

EXTERNAL FIELD JOINT AND REHABILITATION COATING SYSTEMS FOR LINE PIPE

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for field-applied coating systems used for external coating of field joints during the construction of buried or submerged pipelines. It specifies the requirements for coating materials, coating application, inspection and testing and gives procedures for the qualification of coating materials and coating applicators.

The DEP is applicable to the following generic types of field joint coating systems:

- Liquid epoxy
- Liquid polyurethane
- Heat shrink sleeves
- Polyethylene
- Polypropylene
- Fusion bonded epoxy
- Visco-elastic self-healing wrappings

Cold-applied tapes may be used if they fulfill the requirements specified for heat shrink sleeves (3.2.2).

Coal tar enamel and pre-preg fibre reinforced polymers (e.g. UV cured) field joint coating systems shall not be used.

Injection-moulded polyurethane field joint coatings are excluded from the scope of this DEP; it is allowed to use this type of coating, especially in combination with thermal insulation line pipe coating systems, if approved by the Principal and if a qualification program has been performed.

Field joint coatings for elastomeric riser coatings are covered by the riser coating DEP 31.40.30.36-Gen. Field joint coatings of Thermally Sprayed Aluminium (TSA) are covered by DEP 30.48.40.31-Gen.

This DEP is also applicable to coating systems applied in the field as repair (rehabilitation) coating systems to damaged and deteriorated coatings for buried or submerged pipelines.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them.

This DEP is intended to be used by all involved in the design, procurement, manufacturing, and application of field joint coating systems for pipe for oil and gas production, oil refineries, chemical plants, gas plants and distribution depots and installations.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regard to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

adhesive	an intermediate coating layer to improve adhesion between the primer and the coating (three layer system) or between the steel and the coating (two layer system).
applicator	the party that applies the coating to the field joint in the field.
batch	the amount of materials produced within one uninterrupted production run of maximum 8 h under constant production conditions.
chemical pre-treatment	treatment of the blast cleaned pipe surface with a chemical solution before application of the primer or adhesive to improve adhesion of the first coating layer (phosphate, chromate).
field joint	part of the pipeline where pipes have been welded together and where, as a consequence, there is a discontinuity in the pipe coating
general qualification	qualification of a product as a generic field joint coating system
holiday	a defect penetrating through the coating to the steel pipe surface, of such dimensions that it is detectable by means of the specified procedures.
inspector	the party appointed by the Principal to witness the Applicator's quality control of coating materials and the coating process.
maximum design temperature	temperature which is specified by the Principal as the maximum design temperature of the the pipeline.
primer	a coating layer, applied directly onto the bare or pre-treated steel surface to improve the adhesion of the final coating to the pipe surface.
shift	a production run of which the beginning and end coincide with a change in personnel. In the context of the quality control procedures of this DEP, the maximum duration of a shift is 10 h.
specific project qualification	qualification of a product for application for the specified project
three layer system	a coating system consisting of three layers: primer, adhesive and outer layer.

1.4 ABBREVIATIONS

DN	-	Diameter Nominal (mm)
FBE	-	Fusion Bonded Epoxy
ITP	-	Inspection Test Plan
PE	-	Polyethylene
PP	-	Polypropylene
UV	-	Ultraviolet light

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (10).

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the DEP Administrator at standards@shell.com. Shell staff may also post comments on this DEP on the Surface Global Network (SGN) under the Standards folder.

2 GENERAL INFORMATION

2.1 GENERAL

This DEP shall be used for general qualification of external field joint systems and products, and to define the requirements for qualification, application and testing of external field joint systems for specific projects including rehabilitation or repairs of existing pipelines/equipment coating systems.

General field joint coating qualification is performed for the purpose of an overall qualification of field joint coating system and Applicator, but is not necessarily related to a specific project. With this process, a list of qualified coating systems and Applicators is developed, from which the Principal may select a field joint coating system and Applicator for a specific project.

The general qualification may be given independent of line pipe diameter and wall thickness. When qualification is required for a specific project, additional testing should be performed on the specific line pipe diameters and wall thicknesses during the applicator qualification, see section (6).

The field joint coating system shall be suitable for the temperature range, based on the maximum design temperature of the pipeline. This DEP does not identify maximum temperature limits for generic coating systems because there are a large variety of available grades of systems and components. The maximum allowable temperature for a coating system is defined by the choice of the individual components.

For general coating qualification, the coating Manufacturer/Applicator shall specify the temperature range.

The suitability of a coating system for a particular temperature class shall be demonstrated by performing the qualification tests at the relevant test temperature given in this DEP. For a specific project, additional testing should be performed at temperatures specified by the Principal.

Unless otherwise agreed, the selection of the field joint coating system for a given project shall be made by the Principal.

2.2 CLASSIFICATION OF THE COATING SYSTEMS

The field joint coating system shall be suitable to provide corrosion protection to the field joints of a pipeline to the same standard or better than the pipe coating system used on the main body of the pipeline.

The field joint coating system described in this DEP shall be manufactured to obtain the required coating properties under the prevailing design, installation and operating conditions.

2.2.1 Coating types

2.2.1.1 Liquid epoxy

Liquid epoxy and epoxy-modified coatings are two-pack coating systems composed of a base (epoxy resin) and a curing agent. The coating system can be modified with other components.

Reinforcement of the coating systems can be achieved by using glass fibres or glass flakes.

2.2.1.2 Liquid polyurethane

Liquid polyurethane and polyurethane-modified coatings are two-pack coating systems composed of polyol (pack A) and isocyanate (pack B). The coating system can be modified with other components.

2.2.1.3 Heat shrink sleeve

A heat shrink sleeve is a type of field joint coating, applied to a pre-heated pipeline in the form of a sleeve or wrap, which shrinks in the circumferential direction under the influence of heat or by other means, forming an adherent field joint coating.

The shrink sleeve consists of a polyolefin (PE or PP) based backing with an adhesive layer (mastic or hot melt) on one side. The shrink sleeve may be applied with or without a primer.

2.2.1.4 Polyethylene

Polyethylene heat shrink sleeve

This type of polyethylene coating is described in (2.2.1.3).

Flame sprayed polyethylene

This coating shall be applied over an epoxy primer coating (either a powder applied by dusting or electrostatic spray or a spray-applied liquid coating). The primer shall be overcoated with modified polyethylene powder applied by spray or by flame spray and the required thickness shall be achieved by further flame spray application of the modified polyethylene powder.

Polyethylene tape / sheet

This coating shall be applied over an epoxy primer coating (either a powder applied by dusting or electrostatic spray or a spray applied liquid coating). The primer shall be overcoated with modified polyethylene powder applied by spray and the required thickness shall be achieved by wrapping the joint with polyethylene tape/sheet; either in a spiral or a single piece large enough to cover the required area.

2.2.1.5 Polypropylene

Polypropylene heat shrink sleeve

This type of coating is described in (2.2.1.3). For this coating type a polypropylene copolymer adhesive layer and epoxy primer layer shall be used.

Flame sprayed polypropylene

This coating shall be applied over an epoxy primer coating (either a powder applied by dusting or electrostatic spray or a spray applied liquid coating). The primer shall be overcoated with modified polypropylene powder applied by spray or by flame spray and the required thickness shall be achieved by further flame spray application of the modified polypropylene powder.

Polypropylene tape / sheet

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

Injected moulded polypropylene

This coating shall be applied over an epoxy primer coating (either a powder applied by dusting or electrostatic spray or a spray applied liquid coating). The primer shall be overcoated with modified polypropylene powder applied by spray and the required thickness achieved by injecting polypropylene into a suitable mould around the joint.

2.2.1.6 Fusion bonded epoxy

This coating shall consist of a fusion bonded epoxy layer applied by spraying epoxy powder on an electrostatically heated pipe surface.

2.2.1.7 Visco-elastic self-healing wrapping system

This coating system shall consist of two layers. The first layer is a visco-elastic polymeric tape with self-healing properties to provide corrosion protection to the underlying substrate. The second layer is an outerwrap applied to provide mechanical protection.

2.2.2 Temperature

The suitability of a field joint coating for a particular temperature shall be demonstrated by performing the qualification tests at the relevant test temperature given in this DEP.

2.2.3 Pipe coating compatibility

The field joint coating shall possess the required adhesive properties when applied on the base pipe and the various line pipe coating materials. The preheat and application temperatures required for the application of the field joint coating shall not cause loss of functional properties of the line pipe coating.

The generic types of line pipe coatings are:

- Polyethylene
- Polypropylene
- Fusion Bonded Epoxy
- Hot applied bitumen, asphalt or coal tar enamels

The suitability of the field joint coating for use with a particular line pipe coating system shall be demonstrated by carrying out a full application procedure followed by adhesion testing using the generic types of pipe coating as a substrate where required by this specification. Additionally, any deterioration or loss of functional properties of the line pipe coating due to the application of the field joint coating using recommended procedures shall render the field joint coating unsuitable for use in conjunction with that type of line pipe coating.

2.2.4 Pipeline diameter

The field joint coating shall be suitable for application in the field on the pipeline diameters used in a specific project, in accordance with the manufacturer's application instructions.

Variation in pipeline diameter is not part of the common qualification procedure, except when different diameters require different application procedures (e.g. flame heating rather than induction heating, or one-person rather than two-person application). The Contractor shall demonstrate that a field joint coating, applied on the pipeline of specified diameter in the field, complies with this DEP.

Procedures for the testing of applied field joint coating in the field are specified in (4). Qualification of the Applicator is specified in (6).

2.3 INFORMATION TO BE SUBMITTED BY THE PRINCIPAL

For a project qualification, the Principal shall supply technical information to the Contractor regarding the project, in particular the installation and operating conditions. This information shall include at least:

- project name;
- number of field joints to be coated;
- the type and thickness of the field joint coating required;
- line pipe coating cut back length;
- end preparation and bevel angle of line pipe coating;
- the type and thickness of the line pipe coating;
- the minimum and maximum operating temperature of the pipeline;
- description of steel pipe;
- the applicable coating specification;
- the geographical area (land/subsea);

- expected ambient temperature range during installation;
- installation method;
- soil and backfill conditions for land pipelines;
- seabed trenching, laying and burial conditions for subsea pipelines;
- subsequent coatings to be applied (e.g. weight coating, insulation);
- requirements for anti-slip treatment;
- type of cathodic protection system.

2.4 INFORMATION TO BE SUBMITTED BY THE CONTRACTOR

The Contractor shall submit information to the Principal on the field joint coating system to be used. This information shall include at least:

- coating system identification (5.2);
- Manufacturer's data (5.3);
- coating system qualification information (5.4);
- coating installation procedures;
- proposed coating Applicator(s);
- Applicator's qualification information (6);

The Contractor shall confirm that the field joint coating system is suitable for use under the specified conditions (2.3).

3. COATING SYSTEM REQUIREMENTS

3.1 GENERAL

The field joint coating system shall be suitable for the pipeline installation and operating conditions specified by the Principal (2.3).

Before commencing installation, the Contractor shall demonstrate that the coating system will fulfil the qualification requirements in accordance with (5.4). Any modification of a qualified field joint coating system shall require re-qualification of the modified system.

The Contractor shall demonstrate by effective quality control procedures in accordance with (4.3) that the coating, as applied in the field, fulfils the requirements of this DEP.

3.1.1 Immersed service

3.1.1.1 General

The Principal shall specify if the field joint coating will be used in continuously immersed service (examples of which are subsea pipelines, pipelines in swamps, river crossings, etc). If it is not certain, but possible, that this type of service applies (e.g. with varying ground water levels), immersed service should be specified for the selection of field joint coatings.

For immersed service, the field joint coating shall retain all functional properties after exposure to the specified immersed conditions.

3.1.1.2 Test procedure

At least three coated test samples shall be immersed in tap water at the test temperature specified in Table 1. The test sample shall consist of the field joint coating applied on steel with weld bead and shall overlap the existing line pipe coating. The bare edges of the sample shall be coated to prevent ingress of moisture beneath the coating.

Table 1 Water test temperature for immersed service

Maximum design temperature, °C	Test temperature, °C
< 20	20 ± 2
20 to 60	60 ± 2
60 to 80	80 ± 2
> 80	Maximum design temperature ± 2

For immersed service the immersion time shall be 100 days, after which the coated sample shall be removed from the water bath and allowed to cool to ambient temperature. The coating shall then be examined visually and tested as specified in Table 2. The coating properties shall be tested on the steel, on the weld and on the overlap with the existing line pipe coating.

The coating requirements after immersion are similar as for the requirements specified for the 28 days Hot Water Soak test (7.8).

Table 2 specifies the coating properties to be tested at ambient temperature after immersion and the acceptance criteria for each coating type.

The visco-elastic self-healing wrapping system shall also be tested for its self-healing properties in accordance with (7.14) after immersion.

Table 2 Acceptance criteria for testing after immersion

Field joint coating type	Property		
	Adhesion	Flexibility	Destructive
Liquid epoxy/ polyurethane	No blistering (less than 10 % of the test area) ≤ rating 2 > 7 N/mm ²	> 2 % strain	7.12
Heat Shrink Sleeve	PE backed > 2.5 N/mm	PP backed > 4.0 N/mm	7.12
Polyethylene/ polypropylene	PE > 4 N/mm	PP > 15 N/mm	7.12
FBE	No blistering (less than 10 % of the test area) ≤ rating 2 > 7 N/mm ²	> 2 % strain	
Visco-elastic self-healing wrapping	Substrate coverage > 95 % Remaining thickness > 0.6 mm > 0.2 N/mm Self-healing requirement		7.12

3.2 FINISHED COATING SYSTEM REQUIREMENTS

3.2.1 Liquid epoxy and liquid polyurethane

3.2.1.1 Acceptance criteria

The acceptance criteria shall be in accordance with Table 3.

Table 3 Acceptance criteria for liquid coatings

Property	Requirement	Section
Visual appearance	Free from blisters, scratches, etc.	3.2.1.2
Total thickness	By agreement or specified	3.2.1.3
Holiday test	No holidays	3.2.1.4
Hardness Shore D	In accordance with manufacturer's specification	3.2.1.5
Adhesion	rating 1 > 10 N/mm ²	3.2.1.6
Impact	5 J/mm (at 23 °C) 3 J/mm (at 0 °C)	3.2.1.7
Indentation	< 0.2 mm (at 23 °C) < 0.4 mm (at T _{max})	3.2.1.8
Flexibility	No holidays	3.2.1.9
Hot water soak 28 days	No blistering (less than 10 % of the test area) ≤ rating 2 > 7 N/mm ² > 2 % strain	3.2.1.10
Cathodic disbonding	see Table 4	3.2.1.11
Thermal ageing 100 days	No blistering ≤ rating 2 > 7 N/mm ² > 2 % strain	3.2.1.12

3.2.1.2 Visual appearance

The coating shall be free from blisters, visual holidays, scratches or any other irregularities and shall have a uniform colour and gloss.

3.2.1.3 Coating thickness

The minimum thickness of the coatings shall be as specified or agreed between the Principal and the Contractor and shall not be less than the manufacturer's recommendation.

The coating thickness shall be measured in accordance with (7.2).

3.2.1.4 Holidays

The coating system shall be free from holidays when tested in accordance with (7.3).

The test voltage shall be 5 kV/mm, with a maximum of 25 kV.

3.2.1.5 Shore D hardness

The requirement shall be in accordance with the manufacturer' specification.

The test shall be carried out in accordance with the method defined in ISO 868.

3.2.1.6 Adhesion

The adhesion of the coating system on the pipe surface and the plant coating shall be tested. The adhesion of the coating system shall be such that any attempt to remove the coating shall result in a cohesive break in the coating material and not in an adhesive failure of the coating/substrate interface (maximum rating 1) when tested in accordance with (7.4.2).

The adhesion of the coating system shall also be tested by the dolly pull-off method in accordance with (7.4.3). The pull-off adhesion strength shall be more than 10 N/mm² and the failure mode shall be cohesive for more than 75 % of surface area.

For information, test results may be given when tested at the maximum design temperature.

3.2.1.7 Impact resistance

The impact resistance of the coating system at ambient temperature shall be more than 5 J/mm at 23 °C and 3 J/mm at 0 °C when tested in accordance with (7.5)

3.2.1.8 Indentation resistance

The indentation shall be not more than 0.2 mm at 23 °C and not more than 0.4 mm at the maximum design temperature when tested in accordance with (7.6).

3.2.1.9 Flexibility

The flexibility of the coating shall be such that holidays do not appear when tested in accordance with (7.7).

At 0 °C a 2 % strain, and at 23 °C a 3 % strain, shall be induced in the coating of the sample.

3.2.1.10 Hot water soak

Hot water resistance shall be tested in accordance with (7.8) at a test temperature related to the maximum design temperature as specified in Table 15. The test duration shall be 28 days. After the exposure, the coating shall show no significant evidence (less than 10 % of the test area) of blistering or disbonding and shall show an adhesion rating of maximum 2 when tested in accordance with (7.4.2).

The adhesion of the coating system on the pipe surface and the plant coating shall also be tested by the dolly pull-off method (7.4.3). The pull off adhesion strength shall be more than 7 N/mm² and the major failure mode (> 75 % of surface area) shall be cohesive.

The flexibility of the coating after exposure shall be such that holidays do not appear when it is tested in accordance with the procedure in (7.7) with 2 % strain induced in the coating of the sample at 23 °C.

3.2.1.11 Cathodic disbonding resistance

Cathodic disbonding shall be tested in accordance with (7.9) at a test temperature related to the maximum design temperature as specified in Table 4. The duration of the test for coating qualification shall be 28 days. After the test, the maximum radius of disbonding shall be less than the value given in Table 4.

Table 4 Cathodic disbonding resistance for liquid coatings

Maximum design temperature, °C	Test temperature, °C	Maximum disbonding radius, mm
< 20	20 ± 2	5
20 to 60	60 ± 2	10
60 to 80	80 ± 2	10
> 80	Maximum design temperature ± 2 (but no higher than 95 ± 2)	10

3.2.1.12 Thermal ageing

Thermal ageing shall be tested in accordance with (7.10) at a test temperature related to the maximum design temperature as specified in Table 16. The duration of the test shall be 100 days. After the exposure, the coating shall show no significant evidence (less than 10 % of the test area) of blistering or disbonding and shall show an adhesion rating of maximum 2 when tested in accordance with (7.4.2).

The adhesion of the coating system on the pipe surface and the plant coating shall also be tested by the dolly pull-off method (7.4.3). The pull off adhesion strength shall be more than 7 N/mm² and the major failure mode (> 75 % of surface area) shall be cohesive.

The flexibility of the coating after exposure shall be such that holidays do not appear when it is tested in accordance with the procedure in (7.7) with 2 % strain induced in the coating of the sample at 23 °C.

3.2.2 Heat shrink sleeve

3.2.2.1 Acceptance criteria

The acceptance criteria shall be in accordance with Table 5.

Table 5 Acceptance criteria for heat shrink sleeves

Property	Requirement		Section
Visual appearance	Free from blisters, scratches, etc.		3.2.2.2
Total thickness	By agreement or specified		3.2.2.3
Holiday test	No holidays		3.2.2.4
Adhesion (peel strength), 20 °C 25 to 60 °C > 60 °C	PE backed > 2,5 N/mm > 0.5 N/mm > 0.3 N/mm	PP backed > 4.0 N/mm > 2.0 N/mm > 2.0 N/mm	3.2.2.5
Lap shear strength, 20 °C 25 to 60 °C > 60 °C	PE backed 0.5 N/mm ² 0.3 N/mm ² 0.1 N/mm ²	PP backed 2.0 N/mm ² 0.5 N/mm ² 0.5 N/mm ²	3.2.2.6
Impact	> 15 J		3.2.2.7
Indentation (remaining thickness)	> 0.6 mm		3.2.2.8
Hot water soak 28 days	PE backed > 2.5 N/mm	PP backed > 4.0 N/mm	3.2.2.9
Cathodic disbonding	see Table 6		3.2.2.10
Thermal ageing 100 days	PE backed > 1.8 N/mm	PP backed > 3.0 N/mm	3.2.2.11
Destructive testing	Regular distribution of adhesive.No bare steel visible, etc		3.2.2.12

3.2.2.2 Visual appearance

The applied heat shrink sleeve shall be free from blisters formed by entrapped air, pinholes, scratches, burn marks or any other irregularities and shall have a uniform colour and gloss.

The adhesive shall be regularly distributed under the full area of the sleeve and shall be visible at both ends of the sleeves around the full circumference of the pipe.

3.2.2.3 Total thickness

For the shrink sleeves the thickness in the as-delivered state shall be as specified by the manufacturer of the shrink sleeve. The applied shrink sleeve shall be of even thickness over the total sleeve surface allowing for some variation on weld seams.

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

The thickness shall be measured in accordance with the method described in (7.2).

3.2.2.4 Holidays

The applied shrink sleeve shall be free from holidays and/or pinholes that are indicated when tested in accordance with (7.3).

The test voltage shall be 5 kV/mm + 5 kV, with a maximum of 25 kV.

3.2.2.5 Adhesion

The adhesion of the shrink sleeve to the pipe steel, the weld and the pipe coating shall be determined as peel strength, measured at room temperature and at a test temperature related to the maximum design temperature using the test procedure in (7.4.4). The minimum peel strength values at the given test temperature shall be as specified in Table 5.

After each peel strength test the test surface shall be examined for the mode of failure. There shall be no adhesive failure between the shrink sleeve adhesive component and the (primed) pipe or weld surface.

There shall be no adhesive failure between the shrink sleeve adhesive component and the pipe coating or shrink sleeve backing over more than 10% of the test surface.

3.2.2.6 Lap shear strength

The lap shear strength of the shrink sleeve adhesive to steel shall be determined at room temperature and at a test temperature related to the maximum design temperature in accordance with the test method described in (7.11). The minimum lap shear strength values at the given test temperature shall be as specified in Table 5.

The mode of failure shall be cohesive within the adhesive layer.

3.2.2.7 Impact resistance

The impact resistance of the shrink sleeve system shall be tested at $(23 \pm 3) ^\circ\text{C}$ in accordance with the test method described in (7.5)

The minimum impact resistance shall be 15 J for all pipe diameters.

3.2.2.8 Indentation resistance

The indentation resistance of the shrink sleeve shall be tested at room temperature and at maximum design temperature in accordance with the test method described in (7.6).

The minimum remaining thickness after indentation shall be more than 0.6 mm.

3.2.2.9 Hot water soak

Hot water resistance shall be tested in accordance with (7.8) at a test temperature related to the maximum design temperature as specified in Table 15. The duration of the test shall be 28 days.

After the exposure, the coating shall show no significant evidence (less than 10 % of the test area) of blistering or disbonding.

The adhesion of the shrink sleeve to the pipe steel, the weld and the pipe coating shall be more than 2.5 N/mm for PE backed sleeves and more than 4.0 N/mm for PP backed sleeves when tested in accordance with (7.4.4) at 23 °C.

3.2.2.10 Cathodic disbonding resistance

Cathodic disbonding shall be tested in accordance with (7.9) at a test temperature related to the maximum design temperature as specified in Table 6. The duration of the test shall be 28 days. After the test, the maximum radius of disbonding shall be less than the value given in Table 6.