INTERNATIONAL STANDARD

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Plastics piping systems for renovation of underground water supply networks —

Part 4:
Lining with cured-in-place pipes

Systèmes de canalisation en plastique pour la rénovation des réseaux enterrés d'alimentation en eau —

Partie 4: Tubage continu par tubes polymérisés sur place

Reference number
ISO 11298-4:2021(E)

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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.

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 8, *Rehabilitation of pipelines systems*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 155, *Plastics piping systems and ducting systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 11298 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

This document is a part of a system standard for plastics piping systems of various materials used for renovation of existing pipelines in a specified application area. System standards for renovation dealing with the following applications are either available or under preparation:

— the ISO 11296 series, *Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks*;

— the ISO 11297 series, *Plastics piping systems for renovation of underground drainage and sewerage networks under pressure*;

— the ISO 11298 series, *Plastics piping systems for renovation of underground water supply networks* (including this document);

— the ISO 11299 series, *Plastics piping systems for renovation of underground gas supply networks*.

These system standards are distinguished from those for conventionally installed plastics piping systems by the requirement to verify certain characteristics in the “as-installed” condition, after site processing. This is in addition to specifying requirements for plastics piping systems components “as manufactured”.

Each of the system standards comprises a:

— *Part 1: General*

and all applicable renovation technique family-related parts, which for water supply networks include or potentially include the following:

— *Part 2: Lining with continuous pipes;*

— *Part 3: Lining with close-fit pipes;*

— *Part 4: Lining with cured-in-place pipes* (this document)*;*

— *Part 5: Lining with discrete pipes;*

— *Part 6: Lining with adhesive-backed hoses;*

— *Part 10: Lining with sprayed polymeric materials;*

— *Part 11: Lining with inserted hoses.*

The requirements for any given renovation technique family are specified in Part 1, applied in conjunction with the other relevant part. For example, ISO 11298-1 and this document together specify the requirements relating to lining with cured-in-place pipes. For complementary information, see ISO 11295. Not all technique families are pertinent to every area of application and this is reflected in the part numbers included in each System Standard.

A consistent structure of clause headings has been adopted for all parts of ISO 11298 to facilitate direct comparisons across renovation technique families.

Figure 1 shows the common part and clause structure and the relationship between the ISO 11298 series and the system standards for other application areas.

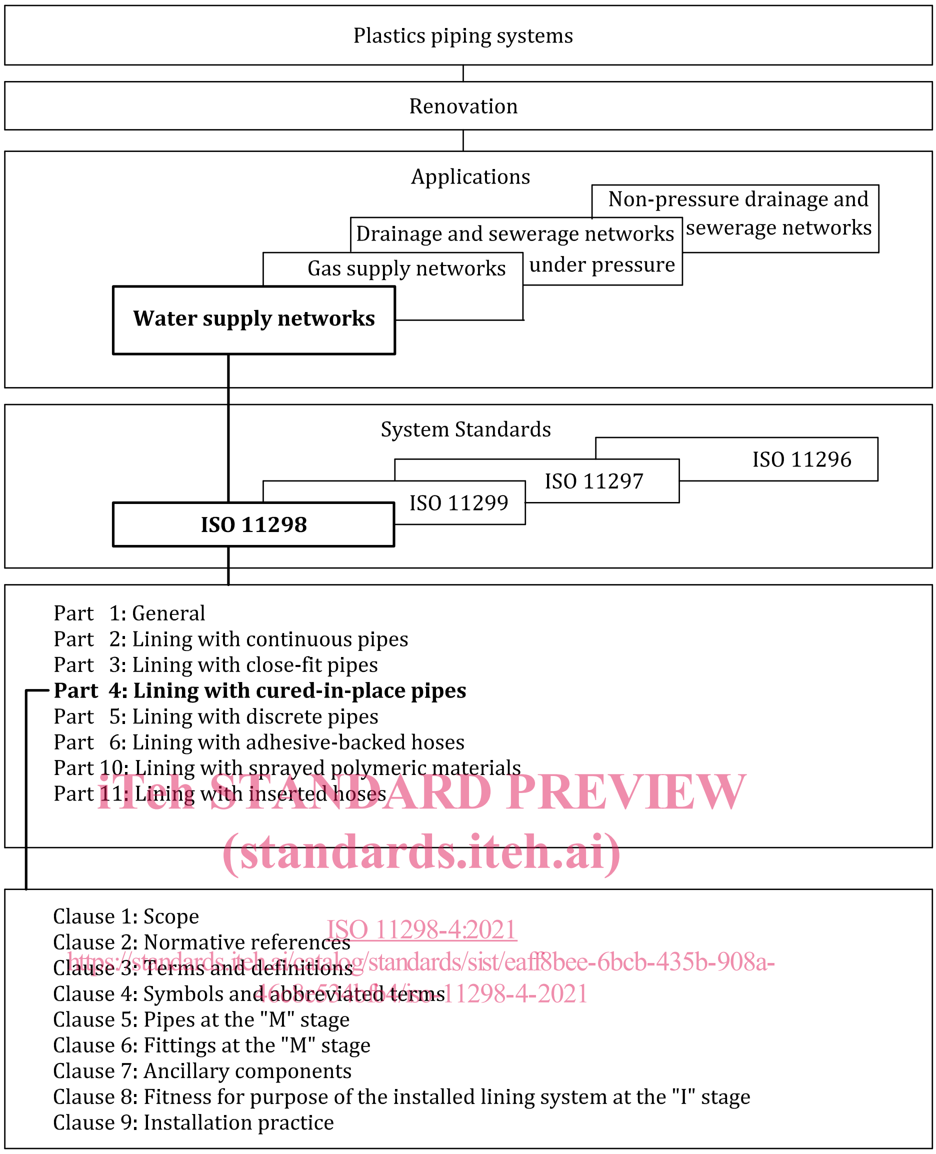

Figure 1 — Format of the renovation system standards

Plastics piping systems for renovation of underground water supply networks —

Part 4: Lining with cured-in-place pipes

1 Scope

This document, in conjunction with ISO 11298-1, specifies requirements and test methods for cured-in-place pipes and fittings used for the renovation of water supply networks, which transport water intended for human consumption, including raw water intake pipelines.

It applies to independent (fully structural, class A) and interactive (semi structural, class B) pressure pipe liners, as defined in ISO 11295, which do not rely on adhesion to the existing pipeline. It applies to the use of various thermosetting resin systems, in combination with compatible fibrous carrier materials, reinforcement, and other process-related plastics components (see 5.1).

It does not include requirements or test methods for resistance to cyclic loading or the pressure rating of CIPP liners where passing through bends, which are outside the scope of this document.

It is applicable to cured-in-place pipe lining systems intended to be used at a service temperature of up to 25 °C.

NOTE For applications operating at service temperatures greater than 25 °C, guidance on re-rating factors can be supplied by the system supplier.

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 75-2:2013, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 178:2019, *Plastics — Determination of flexural properties*

ISO 899-2:2003, *Plastics — Determination of creep behaviour — Part 2: Flexural creep by three-point loading*

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

ISO 7432, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of locked socket-and-spigot joints, including double-socket joints, with elastomeric seals*

ISO 7509, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of time to failure under sustained internal pressure*

ISO 7685:2019, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial ring stiffness*

ISO 8513:2016, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test methods for the determination of the initial longitudinal tensile strength*

ISO 8521:2020, *Glass-reinforced thermosetting plastic (GRP) pipes — Test methods for the determination of the initial circumferential tensile wall strength*

ISO 8533, *Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of cemented or wrapped joints*

ISO 10468, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the ring creep properties under wet or dry conditions*

ISO 10639:2017, *Plastics piping systems for pressure and non-pressure water supply — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin*

ISO 10928:2016, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Methods for regression analysis and their use*

ISO 11295:2017, *Classification and information on design and applications of plastics piping systems used for renovation and replacement*

ISO 11298-1:2018, *Plastics piping systems for renovation of underground water supply networks — Part 1: General*

ISO 13002, *Carbon fibre — Designation system for filament yarns*

ISO 14125:1998, *Fibre-reinforced plastic composites — Determination of flexural properties*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11298-1 and the following apply.

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

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

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

3.1 General terms

3.1.1
carrier material
porous component of the *lining tube* (3.1.8), which carries the liquid *resin system* (3.1.14) during insertion into the pipe being renovated and forms part of the installed lining system once the resin has been cured

3.1.2
CIPP product
cured-in-place pipe of a particular design, produced from a *lining tube* (3.1.8) of specified materials, with a wall structure which is uniquely defined for each diameter/wall thickness combination, and which is impregnated with a specific *resin system* (3.1.14) and installed by a specific process

3.1.3
close fit
situation of the outside of the installed liner relative to the inside of the existing pipeline, which can either be an interference fit or include a small annular gap resulting from shrinkage and tolerances only

3.1.4
composite
combination of cured *resin system* (3.1.14), *carrier material* (3.1.1) and/or *reinforcement* (3.1.13), excluding any internal or external membranes

3.1.5
curing
process of resin polymerization, which can be initiated or accelerated by the use of heat or exposure to light

3.1.6
design thickness
required wall thickness of the *composite* (3.1.4), excluding any abrasion layer, as determined by structural design

3.1.7
first break
elastic limit or first major discontinuity of the stress-strain curve associated with local failure of the resin matrix or reinforcing fibres

3.1.8
lining tube
flexible tube, consisting of *carrier material* (3.1.1), *resin system* (3.1.14) and any membranes and/or *reinforcement* (3.1.13), as combined prior to insertion in the pipe to be lined

3.1.9
nominal CIPP "M" stage wall thickness
one of a range of discrete *lining tube* (3.1.8) wall thicknesses dictated by the sum of the thicknesses of the individual layers of materials used for tube construction at the "M" stage, excluding any internal or external membranes

Note 1 to entry: This term is expressed using the symbol $e_{n,M}$ (see 4.1).

3.1.10
nominal CIPP "I" stage wall thickness
one of a range of discrete *CIPP product* (3.1.2) wall thicknesses at the "I" stage, dictated by the sum of the thicknesses of the individual layers of materials used for *lining tube* (3.1.8) construction, excluding any internal or external membranes

Note 1 to entry: This term is expressed using the symbol $e_{n,I}$ (see 4.1).

3.1.11
permanent membrane
internal or external membrane designed to retain its integrity through the processes of *lining tube* (3.1.8) insertion and *resin system* (3.1.14) cure, and to provide functions for the operational life of the CIPP liner

3.1.12
preliner
permanent or semi-permanent external membrane which is installed separately, before insertion of the resin-impregnated *lining tube* (3.1.8)

3.1.13
reinforcement
fibres incorporated in the *lining tube* (3.1.8), which enhance the dimensional stability of the lining tube and/or the structural properties of the cured *composite* (3.1.4)

Note 1 to entry: The reinforcement can be incorporated in the *carrier material* (3.1.1), constitute the carrier material, or can be a separate layer.

3.1.14
resin system
thermosetting resin including the curing agent(s) and any fillers or other additives, in specified proportions

3.1.15
semi-permanent membrane
internal or external membrane designed to retain its integrity through the processes of *lining tube* (3.1.8) insertion and *resin system* (3.1.14) cure, but not relied on to retain its integrity at the "I" stage

3.1.16
service temperature
maximum sustained temperature at which a system is expected to operate

Note 1 to entry: Service temperature is expressed in degrees Celsius (°C).

3.1.17
temporary membrane
membrane forming the internal or external surface of the pipe at the "M" stage, with functions at the "M" stage only, removed during or after installation

3.1.18
total thickness
thickness of cured-in-place pipe (CIPP) at the "I" stage comprising the composite (3.1.4) and any *semi-permanent* (3.1.15) and *permanent membranes* (3.1.11)

3.1.19
type testing
testing performed to prove that the material, product, joint or assembly is capable of conforming to the requirements given in the relevant standard

3.2 Techniques

3.2.1
inversion
process of turning a flexible tube or hose inside out by the use of fluid (water or air) pressure

3.2.2
inverted-in-place insertion
method whereby the impregnated *lining tube* (3.1.8) is introduced by *inversion* (3.2.1) to achieve simultaneous insertion and inflation

3.2.3
winched-in-place insertion
method whereby the flat impregnated *lining tube* (3.1.8) is first pulled into the pipe to be lined and then inflated to bring it up to size

Note 1 to entry: With some techniques, inflation is achieved by *inversion* (3.2.1) through the pulled-in lining tube of a separate impregnated tube or dry hose, which is either withdrawn after resin cure or left in place as a permanent internal membrane.

3.3 Characteristics

3.3.1
projected failure pressure at 50 years
value at 50 years derived from the pressure regression line obtained from long-term pressure tests performed in accordance with ISO 7509 and analysed in accordance with ISO 10928

Note 1 to entry: This term is expressed using the symbol p_{50} (see 4.1).

[SOURCE: ISO 10639:2017, 3.12.10 — modified.]

3.3.2
minimum failure pressure at 50 years
95% lower confidence level (LCL) of the failure pressure at 50 years

Note 1 to entry: This term is expressed using the symbol $p_{50,\text{min}}$ (see 4.1).

[SOURCE: ISO 10639:2017, 3.12.7 — modified.]

3.4 Materials

No additional definitions apply.

3.5 Product stages

No additional definitions apply.

3.6 Service conditions

3.6.1
PN
nominal pressure
alphanumeric designation for a nominal pressure class, which is the maximum sustained hydraulic internal pressure for which a pipe is designed in the absence of other loading conditions than internal pressure

Note 1 to entry: Nominal pressure is expressed in bars (i.e. 1 bar = 0,1 MPa = 0,1 N/mm^2 = 10^5·N/m^2).

Note 2 to entry: The designation for reference or marking purposes consists of the letters PN plus a number.

[SOURCE: ISO 10639:2017, 3.12.2, modified — the last part of the definition has been deleted for simplification.]

4 Symbols and abbreviated terms

4.1 Symbols

b width of test piece

C_E Correction factor on 3-point flexural modulus for curvature of test piece

C_σ Correction factor on 3-point flexural stress for curvature of test piece

d_i inside diameter

d_m mean diameter of pipe sample at mid-thickness of the composite (= $2R_2$)

d_n nominal outside diameter

E_0 short-term flexural modulus

E_c apparent flexural modulus of curved 3-point bend test piece, before correction for curvature

E_f apparent flexural modulus of flat 3-point bend test piece

E_x long-term flexural modulus at x years

E_t flexural creep modulus at time t

EI section bending stiffness per unit length of the pipe wall

EI_c apparent section bending stiffness of curved 3-point test piece before correction for curvature

e_1 thickness of internal membrane

e_2 thickness of external membrane

e_c thickness of the composite