International Standard 5256

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Steel pipes and fittings for buried or submerged pipelines — External and internal coating by bitumen or coal tar derived materials

Tubes et accessoires en acier utilisés pour canalisations enterrées ou immergées — Revêtements externe et interne au moyen de matériaux hydrocarbonés

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Foreword

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Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Contents

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Steel pipes and fittings for buried or submerged pipelines — External and internal coating by bitumen or coal tar derived materials

1 Scope

This International Standard specifies the bitumen and coal tar derived coatings suitable for protecting the external and internal surfaces of steel pipes and fittings, either individually or after assembly, and used in buried pipelines or conduits, or underground galleries, or submerged, and also the conditions for the application of such protective coatings.

In the case of submerged pipes, special provisions shall be taken with regard to laying or immersion conditions (depth, fresh water, salt water).

These specifications cover use for the transport of fluids the temperatures of which are within the following limits :

a) − 10 °C, + 80 °C [1] if only an external coating is applied;

b) 0 °C, + 40 °C if an internal coating is applied (only or additionally).

In a case where different temperatures are required, the bitumen or coal tar derived materials to be used shall present characteristics to be defined by agreement between the parties concerned.

The internal protective coatings of pipes intended for the transport of potable water and food products shall satisfy the public hygiene criteria of the country of use.

2 Field of application

2.1 Types of pipes to be coated

The types of pipes to which this International Standard is applicable include both welded and seamless pipes of non-alloy steels used for the conveyance of fluids. In particular this International Standard is applicable to pipes covered by standards mentioned in clause 3.

2.2 Types of fittings to be coated

The types of fittings to which this International Standard is applicable are mainly bends, tees, reducers and collars.

3 References

ISO 559, *Welded or seamless steel tubes for water, sewage and gas.*

ISO 565, *Test sieves — Woven metal wire cloth and perforated plate — Nominal sizes of apertures.*

ISO 630, *Structural steels.*

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

ISO 2546, *Seamless plain end tubes made from unalloyed steel and without quality requirements.*

ISO 2547, *Welded plain end tubes made from unalloyed steel and without quality requirements.*

ISO 2604/2, *Steel products for pressure purposes — Quality requirements — Part 2 : Wrought seamless tubes.*

ISO 2604/3, *Steel products for pressure purposes — Quality requirements — Part 3 : Electric resistance and induction-welded tubes.*

ISO 2604/6, *Steel products for pressure purposes — Quality requirements — Part 6 : Submerged arc longitudinally or spirally welded steel tubes.*

ISO 3183, *Oil and natural gas industries — Steel line pipe.*

ISO 3419, *Non-alloy and alloy steel butt-welding fittings.*

ISO 4602, *Textile glass — Woven fabrics — Determination of number of yarns per unit length of warp and weft.*

ISO 8501/1, *Preparation of steel substrates before application of paints and related products — Visual assessment of rust grades and of preparation grades — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.* [2]

1) The basic materials which are most commonly used for making up the protective coating are suitable for temperatures of use between the limits − 10 to + 60 °C. Studies are being undertaken to define the characteristics of the materials to be used at temperatures between 60 and 80 °C.

2) At present at the stage of draft.

4 Description of coatings

4.1 External coating

The external coating consists of

a) a primer or bonding coat based on petroleum bitumen or synthetic resin, of the types defined in 5.2.1 and table 1;

b) one or more protective coats based on petroleum bitumen or coal tar derived materials, with or without filler, of the types defined in 5.2.2 and tables 2 and 3 built up to form the thickness required for the class of protection (I to IV) defined in 7.1 and table 6;

c) one or more reinforcements of glass fibre or woven glass cloth, embedded in each protective layer.

The various components of any coating shall be compatible, particularly chemically. The class of thickness of the coating shall be taken from table 6, and shall satisfy the requirements of 7.1.2.

External coatings usually also have solar protection, commonly lime, to prevent excessive heating of the coating by solar radiation.

In certain special cases (for example, nature of backfill, environmental temperature or working temperature between + 60 and 80 °C), additional mechanical protection can be applied by agreement between the parties concerned.

When the pipeline is to be cathodically protected, mechanical protection of any sort shall not form an insulating barrier to the protective current.

4.2 Internal coating

The internal coating consists of one or more layers of petroleum bitumen or coal tar derived materials, filled or unfilled, with or without a primer coat, as defined in 5.2.1, 5.2.2 and 5.2.3 and specified in tables 1, 2 and 3; it is applied in accordance with the required classes of protection (A to D), defined in 7.2 and table 7.

5 Raw materials

5.1 Definitions

5.1.1 bitumen and coal tar derived materials : (The use of the terms bitumen and coal tar derived material is limited to materials defined in 5.1.2 and 5.1.3 and which may be reinforced with a filler defined in 5.1.5.)

5.1.2 petroleum bitumen : A mixture of high molecular mass hydrocarbons derived from petroleum by oxidation of suitable selected bases to a varying extent, possibly by adding fillers, in order to produce a material conforming to one of the grades Pa, Pb, Pc or Pd of table 3.

5.1.3 coal tar derived material : A mixture of high molecular mass hydrocarbons, obtained by distillation of high temperature coal tar, processed and containing fillers so that one of the grades Ha or Hb is obtained (see table 3).

5.1.4 primer : A material applied as an undercoat directly to the metal, either molten or in solution, in order to assist the bonding of a subsequent coating of bitumen or coal tar derived material. There are two types of primers : bitumen or coal tar primers and synthetic primers.

5.1.4.1 bitumen or coal tar primer : A primer whose base is a bitumen or coal tar derived material (see 5.1.1).

5.1.4.2 synthetic primer : A primer containing solvent and whose base consists of resins and synthetic plasticizers.

5.1.5 filler : An inert powder which can be incorporated in a bitumen or coal tar derived material in order to improve one or more of its useful properties without changing its quality.

5.1.6 reinforcement : An inert material in the form of a narrow strip of open structure, intended to be saturated within the coating of bitumen or coal tar derived material in order to improve its mechanical performance.

5.1.6.1 non-woven glass fibre fabric : A reinforcement (see 5.1.6) consisting of a continuous sheet of randomly arranged glass fibres held together by a suitable binder and of open structure, and which may be reinforced longitudinally with glass fibre threads. This reinforcement may be impregnated additionally with a suitable bitumen or coal tar derived material.

5.1.6.2 woven glass fibre fabric : A reinforcement (see 5.1.6) consisting of a regular woven pattern of glass threads. This reinforcement may be impregnated uniformly with a suitable bitumen or coal tar derived material.

5.1.6.3 composite glass fibre fabric : A reinforcement (see 5.1.6) consisting of one layer of glass fibre matting and one layer of woven glass, combined with the aid of a suitable bitumen or coal tar derived material binder.

5.1.7 mechanical protection : An inert material which may be in the form of a strip, intended to guard the coating against external mechanical forces.

NOTE — There are materials for mechanical protection other than the asbestos felt defined in 5.1.7.1. When they are used, their description and properties shall be the subject of individual specifications and their use shall be the subject of an agreement between the parties.

5.1.7.1 asbestos felt : A mechanical protection (see 5.1.7) in the form of a narrow strip, consisting mainly of asbestos fibres and impregnated by a suitable bitumen or coal tar derived material; this protection is reinforced longitudinally by glass threads.

5.2 Specifications

5.2.1 Primers

The primer shall be selected in conjunction with the bitumen or coal tar derived coating material with which it shall be compatible.

The primer selected shall meet the requirements of table 1 where the following abbreviations are used :

p^{Pa} is the bitumen based primer for coating material Pa [1];

p^{Pbc} is the bitumen based primer for coating materials Pb and Pc [1];

p^{Hab} is the coal tar based primer for coating materials Ha and Hb [1];

ps is the synthetic primer.

5.2.2 Bitumen or coal tar derived material

The bitumen or coal tar derived material is selected according to the maximum service temperature as set out in table 2 and/or local conditions (particularly of climate, storage, handling and exposure).

Whichever grade of bitumen or coal tar coating is selected it shall meet the corresponding requirements in table 3.

Table 1

Characteristic	Unit	Specification				Methods of tests [1]
		p^{Pa}	p^{Pbc}	p^{Hab}	ps	
Ash content (mass) on dry extract	%	⩽ 0,5	⩽ 0,5	⩽ 0,5	⩽ 0,5	A → M B
Softening point Ring and ball on bitumen base	°C	⩾ 80	⩾ 105			A → D
Cold bend	mm	See table 3 [2]				C → F
Adhesion and compatibility	–					C → J
Flow	mm					C → H

1) See description in the annex.

2) Tests carried out on primer-coating material system.

Table 2

Type of coating material		Pa or Ha	Pb or Pc or Hb	Pd
Maximum service temperature	External coating	35 °C	60 °C	–
	Internal coating	25 °C	40 °C	25 °C

Table 3

Characteristic	Unit	Grade of coating material						Methods of tests [1]
		Pa	Pb	Pc	Pd	Ha	Hb	
Softening point (ring and ball)	°C	⩾ 95	⩾ 110	⩾ 120	⩾ 80	⩾ 100	⩾ 105	C → D
Penetration (25 °C; 100 g; 5 s)	10^{-1} mm	< 25	< 20	< 20	< 30	10 to 20	5 to 12	C → E
Cold bending	mm	20	15	10	20	15	10	C → F
Indentation	mm	⩽ 17	⩽ 10	⩽ 8		⩽ 10	⩽ 5	C → G
Flow (70 °C; 45°; 20 h)	mm	⩽ 6	⩽ 2	⩽ 2	⩽ 6 [2]	⩽ 5	⩽ 3	C → H
Adhesion and compatibility (40 °C; 5 d)	–	shall pass test						C → J
Change on heating								K
– difference in softening point	°C	⩽ 10	⩽ 10	⩽ 10	⩽ 10	⩽ 10	⩽ 10	→ C → D
– difference in penetration	%	⩽ 40	⩽ 40	⩽ 40	⩽ 40	⩽ 40	⩽ 40	→ C → E
Water absorption	g/m²	⩽ 1,5	⩽ 1,5	⩽ 1,5	⩽ 1,5	⩽ 1,5	⩽ 1,5	C → L
Ash content (mass)	%	⩽ 40	⩽ 40	⩽ 55	⩽ 2	25 to 35	25 to 35	C → M

1) See description in the annex.

2) Thickness 2 mm.

1) See table 3.

5.2.3 Filler

The filler shall be non-hygroscopic and unreactive with the other constituents of the protection, and resistant to attack by the medium to which it will normally be exposed. It shall be stable at the maximum application temperature of the coating material. Powdered slate and talc are typical examples of suitable fillers.

5.2.3.1 Particle size

The particle size of the filler shall meet the following requirements (see method N described in the annex).

a) > 500 µm : 0 %

b) > 90 µm : < 10 %

5.2.4 Reinforcements

The type and number of reinforcements to be used are fixed by the class of coating chosen in relation to the performance required of the protection (see 7.1.2).

5.2.4.1 Appearance

The reinforcements shall have, on visual examination, the following appearance.

a) Glass fibre matting

Uniform appearance, optional reinforcement threads evenly spaced over the width of the matting, freedom from visible faults such as holes, slits, folds, thin areas, spots where the binder has not hardened, leafing, frayed or uneven edges, presence of foreign bodies (oily matter, mud, etc.).

b) Woven glass

Regular woven pattern of glass threads, freedom from visible faults such as holes, slits, frayed edges, presence of foreign bodies (oily matter, mud, etc.).

c) Composite

Uniform appearance, freedom from visible faults such as holes, slits, frayed edges, badly impregnated areas, presence of foreign bodies (oily matter, mud, etc.).

5.2.4.2 Characteristics

The glass used shall be of hydrolytic class III as a maximum, as tested to ISO 719.

At the time of unrolling at ambient temperature, the successive layers of the reinforcement shall not stick to one another.

All reinforcements, whether or not impregnated, shall be compatible with the bitumen or coal tar derived material with which they are used and shall have a texture and binder content such that complete impregnation with the coating material is obtained during normal application. In addition the binder for the fibres shall be such as to resist the action of micro-organisms. The compatibility and ability to impregnate will be confirmed at the point of reinforcement application at the same time as the preliminary test on applying the coating.

The reinforcements shall also satisfy the requirements of table 4.

Table 4

Characteristic	Unit	Specifications			Methods of tests[1]	
		Non-woven glass fibre fabric	Woven glass fibre fabric	Woven glass for composite	Reinforcement not impregnated	Reinforcement impregnated
Number of threads per 100 mm in each direction	—		⩾ 30	⩾ 65	R	Pa[2] → Q
Mass per unit area after calcination	g/m²	⩾ 40	⩾ 110	⩾ 40	S	Pa → R
Loss of mass on ignition on mass of glass	%	⩽ 20	⩽ 3	⩽ 3		
Tensile strength — longitudinally (R_{l0}) — transverse (R_{t0})	 N/50 mm N/50 mm	 ⩾ 100 ⩾ 25	 ⩾ 300 ⩾ 300	 ⩾ 250 ⩾ 250	T	Pb → S
Resistance to water	—	$R_{l1} \geqslant 2/3\ R_{l0}$			U	Pb → T
Stability at application temperature	—	$R_{l2} \geqslant 2/3\ R_{l0}$			U	

1) See description in the annex.

2) If necessary.

5.2.5 Mechanical protection

5.2.5.1 Asbestos felt

5.2.5.1.1 Appearance

The asbestos felt shall have, on visual examination, a uniform appearance, possibly with reinforcement threads evenly spaced over the width, small perforations as usually found evenly distributed over the whole surface, freedom from visible faults such as holes, slits, breaks, badly impregnated areas, delamination, uneven or frayed edges.

5.2.5.1.2 Characteristics

At the time of unrolling at ambient temperature, the successive layers of asbestos felt shall not stick to each other.

The bitumen or coal tar derived material used for impregnation shall be compatible with the bitumen or coal tar coating material.

The asbestos felt shall meet the requirements of table 5.

5.2.5.2 Other protection

There are other materials for mechanical protection. When they are used, their description and properties shall be the subject of individual specifications and their use shall be the subject of an agreement between the parties.

6 Application of coating

6.1 General

The external coating is applied :

a) either in the factory or other workplace on each pipe or fitting in accordance with the conditions laid down, in particular, in 10.5;

b) on the site after assembly of the pipeline,

— on the whole line if the pipes have been delivered uncoated,

— on the joints if the pipes and fittings have been factory-coated.

To avoid condensation on the metal surface on the tube, the coating shall never be applied in the open air in rainy or foggy weather or when the temperature is less than the minimum specified by the product manufacturer.

The internal coating is applied in the factory or other workplace on each pipe or fitting in accordance with the conditions laid down in particular in 10.4 and 10.6. The ends of the pipes may be left uncoated for a fixed length, by agreement between the parties.

6.2 Preparation of the metal surface

For both external and internal protective coatings, the surface to be coated shall, at the time of application of the coating, be dry and free from all contaminants (such as previous coatings, paint, loose dirt, grease, oil, salt, etc.) which could be harmful to the surface preparation or to the adhesion of the coating to the steel.

6.2.1 General case

Complete removal of millscale, heat treatment scale and other adherent oxides shall be effected by blast-cleaning or by chemical cleaning; however, if the parties so agree, they may define the quality to be achieved and surface preparation may be by wire brushing.

6.2.1.1 Blast-cleaning

Before blast-cleaning, the surface to be treated shall be dry.

Blast-cleaning shall be carried out to achieve a quality of surface preparation of at least Sa 2, as in ISO 8501/1.

Immediately before the application of the coating, the surface shall be free from all trace of abrasive and dust.

6.2.1.2 Chemical cleaning

Chemical etching shall effect complete removal of oxides from the metal surface without damaging it. It shall be followed by thorough rinsing and optionally by passivating the metal. After

Table 5

Characteristic	Unit	Requirements	Methods of tests[1]
Mass per unit area	g/m^2	$\geqslant$ 586[2]	V
Content of impregnation material calculated on unimpregnated felt (m/m)	%	22 to 40	V → W
Ash content on de-impregnated felt	%	$\geqslant$ 73	W → Y
Asbestos content on de-impregnated felt	%	$\geqslant$ 85	W → Z
Tensile strength, longitudinal	N/25 mm	$\geqslant$ 110	AA
Pliability	—	shall pass test	AB

1) See description in the annex.

2) By agreement between the parties concerned a lower mass per unit area can be accepted subject always to the other requirements specified above being satisfied.

treatment the surface shall be free from acid residues. The treatment baths shall be maintained at effective concentrations.

6.2.2 Particular case — Surface covered by thin millscale

When the metal surface has a thin, continuous and adherent millscale of type A, according to ISO 8501/1, the coating may, by agreement between the parties, be applied over this scale with no other treatment than is required to remove contaminants.

6.3 Application of external coating — Joint protection and repairs

When hot-applied materials are being used, the recommendations of the manufacturer of the product with respect to maximum and minimum temperatures of application and times permitted for melting at elevated temperatures shall always be observed. The melting equipment shall be periodically cleaned to remove any deposits which may have formed. Necessary steps to ensure the homogeneity of the molten material shall be taken.

6.3.1 Application of the primer

The primer shall be applied to a clean dry surface prepared as described in 6.2. At the time of application, particularly when the weather is damp and cold, it may be necessary to pre-heat the metal; this operation shall not be prejudicial to the cleanliness of the surface or to the conditions required for the application of the primer.

The primer film, applied at the thickness specified by the primer manufacturer, shall be uniform and continuous.

6.3.1.1 Hot application

The primer shall be applied to a dry surface by dipping in a bath containing hot bitumen.

The duration of immersion in the bath shall be sufficient for the metal to reach the temperature of the bath.

This procedure is applicable only to petroleum bitumen, used in the factory or workplace.

6.3.1.2 Cold application of materials in solution

The application shall be made, for example, by brushing, mopping or spraying. The temperature of the metal at the time of application shall conform to the recommendations of the manufacturer of the primer.

6.3.1.3 Requirements for the primer coating before application of the protective coating

6.3.1.3.1 Dryness

The protective coating shall be applied over a cold-applied primer which has dried sufficiently or to an adequately cooled hot-applied primer, such that the protection will meet, in particular, the adhesion requirement in 7.1.3.

If the maximum time between priming and coating permitted by the manufacturer is exceeded, the primer coating shall be either removed and replaced or over-coated according to the manufacturer's instructions.

6.3.1.3.2 State of the primer coat

The protective layer shall be applied over a primer coat which is continuous, clean and free from moisture.

6.3.2 Application of the reinforced protective layer

Any method of application is permitted. The final coating shall meet the requirements of 7.1.

In the case of a factory-applied multi-layer coating, measures shall be taken to ensure adhesion between the layers. In the case of over-coating, the old coat shall be treated as necessary to ensure adhesion and the homogeneity of the entire coating.

6.3.3 Application of solar protection

Solar protection, if required, shall be applied to the final protective coating by a method appropriate to the product used. It shall be continuous and provide sufficient cover to form an effective barrier to solar radiation.

6.3.4 Application of mechanical protection

The application of mechanical protection by felt, woven or other suitable reinforcement wrap, if required, shall be made while the coating is still hot, before it sets (and before application of the optional solar protection). This mechanical protection shall be applied in such a manner as to minimise folds and voids, and so as to adhere to the underlying coating.

Asbestos felt, if used, is not part of the coating system and shall be regarded as mechanical protection.

Other forms of mechanical protection may be applied at the time of laying the pipe in the trench, following a procedure appropriate to each case.

6.3.5 Application conditions for protection at joints by means of bitumen and coal tar derived materials

The coating materials used shall be compatible with any coating previously applied.

Application conditions for primer and reinforced protective layer shall be those specified in 6.3.1 and 6.3.2.

The protection applied on the site to the joint shall overlap the protection applied in the factory for a sufficient length, so that in the vicinity of joints and fittings the requirements specified in 7.1.2, 7.1.3 and 7.1.4 are met. Solar protection and contaminants which could affect adhesion between coats shall be removed.

When the protective coating is applied by casting in a mould or a similar technique, the reinforcement(s) may be omitted or modified by agreement between the parties concerned.

6.3.6 Repair of coating by means of bitumen or coal tar derived materials

Repair coating materials used shall be compatible with the coatings to be repaired.

The technique to be used in each case shall be agreed between the parties.

The repaired coating shall meet the requirements specified in 6.3.2, 7.1.2, 7.1.3 and 7.1.4.

6.3.7 Assembly joint protection and repair using other products

The use of products other than the hot applied bitumen or coal tar derived materials, which are covered by this International Standard, is permitted for the protection of assembly joints and coating repairs. They shall however be agreed by the parties concerned. They shall be adherent to and compatible with the coating in contact.

6.4 Application of the internal coating — Joint protection and repairs

When hot-applied materials are being used, the recommendations of the manufacturer of the product with respect to maximum and minimum temperatures of application and times permitted for holding at elevated temperatures shall always be observed. The melting equipment shall be periodically cleaned to remove any deposits which may have formed. Necessary steps to ensure the homogeneity of the molten material shall be taken.

6.4.1 Application of primer or coating of classes A and B [1)]

The application shall be made hot or cold as specified in 6.3.1.

6.4.2 Application of coating of classes C and D [1)]

The application shall be made by rotating the pipe and introducing the coating material in the molten state. The coating shall always meet the requirements specified in 7.2.

6.4.3 Application conditions for protection of joints

The coating materials used shall be compatible with the coatings previously applied. Application conditions for the primer are as specified in 6.3.1.

Coating material in the molten state may be applied by any suitable means such as casting against a backing-up ring, trowelling, swabbing or by application using localized heating of pre-cast strips of lining material to the primed surface. In all cases it is essential to ensure non-porosity and good adhesion between the applied coating material, pipe surface and lining of pipes. When manual processes are used, the joint material shall be finished smooth and flush with the pipe linings, for example by smoothing with a heated flexible blade.

By agreement between the parties, protection at certain types of joint may be effected by the application of a thick, cold-applied bitumen or coal tar derived coating.

1) See requirements in table 7.

6.4.4 Repair of linings by means of bitumen or coal tar derived materials

Coating materials used shall be compatible with the previously applied coating.

Application conditions for the primer shall be as specified in 6.3.1. Damaged and non-adherent lining shall be removed before effecting a repair.

After cleaning and priming exposed surfaces, the lining shall be built up, pore-free, to the full thickness by trowelling or swabbing molten coating material, followed by smoothing to the original contour of the bore. Careful warming of the pipe metal and edges of the existing lining may be necessary to achieve satisfactory adhesion.

7 Characteristics of the applied coatings

7.1 External coating

7.1.1 Appearance and constitution (test according to 8.1.1)

On visual examination the coating shall be of uniform appearance and free from any faults detrimental to its performance. The length of uncoated parts shall satisfy the order requirements [see 10.4 d)].

The type and specified number of reinforcements, and the thickness of the coating shall conform to the class as defined in table 6 chosen by the purchaser.

The reinforcement(s) shall be completely impregnated with the protective material or a material compatible with it. The position of the reinforcement(s) shall be such that it (they) nowhere come(s) either less than 1 mm from the surface of the metal or outside the surface of the coating. Each reinforcement shall be free from folds and voids.

All reinforcements shall overlap. In the case of class I coatings, which contain only one reinforcement, the overlapping of successive turns shall be at least 15 mm. For the other classes the number of reinforcements in any cross-section of the protection shall be at least that specified (see 7.1.2).

7.1.2 Thickness (test according to 8.1.2)

The minimum thickness, excluding mechanical protection, as measured at any point on the coating, shall be that specified in table 6 for the class selected by the purchaser except along the

Table 6

Class [1)]	Number of reinforcements	Minimum thickness of coating mm
I	1	3
II	2	3
III	⩾ 2	4
IV	⩾ 2	6

1) It should be noted that the numbering of the classes in the table is not to be interpreted as an order of quality.

line of the weld which shall be the subject of previous agreement between the parties concerned.

For all classes the first reinforcement shall be glass fibre matting.

For classes II and III subsequent reinforcement(s) may be glass fibre matting or woven glass. The final reinforcement may alternatively be a composite of glass fibre matting and woven glass.

For class IV any intermediate reinforcements may be glass fibre or woven glass. The final reinforcement shall be woven glass or a composite of glass fibre matting and woven glass.

7.1.3 Adhesion (test according to 8.1.3)

The coating shall adhere adequately to the pipe.

The adhesion is considered to be satisfactory when there is no clear separation between removable parts of the coating and primer, or primer and metal.

Any separation shall be less than 10 mm from the edge of the section.

7.1.4 Freedom from holidays (test according to 8.1.4)

The coating shall be free from defects which can be detected by applied electric potential using an electrode giving a spark length, set at the time of test to a minimum length of 10 mm, or twice the minimum specified thickness of the coating, whichever is the greater, corresponding approximately to 10 kV.

Testing shall preferably be carried out before application of any mechanical protection. However, if the coating carries a mechanical protection applied at the same time as the coating, the spark length shall be set to at least three times the minimum specified thickness of coating.

7.2 Internal coating

7.2.1 Appearance (test according to 8.2.1)

The coating shall be of uniform appearance and free from any faults detrimental to its performance.

7.2.2 Thickness (test according to 8.2.2)

The minimum thickness at any point of the coating shall be that specified in table 7 for the class selected by the purchaser.

Table 7

Class	Minimum thickness of coating µm
A [1]	50
B	400
C	1 500
D	3 000

1) Class A, at a thickness of approximately 50 µm, shall not be considered a protective coating. It is a temporary coating only for transport, storage, and possibly for improved appearance.

7.2.3 Adhesion (test according to 8.2.3)

The coating shall adhere adequately to the pipe.

Internal coatings of class A shall not be submitted to this test. Pending agreement on a test method for adhesion for class B coatings, the adhesion test applicable to this class shall be agreed between the supplier and purchaser.

7.2.4 Continuity (test according to 8.2.4)

Internal coatings of classes C and D shall be free from defects which can be detected by applied electric potential using an electrode giving a spark length set at the time of test to at least twice the minimum specified thickness of the coating.

Coatings of classes A and B shall not be submitted to this test.

8 Test methods for inspection of coated pipes and fittings

8.1 External coating

8.1.1 Appearance and constitution

The general appearance of the coating is judged visually. In order to check its constitution and particularly the number of reinforcements and their position, examine a cross-section detached from the metal with a cutting tool.

8.1.2 Thickness

8.1.2.1 Principle

The thickness is determined

— either by direct measurement with a penetration gauge (destructive test);

— or by magnetic measurement (non-destructive test) to an accuracy of ± 10 %.

In case of dispute, only the results of a direct measurement shall be accepted.

8.1.2.2 Procedure

Carry out the non-destructive test with a magnetic or electromagnetic instrument, calibrate the instrument on the coated metal and in the range of thickness to be measured. Recalibrate the instrument frequently to ensure its satisfactory performance and precision.

When the measurement is made with a gauge, it shall be inserted perpendicular to the coating and its point brought into contact with the metal. Make good the coating damage immediately after each test. Submit all repairs to the electrical test for continuity.

Carry out the measurements at a minimum distance from the end of the coating to be agreed between the parties, but which shall in no case be less than 200 mm.

8.1.3 Adhesion

8.1.3.1 Principle

The test consists of peeling a strip cut from the coating.

8.1.3.2 Equipment

A cutting tool with a thin sharp blade.

8.1.3.3 Procedure

Carry out the test on a coating which has reached ambient temperature (35 °C max.) :

a) either 48 hours after application and at not less than 10 °C; the coating shall adhere to the metal,

b) or outside the conditions set in a).

See 9.3.1 e) for interpretation of the results of tests in a) and b).

Cut out, with the aid of a tool, a 50 mm square taking care to cut the coating down to the metal, avoiding in so doing any shock which may give rise to premature detachment of the remaining coating.

Insert the blade into the coating to a distance of about 10 mm (in the case of internal coatings) or into the middle of the layer between the first reinforcement and the metal (in the case of external coatings) and lift smoothly.

8.1.4 Electrical test for freedom from holidays

8.1.4.1 Principle

The test consists of looking for possible faults in the coating by means of a high tension scanning electrode.

8.1.4.2 Equipment

8.1.4.2.1 A variable voltage fault detector (holiday detector).

8.1.4.2.2 A scanning electrode in the form of a metallic brush or a joined spiral spring or conductive rubber.

8.1.4.3 Procedure

Carry out this test only on reinforcements free from surface moisture. Connect the apparatus to the selected electrode and also to the metal wall of the pipe fitting, or pipeline, or to a low resistance earth. Check at the time of test on a pipe of the type to be tested that the spark length is not less than the minimum value specified; see 7.1.4 and 7.2.4.

This calibration is to be verified at intervals not exceeding 4 h.

Place the electrode in contact with the surface to be tested. Operate the electrode with a continuous movement at the rate recommended by the maker of the equipment. In the absence of such recommendation the rate shall be approximately 0,2 m/s.

The coating is considered defective at all points which give rise to a spark and an acoustic or optical signal.

Mark all such defective areas and repair.

8.2 Internal coating

8.2.1 General appearance

The general appearance of the coating is judged visually.

8.2.2 Thickness

The thickness shall be determined by the non-destructive test, which is carried out with a magnetic or electromagnetic instrument. The instruments shall be calibrated on the coated metal and in the range of thickness to be measured; they shall be recalibrated frequently to ensure satisfactory performance and precision.

8.2.3 Adhesion

The method described in 8.1.3 shall also be used for internal coatings of classes C and D.

For classes A and B, see 7.2.3.

8.2.4 Electrical test for continuity

The method described in 8.1.4 shall be applied to classes C and D coatings.

For classes A and B, see 7.2.4.

9 Inspection of coated pipes and fittings

9.1 General

Coating inspection shall be carried out by the responsible department at the factory. It shall include three types of operations :

a) continuous inspection of the various parameters applicable, i.e. :

- surface preparation (see 6.2),
- conditions of application (see 6.3 and 6.4),
- overlapping of reinforcement (see 7.1.1);

b) systematic inspection of each pipe or fitting, i.e. :

- visual inspection of appearance (see 7.1.1 and 7.2.1),
- inspection of continuity by electrical testing (see 7.1.4 and 7.2.4),
- inspection of the uncoated lengths at the ends (see 7.1.1);

c) non-systematic inspection of samples taken according to the rules of 9.2, i.e. :

— visual inspection of constitution (see 7.1.1),

— adhesion inspection (see 7.1.3 and 7.2.3),

— thickness inspection (see 7.1.2 and 7.2.2).

The sequence of operations is arranged so as to avoid later tests being carried out unnecessarily.

The tests shall be performed by the manufacturer. A representative of the purchaser may attend the various operations.

9.2 Definition of batches and rules for sampling

9.2.1 Definition of a production unit

By a production unit is meant a whole set of coated pipes or fittings with the following characteristics :

— same type of product (bitumen or coal-tar derived coating and reinforcement);

— same outside diameter of pipe or type of fitting;

— same class of coating;

— same thickness of coating;

— same production series;

— same coating unit;

— a fixed number of pipes or fittings.

9.2.2 Rules for sampling for non-systematic inspection

The pipes or fittings on which the planned non-systematic tests [see 9.1 c)] are performed shall be selected at the beginning, middle and end of the production unit. The test pieces shall be taken from the middle or ends (at a minimum 1000 mm distance from ends) of pipes, or from the middle or ends (at a minimum 200 mm distance) of fittings, and marked. Similarly the pipes or fittings from which test pieces are taken shall be marked for ready identification.

The frequency of testing and number of pipes or fittings in the production unit are as specified in the product standard or by agreement between the parties concerned.

9.3 Results of inspection tests and interpretation

9.3.1 Requirements

The inspection shall be considered satisfactory if the results conform to the corresponding test requirements :

a) appearance and constitution (see 7.1.1 or 7.2.1);

b) lengths of uncoated ends (see 7.1.1);

c) continuity (see 7.1.4 or 7.2.4);

d) thickness (see 7.1.2 or 7.2.2);

e) adhesion (see 7.1.3 or 7.2.3).

1) If the adhesion test has been carried out under the conditions of 8.1.3.3 a), any poor result leads to rejection subject to the provisions of 9.3.2.

2) If the adhesion has been carried out under the conditions of 8.1.3.3 b), and the results are satisfactory, the coating is accepted as having satisfactory adhesion. Poor results obtained in such conditions are not taken as final but necessitate repetition of the test after a longer time and/or at a higher temperature, until the results are either satisfactory or are obtained under the conditions of 8.1.3.3 a).

In case of dispute the decision shall be taken on the basis of the test carried out under the conditions defined in 8.1.3.3 a).

Account is not taken of tests where unsatisfactory results are due not to the quality of the protection but to :

— faulty taking of the test piece, or

— defective setting up or abnormal operation of the test equipment.

In such cases the test shall be repeated.

9.3.2 Interpretation of results

9.3.2.1 If all tests or inspections are considered satisfactory, the production unit is considered to conform to the requirements. The coating of those pipes or fittings used for destructive testing is then repaired (see 6.3.6 and 6.3.7). These are then inspected again using non-destructive tests for continuity and, if required, for appearance and thickness, the specifications adopted being those of the corresponding repair materials.

9.3.2.2 If, however, the results of one or more tests are found poor or insufficient, two cases arise :

a) tests or inspections according to 9.1 a) or 9.1 b) : in such cases the pipes or fittings of which the coating acknowledged defective shall be taken back by the manufacturer for appropriate improvement;

b) tests or inspections according to 9.1 c) : unless otherwise agreed, additional tests shall be carried out at the rate of two tests for each unsatisfactory test of the same type — on, if possible, the pipe or fitting the coating of which was applied immediately before or after that of the defective pipe or fitting.

If all these additional tests are satisfactory, the production unit shall be considered to conform to the prescribed conditions (refer to 9.3.2.1 for the reconditioning of the pipes or fittings after inspection).

If at least one additional test still does not give satisfactory results, the manufacturer may carry out the corresponding test on each pipe or fitting of a given type in the production unit concerned. He shall then present the results obtained indicating all pipes or fittings giving satisfactory results. Pipes and fittings with a defective coating shall be rejected.

10 Ordering or laying contract wording

In the order for pipes or fittings to be coated in the factory or workplace, in the pipeline laying contract or in the specifications provided by the purchaser, all or part of the following information shall be given as appropriate.

10.1 Characteristics of the pipes (welded or seamless, end shape) or fittings to be coated, that is :

a) steel quality and diameter;

b) wall thickness and total length of pipes;

c) quality and diameter of fittings;

d) nature of fluid to be transported.

10.2 For surfaces

a) preparation of metal surfaces (shot or grit blasting, mechanical or manual wire brushing, etching, etc.), and the minimum care required;

b) methods of preparation of already coated surfaces, to be protected by manually-applied or mechanical coating on the laying site.

10.3 Required coating type (external, internal or both); i.e.

a) place;

b) method of coating application (in works, at workplaces, on the site; for each pipe or fitting, for the whole pipeline; using a machine or manually);

c) temperatures of operation of the pipeline (normal and maximum).

10.4 For all coatings :

a) nature and system of application of the primer or bonding coat (cold or hot application);

b) nature of bonding agent (petroleum bitumen, coal tar, mineral filler, main characteristics of the product);

c) temperatures of melting and application of the binder (maximum and minimum);

d) lengths of uncoated areas at pipe or fitting ends; surface condition (bare, with a temporary primer or protection layer, nature and type of the latter);

e) the types of storage and transport of coated pipes or fittings.

10.5 For external coatings :

a) grade;

b) minimum permitted thickness over seams or other prominent parts;

c) number and type of reinforcements as in 5.1.6.1, 5.1.6.2 and 5.1.6.3 and minimum overlapping;

d) nature and types of mechanical and solar protective coatings, if any;

e) mean thickness and for bent or ballasted pipes maximum thickness;

f) additional instructions for coating and repairs.

10.6 For internal coatings :

a) grade;

b) for potable water pipelines, hygiene criteria of the country of use.

10.7 Marking of coating (indication of class and type, colours, positioning, dimensions, etc.).

10.8 Coating inspection :

a) composition of production units (number of pipes or fittings or total length of joints or pipeline);

b) required inspection types and frequency per unit of production;

c) number of samples and measurements (non-systematic testing) per unit;

d) number of pipes, fittings, joints or length of pipeline represented by each sample and measurement;

e) details of test result interpretation, of additional tests and of repaired coating inspection;

f) type of acceptance certificate required.

11 Documents to be provided

The conformity of the delivery shall be guaranteed by the following documents.

11.1 Acceptance by the purchaser

The acceptance certificate signed by the purchaser's appointed inspecting authority contains the results of all tests and inspections specified carried out in his presence, and certifies that these were carried out on the manufacturer's premises on the samples taken from the products in the delivery.