BRITISH STANDARD

BS EN
10339:2007

Steel tubes for onshore and offshore water pipelines — Internal liquid applied epoxy linings for corrosion protection

The European Standard EN 10339:2007 has the status of a British Standard

ICS 23.040.99; 25.220.60

BSI
British Standards

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 10339:2007.

The UK participation in its preparation was entrusted to Technical Committee ISE/8, Steel pipes.

A list of organizations represented on ISE/8 can be obtained on request to its secretary.

Compliance with this Standard does not automatically imply a presumption that the product is suitable for the transport of water intended for human consumption, within the meaning of European Directive 89/106/EEC (also known as the Construction Products Directive). Until the proposed European Acceptance Scheme for construction products in contact with water intended for human consumption (or an alternative programme put forward by the European Commission) is in place, and this Standard revised to reflect this, products conforming to this Standard may be used in applications involving the transport of water for human consumption if they also conform to the relevant national, regional or local regulatory provisions applicable in the place of use.

In the UK, products and processes need to be approved by the Drinking Water Inspectorate (DWI). This involves obtaining approvals under regulation 31 for both the coating and the coating applicator. For more details please refer to http://www.dwi.gov.uk/cpp/index.shtm.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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English Version

Steel tubes for onshore and offshore water pipelines - Internal liquid applied epoxy linings for corrosion protection

Tubes pour canalisations d'eau enterrées et immergées - Revêtements internes en résine époxyde appliquée à l'état liquide pour la protection contre la corrosion

Stahlrohre für erd- und wasserverlegte Wasserleitungssysteme - Innenauskleidung mit Epoxidharzen als Korrosionsschutz

This European Standard was approved by CEN on 20 December 2006.

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

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Foreword

This document (EN 10339:2007) 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 August 2007, and conflicting national standards shall be withdrawn at the latest by August 2007.

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1 Scope

This European Standard specifies the requirements for the application of liquid applied epoxy internal linings, for the corrosion protection of steel tubes.

This type of lining is generally used in the transport and distribution, under pressure or by gravity, of water intended for human consumption and industrial use, sea water, waste water and also in fire water. The temperature of the water transported generally does not exceed 50 °C.

The choice of the lining and its limits of use depend on the type of product used, the pipe laying conditions, the temperature and the chemical composition of the fluid. The choice of the product for the medium to be transported and its qualification are not part of this European Standard.

The lining consists normally of one layer of liquid product, applied by spray airless technique after surface preparation.

All or some of the requirements of this European Standard can apply to the internal linings of fittings, if agreed by the purchaser and the coater.

The lining in this European Standard can be applied to longitudinally or spirally welded tubes and to seamless steel tubes used for the construction of pipelines for conveying liquids.

These tubes are not intended to be bent after the epoxy lining has been applied.

This European Standard does not cover in-situ applied or rehabilitation linings.

The constituent materials of epoxy linings, when used under the conditions for which they are designed, in permanent or temporary contact with water intended for human consumption, should not change the quality of that water to such an extent that it fails to comply with the requirements of European regulations at the end user. For this purpose, reference should be made to the relevant national standards transposing EN standards when available, dealing with the influence of materials on water quality.

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 1184, *Materials and articles in contact with foodstuffs — Test methods for translucency of ceramic articles*

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

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

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

EN ISO 3251, *Paints, varnishes and plastics — Determination of non-volatile-matter content (ISO 3251:2003)*

EN ISO 4287, *Geometrical product specification (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters (ISO 4287:1997)*

EN ISO 4624, *Paints and varnishes — Pull-off test for adhesion (ISO 4624:2002)*

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 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)*

EN ISO 8503-4, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile — Stylus instrument procedure (ISO 8503-4:1988)*

3 Terms and definitions

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

3.1
product manufacturer
supplier of the epoxy materials in a condition suitable for application to the product to be coated

3.2
coater
company responsible for applying the lining material to the components to be coated

3.3
purchaser
company that buys the coated tubes and fittings

4 Symbols and abbreviations

For the purposes of this document, the following symbol applies.

R_Z the average roughness from five successive evaluation areas defined according to EN ISO 4287, expressed in microns (µm)

5 Lining materials

5.1 General

The lining material is generally composed of a base (epoxy resin) and a curing agent. A primer may be used when recommended by the product manufacturer.

The base (epoxy resin) and curing agent should have different colours allowing the verification of the correct mixing by checking the uniformity of the colour of the mixed product.

This European Standard calls for the use of substances and/or procedures that may be injurious to health if precautions are not taken. It refers only to technical suitability and in no way absolves the user from statutory obligations relating to health and safety at any stage.

5.2 Technical specification

The technical specification drawn up by the product manufacturer shall contain as a minimum the information detailed in Table 1. Where testing standards are mentioned in Table 1, the data supplied by the product

manufacturer shall be according to these standards. Otherwise, test methods shall be given for any test detailed in Table 1. Tests shall be done to be consistent with the product manufacturer's recommendations for application.

Infrared scan of the product components shall be made available on request to the coater.

Other data or tests can be agreed between the parties at the time of enquiry and/or order.

If test certificates are required, they shall at least contain the data mentioned in Table 1.

Table 1 — Contents of Technical data sheet and Test certificates

Elements	Technical data sheets	Test certificates
Date of issue	x	x
Name of manufacturer	x	x
Field of application	x	
Name and type of product	x	x
Type of base (epoxy resin)	x	
Type of curing agent	x	
Factory of origin		x
Batch or production lot number		x [a]
Use by date		x [a]
Colour	x [a]	
Methods of application	x	
Solids by volume	x	
Solids by weight of the mixed product according EN ISO 3251	x [b]	
Theoretical coverage per m² for nominal thickness	x	
Shelf life	x [a]	
Storage conditions	x	
Pot-life	x	
Surface preparation	x	
Recommended instructions for application	x	
Recommended repair method(s)	x	
Mixing instructions (induction time if applicable)	x	
Recommended dry film thickness (nominal and range)	x	
Maximum recommended dry film thickness applicable in one layer	x	
Minimum and maximum overcoating time	x	
Range of application temperature (ambient, tube and product) and humidity	x	
Specific curing requirements	x	
Hardness measured by Buchholz indentation test according to EN ISO 2815 of cured lining measured	x	
Time related to curing temperature to achieve the full curing	x	
Viscosity	x	x [cd]
Density according to EN ISO 2811-1	x [d e]	x [a]
Elongation at break on free film according to EN 1184	x	
Pull-off test for adhesion according to EN ISO 4624	x	

a Required for the base (epoxy resin) and curing agents.

b In contradiction to the curing cycle specified in EN ISO 3251, curing cycle of 2 days at 23 °C ± 2 °C will apply.

c Required for the base (epoxy resin), curing agent and the mixed product.

d The acceptable limits shall be mentioned in the test certificate.

e Required for the base (epoxy resin), curing agent. For the mixed product, density can be calculated.

5.3 Packaging

As a minimum requirement, all materials supplied for lining operations shall be suitably marked with the following details:

— the product manufacturer's name;

— the name of the material;

— the batch number;

— the use-by date;

— the recommended storage conditions;

— the colour of the material.

6 Information to be supplied by the purchaser

6.1 Mandatory

The purchaser shall state in his enquiry and order the following minimum information:

Tubes and fittings to be coated according to this European Standard. These shall be designated by reference to this European Standard. If applicable, the reference to the standard for the tube to which the lining is applied shall be added to this designation.

EXAMPLE: 5 000 m of tube - EN 10224 of 406, 4-4, 0

— Internal lining EN 10339;

— type of fluid to be transported;

— minimum dry film thickness of the lining (see 8.3);

— service temperature;

6.2 Options to be indicated by the purchaser

— Maximum number and dimensions of repairs (not including repairs due to destructive tests);

— cut back lengths (see 8.7).

7 Surface preparation and application of the lining

7.1 Surface preparation

7.1.1 Prior to abrasive blast cleaning, the steel surface shall be dry and free from contamination (oil, grease, temporary corrosion protection etc.) and surface defects (slivers, laminations etc.) detrimental to the surface or to the adhesion of the lining.

7.1.2 Tubes shall be abrasive blast cleaned. The degree of cleanliness shall be at least Sa 2,5 when examined according to EN ISO 8501-1.

Unless otherwise recommended by the manufacturer of the product, the blast cleaned surface shall have a roughness Rz, as defined in EN ISO 4287 between 50 µm and 90 µm, as measured according to EN ISO 8503-4.

Grading of the surface can also be examined according to EN ISO 8503-2, the profile grade shall be “medium”.

7.1.3 After blast cleaning, the surface of the components shall be visually inspected. All slivers, laminations, weld spatter and other surface imperfections made visible by the blast cleaning process shall be removed.

After removal of these defects, the residual thickness of tubes shall satisfy the minimum tolerance requirements specified by the relevant standard. All treated areas greater than 10 cm² shall be prepared to provide a profile to satisfy the requirements of 7.1.2.

7.1.4 During surface preparation, the temperature on the surface of the tubes shall be maintained at least 3 °C above the dew point temperature prior to lining.

7.1.5 Contaminants (e.g. residual abrasive dust) shall be removed prior to lining.

7.1.6 The temperature on the surface of the tubes and the holding time prior to lining shall not result in oxidation of its surface, detrimental to the good quality and adhesion of the lining.

7.2 Application of the lining

7.2.1 General

The lining shall be applied according to the written procedure established by the coater taking into account the instructions of the product manufacturer.

7.2.2 Mixing

The contents of each container shall be stirred or agitated to a homogeneous state before any material is withdrawn.

Base (epoxy resin) and curing agent shall be mixed in the proportions specified by the product manufacturer.

For twin feed airless application, appropriate monitoring shall be used to ensure correct metering of the two pack materials.

The quantity of material made up at one time shall not exceed that which can be used within the pot life stated by the product manufacturer.

Also, the induction time, if applicable, shall be taken into account.

7.2.3 General application procedure

The lining shall be applied to the blast cleaned components using the method and equipment recommended by the product manufacturer.

At the time of application, the ambient temperature and the temperature range on the surface of the tube to be lined shall be determined in agreement with the product manufacturer.

The temperature on the surface of the tubes shall be monitored using suitable means in order to make sure that the application conditions are fully satisfied.

The lining shall be uniform.

If multiple layers are required, these shall be applied according to the overcoating times (minimum and/or maximum) prescribed by the product manufacturer.

Particular attention shall be paid to the recommended dry film thickness for each layer.

The wet film thickness shall be measured according to EN ISO 2808.

If pre-heating of the base (epoxy resin) and/or the curing agent is required prior to mixing and application, this shall be carried out according to the product manufacturer's procedure.

If post-heating of the lining after application is required, this shall also be carried out according to the product manufacturer's procedure.

No thinner shall be used unless recommended by the product manufacturer. **The use of thinner for water intended for human consumption is forbidden.** Tools and equipment shall be cleaned using only such solvents as are recommended by the product manufacturer.

During the lining application the surface temperature of the substrate shall be at least 3 °C above the dew point and the relative humidity shall not exceed 80 %, unless otherwise specified by the product manufacturer.

8 Requirements of the applied lining

8.1 General

The applied lining shall be tested as follows:

— appearance and continuity;

— minimum dry film thickness of the lining;

— hardness measured by Buchholz indentation;

— non porosity;

— adhesion;

— cut back at the ends.

8.2 Appearance and continuity

The appearance and continuity of the lining shall be inspected visually over the total length of all the tubes.

The lining shall be of uniform colour, appearance and be free of holidays, defects and laminations detrimental to the quality of the lining.

8.3 Minimum dry film thickness of the lining

The thickness of the lining shall conform to the contractual requirements (see 6.1). The minimum dry film thickness shall take into account the service conditions such as: the medium, the temperature, the life expectancy etc. However, in any case, the absolute minimum dry film thickness of the lining at any point shall not be less than 320 μm.

Lining thickness shall be measured according to method 10 of EN ISO 2808.

8.4 Hardness measured by Buchholz indentation

This test is to assess the curing of the lining. It shall be carried out with Buchholz indentation test according to the method defined in EN ISO 2815.

The acceptance criteria shall be as stated by the product manufacturer on his technical data sheet.

8.5 Non porosity

The purchaser shall approve the written procedure for non-porosity test established by the coater.

Tubes shall be free of any porosity.

Porosity test shall be carried out with one of the two following methods:

— wet sponge with a voltage from 60 V to 90 V;

— spark tester with a voltage of 5 V/µm, referring to the required minimum dry film thickness.

Method of control shall be detailed in a written procedure established by the coater and approved by the purchaser, taking into account the recommendation of the supplier of testing equipment.

Detected defects, e.g. holes, porosity or other damages shall be repaired according to Clause 9.

8.6 Adhesion

The resistance of the lining to removal shall be determined according to the requirements of Annex A.

The adhesion of the lining shall satisfy the requirements of rating 2 or better at (23 $\pm$ 2) °C.

8.7 Cut back lengths

The cut back lengths shall be determined according to the contract requirements (see 6.1).

The cut back lengths shall be determined to avoid any degradation due to welding.

It is recommended to have at least 50 mm from the end.

8.8 Summary of the required properties

Table 2 gives the summary of the required properties of the lining.

Table 2 — Summary of the required properties

Properties	Requirements	Subclause
Appearance and continuity	Uniform colour, smooth appearance and free from defects	8.2
Minimum dry film thickness of the lining	320 μm minimum	8.3
Hardness measured by Buchholz indentation	Specified by the manufacturer	8.4
Non porosity	Free from porosity	8.5
Adhesion	Rating 2 or better	8.6
Cut back lengths	Contract agreement	8.7

9 Repairs

All local repairs of lining defects and those resulting from destructive tests shall be as follows:

The repairs shall be done according to a written procedure established by the coater assessing that the materials to be used for repairing defects shall satisfy two conditions:

— be suitable for the required service conditions as given in 6.1;

— be compatible with the epoxy lining applied previously;

— be in compliance with the relevant national standards for water intended for human consumption.

The lining thickness of the repair area shall not be less than the required thickness of the original lining.

The surface preparation and the application conditions for repair materials shall be those defined in the repair product manufacturer's technical data sheet. The surface of the tube shall be maintained in a dry condition during application of the repair material.

The completed repair shall satisfy the values specified in the repair product manufacturer's technical data sheet.

After curing and prior to delivery, all repaired areas shall be tested for dry film thickness according to 8.3 and for non-porosity according to 8.5.

10 Marking

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

— identification;

— name of the producer of the steel pipes (if known);

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

— reference to the steel pipe standard (if known);

— reference to this European Standard, i.e. EN 10339, followed by the internal lining, the minimum thickness in micrometres.

Marking shall be carried out using a method such as stencil painting or printing, making possible legible and indelible identification, using durable materials compatible with the later use of the components. Marking shall be done on the external surface of the pipes, unless otherwise specified.

11 Handling, transportation and storage

11.1 Handling and transportation to the storage area

Coated tubes shall be handled and transported without causing damage to the ends of the tubes or to the lining.

11.2 Storage

Storage shall be carried out so that the lining does not deteriorate.

11.3 Loading of tubes for delivery

The coater is responsible for the supply of correctly lined tubes as detailed in the tender documentation.

Loading of tubes shall be done taking into account all reasonable precautions to make sure that loading is carried out correctly in order to avoid damage to the tube or to the lining during transportation.

Annex A
(normative)

Adhesion test - Resistance to removal

A.1 General

The test checks the adhesion of the lining by a destructive process.

A.2 Apparatus

Apparatus shall consist of:

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

— a steel rule, if required;

— a steel rod, if required;

— an oven.

A.3 Procedure

A.3.1 The test area shall consist of any coated area on the tube or test panels. Surface preparation, lining application and dry film thickness of the test panels shall be the same as that for the tubes. The test area shall be of the correct dry film thickness and be free of all defects.

The lining of tubes or test panels shall be properly cured as determined by the hardness measured according to the Buchholz indentation test (see 8.4).

An accelerated curing of the test area is acceptable provided this is according to product manufacturer's recommendations and the curing temperature does not exceed 50 °C.

A.3.2 Using a sharp-bladed utility knife against a steel rule if necessary, straight 50 mm minimum long cuts shall be made in the lining through to the metal surface to form an X with an angle of approximately 30° at the intersection point.

A.3.3 The point of the utility knife shall be inserted horizontally (i.e. using the flat of the blade) under the lining at the point of intersection of the cuts in the area of the 30° angle such that the blade point is at the metal surface.

A.3.4 A levering action against a fulcrum (such as steel rod) shall be used to force the flat point of the blade up from the metal surface describing a single, vertical (i.e. at 90° to the surface) motion in an attempt to prise the lining off.

A.3.5 The same procedure (from A.3.2 to A.3.4) shall be applied to test the lining at the maximum service temperature.

— A sample shall be conditioned in an oven for 4 h.

— Immediately after the removal from the oven, an adhesion test shall be carried out according to the procedure mentioned above.

— Then the sample shall be maintained at (23 ± 2) °C for 24 h and the adhesion test shall be repeated.

A.4 Results

The adhesion of the lining shall be determined by the following rating system:

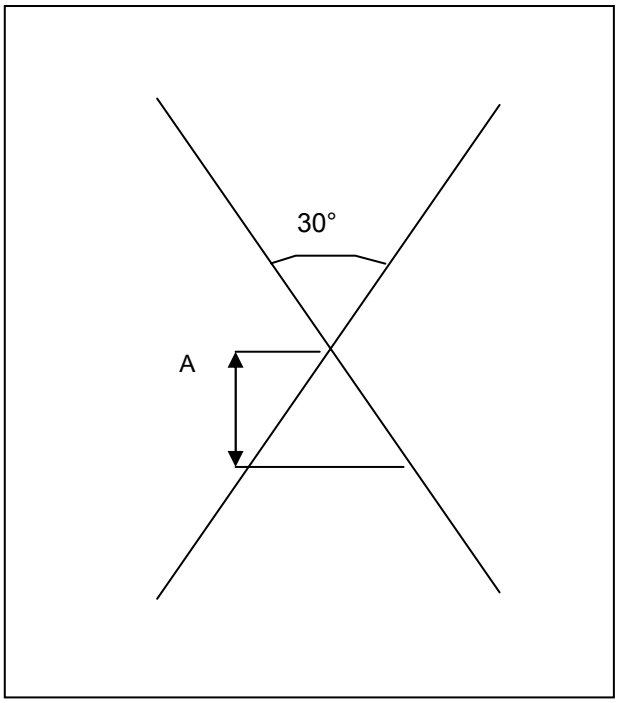
Rating 1: No removal of lining other than that caused by insertion of the flat point of the knife blade at the intersection point (nominally less than 1 mm).

Rating 2: Not more than 2 mm of adhesive loss of lining from the metal surface.

Rating 3: Not more than 3 mm of adhesive loss of lining from the metal surface.

Rating 4: Not more than 5 mm of adhesive loss of lining from the metal surface.

Rating 5: More than 5 mm of adhesive loss of lining from the metal surface.



Key

A disbonded length

Figure A.1 — Rating system

The adhesive loss, in millimetres, is measured from the intersection point of X-cuts to the nearest point of the adherent lining, not along the X-cuts (see Figure A.1).

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

Bibliography

[1] EN 24624, Paints and varnishes — Pull-off test (ISO 4624:1978)

[2] EN ISO 12944:1998 (all parts), Paints and varnishes — Corrosion protection of steel structures by protective paint systems

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