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## Internal protection by polymeric lining for ductile iron pipes — Requirements and test methods —

### Part 2: epoxy lining

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 2, *Cast iron pipes, fittings and their joints*.

A list of all parts in the ISO 24131 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

The ISO 24131 series specifies the requirements and test methods applicable to factory applied polymeric linings for ductile iron pipes according to ISO 2531, ISO 7186 and ISO 16631. The ISO 24131 series is intended to include several types of polymeric linings.

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# Internal protection by polymeric lining for ductile iron pipes — Requirements and test methods —

## Part 2: epoxy lining

### 1 Scope

This document specifies the requirements and test methods applicable to factory applied internal epoxy lining for ductile iron pipes according to ISO 2531, ISO 7186 and ISO 16631.

It covers internal linings for use in the conveyance of raw water, potable water and sewage water for operating temperature up to 50 °C.

### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 2531, *Ductile iron pipes, fittings, accessories and their joints for water applications*

ISO 7186:2011, *Ductile iron products for sewerage applications*

ISO 16631, *Ductile iron pipes, fittings, accessories and their joints compatible with plastic (PVC or PE) piping systems, for water applications and for plastic pipeline connections, repair and replacement*

ISO 4624, *Paints and varnishes — Pull-off test for adhesion*

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

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2531 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

#### 3.1

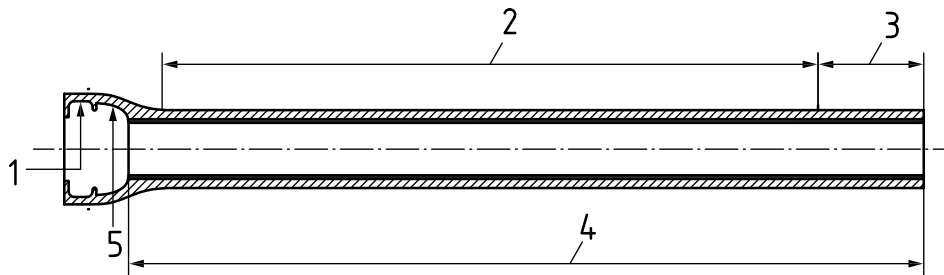
##### epoxy lining

factory applied lining

Note 1 to entry: It can be with either

- fusion bonded epoxy powder applied by spraying or dipping in a fluidised bed on preheated parts, with or without post curing, or
- two-pack liquid epoxy consisting of a base and a catalyst component which are mixed together in the proportion specified by the manufacturer before application.

Note 2 to entry: See [Figure 1](#).



**Key**

- 1 gasket seat
- 2 pipe barrel
- 3 spigot end
- 4 lining
- 5 internal socket profile

**Figure 1 — Location of the defined pipe areas**

**3.2**

**epoxy**

family of basic components or cured end products of epoxy resins, which are a class of reactive prepolymers and polymers which contain epoxide groups

Note 1 to entry: Epoxy is created by mixing two different compounds known as a resin and a hardener.

**3.3**

**operating temperature**

applicable temperatures under which the product maintains its properties

**3.4**

**chalking**

superficial reaction of *epoxy lining* (3.1) due to exposure to UV-radiation

Note 1 to entry: The process is confined to the surface only and results in a dulling of the surface.

**3.5**

**minimum lining thickness**

minimum value of the lining thickness measured at the lined item

**3.6**

**local thickness**

measured thickness at any one point of one lined product

**3.7**

**adhesion**

**pull off test**

force per unit area, applied perpendicular to the surface, which is necessary to separate the lining from its substrate

**3.8**

**cross linkage**

chemical reaction between epoxy resin and hardener to form the final cured lining

**3.9**

**non-porosity**

absence of electrical puncture in a high voltage test (holiday test) under defined test conditions



**3.10****protection of pipe ends**

factory applied coating/lining on spigot end and internal socket profile of pipes

Note 1 to entry: See [Figure 1](#).

**3.11****abrasion resistance**

ability of materials and structures to withstand abrasion

**3.12****impact resistance**

energy which a lining can withstand without damage under defined test conditions

**3.13****indirect impact resistance**

impact energy applied from outside of the pipe with deformation to which a lining can withstand without damage under defined test conditions

**3.14****ovalization**

100 times the measured vertical deflection, (caused by the applied load) divided by the measured pipe external diameter

**3.15****routine test**

test carried out to control the manufacturing process

Note 1 to entry: The frequency of the test is defined by this document or the manufacturer.

**3.16****performance test**

test which is done once and thereafter only when there is a change in the lining material or lining process

**4 Technical requirements****4.1 General**

The following technical requirements shall be demonstrated by routine tests applied in production, on in-process and finished lined products with defined frequency. Routine tests shall be in accordance with the overview of requirements provided in [Table A.2](#).

Quality assurance for epoxy lining shall be in accordance with [Annex A](#).

**4.2 Surface preparation**

Prior to lining application, all surfaces to be lined shall be substantially clean and free from oil, grease and moisture.

In cold weather, or anytime when moisture tends to condense on the surface of the pipe, it shall be uniformly warmed for sufficient time to dry prior to cleaning. The surface temperature shall be maintained at least 3 °C above the dew point.

Surface preparation shall be designed in order to reach the required performances specified in this document. It is the responsibility of the manufacturer to demonstrate the fitness for purpose of surface

preparation technology and to put in place a quality control procedure to ensure the stability of those performances.

NOTE The requirements of Class Sa 2.5 of ISO 8501-1 and  $\leq$  Rating 3 dust quantity and Class 2 for dust size of ISO 8502-3 can be applied.

### 4.3 Lining appearance

The lining of the final product shall be of

- uniform colour, except for permitted marking;
- uniform appearance and smoothness, except for allowable repairs;
- free of visible defects (i.e. pinholes, bubbles, blisters, wrinkles, cracks or voids).

Slight superficial colour variations due to repairs or long exposure to sunlight (chalking) are permissible.

### 4.4 Minimum lining thickness

When measured in accordance with the method defined in 6.1.3, the minimum local thickness shall be greater than 200  $\mu\text{m}$  and the minimum average thickness shall be greater than or equal to 250  $\mu\text{m}$ .

### 4.5 Adhesion (pull off test/cross cut knife test)

Adhesion (pull off test) shall be tested in accordance with the test method defined in 6.1.4 on production samples.

The lining adhesion shall achieve an average value of at least 8,0 MPa and a minimum single value of 6,0 MPa. The manufacturer shall determine the test locations on the products.

Alternatively, the adhesion test can also be done by cross cut knife test method. Where the cross knife test is chosen for adhesion, it shall be carried out according to Annex B. The adhesion rating shall be no more than level 2.

### 4.6 Cross linkage (MIBK/ $\Delta T_g$ )

When tested in accordance with the test method defined in 6.1.5, after wiping with a methyl isobutyl ketone (MIBK) solution, the cloth and the lining surface shall be visually examined. Any discolouration, matting and/or smearing observed shall not exceed the limits specified by the lining manufacturer.

Alternatively, the cross linkage of lining can be determined by its change in glass transition temperature ( $\Delta T_g$ ) and  $\Delta T_g$  shall be no more than 5 °C.

### 4.7 Non-porosity

When tested in accordance with the test method described in 6.1.6, with a voltage of 1 500 V, the lined body of the product shall be free from porosity. This means that no electrical puncture should occur. This requirement does not apply to pipe ends.

The electrode shall not be damaged and shall be in constant touch with the lining.

### 4.8 Protection of pipe ends

Spigot end and internal socket profile (see Figure 1) shall be coated in accordance with ISO 2531, ISO 7186 and ISO 16631.

## 4.9 Marking

All pipes shall be marked legibly and durably according to the pipe standards, ISO 2531, ISO 7186 and ISO 16631. Reference to this document shall be legibly and durably applied by any method upon the external surface.

Marking shall be checked in accordance with the test method described in [6.1.7](#).

## 4.10 Repairs

Repairs shall be carried out when there is a fault. The fault can be

- localized damage,
- holding point,
- earthing surface for the non-porosity test, or
- other lining fault.

The lining manufacturer should establish the repair procedure. The material to be used shall satisfy two conditions:

- be suitable for protecting pipes under the required service conditions;
- be compatible in all aspects with the previously applied lining.

The repairs shall conform to the requirements specified in [4.4](#), [4.6](#) and [4.7](#).

The information about handling, transportation and storage of epoxy lined pipes is given in [Annex C](#).

## 5 Performance requirements

### 5.1 General

The following technical requirements shall be demonstrated by performance tests in order to verify the lining material and process prior to production lining. Performance tests shall be in accordance with the overview of requirements provided in [Table A.1](#). Where there is a change of lining material or process, the performance tests shall be undertaken on the new lining material or process.

### 5.2 Materials in contact with water intended for human consumption

When used under the conditions for which it is designed, in permanent or in temporary contact with water intended for human consumption, the lining shall not have any detrimental effects on the properties of that water for its intended use.

When used for conveying water intended for human consumption, the lining materials in contact with the water shall meet the relevant requirements of ISO 2531, or the national standards or regulations in the country of use with respect to effect on water quality.

### 5.3 Abrasion resistance only for sewage applications

The linings shall conform to the requirements of abrasion resistance in accordance with ISO 7186:2011, 7.7.