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# Internal protection by polymeric lining for ductile iron pipes — Requirements and test methods — Part 1: Polyurethane lining



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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.

## Introduction

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

# Internal protection by polymeric lining for ductile iron pipes — Requirements and test methods — Part 1: Polyurethane lining

## 1 Scope

This document specifies the requirements and test methods applicable to factory applied internal polyurethane 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 8503-1, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces*

ISO 868, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)*

ISO 62, *Plastics — Determination of water absorption*

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

ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

## 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:

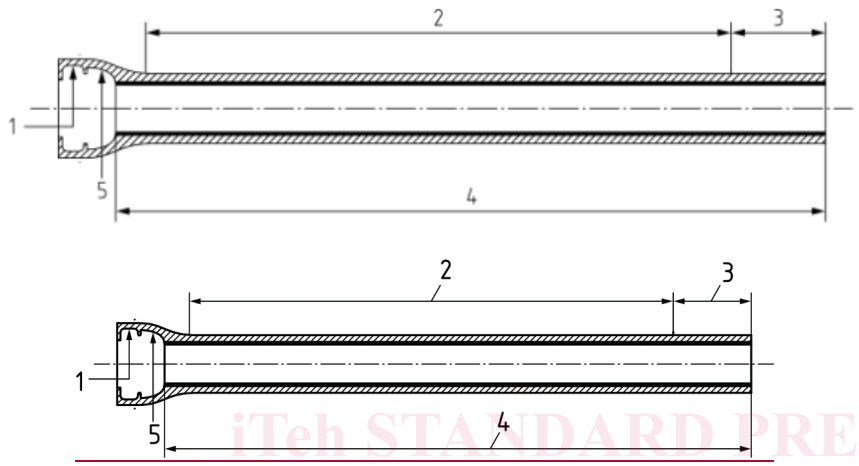
— ISO Online browsing platform: available at https://www.iso.org/obp

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

**3.1**
**polyurethane lining**

factory applied lining which consists of *polyurethane* (3.2) on the inside of the pipe

Note 1 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**
**polyurethane**
polymers made by combining diisocyanates and polyols

**3.3**
**operating temperature**
applicable temperatures under which the product maintains its properties

**3.4**
**chalking**
superficial reaction of *polyurethane 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**
**adhesion**

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

**3.7**
**cross linkage**
chemical reaction between *polyurethane* (3.2) resin and hardener to form the final cured lining

**3.8**
**non-porosity**
absence of electrical puncture in a high voltage test (holiday test) under defined test conditions

**3.9**
**hardness**
resistance of the lining to the penetration of a ball 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**
**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



**3.13**
**specific lining resistance**
surface related electric resistance of the lining perpendicular to the pipe wall

**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.

~~The information about quality~~Quality assurance for polyurethane lining ~~is given~~shall be in accordance with Annex A.

## ~~4.3~~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 ≤ Rating 3 dust quantity and Class 2 for dust size of ISO 8502-3 can be applied.

## ~~4.4~~4.3 Surface roughness

The surface roughness Ra in accordance with ISO 8503-1 shall be at least 12,5 µm which is equivalent to anchored profile Rz of 63 µm or higher if required by the lining material provider or manufacturer.

## ~~4.5~~4.4 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.

## ~~4.6~~4.5 Lining thickness

When measured in accordance with the method defined in 6.1.4, the lining thickness shall be as indicated in Table 1 for water applications and in Table 2 for sewage applications.

**Table 1 — Minimum lining thickness and test tension for water applications**

| Nominal size<br>DN | Minimum lining thickness<br>µm | Test tension<br>kV |
|---|---|---|
| 80 to 2 600 | 800 | 4 |

**Table 2 — Minimum lining thickness and test tension for sewage applications**

| Nominal size<br>DN | Minimum lining thickness<br>µm | Test tension<br>kV |
|---|---|---|
| 80 to 700 | 800 | 4 |
| 800 to 2 600 | 1 000 | 5 |

### ~~4.7~~4.6 Adhesion

Adhesion shall be tested in accordance with the test method defined in 6.1.5 on production samples.

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

### ~~4.8~~4.7 Cross linkage

Determination of cross linkage by hardness measurement of the lining materials serves as a production control. It is calibrated by a differential scanning calorimetry (DSC) test, see 6.1.6.

The test shall be carried out directly after production on a cured proxy sample under the same production condition as the pipe at room temperature (23 ± 2) °C. The test method of ISO 868 shall be used.

### ~~4.9~~4.8 Non-porosity

When tested in accordance with the test method defined in 6.1.7, the lining shall be free from porosity. For 800 µm minimum lining thickness, the test tension shall be 4 kV. For 1 000 µm minimum lining thickness, the test tension shall be 5 kV. The scanning electrode shall be passed over the surface of the lining being inspected with a continuous, relative movement not exceeding 300 mm/s. This requirement does not apply to pipe ends.

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

For thicker linings, a higher test voltage may be used by agreement between the manufacturer and the purchaser.

### ~~4.10~~4.9 Hardness

The different applications (e.g. drinking water, sewage) can use different hardness which are indicated in the pipe manufacturer's catalogue. They shall be tested in accordance with 6.1.8.

### ~~4.11~~4.10 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.

### ~~4.12~~4.11 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 6.1.9.

### ~~4.13~~4.12 Repairs

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

— localized damage,