BRITISH STANDARD

BS EN 10300:2005

Steel tubes and fittings for onshore and offshore pipelines — Bituminous hot applied materials for external coating

The European Standard EN 10300:2005 has the status of a British Standard

ICS 23.040.99; 25.220.60; 75.180.10

BSI British Standards

National foreword

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Foreword

This document (EN 10300:2005) 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of an identical text or by endorsement, at the latest by May 2006, and conflicting national standards shall be withdrawn at the latest by May 2006.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, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies requirements for the application of factory applied external bitumen based hot applied coatings for the corrosion protection of steel tubes and fittings for onshore and offshore pipelines.

This specification covers the use of bitumen based enamel when the design temperature of the pipeline is within the following limits:

— oxidized bitumen – 15 °C to + 75 °C;

— modified bitumen – 30 °C to + 90 °C.

The coatings described in this European Standard can be applied to longitudinally or spirally welded tubes or to seamless tubes and fittings used for the construction of pipelines for the conveyance of liquids or gases.

NOTE Tubes coated with bitumen based enamel may be further protected by means of cathodic protection.

2 Normative references

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

EN 1426, *Bitumen and bituminous binders - Determination of needle penetration*

EN 1427, *Bitumen and bituminous binders - Determination of softening point - Ring and ball method*

EN 1849-1, *Flexible sheets for waterproofing - Determination of thickness and mass per unit area - Part 1: Bitumen sheets for roof waterproofing*

EN 12311-1, *Flexible sheets for waterproofing - Part 1: Bitumen sheets for roof waterproofing - Determination of tensile properties*

EN ISO 2431, *Paints and varnishes - Determination of flow time by use of flow cups (ISO 2431:1993, including Technical Corrigendum 1:1994)*

EN ISO 2592, *Determination of flash and fire points - Cleveland open cup method (ISO 2592:2000)*

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)*

EN ISO 13736, *Petroleum products and other liquids - Determination of flash point - Abel closed cup method (ISO 13736:1997)*

ISO 719, *Glass - Hydrolytic resistance of glass grains at 98 °C - Method of test and classification*

ISO 2591-1:1988, *Test sieving - Part 1: Methods using test sieves of woven wire cloth and perforated metal plate*

ASTM *D737*-96, *Test Method for Air Permeability of Textile Fabrics*

3 Terms and definitions

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

3.1
coater
company responsible for applying the coating material to the components to be coated in accordance with the provisions of this document or the special requirements given in the tender specification and in the order

3.2
bitumen
viscous liquid or a solid, consisting of hydrocarbons and their derivatives, which is soluble in carbon disulfide or trichloroethylene

NOTE It is substantially non-volatile and softens gradually when heated. It is black or brown in colour and possesses waterproofing and adhesive properties. It is obtained by refinery processes from petroleum.

3.3
oxidized bitumen
bitumen which has been rheologically changed by the action of blowing air through the bitumen

3.4
modified bitumen
bitumen which has been rheologically changed by the addition of polymers

3.5
bitumen based enamel
coating material which is substantially comprised of either oxidized bitumen and filler or modified bitumen and filler

3.6
bitumen based tapes
pre-fabricated tape coating material which is substantially comprised of bitumen based enamel with a carrier

3.7
hot applied material
material which is solid at ambient temperature and becomes fluid on heating to application temperature

3.8
primer
material applied as a thin film to metal in order to ensure adhesion of the subsequent protective coating

3.9
non-woven glass fabric
continuous sheet of randomly arranged glass fibres in an open porous structure bonded by a suitable resin and reinforced by continuous longitudinal glass yarns

3.10
woven glass fabric
regular woven glass fabric made from glass yarns held together by a binder

3.11
composite glass fabric
one layer of glass fibre tissue and one layer of woven or lock welded glass mesh held together by a binder

3.12
composite polyester/glass fabric woven polyester
glass mesh with a layer of glass fibre tissue held together by a binder

3.13
inner-wrap
porous reinforcement of glass fibre which is buried within the bitumen based enamel coating in order to improve its mechanical performance

3.14
outer-wrap
continuous sheet of reinforced glass fibre fabric or glass fibre/polyester composite fabric impregnated by a suitable bitumen based material which is compatible with the bitumen based coating and fused into the outer surface to improve its mechanical performance

4 Composition of the coating

4.1 Description of coating

A coating generally shall comprise a number of layers or components as follows:

— primer which shall be compatible with the chosen enamel coating;

— enamel comprising a bitumen based material containing a filler;

— reinforcing glass fabric inner-wraps as required by the category and thickness of the coating enamel;

— glass or composite fabric outer-wraps as required by the category of coating enamel;

— solar protection, i.e. weather resistant material to protect the coating from sunlight.

NOTE In special cases (for example, for onshore use, due to the nature of backfill material, or for offshore use) additional mechanical protection or a concrete weight coating may be applied by agreement. The type and grade of outer-wrap may be influenced by the presence or absence of the additional mechanical protection.

4.2 Constituent materials

4.2.1 General

All constituent materials shall be supplied with the following identification:

- name of manufacturer;

- date of manufacture;

- batch number/letter(s);

- reference to this European Standard;

- type and grade of material;

- expiry date (where applicable).

4.2.2 Primers

4.2.2.1 General

Any primer without the required identification shall be rejected and replaced with approved material. The primer shall be supplied in suitable airtight containers.

The primer shall be compatible with the chosen bitumen based enamel coating.

4.2.2.2 Primer Type 1

Primer Type 1 for cold application shall consist of chlorinated rubber and plasticizer and, when required, colouring matter, together with solvents needed to give a consistency suitable for application by spray, brush or other approved method. Primer Type 1 shall conform to the requirements given in Table 1.

4.2.2.3 Primer Type 2

Primer Type 2 for cold application shall consist of hydrocarbon resins and plasticizer and, when required, colouring matter, together with solvents needed to give a consistency suitable for application by spray, brush or other approved method. Primer Type 2 shall conform to the requirements given in Table 1.

Table 1 — Characteristics of synthetic primers

Characteristics	Primer Type 1	Primer Type 2	Method of test
Flow time (Flow cup n°4 at 23 °C), seconds	35 to 60	35 to 60	EN ISO 2431
Flash point (Abel closed cup), minimum °C	23	23	EN ISO 13736
Volatile matter, maximum % loss by mass	75	75	Annex H

4.2.2.4 Other primers

Primers based on other materials (e.g. epoxy resin based aqueous primers) may be used providing that, when used in combination with the selected bitumen based enamel coating, they fulfil the performance criteria given in 4.2.4.

4.2.3 Filler

The filler shall comprise a finely divided mineral powder which is not hygroscopic, not electrically conductive and is inert with respect to the other constituents of the tube coating and is resistant to attack by the medium to which it will normally be exposed. It shall be physically and chemically stable at the maximum application temperature of the coating material.

NOTE Powdered slate and talc are typical examples of suitable filler types.

The filler grading shall meet the following requirements:

— passing 90 µm: not less than 93 % by mass;

— passing 250 µm: not less than 99 % by mass;

when tested using the wet sieving method in accordance with 7.3 of ISO 2591-1:1988.

4.2.4 Bitumen based coating enamels

NOTE 1 Bitumen based coating materials are classified into two categories:

— Category 1: oxidized bitumen enamel containing filler;

— Category 2: modified bitumen enamel containing filler.

NOTE 2 Bitumen based coating materials are further sub-divided into a number of grades according to the conditions of application and service, see Annex J.

4.2.4.1 Oxidized bitumen enamel (Category 1)

Category 1 coating materials shall consist of a uniform mixture of oxidized bitumen and filler. The grading of the filler shall be as described in 4.2.3.

Category 1 coating materials shall conform to the requirements for the appropriate grade given in Table 2 when tested by the corresponding methods.

Category 1 coating materials detailed in Table 2, in conjunction with an appropriate primer, shall also conform to the requirements for the appropriate grade given in Table 3 when tested by the corresponding methods.

Table 2 — Characteristics of Category 1 coating enamels

Characteristics	Grade a	Grade b	Grade c	Method of test
Filler content by ignition, % by mass	25 to 35	25 to 35	45 to 55	Annex K
Density at 25 °C, g/cm^3	1,2 to 1,4	1,2 to 1,4	1,4 to 1,65	Annex L
Softening point (ring and ball), °C	100 to 120	110 to 130	120 to 150	EN 1427
Penetration at 25 °C, 0,1 mm	10 to 20	5 to 17	5 to 15	EN 1426
Flash point (Cleveland open cup), minimum °C	250	260	260	EN ISO 2592

Table 3 — Tests for Category 1 coating enamels

Property		Grade a	Grade b	Grade c	Method of test
Sag, maximum mm	60 °C, 24 h	1,5	—	—	Annex D
	75 °C, 24 h	—	1,5	1,5	
Impact disbonded area, maximum mm^2	0 °C	15 000	—	—	Annex E
	25 °C	—	6 500	6 500	
Peel initial and delayed, maximum mm	30 °C	3,0	3,0	—	Annex F, F.4.1
	40 °C	3,0	3,0	3,0	
	50 °C	3,0	3,0	3,0	
	60 °C	3,0	3,0	3,0	
Bend at 0 °C, minimum, mm		20	15	10	Annex G
Cathodic disbonding, disbonded radius after 28 d, maximum, mm		10	10	10	Annex I

4.2.4.2 Modified bitumen enamel (Category 2)

Category 2 coating materials shall consist of a uniform mixture of modified bitumen and filler. The grading of the filler shall be as described in 4.2.3.

Category 2 coating materials shall conform to the requirements for the appropriate grade given in Table 4 when tested by the corresponding methods.

Category 2 coating materials specified in Table 4, in conjunction with an appropriate primer, shall also conform to the requirements for the appropriate grade given in Table 5 when tested by the corresponding methods.

Table 4 — Characteristics of Category 2 coating enamels

Characteristics	Grade a	Grade b	Method of test
Filler content by ignition, % by mass	20 to 30	25 to 35	Annex K
Density at 25 °C, g/cm^3	1,1 to 1,3	1,2 to 1,4	Annex L
Softening point (ring and ball), °C	115 to 135	130 to 160	EN 1427
Penetration at 25 °C, 0,1 mm	10 to 30	5 to 15	EN 1426
Flash point (Cleveland open cup), minimum °C	260	260	ISO 2592

Table 5 — Tests for Category 2 coating enamels

Property		Grade a	Grade b	Method of test
Sag, maximum mm	80 °C, 24 h	1,5	—	Annex D
	90 °C, 24 h	—	1,5	
Impact disbonded area, maximum mm^2	0 °C	—	6 500	Annex E
	- 10 °C	6 500	—	
Peel initial and delayed, minimum N/20 mm	30 °C	80	80	Annex F, F.4.2
	40 °C	50	50	
	50 °C	30	30	
	60 °C	20	20	
Bend at – 10 °C, minimum mm		20	15	Annex G
Cathodic disbonding, disbonded radius after 28 d, maximum mm		7	7	Annex I

4.2.5 Inner-wrap

The inner-wrap shall be a non-woven glass fibre tissue which comprises a continuous sheet of randomly arranged glass fibres in an open porous structure bonded by a suitable resin and shall be reinforced by continuous longitudinal glass yarns at maximum 30 mm spacing.

The inner-wrap shall have a uniform appearance and be free from holes and tears.

The inner-wrap shall be compatible with the bitumen based enamel coating material with which it is used and shall have a texture such that it may be embedded completely within the coating material.

The glass shall be of Hydrolytic Class 3 quality as a minimum when tested in accordance with ISO 719.

The inner-wrap shall conform to the requirements of Table 6.

Table 6 — Characteristics of inner-wrap

Characteristics	Unit	Specification	Method of test
Mass per area	g/m^2	50 ± 3	Annex M
Loss of mass on ignition (binder content), maximum	%	20	Annex M
Tensile strength, minimum - longitudinally - transverse	 N/50 mm N/50 mm	 150 50	EN 12311-1 modified as in Annex N
Thickness, minimum	mm	0,33	EN 1849-1[a]
Porosity	Pa	6 to 19	ASTM D737-96, Annex O
[a] Modified to give a cross-sectional area of 645 mm^2 and a pressure of 13,8 kPa.			

4.2.6 Outer-wrap

The outer-wrap shall have a uniform porosity which allows the air and fumes to escape and the hot coating to bleed through the outer-wrap ensuring it is fused into the outer surface.

The outer-wrap shall have a uniform appearance free from holes, slits and other visible faults. The reinforcement yarns shall be spaced evenly across the width.

At the time of unrolling at ambient temperature the successive layers of outer-wrap shall not stick to each other.

The bitumen based material used for impregnation shall be compatible with the bitumen based enamel coating material. The outer-wrap shall meet the requirements of the type selected from Table 7.

NOTE For Guidelines on the use of outer-wrap, see Annex J.

Table 7 — Characteristics of outer-wrap

Characteristic	Unit	Type						Method of test
Base glass/carrier		A	B	C	D	E	F	
Type of base glass/carrier		non-woven glass fibre tissue	non-woven glass fibre tissue	woven glass fibre	composite glass fibre	composite glass/ polyester fibre	composite glass/ polyester fibre	
Mass per area of base glass before impregnation, minimum	g/m^2	50	80	170	90	70	110	Annex M
Outer-wrap								
Mass per area, minimum	g/m^2	450	550	250	500	450	450	Annex M
Thickness, minimum	mm	0,6	0,76	0,76	0,76	0,5	0,6	EN 1849-1 [a]
Tensile strength, minimum								EN 12311-1 modified as in Annex N
- longitudinal	N/50 mm	300	300	800	700	400	800	
- transverse	N/50 mm	150	230	800	700	200	800	

[a] Modified to give a cross-sectional area of 645 mm^2 and a pressure of 13,8 kPa.

4.2.7 Hot applied bitumen based tapes

NOTE Tubes may be coated by the use of pre-formed hot applied bitumen based tapes. The process is analogous to flood coating or extrusion coating but differs significantly in its detail. For guidelines on the use of hot applied bitumen based tapes, see Annex J.

Composition, use and application of hot applied bitumen based tapes shall be in accordance with Annex P.

5 Method of application

5.1 Surface preparation

5.1.1 General

Tubes and components shall be maintained at least 3 °C above the dew point temperature at all times during the cleaning and coating process.

NOTE At the time of application, particularly when the weather is damp and cold, it may be necessary to pre-heat the tubes and components, and this operation should not be prejudicial to the cleanliness of the surface or to the conditions required for the application of the primer.

5.1.2 Pre-blast requirements

Immediately prior to blast cleaning, the tubes shall be inspected for surface contamination (oil, grease, temporary corrosion protection, etc.). Where oil, grease or other surface contaminants are present they shall be removed (without spreading over the surface) with a suitable solvent (e.g. Xylene) or a biodegradable emulsifier.

All surface defects (slivers, laminations, etc.) detrimental to the surface or to the adhesion of the coating shall be removed.

When necessary, tubes shall be washed with fresh potable water before blast cleaning to remove surface contaminants including mud, salts and other loosely adhering mineral matter. The tubes and components shall then be preheated to a minimum of 30 °C in order to remove moisture and to prevent contamination of the abrasive media.

5.1.3 Blast cleaning

Tubes and components shall be blast cleaned. The grade of abrasive shall give a blast peak to trough surface profile of 75 µm ± 25 µm. The degree of cleanliness shall be to Sa 2½ in accordance with EN ISO 8501-1.

Only dry abrasive techniques shall be employed. The abrasive shall be reusable chilled iron grit or steel grit or a mixture of grit and shot. The abrasive shall be kept free from dust, salts and other impurities.

Sand shall not be used.

5.2 Priming

The primer shall be applied to a dust free, clean, dry, prepared surface. The primer shall be applied in accordance with the primer manufacturer's recommendations.

The primer film applied at the thickness specified by the primer manufacturer shall be uniform and continuous. The dry film thickness shall be measured at least once per shift. The primer shall be free from runs, drips, sags, misses, holidays and bare areas. Tubes not primed correctly shall be re-cleaned and re-primed.

Tubes on which the primer has deteriorated, or become contaminated shall be rejected and shall be re-cleaned and re-primed.

5.3 Application of enamel coating, inner-wraps and outer-wrap

5.3.1 Enamel preparation

The enamel shall be heated in kettles fitted with mechanical stirrers providing continuous agitation of the enamel, and accurate, easily readable recording thermometers, which extend to within 100 mm of the bottom of the kettle. The thermometers shall be calibrated and maintained in working order.

NOTE Bulk deliveries of molten enamel can be transferred directly to the kettles.

Solid enamel shall be broken up into small pieces, not exceeding 10 kg, in a suitable place free from contamination. The heat setting may be increased once a quantity of molten enamel forms in the kettle bottom, but the heat initially shall be applied on a low setting. Whilst the enamel is molten it shall be stirred and the lid of the kettle kept firmly closed, unless to withdraw molten enamel or to add fresh material. The quantity of enamel remaining in the kettle, which may be reheated, shall never exceed 10 % of the fresh loading. The enamel shall be heated to the manufacturer's recommended application temperature and shall not be held for a longer period than that recommended by the manufacturer.

Enamel that has been heated in excess of the manufacturer's maximum recommended temperature or held at application temperature for over 6 h shall be tested for softening point and penetration which shall conform to Table 3 or Table 4 depending on the category of enamel. Further tests shall be conducted at regular intervals, agreed at the time of ordering, to confirm that the material continues to conform to Table 3 or Table 4, otherwise it shall be rejected and discarded.

All application kettles shall be equipped with screens to exclude particles of foreign matter or other materials that may cause coating flaws. Ensure there is no mixing of material from different sources or of different categories unless experience has shown that the final product has satisfactory properties. In particular it shall be recognized that the chemical and physical characteristics of coal-tar-based coatings differ from those of bitumen-based coatings and that the two kinds of coating shall not be blended together in protective coatings. The plant shall be

cleaned out thoroughly when the use of bitumen coating materials follows that of coal-tar coating materials or vice versa. The same precaution shall be taken when interchanging between different types of bitumen enamels. The residual material removed from the kettles during cleaning shall be discarded, not blended with other enamel.

5.3.2 Application

5.3.2.1 General

Coat and wrap application shall follow priming within 2 h, and the primed surface shall be dry and free from surface contamination prior to enamel application.

NOTE Thickness recommendations for Category 1 and Category 2 coatings are given in Annex J.

5.3.2.2 Category 1 enamel

Category 1 enamel shall be applied by flood coating or pouring with equipment for spirally wrapping the inner-wrap(s) and outer-wrap under controlled tension using trained operators. Such equipment shall be approved prior to commencement.

The flood coat of enamel shall have the inner-wrap(s) pulled in and the outer-wrap pulled on immediately following flood coating. The inner-wrap(s) shall not touch the surface of the pipe and shall be embedded in the middle third of the enamel thickness. If two inner-wraps are required, they shall be separated at spacings to be specified at the time of ordering, see 6.2.2. The outer-wrap shall be pulled onto the enamel and be well bonded with some bleed through of enamel occurring.

All wraps shall be wrinkle-free with minimum overlap of 12 mm. The enamel shall be applied at a temperature in accordance with the manufacturer's recommendations. The enamel shall flow evenly onto the pipe and be free from any solid particles which may cause irregularities in flow.

The coating shall be cut-back where necessary to meet the specification. The method of removal of cut-back shall be approved prior to commencement of coating.

5.3.2.3 Category 2 enamel

NOTE 1 Due to their higher viscosity, Category 2 materials are not suitable for flood coating.

Category 2 materials shall be applied by an extrusion process.

Equipment shall be used for spirally wrapping the outer-wrap under controlled tension using trained operators.

NOTE 2 Category 2 materials do not require the use of inner-wraps.

The extruded enamel shall have the outer-wrap pulled on immediately following enamel application. The outer-wrap shall be pulled onto the enamel and be well bonded with some bleed through of enamel occurring.

All wraps shall be wrinkle-free with minimum overlap of 12 mm. The enamel shall be applied at a temperature in accordance with the manufacturer's recommendations. The enamel shall flow evenly onto the pipe and be free from any solid particles which may cause irregularities in flow.

The coating shall be cut-back where necessary to meet the specification. The method of removal of cut-back shall be approved prior to commencement of coating.

5.4 Solar protection

When specified, a weather resistant solar protection which is compatible with the coating shall be applied to the total coated pipe prior to stockpiling. Surplus solar reflective coating shall be removed from the uncoated ends of the pipe.

6 Inspection and testing

6.1 General

Testing shall include but not be restricted to:

— visual checks for appearance and continuity;

— holiday detection;

— evaluation of adhesion;

— determination of enamel coating thickness.

The identity of the tube under test and the results of the tests detailed below shall be recorded.

NOTE Recommended minimum quality control requirements are listed in Annex Q.

6.2 Visual

6.2.1 General

The general appearance of the coating shall be evaluated visually. The coating shall be of uniform appearance and free from any wrinkling, pinholes, voids, laminations, holidays, dry wrap and contamination. The coating shall be completely bonded to the tube surface.

6.2.2 Distribution of inner-wrap

At the quarter, half and three quarter positions along the length of the tube, a sample approximately 100 mm × 20 mm in size shall be taken immediately after coating from one tube in twenty. One sample shall be taken along the weld. The samples shall be examined in cross-section to ascertain the distribution of the inner-wraps through the enamel.

For Category 1 enamels, the inner-wraps shall be completely embedded within the enamel. The position of the inner-wraps shall be such that they are evenly spaced through the enamel and at no point more than 1 mm from the surface of the metal or 1 mm from the outside surface of the coating. Each reinforcement shall be free from folds, wrinkles and voids.

If any of the three samples indicates that the coating does not meet the requirements specified in 4.2.5, then the coating shall be considered defective and shall be stripped and re-coated.

6.3 Holiday detection

Holiday detection shall be carried out on every coated tube as specified in Annex R.

The coating shall be free from holidays.

6.4 Adhesion

A field bond test shall be conducted on the coated tubes 24 h after coating on one tube in every 20. Three tests shall be conducted on each selected tube.

The coating shall adhere to the steel in accordance with the limits specified in Annex S.

6.5 Enamel coating thickness

A film thickness gauge of the magnetic or electro-magnetic type shall be used to measure the coating thickness of each tube (including coating over the weld where applicable) in accordance with Annex T. The instrument shall be calibrated at least twice daily. The thickness readings made on every twentieth tube shall be recorded.

NOTE The thickness of the coating should conform to the requirements of the order and it is recommended that the thickness should be in accordance with Annex J.

6.6 Non-conformance procedure

During production quality control, if the coated tube selected for tests specified in 6.2, 6.3, 6.4 and 6.5 shows defects/failures that give cause for rejection, then the three tubes preceding and the two tubes following this tube shall also be tested. These five tubes shall be subjected to the tests specified in 6.2, 6.3, 6.4 and 6.5.

If the results from these tubes are satisfactory, the coating shall be considered acceptable. If not, the coating shall be considered unacceptable.

If further defects/failures are detected then the entire production for that shift shall be checked and examined. If the coating is rejected, the coater shall re-coat tubes and components and present the re-coated tubes for acceptance again.

If in any total production batch the rejection rate is higher than 10 %, the whole batch shall be rejected and the cause of the failures ascertained. Production shall not recommence until the cause of the failure has been satisfactorily established.

6.7 Cathodic disbonding

Cathodic disbonding tests on coated tubes shall be undertaken only if requested at the time of ordering and in accordance with the method given in Annex I except that the bitumen based coating shall be applied to the tubes in accordance with Clause P.5.

7 Repairs

NOTE Tubes or components with localized defects (e.g. porosity, surface defects) as well as those which have been subjected to destructive control tests may be repaired.

The repair procedure shall be agreed at the time of the purchase enquiry or order.

The coating materials that can be used for repairing defects shall satisfy two conditions:

— be suitable for protecting onshore and offshore pipelines in the required service conditions (e.g. working temperature);

— be compatible with and adhere to the bitumen based coating applied previously.

The application conditions for repair materials shall be approved prior to commencement of coating.

After application the repair shall be subjected to holiday detection. The repair shall be free from holidays.

8 Marking

Marking shall be undertaken on each tube or fitting and shall include the following information:

— identification;

— code or name of the tube manufacturer;

— code or name of the coater, if it differs from the preceding code;

— reference to the steel standard;

— reference to this European Standard.

Marking shall be carried out using a suitable method such as stencil painting or printing. The identification marking shall be legible and indelible and shall utilize durable materials compatible with the exposure of the components to mechanical damage and weathering.

9 Handling, transport and storage

9.1 Handling

Coated tubes and components shall be handled without causing damage to the ends of the tubes or to the coating. The use of steel ropes, steel slings or of any lifting equipment which could damage the coating and the tube ends shall be prohibited.

Tubes shall be handled by means of end hooks or by flat slings, which cradle the tube. Hooks and slings, and other lifting equipment such as spreader bars, beams, hoists and cranes, shall be considered suitable and safe for handling tubes.

Tubes shall at all times be handled in a way, which prevents damage to and contamination of the surface of the coating. Hooks and slings shall be designed to prevent damage to the surface, coating or bevelled ends. If skids are used these shall be wide and padded to prevent damage. Bare cables, chains, hooks, metal bars or narrow skids shall not be permitted to come into contact with coated and wrapped surfaces.

Any damage to the tube or coating caused by handling shall be repaired according to Clause 7.

9.2 Transportation to the storage area

During transportation to the storage area at the coating factory, all relevant precautions shall be taken to avoid damage to the tubes and components and to the coating.

9.3 Storage

Coated tubes shall be stored so that the coating does not deteriorate. Where tubes are stacked a suitable soft material, for example foam, sand bags, straw bags, etc., shall be used as padding to prevent damage to the coating. Stacks of tubes which are intended to be stored for a long period shall be protected from the action of ultraviolet light on the coating by the use of a suitable method (see 5.4).

9.4 Loading of tubes and components for delivery

Loading of coated tubes and components at the factory shall be undertaken such that no damage is caused to the coating.

The coater shall be responsible for the supply of correctly coated tubes and components as detailed in the tender documentation and order (see Annex U).

Annex A
(normative)

Preparation of steel surfaces for the tests given in Annexes D, E, F and G

Prepare the steel surfaces used in the tests given in Annexes D, E, F and G as follows.

Clean the surface of the steel plate from all contamination by oil and grease. Then, blast it to a uniform steel grey finish, removing rust, scale and all other foreign matter to achieve a minimum standard of Sa 2½ (according to EN ISO 8501-1) and so that the surface profile is 75 µm ± 25 µm.

NOTE It is important to ensure that blasted steel surfaces are free from traces of previous coating materials and do not subsequently become contaminated with oil or grease.

Annex B
(normative)

Priming of steel surfaces for the tests given in Annexes D, E, F and G

B.1 General

After preparing the steel surfaces by the method given in Annex A, prime them using an appropriate primer as specified in 4.2.2.1.

B.2 Method for primer Types 1 and 2

See 4.2.2.2 and 4.2.2.3.

Apply the primer with a clean flat bristle brush of 25 mm width to the plates lying in a horizontal position. Apply the primer at the coverage rate detailed in 5.2 in such a manner that the surface is uniformly covered with an even film free from air bubbles. Allow the primer to dry at an air temperature of not less than 15 °C, in a well ventilated atmosphere having a relative humidity not greater than 60 %.

B.3 Coating

When the film is hard dry, apply coating material to the plate by the method given in Annex C, not less than 1 h after application of the primer.

B.4 Other primer types

See 4.2.2.4.

NOTE Other primer types and the subsequent enamel should be applied in accordance with the manufacturer's recommendations.

Annex C
(normative)

Application of coating material for the tests given in Annexes D, E, F and G

Break approximately 7 kg of the coating material, according to the number of tests required, into pieces not greater than 50 mm size. Melt the pieces in a container of uniform cross-section not less than 150 mm or more than 300 mm in diameter, and fitted with a lid.

Heat the container so that the coating material reaches the application temperature recommended by the manufacturer within 2 h.

NOTE 1 Heating may be by any convenient method such as a fluidized or liquid bath, electric hot-plate or gas.

If gas is used, interpose a steel plate of not less than 6 mm thickness between the container and the gas flame.

Stir the material frequently until it reaches the application temperature recommended by the manufacturer, replacing the lid between intervals of stirring. Immediately after it has reached the application temperature, pour the coating material over the primed surface of each plate, held in a horizontal position and at a temperature between 15 °C and 30 °C, in such a manner that fresh enamel constantly flows onto the specimen surface.

Apply the coating material to a thickness of 1,5 mm to 2,5 mm to each test specimen.

NOTE 2 It is convenient to adjust to this thickness immediately after coating by sweeping off the surplus hot enamel with a warmed blade moved along guide rails set for the required thickness.

Annex D
(normative)

Sag test

D.1 Principle

Measurement of resistance of the coating to slump under its own weight.

D.2 Apparatus

Oven, capable of maintaining a temperature of 70 °C ± 2 °C.

D.3 Preparation of test specimens

Prepare one steel test plate, measuring at least 300 mm × 300 mm × 3 mm, by the method given in Annex A, prime it by the method given in Annex B and coat it with coating material prepared by the method given in Annex C. Leave a 15 mm uncoated border around the four edges of the plate. Draw three lines parallel with one edge at 75 mm intervals across the surface of the coating material and continued on the uncoated surface of the plate to the edges. Draw the lines in such a way that the prepared surface is not damaged.

D.4 Procedure

Store the plate in a vertical position in an oven. Maintain the oven (see Clause D.2.1) at the temperature and for the period specified for the appropriate grades in Table 4 and Table 6. At the end of this period remove the plate and allow it to cool to room temperature. Measure the maximum sag of each line on the plate. In cases of disagreement, repeat the test on two fresh specimens.

D.5 Measurement of results

Record the sag of the coating material as the average of the maximum sags of the three lines.

D.6 Test report

Report the average sag in mm at the test temperature.

Annex E
(normative)

Impact test

E.1 Principle

The area of disbonded coating resulting from the impact of a steel ball dropped from a height of 2,45 m is measured.

E.2 Apparatus

E.2.1 Refrigerator.

E.2.2 Lint-free paper towel.

E.2.3 Cold cabinet.

E.2.4 Block of wood.

E.3 Preparation of test specimens

E.3.1 General

Prepare a test plate, measuring approximately 300 mm × 300 mm × 12,5 mm, by the method given in Annex A, prime it by the method given in Annex B and coat it with coating material prepared by the method given in Annex C.

E.3.2 For test at 0 °C

After preparation allow the plate to reach room temperature and then maintain it at a temperature of 0 °C ± 1 °C in a refrigerator (see E.2.1) for 6 h before testing. Remove the plate quickly from the refrigerator, dry it with a lint-free paper towel (see E.2.2) if necessary and subject it to the impact test.

E.3.3 For test at 25 °C

Allow the plate to reach room temperature and then maintain it at a temperature of 25 °C ± 1 °C in an oven for at least 6 h before testing. Remove the plate quickly from the oven, dry it with a lint-free paper towel if necessary and subject it to the impact test.

E.3.4 For test at - 10 °C

Allow the plate to reach room temperature and then maintain it at a temperature of – 10 °C ± 1 °C in a cold cabinet (see E.2.3) for at least 6 h before testing. Remove the plate quickly from the cold cabinet, dry it with a lint-free paper towel if necessary and subject it to the impact test.

E.4 Procedure for tests at - 10 °C, 0 °C and 25 °C

Support the plate on a flat horizontal surface of a block of wood (see E.2.4) with the coated face uppermost. Drop a 630 g to 650 g spherical steel ball with a well polished surface from a height of 2,45 m above the surface of the plate, so as to strike the coating material at the centre of the plate.

E.5 Measurement of results

Examine the plate for evidence of disbonding (see Note 1). Remove all the disbonded coating and measure its area in square millimetres.

Record the area of disbonded coating for impact tests at - 10 °C, 0 °C and 25 °C (see Note 2).

NOTE 1 Disbonded coating is that which can be easily and readily removed from the plate with little force by the use of a knife blade or similar instrument.

NOTE 2 For tests at 0 °C and - 10 °C, if the area disbonded exceeds the maximum given in Table 4 or Table 6 repeat the test in accordance with Clause E.4 on two new plates prepared in accordance with E.3.1, E.3.2, E.3.3 and E.3.4. If the disbonded area on each plate is less than the permitted area, the material is deemed to have passed the test.

E.6 Test report

Report the area of disbonded sheet in square mm at the test temperature.

Annex F
(normative)

Peel test

F.1 Principle

This test shall verify that the coating will adhere firmly to the steel substrate.

Two methods are detailed:

— method 1 shall be used with oxidized bitumen enamel coatings;

— method 2 shall be used with modified bitumen enamel coatings.

F.2 Apparatus

F.2.1 Oven.

F.2.2 Water bath containing tap water.

F.2.3 Stiff scraper, with a sharpened, square-ended blade of approximately 20 mm width.

F.2.4 Spatula, flat with dimensions of approximately 20 mm width.

F.2.5 Hand-held tensometer, with digital readout, peak force indication and a minimum capacity of 200 N incorporating a wedge grip.

F.3 Preparation of test specimens

Prepare two test plates, measuring approximately 300 mm × 300 mm × 12,5 mm, by the method given in Annex A, prime them by the method given in Annex B and coat them with coating material prepared by the method given in Annex C. After applying the coating material, allow the plates to cool to room temperature.

F.4 Procedure

F.4.1 Method 1 — Category 1 oxidized bitumen enamel coating

Use one test plate, without further treatment, for the initial peel test. Store the second test plate in a horizontal position, with the coated side up, in an oven (see F.2.1) at 70 °C ± 2 °C for 72 h. At the end of this period remove the plate, allow it to cool to room temperature and use it for the delayed peel test.

Carry out the peel test by immersing the plate in a water bath (see F.2.2) for approximately 30 min at the lowest temperature specified for the particular grade of coating material in Table 3. At the end of this period remove the plate from the bath and immediately test for peel as follows.

Make two parallel cuts through the coating material approximately 20 mm apart and 100 mm long toward the centre of the plate.

Using a stiff scraper (see F.2.3), make a cut through the coating for the full width between the parallel cuts. With a gentle levering action separate an approximately 15 mm long strip of coating from the steel plate. Carefully turn the blade of the scraper, and the separated coating, until they are vertical to the plate. Gripping the coating and blade between finger and thumb, pull upwards until the coating breaks.

Measure the amount of peeling from the point where the separation through leverage and cutting had ceased to the line of breakage of the coating.

Carry out at least two tests at each temperature.

NOTE In case of failures, more tests can be carried out, extending the parallel cuts if necessary and reporting the average results obtained.

Repeat this procedure, making new parallel cuts, separated by at least 15 mm from the cuts for the preceding test, for each of the successive temperatures specified in Table 3.

F.4.2 Method 2 — Category 2 modified bitumen enamel coating

Use one test plate, without further treatment, for the initial peel test. Store the second test plate in a horizontal position, with the coated side up, in an oven at 70 °C ± 2 °C for 72 h. At the end of this period remove the plate, allow it to cool to room temperature and use it for the delayed peel test.

Carry out the peel test by immersing the plate in a water bath for approximately 30 min at the lowest temperature specified for the particular grade of coating material in Table 5. At the end of this period remove the plate from the bath and immediately test for peel as follows.

Make two parallel cuts through the coating material approximately 20 mm apart and 100 mm long toward the centre of the plate.

Using a stiff scraper, make a cut through the coating for the full width between the parallel cuts. A flat spatula (see F.2.4) shall be inserted at the bottom of the cuts and the coating shall be lifted from the pipe surface.

Once sufficient coating has been lifted, a hand-held tensometer (see F.2.5) shall be attached to the coating at its interface with the steel. Applying an even, steady force the coating shall be pulled at 90° to the steel surface. When either, the coating begins to detach from the primer surface or when the strip breaks, the tension is immediately released and the peak value shall be read from the force gauge.

The bond shall be considered satisfactory if the peak force gauge reading for the 20 mm wide strip complies with the requirements of Table 5.

Carry out at least two tests at each temperature.

NOTE In case of failures, more tests can be carried out, extending the parallel cuts if necessary and reporting the average results obtained.

Repeat this procedure, making new parallel cuts, separated by at least 15 mm from the cuts for the preceding test, for each of the successive temperatures specified in Table 5.

F.5 Expression of results

F.5.1 Method 1 — Category 1

Measure the amount of peeling from the point where the separation through leverage and cutting had ceased to the line of breakage of the coatings.

F.5.2 Method 2 — Category 2

Take the peak force gauge reading when either the coating begins to detach from the primer surface or where the strip breaks.

F.6 Test report

Report the result as a pass or fail at the test temperature.

Annex G
(normative)

Bend test

G.1 Principle

The flexibility of the enamel at low temperatures when used as a coating on steel is measured.

G.2 Apparatus

G.2.1 Water/ice bath containing tap water, refrigerator/freezer.

G.2.2 Knifes, with 3 mm radius edges spaced on 240 mm centres.

G.2.3 Mandrel, with a 12 mm radius.

G.2.4 Electrical holiday detector.

G.2.5 Straight brush, approximately 75 mm long and 6 mm wide with soft, metallic bristles 6 mm long.

G.3 Preparation of specimens

Prepare four test plates, measuring approximately 250 mm × 100 mm × 1,5 mm, by the method given in Annex A, prime them by the method given in Annex B and coat them with coating material prepared by the method given in Annex C.

G.4 Procedure

G.4.1 Store the plates at the test temperature (0 °C or – 10 °C as appropriate) in a water/ice bath, refrigerator/freezer (see G.2.1) for a minimum of 6 h. Then remove and test immediately.

G.4.2 Test the plates for deflection by supporting them on the knife (see G.2.2) edges which are spaced on 240 mm centres. Apply the deflecting load centrally across the plate by means of a mandrel (see G.2.3) at the rate of 1 mm/s (to produce tension in the coating) until cracking occurs, as indicated by an electrical holiday detector (see G.2.4) operated continuously as in G.5.

G.5 Evidence of cracking by means of a holiday detector

Fit a holiday detector with a straight brush (see G.2.5), and adjust it to provide a voltage of 10 kV so arranged that the maximum short circuit current is not greater than 8 mA. If the holiday detector is not equipped with voltage indication, set it to give a 12 mm spark in air to a steel plate. Pass the holiday detector over the coated steel surface. Ignore edge effects and holidays detected prior to refrigeration.

G.6 Measurement of results

Measure the deflection in mm at which the first crack is detected.

G.7 Test report

Report, in millimetres, the deflection producing the first crack.

Annex H
(normative)

Determination of volatile matter — Percent loss of mass

H.1 Principle

The mass of volatile matter which is lost from the sample when held for a period of 3 h at 105 °C to 110 °C is measured.

H.2 Apparatus

H.2.1 Flat-bottomed circular dish.

H.2.2 Oven.

H.2.3 Desiccator.

H.3 Procedure

Weigh to the nearest milligram between 1,0 g and 2,0 g of the primer into the tared flat-bottomed circular dish (see H.2.1) about 75 mm in diameter.

Heat the dish and its contents in the oven (see H.2.2) at 105 °C to 110 °C for 3 h. Allow the dish to cool to room temperature in the desiccator (see H.2.3) and reweigh to the nearest milligram.

H.4 Measurement of results

Calculate the volatile matter, *V,* as a percentage by mass of the primer as follows:

$$V = 100\,\frac{M_1 - M_2}{M_1}$$

where

M_1 is the mass of sample before heating;

M_2 is the mass of sample after heating.

H.5 Test report

Report the result to the nearest 0,1 % by mass.

Annex I
(normative)

Cathodic disbonding test

I.1 Principle

Measurement of the amount of disbonding of the coating caused by an applied voltage.

I.2 Apparatus

I.2.1 Stabilized D.C. power unit, having a controlled voltage output between 0 V and 10 V and a current capacity sufficient to supply 20 mA simultaneously to each test site in the circuit.

I.2.2 Digital voltmeter, range 1,999 V (3½ digit), input impedance 10^3 MΩ, accuracy 0,1 % ± digit at 23 °C ± 1 °C

I.2.3 Variable resistor, range 5 kΩ ± 10 %, 1 W for each test site.

I.2.4 Fixed resistor, 10 Ω ± 1 %, 1 W for each test site.

I.2.5 Fixed resistor, 510 Ω ± 2 %, 1 W for each test site.

I.2.6 Holiday detector, as described in Annex R.

I.2.7 Reference electrode, saturated calomel type electrode, constructed from glass or plastics with porous plug, of diameter less than 10 mm.

I.2.8 Platinum wire, of 0,8 mm diameter, one 75 mm length for each test site.

I.2.9 Rigid plastics tube, of 50 mm nominal bore, one 60 mm length for each test site.

I.2.10 Elastomeric adhesive, for fixing the plastics tube solution containers to the test surface.

I.2.11 Twist drill, of 6 mm diameter.

I.2.12 Lint free paper towel.

I.2.13 Deep-freeze cabinet.

I.2.14 Hammer.

I.2.15 Trigger spray bottle, with potable water.

I.3 Reagents

I.3.1 Sodium chloride solution (3 % mass/volume).

I.3.2 Phenolphthalein acid/base indicator.

I.4 Procedure

Prepare one test plate, measuring at least 200 mm x 100 mm x 15 mm, by the method described in Annex A, prime it by the method described in Annex B and coat it with the bitumen based coating by the method described in Annex C.

To ensure freedom from accidental damage, test the prepared plate with the holiday detector (see I.2.6) by the method described in Annex R.

Affix two plastics tubes (see I.2.9) perpendicular to the coated surface using a suitable elastomeric adhesive (see I.2.10). Place them at a minimum distance of 33 mm from the panel ends and from each other with their centres on the centre line of the panel width. Leave over night to allow the adhesive to cure fully.

Drill a 6 mm hole (see I.2.11) through the coating material to the metal surface in the centre of each test site, as a pre-damaged area.

Fill each plastics tube (see I.2.9) to a depth of approximately 50 mm with sodium chloride solution (see I.3.1) and connect to the apparatus as shown in Figure I.1.

Connect the voltmeter (see I.2.2) as shown in Figure I.2 and with the porous tip of the reference electrode (see I.2.7) placed within 10 mm of the hole in the coating material, adjust the variable resistor (see I.2.3) until the voltmeter reads – 1 500 mV ± 5 mV with respect to the calomel electrode.

At intervals of 24 h record the voltmeter reading and adjust the variable resistor to correct any drift from the – 1 500 mV setting.

Continue the test for 28 days, maintaining the temperature at 23 °C ± 2 °C. After this period assess disbonding at both sites by the method described in Clause I.5. Assess the bonding by the method described in Clause I.5.

I.5 Expression of results

I.5.1 Assessment

Remove the plastics tube from each test site and wipe along the surface of the coating using a lint free paper towel (see I.2.12) and cathode area material.

I.5.2 Method 1

Make two parallel incisions through the coating and 12,5 mm apart across the panel so as to include the pre-damage area. The cuts shall extend 50 mm on each side of the pre-damaged area.

Using a square ended pallet knife insert it into the centre portion of the pre-damaged area, between the parallel cuts, down to the metal. Using a gentle levering action, lift the strip of coating, if possible, with a slow peeling action and then grip the coating between the blade and the thumb and continue the peeling action until the coating breaks.

Repeat the peeling test in the opposite direction and then repeat the procedure at an angle of 90° to the first test.

Apply one spot of phenolphthalein acid/base indicator (see I.3.2) to the exposed metal surface at the outside edge and allow it to flow towards the pre-damaged area. The purple boundary shall indicate the extent of disbonding.

I.5.3 Method 2

In order to obviate the possibility of contamination of the disbonded area by sodium hydroxide transferred by the knife during cutting of the bitumen based coating, the following method shall be applied.

Take the test plate and place in a deep-freeze cabinet (see I.2.13) at – 40 °C for a minimum of 6 h or overnight. Remove the test plate from the cabinet and dislodge the bitumen based coating by striking the back of the steel plate sharply with a hammer (see I.2.14). The coating shall readily disbond from the plate. Place the test plate in a low temperature oven set at 40 °C for 2 h.

Place the warmed test plate on a flat surface and spray with a 0,2 % solution of phenolphthalein acid/base indicator. The temperature of the plate shall allow rapid drying leaving an invisible homogeneous film of indicator on the surface. The indicator shall be then developed by spraying a fine mist of potable water through a trigger spray bottle (see I.2.15).

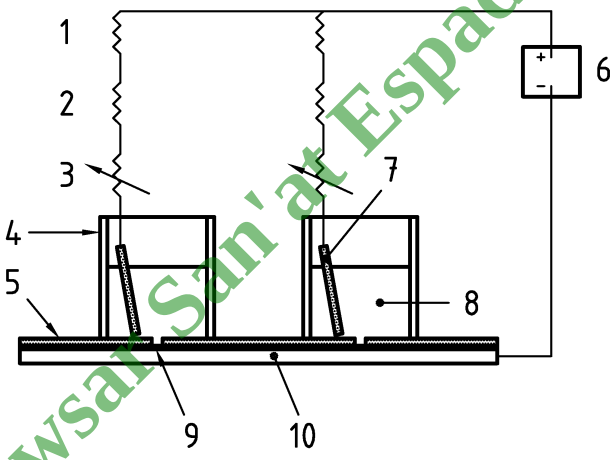
NOTE 1 In practice the spray should be held some distance above the test plate.

Instantly a purple ring of indicator shall appear marking the extent of the hydroxyl contamination which marks the limit of the cathodic disbonding.

NOTE 2 If required the extent of disbonding may be photographed at this stage.

I.6 Test report

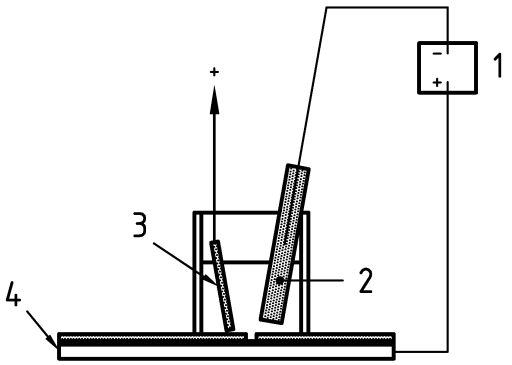
Report the extent of the disbonding as the average distance in millimetres from the edges of the pre-damaged areas. Alternatively, if the coating is strongly adherent to the steel substrate, take the average distance at which the coating breaks as the extent of the disbonding.



Key

1 510 Ohm
2 10 Ohm
3 5 kOhm
4 Plastic tube
5 Coating
6 DC voltage supply
7 Platinum anode
8 NaCl electrolyte
9 Hole ∅ 6 mm
10 Steel test panel (cathode)

Figure I.1 — Cathodic disbonding test rig



Key

1 Voltmeter
2 Calomel electrode
3 Platinum anode
4 Steel test panel (cathode)

Figure I.2 — Voltage adjustment circuit

Annex J
(informative)

Guidelines for the use of coating materials

J.1 Category 1 materials

Category 1 materials are applied externally by flood coating or other means. These materials may be used for on-shore or off-shore corrosion protection. When used on-shore the coated tube should not be exposed to locations which have been contaminated by fuel spillage. These materials are unsuitable for pipelines which are to be laid by reel barge.

Bitumen based enamel is typically applied at a thickness in the range 5,5 mm to 7,5 mm with a minimum coating thickness of 4 mm over the weld.

Coating thickness for small diameter pipes (typically less than 350 mm in diameter) may be in the range 3 mm to 4,5 mm.

In general grades of higher softening point or lower penetration are intended for use under higher temperature conditions. Typical in-service temperatures for the grades are given in Table J.1.

Table J.1 — Category 1 in-service temperatures

Category 1 enamels	Service temperature range	Comment
Grade a	- 15 °C to + 60 °C	Suitable at normal and lower than normal ambient temperatures in temperate climates.
Grade b	- 15 °C to + 75 °C	Suitable at ambient temperatures in both temperate and hotter climates.
Grade c	- 10 °C to + 75 °C	Suitable for use at ambient temperatures and in tropical climates.

J.2 Category 2 materials

Due to their higher viscosity Category 2 materials are not suitable for flood coating and are applied by an extrusion process. These materials may be used for on-shore or off-shore corrosion protection. When used on-shore the coated pipe should not be exposed to locations which have been contaminated by fuel spillage. These materials are highly flexible and may be suitable for pipelines which are to be laid by reel barge.

Modified bitumen enamels are typically applied at a minimum thickness of 4 mm.

Composite glass/polyester outer-wraps are only applied to Category 2 coating materials.

In general grades of higher softening point or lower penetration are intended for use under higher temperature conditions. Typical in-service temperatures for the grades are given in Table J.2.

Table J.2 — Category 2 in— service temperature

Category 2 enamels	Service temperature range	Comment
Grade a	- 30 °C to + 80 °C	Suitable at normal and lower than normal ambient temperatures in temperate climates.
Grade b	- 30 °C to + 90 °C	Suitable for use at normal, lower than normal and elevated temperatures, on hot lines and in tropical climates.

J.3 Seam weld coating

The enamel thickness over the weld is of considerable importance to the integrity of the coating. It is recommended that a stripe of bitumen based enamel is applied over the weld (approximately 50 mm wide by 2 mm thick) after priming and before coating to ensure an adequate coating thickness.

J.4 Inner-wrap

Typically, for Category 1 coatings 4 mm in thickness or less only one inner-wrap is applied. For coatings greater than 4 mm in thickness it is usual to apply two inner-wraps.

J.5 Outer-wrap

The type of outer-wrap used depends on the environmental conditions around the pipeline (see Table J.3). The objective is to provide a mechanical protection against external influences, such as soil stress, stones and pipe movement. All types are suitable for use under a concrete weight coat in submarine conditions. Typically, the stronger the outer-wrap the greater the protection.

Table J.3 — Outerwrap — Types and service conditions

Type	Service conditions
Type A	Suitable for normal conditions.
Type B	Suitable for protection in higher stressed conditions.
Type C	An extra strong woven material for use in high stress conditions.
Type D	An extra strong lock-welded material for use in high stress conditions.
Type E	A strong composite material for use with modified bitumen enamel under normal conditions.
Type F	A heavier duty composite material for use with modified bitumen enamel under high stress conditions.

J.6 Wrap width

The width of the inner and outer-wraps may be decided at the time of ordering and will depend on pipe diameter, coating type and coating application process.

J.7 Pre-fabricated tapes

Pre-fabricated tapes are normally used for the coating of components such as bends, elbows, T-pieces, large diameter tubes, etc., and are applied by torch.

When used on-shore the coated tube should not be exposed to locations which have been contaminated by fuel spillage.

Generally, the coating is applied in two layers with a resultant minimum coating thickness of 5,5 mm.

Typical in-service temperature ranges for tape coating are:

— oxidized bitumen enamel – 15 °C to + 40 °C;

— modified bitumen enamel – 30 °C to + 50 °C.

The use of pre-fabricated tapes outside these temperature ranges may be arranged by agreement at the time of ordering.

Annex K
(normative)

Determination of filler content by ignition

K.1 Principle

Measurement of the filler content of the enamel by its ash content after ignition.

K.2 Apparatus

K.2.1 Silica crucible, approximately 40 mm in diameter and approximately 30 mm in depth.

K.2.2 Muffle furnace.

K.2.3 Desiccator.

K.3 Procedure

Carry out the determination in a tared, pre-ignited silica crucible (see K.2.1).

Weigh to the nearest milligram between 1 g and 1,5 g of coating material into the crucible. Place the crucible in a cold muffle furnace (see K.2.2) with good ventilation and raise it to a temperature of 700 °C to 750 °C over a period of about 1 h. Maintain it at that temperature for a period of not less than 2 h. Then remove the crucible from the muffle furnace and allow it to cool in a desiccator (see K.2.3). Weigh the crucible and ash to the nearest milligram and calculate the mass of sample after heating, M_3.

K.4 Expression of results

Calculate the filler content, *F,* as a percentage by mass of the coating material as follows:

$$F = 100 \times \frac{M_2}{M_1}$$

where

M_1 is the mass of sample before heating;

M_2 is the mass of sample after heating.

K.5 Test report

Report the filler content by ignition as a percentage by mass of the original sample of coating material to the nearest 1 %.

Annex L
(normative)

Determination of density at 25 °C

L.1 Principle

Measurement of the density of the enamel.

L.2 Apparatus

L.2.1 Melting pot, steel pot of approximately 80 mm diameter and 100 mm height. The pot is covered with a loose fitting lid.

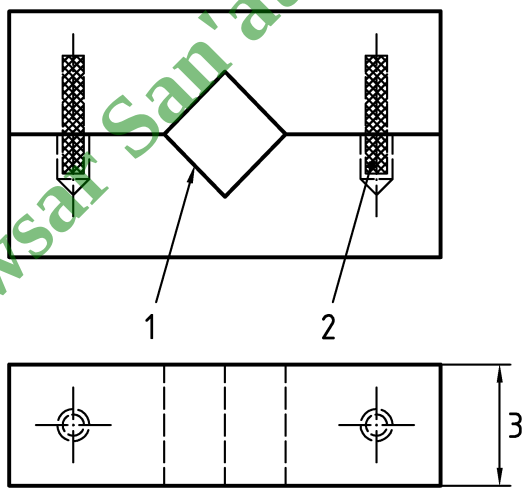
L.2.2 Mould, polished brass mould, as shown in Figure L.1, assembled and placed on a polished brass plate.

L.2.3 Balance, accurate to 0,001 g.

L.2.4 Fine wire or thread.

L.2.5 Wetting agent.

L.2.6 Beaker.



Key

1 18 mm square
2 Dowel pins
3 18 mm

Figure L.1 — Polished brass mould

L.3 Procedure

Heat approximately 100 g of enamel sample slowly in the melting pot (see L.2.1) to between 60 °C and 70 °C above the softening point, keeping the lid on when not stirring. Until the sample is completely fluid, stir continually to avoid local overheating and excessive loss of vapour. Thereafter stir occasionally.

Then, pour the fluid material carefully into the mould (see L.2.2), avoiding the inclusion of air bubbles, until the mould is almost full.

NOTE It is convenient to fill the cylinder for the penetration test and the mould for the density test at the same time.

Allow the material and the mould to cool to ambient temperature and then separate the mould.

Suspend the moulded specimen from the hook on a balance (see L.2.3) using a suitable length of fine wire thread (see L.2.4) and weigh it to the nearest milligram.

Add a few drops of wetting agent (see L.2.5) to a small beaker (see L.2.6) of water at 25 °C. Place the beaker on a bridge across the balance pan. Suspend the moulded specimen from the hook on the balance so that it is fully immersed in the water about 25 mm from the bottom of the beaker. Carefully remove all air bubbles adhering to the specimen and to the thread.

Weigh the specimen to the nearest milligram whilst suspended in the water.

L.4 Expression of results

Calculate the density of the sample to the second decimal place, assuming the density of water to be 1,00 g/cm^3, as follows:

$$\text{Density at 25 °C (g/cm}^3\text{)} = \frac{M_\text{a}}{M_\text{a} - M_\text{w}}$$

where

M_a is the mass of sample in air;

M_w is the mass of sample in water at 25 °C.

L.5 Test report

Report the density of the sample to the second decimal place in grams per centimetre cubed.

Annex M
(normative)

Determination of mass per area and loss of mass on ignition

M.1 Principle

Measurement of the mass per area of the inner-wrap or outer-wrap and the inner-wrap after ignition at the specified temperature. The percentage loss of mass on ignition is calculated from the results.

M.2 Apparatus

M.2.1 Balance, accurate to 0,001 g.

M.2.2 Muffle furnace, which can reach a temperature of at least 800 °C.

M.2.3 Porcelain or fired silica dish of approximate dimensions 110 mm × 110 mm.

M.3 Procedure

M.3.1 Determination of initial mass per area

Cut ten fabric wrap specimens of dimension 100 mm × 100 mm.

Determine the mass per area of the inner-wrap, expressed in grams per square metre, from the total mass of the ten specimens.

M.3.2 Determination of loss of mass on ignition

Take four of the specimens used for determining the initial mass (m_1) and weigh them in the tared dish (see M.2.3) using the balance (see M.2.1) to the nearest 0,001 g.

Ignite them in the muffle furnace (see M.2.2) at a temperature of 625 °C ± 25 °C for 5 min, to destroy the binder and/or the protective coating on the glass fibres.

Allow the specimens to cool to room temperature.

Weigh the specimens to the nearest 0,001 g (m_2).

Calculate the loss of mass after calcination, expressed in per cent, using the following formula:

$$\text{Loss of mass (\%)} = \frac{(m_1 - m_2)}{m_1} \times 100$$

where

m_1 is the initial mass;

m_2 is the mass after calcination and cooling.

M.4 Test report

Report the results expressed as a percentage to the nearest 0,1 g/m^2 for the inner-wrap and to the nearest 1 g/m^2 for the outer-wrap.

Report the percentage loss of mass after ignition to the nearest 0,1 %.

Annex N
(normative)

Glass fabric — Tensile strength

N.1 Principle

Determination of the tensile strength of the wrap when measured in accordance with EN 12311-1.

N.2 Apparatus

The apparatus shall be in accordance with EN 12311-1.

N.3 Sampling

Take a sample size sufficient to produce five test specimens in both the longitudinal and the transverse directions. The test specimens shall be taken across a diagonal path.

NOTE If the width of the sample roll is too small to provide specimens of this size, smaller test specimens may be used, provided this is stated specifically in the test report.

Test specimens shall be cut not closer than 50 mm from the edge of the sheet, with the aid of a template, or die cutter, to provide the rectangular test specimens measuring (50 ± 0,5) mm wide by a length of at least 200 mm + 2 × gripping length, the longer direction being the test direction.

N.4 Procedure

N.4.1 Preparation of tensile specimens

If necessary to prevent damage of the specimen by the jaw clamps treat the ends of the specimens with latex of a suitable viscosity so that the centre 200 mm is kept free from latex. Allow the latex to dry.

The test specimens shall be conditioned for at least 20 h at 23 °C ± 2 °C.

N.4.2 Measuring tensile strength

The procedure is carried out with a constant rate of jaw separation of 100 mm ± 10 mm per min in accordance with EN 12311-1.

If a specimen breaks in or near the clamps, ignore the value obtained and carry out an extra determination with a new specimen.

Make separate tests for the determination of tensile strength in the longitudinal and transverse directions.

N.5 Expression of results

Calculate the tensile strength as the arithmetic mean of five determinations, performed under the conditions specified above.

N.6 Test report

Report the tensile strength in N/50 mm to the nearest 5 N for both the longitudinal and transverse directions.

Annex O
(normative)

Determination of porosity

O.1 General principle

This test determines the porosity or air permeability of innerwrap by measuring the pressure difference across the sample under an average air velocity of 61 m/min.

O.2 Apparatus: permeability testing machine

The apparatus shall consist essentially of a suction fan for drawing air through a known area of unsaturated glass fibre innerwrap, a circular orifice over which the innerwrap to be tested can be clamped, a manometer for measuring the pressure drop across the innerwrap, and a flow meter for measuring the volume of air flowing through the innerwrap. The clamp shall effectively eliminate edge leakage. The apparatus shall be capable of testing unsaturated glass fibre innerwraps of different thicknesses and of testing large pieces of innerwrap without cutting. The instrument shall be calibrated directly with a precision instrument.

O.3 Procedure

All tests shall be made at 23 °C ± 1 °C and 50 % ± 2 % relative humidity.

Five specimens, at least 250 mm × 250 mm, representative of the innerwrap to be tested, shall be obtained. Alternatively, five places on the innerwrap, separated by greater than 100 mm, may be tested without cutting.

The porosity shall be determined in accordance with ASTM D737-96 modified. The test specimen shall be mounted between the clamp and the circular orifice with sufficient tension to draw the innerwrap smooth. The test specimen shall not be distorted in its own plane. Conditioned air shall be drawn through the known area of the innerwrap and through the calibrated flowmeter at the rate of 61 m/min.

O.4 Expression of results

The pressure drop across the innerwrap shall be recorded in mm of water or in pascals (Pa).

O.5 Test report

The average of the test results in pascals (to the nearest whole number) for the five test specimens or the five different test locations of the innerwrap shall be reported as the porosity.

NOTE 1 mm of water pressure is equivalent to 9,8 Pa.

Annex P
(normative)

Use of hot applied bitumen tapes for coating steel components

P.1 General

Tubes coated by the use of pre-fabricated hot applied bituminous tapes shall conform to this document in all respects except where specifically excluded in this annex or where an alternative is permitted as described in this annex.

P.2 Surface preparation

Tube pre-treatment shall be the same as detailed in 5.1.

P.3 Priming

Priming shall be as detailed in 4.2.2.1 and 5.2 with the exception that solvent diluted bitumen primers, based on bitumen, hydrocarbon resins and/or synthetic polymers are permitted which conform to Table 1 or Table P.1.

Table P.1 — Requirements to be met by the bitumen based primer

Property	Unit	Value	Method of test
Softening point of non-volatile bitumen base, minimum	°C	105	EN 1427
Volatile matter, maximum	% by mass	60	Annex H

P.4 Enamel

Enamel coating materials used to impregnate the pre-fabricated tapes shall be as detailed in 4.2.4.

P.5 Fabric tapes

Only woven glass or synthetic fibre fabric shall be used for the pre-fabricated tapes.

The glass fabric carrier for the pre-fabricated tapes shall be as detailed in 4.2.6 and Table 7, types C to F.

Additionally, pre-fabricated tapes may be used which conform to Table P.2 below.

Table P.2 — Requirements for reinforcement

Property	Unit	Woven glass	Synthetic fibre fabric	Synthetic fibre fabric	Method of test
Mass per area, minimum	g/m^2	200	100	110	Annex K
Loss on ignition, maximum	% by mass	10	—	—	Annex K
Tensile strength, minimum					EN 12311-1 modified as in Annex L
— longitudinal	N/50 mm	400	400	800	
— transverse	N/50 mm	300	300	800	

NOTE 1 Tapes are produced by impregnation of a carrier with a bitumen based material. The carrier is embedded in the bitumen based enamel to a uniform thickness of at least 3 mm. Additional inlays, such as polyester foils, may be agreed at the time of ordering.

NOTE 2 To prevent the tape from sticking to itself in the roll a plastic backing film or talcum powder may be used.

P.6 Application

Bitumen based tapes shall be applied in accordance with the tape manufacturer's recommendations.

After the primer has cured the tapes shall be heated on the thick enamel side using a propane burner until about 0,5 mm to 1 mm of the bitumen has melted. Then the tape shall be applied to the preheated steel surface under tension avoiding any creases and pressed into place. The application shall be made either circumferentially, in sections, or by spiral wrapping.

The tapes shall be butt jointed one against the other. The second layer shall be applied in the same way but with the joints offset by a minimum of 25 mm from those in the first layer. The joints in the second layer shall be covered by a band of tape about 100 mm wide.

P.7 Inspection and testing

Following application the wrapped pipe shall be tested in accordance with Clause 6 with the exception of 6.2.2.

An alternative test shall be carried out every tenth component to check the overlap by cutting a 20 mm wide strip across a whole tape width.

Annex Q
(informative)

Recommended minimum quality control requirements for bituminous enamel pipeline coatings

Table Q.1 — Materials

Property	Subclause	Test method	Frequency	Acceptance criteria
Primer	**4.2.2.1**	Table 1	each batch	**5.2** plus Table 1
Filler	**4.2.3**	ISO 2591-1	each batch	**4.2.3**
Enamel	**4.2.4**	Properties Table 2 or Table 4	each batch	Table 2 or Table 4
Enamel	**4.2.4**	Performance Table 3 or Table 5	by agreement	Table 3 or Table 5
Fabric wraps				
- inner-wrap	**4.2.5**	Table 6	by agreement	**4.2.5**
- outer-wrap	**4.2.6**	Table 7	by agreement	**4.2.6**
NOTE Materials batch testing may be by certificate.				

Table Q.2 — Coating operations and coating system

Property	Subclause	Test method	Frequency	Acceptance criteria
Ambient conditions	**5.1.1**	ASTM E337	twice per shift	**5.1.1**
Surface condition before blast-cleaning	**5.1.2**	Visual	each pipe	**5.1.2**
Cleanliness of blast-cleaned surface	**5.1.3**	EN ISO 8501-1	each pipe	**5.1.3**
Surface profile	**5.1.3**	ISO 8503-2	four pipes per shift	**5.1.3**
Primer thickness and appearance	**5.2**	Manufacturer's recommendations	four pipes per shift	**5.2**
Pipe surface temperature before surface preparation	**5.1.1**	Surface contact or IR thermometer	by agreement	**5.1.1**
Pipe surface temperature before priming	**5.2**	Surface contact or IR thermometer	by agreement	**5.2**
Visual appearance of coating	**6.2.1**	Visual	each pipe	**6.2.1**
Coating system thickness	**6.5**	**6.5**	every fifth pipe	Annex J (by agreement)
Distribution of inner-wrap	**6.2.2**	**6.2.2**	one pipe per 20	**6.2.2**
Holiday detection	**6.3**	Annex R	each pipe	**6.3** and subject to repair criterion (see Clause 7)
Adhesion	**6.4**	Annex S	one pipe per 20 (minimum one pipe per day)	**6.4**
Pipe ends	**5.3.2**	Visual	by agreement	by agreement

Annex R
(normative)

Holiday detection test

R.1 Principle

Measurement of any porosity or defect in the coating using a scanning electrode energized by a high-arc-voltage.

Porosity shall be detected by a spark occurring between the steel of the tube and the electrode at the defect, accompanied by a sound or light signal provided by the holiday detector apparatus.

R.2 Apparatus

R.2.1 Adjustable high-voltage holiday detector, equipped with a sound and light signal.

R.2.2 Scanning electrode, in the form of a metal brush, or coiled spring with continuous spirals, or conductive rubber conforming to the shape of the tubes.

R.2.3 Conductors, which are used for connecting the tube to an earth electrode.

R.3 Procedure

This test shall only be undertaken on a coating free from surface moisture.

At the time of the test, the voltage shall be set at 10 kV per mm of coating thickness up to a maximum of 25 kV.

Connect the scanning electrode (see R.2.2) and earth the coated tube.

The electrode shall be switched on and moved continuously in contact with the surface of the coating to be inspected; the rate of travel of the electrode shall be approximately 300 mm/s and it shall be demonstrated that a defect of a diameter one millimetre can be detected.

R.4 Expression of results

The scanning electrode shall be moved continuously in contact with the surface of the coating and the number of detected defects (holidays) noted and marked.

R.5 Test report

The tube's or component's unique identification number and the number of holidays detected shall be recorded.

Annex S
(normative)

Field bond test

S.1 Principle

To determine that the factory applied coating has adhered firmly to the steel substrate is measured.

NOTE This test is a variant of the peel test given in Annex F.

Two methods are detailed:

— method 1 shall be used with oxidised bitumen enamel coatings;

— method 2 shall be used with modified bitumen enamel coatings.

Adhesion testing shall be carried out 24 h after coating has taken place on one pipe in every 20. Three tests shall be carried out on the selected pipe. After testing the coating shall be repaired in accordance with the qualified repair procedure.

Pipes that do not conform to the requirements shall be marked and removed from the coating line for repair or recoating. If subsequent pipes do not conform to the requirements, the coating process shall be checked or stopped to remove the cause of the problem.

S.2 Apparatus

S.2.1 Blade, sharp and heated.

S.2.2 Flat spatula.

S.2.3 Hand-held tensometer, with digital readout, peak force indication and a minimum capacity of 200 N incorporating a wedge grip.

S.3 Procedure

S.3.1 Method 1 — Category 1 oxidised bitumen enamel coating

The pipe coating and steel surface shall be between 10 °C and 25 °C for Category 1, Grade a and Grade b enamels and between 15 °C and 25 °C for Category 1, Grade c enamel.

Using a heated sharp blade (see S.2.1), two cuts shall be made in the coating 25 mm apart, 150 mm in length. The two cuts shall be joined by another cut on one end only. A flat spatula (see S.2.2) of the correct width shall be inserted at the bottom of the cuts and the coating shall be lifted from the pipe surface. Once sufficient coating has been lifted, the coating shall be gripped between the thumb and the spatula blade, and, applying an even, steady force, an attempt made to peel the coating from the pipe surface.

The bond shall be considered satisfactory if the coating does not exhibit adhesive failure but only exhibits cohesive failure.

S.3.2 Method 2 — Category 2 modified bitumen enamel coating

The pipe coating and steel surface shall be between 10 °C and 25 °C for Category 2, Grade a and Grade b modified bitumen enamels.

Using a heated sharp blade, two cuts shall be made in the coating 20 mm apart, 150 mm in length. The two cuts shall be joined by another cut on one end only. A flat spatula of the correct width shall be inserted at the bottom of the cuts and the coating shall be lifted from the pipe surface. Once sufficient coating has been lifted, a hand-held tensometer (see S.2.3) shall be attached to the coating at its interface with the steel. Applying an even, steady force the coating shall be pulled at 90 ° to the steel surface. When, either the coating begins to detach from the primer surface or when the strip breaks, the tension is immediately released and the peak value shall be read from the tensometer gauge.

S.4 Expression of results

S.4.1 Method 1 — Category 1

The bond shall be considered satisfactory if the coating does not exhibit adhesive failure but only exhibits cohesive failure.

S.4.2 Method 2— Category 2

The bond shall be considered satisfactory if the peak force gauge reading for the 20 mm wide strip is greater than 80 N (i.e. 80 N/20 mm).

S.5 Test report

Report the result as a pass or fail at the test temperature.

Annex T
(normative)

Inspection of coating thickness

T.1 Principle

The thickness of the applied coating is measured, by means of a non-destructive process.

T.2 Apparatus

Magnetic, electromagnetic or ultrasonic measuring instrument, with ± 10 % accuracy shall be used. The instrument shall be calibrated with respect to the steel on which the coating is applied in the range of thickness of the coating to be tested. It shall be adjusted frequently.

T.3 Procedure

On each tube to be tested, at least 12 measurements shall be carried out.

For SAW tubes an additional four thickness measurements shall be undertaken on the weld area.

The measurements points shall be distributed along four equally spaced longitudinal lines at the intersection with three equally spaced circumferential lines and at a distance of at least 200 mm from the end of the coating.

In case of dispute of the result at one point, the re-calibration of the instrument shall be undertaken and five measurements at this point shall be carried out again. The arithmetic mean of the five results shall be calculated to represent the measurement at this point.

T.4 Expression of results

A calculation of the arithmetic mean from the measured values shall be made.

The arithmetic mean of the result of the five measurements shall be calculated.

T.5 Test report

Report the coating thickness to the nearest 0,1 mm.

Annex U
(informative)

Information to be supplied at the time of ordering

For tubes and components coated in accordance with this document, the following information should be supplied at the time of ordering:

- reference to the standard for the tube to which the external coating shall be applied plus total length, outside diameter and wall thickness;

- type of primer;

- coating enamel category, grade and total coating thickness;

- number of inner-wraps (if any) and wrap width;

- grade of outer-wrap and wrap width;

- length of cut-back;

- whether or not a weight coating is to be applied;

- minimum and maximum pipeline design temperature range (DTR).

Bibliography

[1] EN ISO 8503-2, *Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates - Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel - Comparator procedure (ISO 8503-2:1988)*

[2] ASTM E337, *Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)*

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