Holiday detection test	7.1.6.3	Annex B	3 joints	Each joint
Peel strength test	7.1.6.4	D.1, D.2	3 joints	-
Peel strength test	7.1.6.4	D.3	-	Once per shift

[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.

Table I.2 — Testing of coatings from liquid epoxy resin or liquid polyurethane

Properties	Subclause	Method of testing	Frequency	
			Qualification [a]	Production
Surface condition of the component before preparation	7.2.4	Visual	3 joints	Each joint
Visual inspection of the blast cleaned surface	7.2.4	EN ISO 8501-1	3 joints	Each joint
Roughness of the blast cleaned surface of the joint	6.1.2	EN ISO 4287	3 joints	3 times per shift
Examination of the cleaned factory applied coating	6.1.3	Visual	3 joints	Each joint
Temperature of the surface to be coated	7.2.5.2	-	3 joints	Each joint
Visual inspection of the coating	6.3	-	3 joints	Each joint
Inspection of the thickness	7.2.6.2	Annex A	3 joints	Each joint
Holiday detection test	7.2.6.3	Annex B	3 joints	Each joint
Adhesion test	7.2.6.4	Annex C	3 joints	Once per shift
Shore D hardness	7.2.6.5	EN ISO 868	3 joints	-
Cathodic disbondment test		EN 10289 EN 10290	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.

Table I.3 — Testing of coatings from polypropylene

Properties	Subclause	Method of testing	Frequency	
			Qualification [a]	Production
Surface condition of the component before preparation	7.3.4	Visual	3 joints	Each joint
Visual inspection of the blast cleaned surface	7.3.4	EN ISO 8501-1	3 joints	Each joint
Roughness of the blast cleaned surface of the joint	6.1.2	EN ISO 8503-1	3 joints	3 times per shift
Examination of the cleaned factory applied coating	6.1.3	Visual	3 joints	Each joint
Temperature of the surface to be coated	7.3.5.2	-	3 joints	Each joint
Application criteria	7.3.5		3 joints	Continuously
Visual inspection of the coating	6.3	-	3 joints	Each joint
Inspection of the thickness	7.3.6.2	Annex A	3 joints	Each joint
Holiday detection test	7.3.6.3	Annex B	3 joints	Each joint
Peel strength test	7.3.6.4	D.1, D.2	3 joints	-
Peel strength test	7.3.6.4	D.3	-	Once per shift
Degree of cure	7.3.6.5	Annex E	3 joints	-
Cathodic disbondment test	7.3.6.6	Annex F	3 joints	-
Impact resistance test	7.3.6.7	Annex G	3 joints	-
Indentation resistance test	7.3.6.8	Annex H	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.

Table I.4 — Testing of coatings from epoxy powder

Properties	Subclause	Method of testing	Frequency	
			Qualification [a]	Production
Surface condition of the component before preparation	7.4.4	Visual	3 joints	Each joint
Visual inspection of the blast cleaned surface	7.4.4	EN ISO 8501-1	3 joints	Each joint
Roughness of the blast cleaned surface of the joint	6.1.2	EN ISO 8503-1	3 joints	3 times per shift
Examination of the cleaned factory applied coating	6.1.3	Visual	3 joints	Each joint
Temperature of the surface to be coated	7.4.5.2	-	3 joints	Each joint
Application criteria	7.4.5		3 joints	Continuously
Visual inspection of the coating	6.3	-	3 joints	Each joint
Inspection of the thickness	7.4.6.2	Annex A	3 joints	Each joint
Holiday detection test	7.4.6.3	Annex B	3 joints	Each joint
Adhesion test	7.4.6.4	Annex C	3 joints	-
Degree of cure	7.4.6.5	Annex E	3 joints	-
Cathodic disbondment test	7.4.6.6	Annex F	3 joints	-
Impact resistance test	7.4.6.7	Annex G	3 joints	-
Adhesion after immersion in water	7.4.6.8	-	3 joints	-
Electrical insulation resistance	7.4.6.9	EN 10289	3 joints	-
Buchholz hardness of the cured film	7.4.6.10	EN ISO 2815	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.

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