TECHNICAL SPECIFICATION

ISO/TS 23818-2

First edition
2021-08

Assessment of conformity of plastics piping systems for the rehabilitation of existing pipelines —

Part 2: Resin-fibre composite (RFC) material

Évaluation de la conformité des systèmes de canalisations en plastique destinés à la réhabilitation des réseaux existants —

Partie 2: Matériau composite résine-fibres (RFC)

Reference number
ISO/TS 23818-2:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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 pipeline systems*.

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.

A list of all parts in the ISO 23818 series can be found on the ISO website.

Introduction

System standards dealing with the following applications are either available or in preparation for pipeline rehabilitation:

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

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

— ISO 11298, *Plastics piping systems for renovation of underground water supply networks*;

— ISO 11299, *Plastics piping systems for renovation of underground gas supply networks*;

— ISO 21225, *Plastics piping systems for the trenchless replacement of underground pipeline 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 system components as manufactured.

For the assessment of conformity, three Technical Specifications for pipe lining systems of distinct materials are applicable:

— ISO/TS 23818-1, *Assessment of conformity of plastics piping systems for the rehabilitation of existing pipelines — Part 1: Polyethylene (PE) material*;

— ISO/TS 23818-2 (this document), *Assessment of conformity of plastics piping systems for the rehabilitation of existing pipelines — Part 2: Resin-fibre composite (RFC) material*;

— ISO/TS 23818-3, *Assessment of conformity of plastics piping systems for the rehabilitation of existing pipelines — Part 3: Unplasticized poly(vinyl chloride) (PVC-U) material*.

These three Technical Specifications cover the system standards, as presented in Table 1.

Table 1 — Structure of Technical Specifications for assessment of conformity

Technical Specification	Material	Technique	Application			
			Non-pressure drainage and sewerage networks	Drainage and sewerage networks under pressure	Water supply networks	Gas supply networks
ISO/TS 23818-1	PE	LINING WITH CONTINUOUS PIPES, CLOSE-FIT PIPES AND SPIRALLY WOUND PIPES	ISO 11296-2 ISO 11296-3 ISO 11296-7	ISO 11297-2 ISO 11297-3	ISO 11298-2 ISO 11298-3	ISO 11299-2 ISO 11299-3
		TRENCHLESS REPLACEMENT USING PIPE BURSTING, PIPE EXTRACTION, HORIZONTAL DRILLING AND IMPACT MOLING	ISO 21225-1 ISO 21225-2	ISO 21225-1 ISO 21225-2	ISO 21225-1 ISO 21225-2	ISO 21225-1 ISO 21225-2
ISO/TS 23818-2	RFC	LINING WITH CURED-IN-PLACE PIPES (CIPP)	ISO 11296-4	ISO 11297-4	ISO 11298-4	
ISO/TS 23818-3	PVC-U	LINING WITH CLOSE-FIT PIPES AND SPIRALLY WOUND PIPES	ISO 11296-3 ISO 11296-7			

The format of the three Technical Specifications is in line with Technical Specifications for assessment of conformity to other system standards, apart from presenting the detailed requirement for Inspection and Testing in two annexes, for non-pressure applications and pressure applications (where applicable) respectively.

The format is schematically represented in Figure 1.

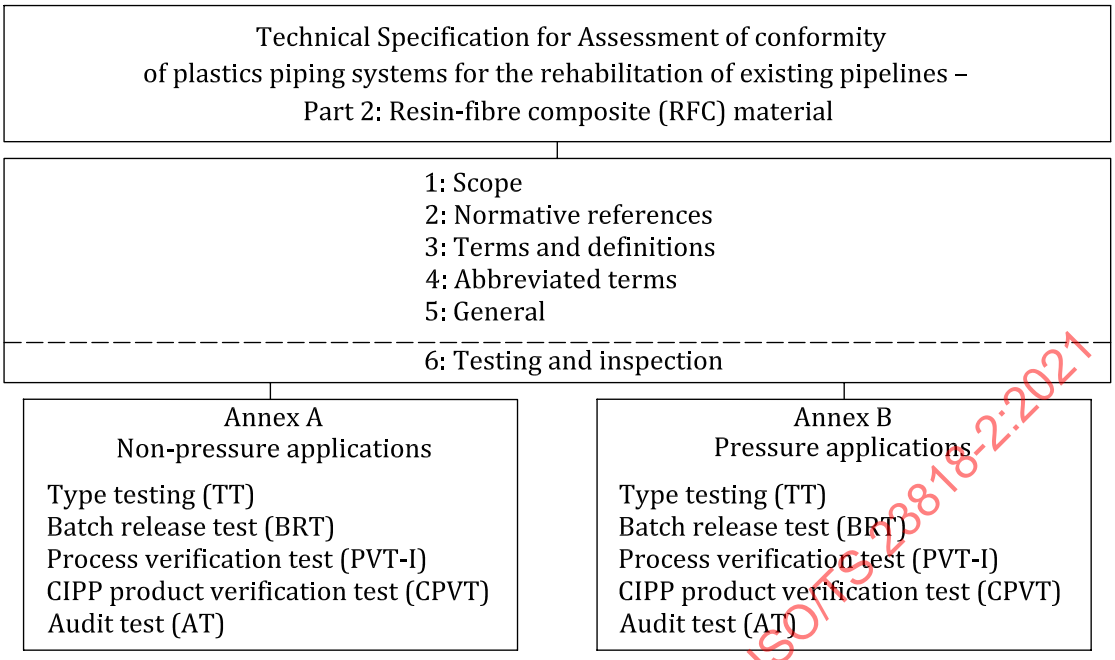

Figure 1 — Format of the Technical Specifications for the assessment of conformity

Figure 2 is intended to provide general information on the concept of testing and organization of those tests used for the purpose of the assessment of conformity. For each type of test, i.e. type testing (TT), batch release test (BRT), process verification test (PVT-I), CIPP product verification test (CPVT) and audit test (AT), this document details the applicable characteristics to be assessed as well as the frequency and sampling of testing.

Figure 2 also provides a typical scheme for the assessment of conformity of RFC pipes, fittings, joints or assemblies by manufacturers and/or installers, including certification.

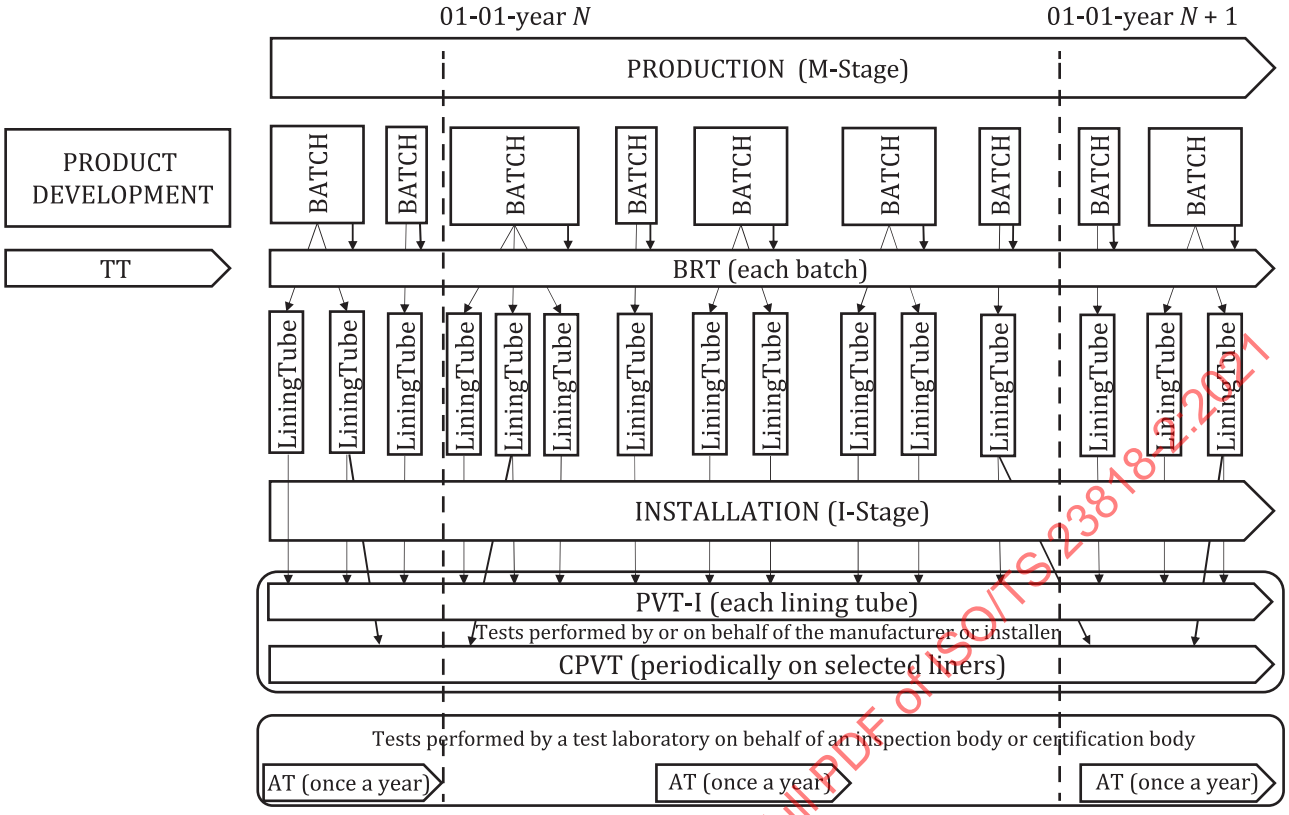

Figure 2 — Typical scheme for the assessment of conformity by a manufacturer, including certification

Assessment of conformity of plastics piping systems for the rehabilitation of existing pipelines —

Part 2:
Resin-fibre composite (RFC) material

1 Scope

This document provides a scheme for the assessment of conformity of RFC products for the rehabilitation of existing pipelines, in accordance with the applicable parts of ISO 11296, ISO 11297 and ISO 11298, and intended to be included in the manufacturer's quality plan as part of the quality management system and for the establishment of certification procedures.

It applies to cured-in-place pipe (CIPP) products only. It applies to non-pressure pipe liners, and 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.

NOTE In order to help the reader, summary tables of overall scheme requirements are provided in Annex E.

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 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

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

ISO 11296-1:2018, *Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks — Part 1: General*

ISO 11296-4:2018, *Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks — Part 4: Lining with cured-in-place pipes*

ISO 11296-4:2018/Amd 1:2021, *Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks — Part 4: Lining with cured-in-place pipes — Amendment 1: Updated definitions, marking requirements and procedure for alternative expression of flexural test results*

ISO 11297-4:2018, *Plastics piping systems for renovation of underground drainage and sewerage networks under pressure — Part 4: Lining with cured-in-place pipes*

ISO 11298-4:2021, *Plastics piping systems for renovation of underground water supply networks — Part 4: Lining with cured-in-place pipes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11296-4, ISO 11297-4, ISO 11298-4 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 Assessment of conformity

3.1.1
certification body
impartial body, governmental or non-governmental, possessing the necessary competence and responsibility to carry out certification of conformity according to given rules of procedure and management

Note 1 to entry: A certification body should preferably operate in accordance with ISO/IEC 17021-1 or ISO/IEC 17065.

3.1.2
inspection body
body that performs inspection

Note 1 to entry: An inspection body can be an organization, or part of an organization.

Note 2 to entry: An inspection body should preferably operate in accordance with ISO/IEC 17020 or ISO/IEC 17021-1.

[SOURCE: ISO/IEC 17020:2012, 3.5, modified — Note 2 to entry added.]

3.1.3
testing laboratory
laboratory which measures, tests, calibrates or otherwise determines the *characteristics* (3.2.6) of the performance of *materials* (3.1.13) and products

Note 1 to entry: In the context of this document, the *materials* (3.1.13) and products can be subjected to *type testing* (3.1.6), *batch release test* (3.1.7), *process verification test at the "I" stage* (3.1.8), *CIPP product verification test* (3.1.20), *audit test* (3.1.9), and *witness test* (3.1.11), as applicable.

Note 2 to entry: A testing laboratory should preferably operate in accordance with ISO/IEC 17025.

3.1.4
quality management system
part of a management system with regard to quality

Note 1 to entry: Requirements for quality management systems are given in ISO 9001.

[SOURCE: ISO 9000:2015, 3.5.4, modified — Note 1 to entry added.]

3.1.5
quality plan
document setting out the specific quality practices, resources and sequence of activities relevant to a particular product or range of products

3.1.6
type testing
TT
testing performed to prove that the *material* (3.1.13), pipe, *joint* (3.1.17) or assembly is capable of conforming to the requirements given in the relevant standard

Note 1 to entry: The type test results remain valid until there is a change in the *material* (3.1.13) or product or assembly provided that the process verification tests are done regularly.

3.1.7
batch release test
BRT
test performed by or on behalf of the manufacturer on a batch of RFC products, which has to be satisfactorily completed before the batch can be released

Note 1 to entry: For CIPP, BRT is applicable to a *lining tube batch* (3.1.19) only.

[SOURCE: ISO/TS 23818-1:2020, 3.1.7, modified — "PE" changed to "RFC" and Note 1 to entry added.]

3.1.8
process verification test at the "I" stage
PVT-I
test performed by or on behalf of the manufacturer or installer at specific intervals during the installation process to confirm that the process as specified in the installation manual continues to be capable of producing installed products which conform to the requirements given in the relevant standard

Note 1 to entry: Such tests are not required to release batches of products and are carried out as a measure of process control.

3.1.9
audit test
AT
test performed by a test laboratory on behalf of an *inspection body* (3.1.2) or *certification body* (3.1.1) to confirm that the product continues to conform to the requirements given in the relevant standard and to provide information to assess the effectiveness of the *quality management system* (3.1.4)

3.1.10
indirect test
IT
test performed by or on behalf of the manufacturer, different from that specified test for that particular *characteristic* (3.2.6), having previously verified its correlation with the specified test

3.1.11
witness test
WT
test accepted by an inspection or a *certification body* (3.1.1) for *type testing* (3.1.6) and/or *audit test* (3.1.9), which is carried out by or on behalf of the manufacturer and supervised by a representative of the inspection or *certification body* (3.1.1), competent in testing

3.1.12
reduced long-term test
RLTT
test using shorter time periods or fewer test pieces than those specified for a full long-term test

[SOURCE: CEN/TS 14632:2012, 3.17, modified]

3.1.13
material
generic term for compositions grouped by families, expressed by generic names, e.g. polypropylene, stainless steel, brass or EPDM

Note 1 to entry: Definition from European Commission, Directorate-General for Enterprise and Industry, Sub-group on Product Testing Procedures (EC, DG ENT and IND, SG PTP).

3.1.14
sample
one or more products drawn from the same production batch or lot, selected at random without regard to their quality

Note 1 to entry: The number of products in the sample is the sample size.

3.1.15
group
collection of similar products from which *samples* (3.1.14) are selected for testing purposes

3.1.16
component
product manufactured out of a specific composition compound brought to the market as part of another product or as a spare part.

Note 1 to entry: For drinking water application, components may be considered as products and be individually approved (e.g. O-ring, gasket) or they are tested as an integral part of a finished product (e.g. in a valve).

3.1.17
joint
connection between two products

3.1.18
product type
generic description of a product

EXAMPLE A pipe or fitting or valve or their main parts, of the same design, from a particular compound.

3.1.19
lining tube batch
clearly identified collection of lining tubes, manufactured consecutively or continuously under the same conditions, using the same *material* (3.1.13) conforming to the same specification

Note 1 to entry: The batch is defined and identified by the lining tube manufacturer.

3.1.20
CIPP product verification test
CPVT
test performed by or on behalf of the manufacturer or installer at the *"I" stage* (3.2.11) to verify that the "I" stage *characteristics* (3.2.6) of the CIPP product conform with the respective *declared values* (3.2.7)

3.2 Rehabilitation general

3.2.1
rehabilitation
measures for restoring or upgrading the performance of existing systems, including *renovation* (3.2.2), repair and replacement

3.2.2
renovation
work incorporating all or part of the original fabric of the pipeline, by means of which its current performance is improved

3.2.3
lining pipe
pipe inserted for *renovation* (3.2.2) purposes

Note 1 to entry: For CIPP, the lining tube fulfils the function of lining pipe

3.2.4
liner
lining pipe (3.2.3) after installation

3.2.5
lining system
lining pipe (3.2.3) and all relevant fittings for insertion into an existing pipeline for the purposes of *renovation* (3.2.2)

3.2.6
characteristic
property, dimension or other feature of a *material* (3.1.13) or *component* (3.1.16)

3.2.7
declared value
limiting value of a *characteristic* (3.2.6) declared in advance by the *lining system* (3.2.5) supplier, which becomes the requirement for the purposes of assessment of conformity

3.2.8
simulated installation
installation of a *lining system* (3.2.5) into a *simulated host pipeline* (3.2.9), using representative equipment and processes, to provide *samples* (3.1.14) for testing which are representative of an actual installation

3.2.9
simulated host pipeline
section of pipeline, which is not part of an operational network, but which replicates the environment of an operational network

3.2.10
"M" stage
stage as manufactured, before any subsequent site processing of *components* (3.1.16) associated with the particular *renovation* (3.2.2) technique

3.2.11
"I" stage
stage as installed, i.e. in final configuration after any site processing of *components* (3.1.16) associated with the particular *renovation* (3.2.2) technique

3.2.12
nominal size
DN
numerical designation of the size of a *component* (3.1.16), which is a convenient round number approximately equal to the inside or outside diameter in millimetres

3.2.13
nominal outside diameter
d_n
specified outside diameter, in millimetres, assigned to a *nominal size* (3.2.12) DN/OD

4 Abbreviated terms

To prevent misunderstanding, the abbreviated terms relating to assessment of conformity in this clause are defined as being the same in each language. For the same reason, the terms are given in three languages, English, French and German.

	English	French	German
AT	audit test	essai d'audit	Überwachungsprüfung
BRT	batch release test	essai de libération de campagne de fabrication	Freigabeprüfung einer Charge
CPVT	CIPP product verification test	essai de vérification du produit CIPP	CIPP-Produktprüfung
IT	indirect test	essai indirect	indirekte Prüfung
PVT-I	process verification test during installation	essai de vérification du procédé d'installation	Einbauprozessprüfung
RLTT	reduced long-term test	essai à long-terme écourté	verkürzte Langzeitprüfung
TT	type testing	essai de type	Typprüfung
WT	witness test	essai témoin	Prüfung unter Aufsicht

Furthermore, the abbreviated terms given in ISO 1043-1 and the following apply:

CIPP cured-in-place pipe

PE polyethylene

RFC resin fibre composite

PVC-U unplasticized poly(vinyl chloride)

5 General

Materials, products, joints and assemblies shall conform to the requirements given in ISO 11296, ISO 11297 or ISO 11298, as applicable.

Where these product standards include clauses entitled 'Regional requirements', in countries of the single European market, conformity shall be assessed against certain different normative references (EN equivalents of ISO standards where not yet merged as EN ISO standards), as specified in the product standards.

Products and assemblies shall be produced by the manufacturer under a quality management system which includes a quality plan.

It is recommended that the quality management system conforms to ISO 9001 or similar management system.

The production of representative "I" stage samples for type testing shall conform to ISO 11296-1:2018 8.8 and 9.4.

For the effect on water quality, attention is drawn to the requirements of National regulations.

6 Testing and inspection

6.1 Grouping

6.1.1 General

For the purposes of this document, the groups specified in 6.1.2 and 6.1.3 apply.

6.1.2 Size and wall strength groups

6.1.2.1 Non-pressure applications

Three size groups are defined for pipes and fittings, as given in Table 2.

For testing purposes, one individual nominal outside diameter, d_n, shall be selected from each group. Within each size group a single ring stiffness shall be selected for testing, as a representative median ring stiffness from the range offered within that size group.

NOTE In the case of structured-wall composites which can exhibit a strong variation of apparent flexural modulus with wall thickness, additional short-term type testing on samples of the same nominal diameter, but with ring stiffness at both extremes of the range offered within the size group, can help to define the extent of such variation.

Table 2 — Size groups for non-pressure applications

Size group	Nominal outside diameter mm
1	$d_n \leq 300$
2	$300 < d_n \leq 1\,200$
3	$d_n > 1\,200$

6.1.2.2 Pressure applications

Size groups are substituted by the wall strength groups given in Table 3.

Table 3 — Wall strength groups

Initial circumferential tensile wall strength group	Wall strength
1	≤ 500 N/mm
2	> 500 N/mm, ≤ 1 000 N/mm
3	> 1 000 N/mm

For testing purposes, a sample with the least nominal wall thickness shall be selected from each group defined by Table 3. The tensile wall strength, expressed in N/mm, determined in these tests is representative for the group.

NOTE For the determination of other strength and stiffness characteristics of RFC pressure liners, a sample with the least proportional content of reinforcing fibres oriented in the direction of testing can be applicable.

6.1.3 Fitting groups

6.1.3.1 Non-pressure applications

Two groups of fittings are defined as given in Table 4.

Table 4 — Fitting groups non-pressure applications

Non-pressure fitting group	Type of fitting
1	Lateral connection collar
2	External saddle

6.1.3.2 Pressure applications

One group of fittings is defined as given in Table 5.

Table 5 — Fitting groups pressure applications

Pressure fitting group	Type of fitting
1	Flange adapters

6.2 Type testing

Relevant type testing shall be carried out on every new system and whenever there is a change in design, material (resin or filler or carrier material/reinforcement type), installation method, other than routine in-process adjustments, and whenever there is an extension of the product range.

For each change condition, characteristics to be type tested and sampling procedures are specified in:

— A.1 TT for systems applied to underground non-pressure drainage and sewerage networks;

— B.1 TT for systems applied to water networks and drainage and sewerage networks under pressure;

The following abbreviations are used to identify change conditions requiring new type testing in the Table A.1 and Table B.1:

N : new system;

D : change in design;

M : change of material;

E : extension of the product range.

The detailed specifications of these change conditions provided in Annex C and parameters for RLTT provided in Annex D shall be observed.

6.3 Batch release tests

Characteristics to be batch release tested and sampling procedures are specified in:

— A.2 BRT for systems applied to underground non-pressure drainage and sewer networks

— B.2 BRT for systems applied to water networks and drainage and sewerage networks under pressure

6.4 Process verification tests during installation

Process verification tests on RFC materials include tests carried out at the “I” stage (PVT-I) only.

If a sample or process parameter does not conform to the requirements of the installation process given in ISO 11296-4, ISO 11297-4 or ISO 11298-4, as applicable, the relevant retest procedure detailed in the manufacturer's quality plan should be performed.

NOTE Failure to meet the required installation process parameters does not necessarily preclude successful installation.

Characteristics to be process verification tested and sampling procedures are specified in:

— A.3 PVT-I for systems applied to underground non-pressure drainage and sewer networks

— B.3 PVT-I for systems applied to water networks and drainage and sewerage networks under pressure

6.5 CIPP product verification tests

Characteristics to be verified at the "I" stage with related sampling procedures are specified in:

— A.4 CPVT for systems applied to underground non-pressure drainage and sewer networks

— B.4 CPVT for systems applied to water networks and drainage and sewerage networks under pressure

6.6 Audit tests

Characteristics to be audit tested and sampling procedures are specified in:

— A.5 AT for systems applied to underground non-pressure drainage and sewer networks

— B.5 AT for systems applied to water networks and drainage and sewerage networks under pressure

6.7 Indirect tests

Generally, testing shall be performed using the test methods specified in ISO 11296-4, ISO 11297-4 or ISO 11298-4, as applicable.

Indirect testing may be used for PVT-I or CPVT characteristics as given in the tables in A.3, A.4, B.3 or B.4, as applicable. Indirect testing shall not be used for TTs or ATs.

The indirect test method used and the correlation or safe relationship of the indirect testing to the specified testing shall be documented in the manufacturer's quality plan. The continuing validity of the indirect testing shall be checked at regular intervals.

In cases of dispute, the PVT-I's and CPVTs as specified in the tables in A.3, A.4, B.3 or B.4, as applicable, shall be used.

If certification is involved, the IT shall be carried out so that it is acceptable for the certification body.

6.8 Test records

Unless otherwise specified all records shall be maintained for a minimum of 5 years in accordance with the information given in the quality management system.

Annex A
(normative)

Test procedures for plastics piping systems for the rehabilitation of networks for underground non-pressure drainage and sewerage

A.1 Type testing

A.1.1 General

For the purposes of this document, the material specification consists of various thermosetting resin systems, in combination with compatible fibrous carrier materials, reinforcement, and other process-related plastics components.

Type tests shall demonstrate that the products conform to all requirements for the characteristics given in Table A.1, as applicable.

Samples at "I" stage may be taken from either actual or simulated installations. The detailed method of sampling shall in all cases be recorded along with the results of type testing.

A.1.2 Type testing, lining tube and CIPP product

Table A.1 — Characteristics of lining tubes and CIPP products that require type testing (TT)

Characteristic	Reference to applicable sub-clause of ISO 11296-4:2018 and ISO 11296-4/Amd 1:2021	Conditions requiring test [a]				Sampling procedure [b]	
		N	D	M	E	Manufacturer	Certification body [c]
Lining tube components at the "M" stage							
Resin type	5.1	+		+		Once per material	Once per material
Filler type	5.1	+		+		Once per material	Once per material
Curing agent type	5.1	+		+		Once per material	Once per material

[a] Explanation in 6.2 and Annex C:

\+ test to be carried out

o reduced long-term test (RLTT) acceptable, see Table D.1.

[b] Sampling procedures include checking declarations.

[c] Recommended sampling procedure for a testing laboratory working for a certification body.

[d] It is expected that only one of these methods of creep testing (dry or wet) will be applied, according to national preferences. In all cases it is recommended that type test results are reported to include values extrapolated to 50 years from the first 1 000 h, 2 000 h and 4 000 h, as well as the full 10 000 h test data.

[e] Where it is difficult to acquire a full ring for testing the characteristics dry creep factor and/or wet creep factor, the 3-point flexural test to determine the long-term flexural modulus under dry or wet conditions provides a practical alternative.

[f] For D and M conformity tests with 6 failure points (3 points between 10 and 1 000 h and 3 points between 1 000 and 6 000 h) per product are required.

[g] Required for design of non-circular liners.

[h] Only one of these methods of long-term strength testing is required, according to national preferences.

Table A.1 *(continued)*

Characteristic	Reference to applicable sub-clause of ISO 11296-4:2018 and ISO 11296-4/Amd 1:2021	Conditions requiring test [a]				Sampling procedure [b]	
		N	D	M	E	Manufacturer	Certification body [c]
Carrier material/ reinforcement type	5.1	+		+		Once per material	Once per material
Membranes	5.1	+		+		Once per material	Once per material
Colour	5.2	+		+		Once per material	Once per material
Temperature of deflection under load	5.3	+		+		Once per resin system	Once per resin system
Marking	5.8	+				Once per future CIPP product	Once per future CIPP product
CIPP product at the "I" stage, short-term							
Material class of composite	8.1	+	+		+	Once per size group	Once per size group
Surface irregularities	8.2	+	+	+	+	Once per size group	Once per size group
CIPP wall structure	8.4.2	+	+		+	Once per size group	Once per size group
Mean wall thickness, $e_{c,m}$	8.4.3	+	+		+	Once per size group	Once per size group
Minimum wall thickness, $e_{c,min}$	8.4.3	+	+		+	Once per size group	Once per size group
Initial specific ring stiffness, S_0	8.5	+	+	+	+	Once per size group	Once per size group
Short-term flexural modulus, E_0 and Section bending stiffness, EI	8.5 and B.5.5	+	+	+	+	Once per size group	Once per size group
Flexural stress at first break, σ_{fb} and Section moment capacity, M	8.5 and B.5.5	+	+	+	+	Once per size group	Once per size group
Flexural strain at first break, ε_{fb}	8.5	+	+	+	+	Once per size group	Once per size group
Ultimate longitudinal tensile stress, σ_L	8.5	+	+	+	+	Once per size group	Once per size group

[a] Explanation in 6.2 and Annex C:

\+ test to be carried out

o reduced long-term test (RLTT) acceptable, see Table D.1.

[b] Sampling procedures include checking declarations.

[c] Recommended sampling procedure for a testing laboratory working for a certification body.

[d] It is expected that only one of these methods of creep testing (dry or wet) will be applied, according to national preferences. In all cases it is recommended that type test results are reported to include values extrapolated to 50 years from the first 1 000 h, 2 000 h and 4 000 h, as well as the full 10 000 h test data.

[e] Where it is difficult to acquire a full ring for testing the characteristics dry creep factor and/or wet creep factor, the 3-point flexural test to determine the long-term flexural modulus under dry or wet conditions provides a practical alternative.

[f] For D and M conformity tests with 6 failure points (3 points between 10 and 1 000 h and 3 points between 1 000 and 6 000 h) per product are required.

[g] Required for design of non-circular liners.

[h] Only one of these methods of long-term strength testing is required, according to national preferences.

Table A.1 *(continued)*

Characteristic	Reference to applicable sub-clause of ISO 11296-4:2018 and ISO 11296-4/Amd 1:2021	Conditions requiring test [a]				Sampling procedure [b]	
		N	D	M	E	Manufacturer	Certification body [c]
Ultimate elongation	8.5	+	+	+	+	Once per size group	Once per size group
CIPP product at the "I" stage, long-term							
Dry creep factor [d, e] $\alpha_{x,dry}$	8.5	+	o	o		Once per CIPP product	Once per CIPP product
Long-term flexural modulus under dry conditions [d, e], $E_{x,dry}$	8.5	+	o	o		Once per CIPP product	Once per CIPP product
Wet creep factor [d, e], $\alpha_{x,wet}$	8.5	+	o	o		Once per CIPP product	Once per CIPP product
Long-term flexural modulus under wet conditions [d, e], $E_{x,wet}$	8.5	+	o	o		Once per CIPP product	Once per CIPP product
Long-term flexural strength under dry conditions [f, g, h], $\sigma_{x,dry}$	8.5	+	o	o		Once per CIPP product	Once per CIPP product
Long-term flexural strength under wet conditions [f, g, h], $\sigma_{x,wet}$	8.5	+	o	o		Once per CIPP product	Once per CIPP product
Resistance to chemical attack in a deflected condition	8.7	+	o	o		Once per CIPP product	Once per CIPP product
Long-term flexural strength under acid conditions [f], $\sigma_{x,acid}$	8.7	+	o	o		Once per CIPP product	Once per CIPP product

[a] Explanation in 6.2 and Annex C:

\+ test to be carried out

o reduced long-term test (RLTT) acceptable, see Table D.1.

[b] Sampling procedures include checking declarations.

[c] Recommended sampling procedure for a testing laboratory working for a certification body.

[d] It is expected that only one of these methods of creep testing (dry or wet) will be applied, according to national preferences. In all cases it is recommended that type test results are reported to include values extrapolated to 50 years from the first 1 000 h, 2 000 h and 4 000 h, as well as the full 10 000 h test data.

[e] Where it is difficult to acquire a full ring for testing the characteristics dry creep factor and/or wet creep factor, the 3-point flexural test to determine the long-term flexural modulus under dry or wet conditions provides a practical alternative.

[f] For D and M conformity tests with 6 failure points (3 points between 10 and 1 000 h and 3 points between 1 000 and 6 000 h) per product are required.

[g] Required for design of non-circular liners.

[h] Only one of these methods of long-term strength testing is required, according to national preferences.

A.1.3 Type testing, fittings

Type testing of lateral connection collars of classes A and B is equivalent to type testing of lining tubes and CIPP products according to Table A.1.

Type testing of lateral connection collars of class C is equivalent to type testing of lining tubes and CIPP products according to Table A.1, with references to ISO 11296-4:2018, 5.1 and 5.3 and ISO 11296-4:2018/

Amd 1:2021, 5.1, with marking according to ISO 11296-4:2018, 6.8 and ISO 11296-4:2018/Amd 1:2021, 6.8.

Type testing of external saddles for cases N, D, M, E is limited to the requirements of ISO 11296-4:2018, 6.1 and should be done once per material type with marking according to ISO 11296-4:2018, 6.8 and ISO 11296-4:2018/Amd 1:2021, 6.8.

A.2 Batch release test

A.2.1 General

Those characteristics specified in ISO 11296-4 and ISO 11296-4:2018/Amd 1 and listed in Table A.2 shall be subject to BRTs with the minimum sampling frequencies as given in Table A.2.

The manufacturer shall specify a batch in their quality plan.

A batch shall only be released for supply when all the relevant tests and inspections have been carried out at least once at the specified frequencies and the requirements have been met.

If a batch fails in respect of any characteristic for BRT, as applicable, the batch shall be rejected or the retest procedures shall be performed for the characteristic on which the product failed. The procedure is specified in the quality plan.

The retest procedure shall be as follows:

— Find the last lining tube, which conforms to the requirements as specified in ISO 11296-4 and ISO 11296-4:2018/Amd 1. Release all products produced before that point and reject the products produced after that point;

— Procedures for dealing with rejected products shall be detailed in the manufacturer's quality plan.

A.2.2 BRT of lining tubes

Table A.2 — Characteristics of lining tubes and minimum sampling frequencies for BRT

Characteristic	Reference to applicable sub-clause of ISO 11296-4:2018 and ISO 11296-4:2018/Amd 1:2021	Sampling procedure [a] Manufacturer
Resin type	5.1	Once per batch
Filler type	5.1	Once per batch
Curing agent type	5.1	Once per batch
Carrier material/ reinforcement type	5.1	Once per batch
Membranes	5.1	Once per batch
Colour	5.2	Once per batch
Marking	5.8	Once per lining tube
[a] Sampling procedures include checking declarations.		

A.2.3 BRT of fittings

BRT of lateral connection collars of classes A and B as defined by ISO 11296-4:2018, Table 3, shall be as specified for lining tubes in Table A.2, with marking according to ISO 11296-4:2018/Amd 1:2021, 6.8 instead of 5.8.

BRT of external saddles is limited to the requirements in ISO 11296-4:2018, 6.1 and should be carried out once per batch with marking according to ISO 11296-4:2018/Amd 1:2021, 6.8.

A.3 PVT-I

PVT-I does not apply to fittings since there are no relevant requirements in ISO 11296-4 and ISO 11296-4:2018/Amd 1.

Table A.3 — Characteristics of lining tubes and minimum sampling frequencies for PVT-I: heat-initiated and ambient curing systems

Characteristic	Reference to applicable subclause of ISO 11296-4:2018 and ISO 11296-4:2018/Amd 1:2021	Minimum sampling frequency [a]
Rate of insertion	9.4.2	Each lining tube
Longitudinal force	9.4.2	Each lining tube
Installation pressure [b]	9.4.2	Each lining tube
Temperatures	9.4.2	Each lining tube
Installation according to manual	9.4.2	Each lining tube

[a] Sampling procedures include checking documentation.

[b] Pressures include those at insertion, inflation, curing and cool-down stages.

Table A.4 — Characteristics of lining tubes and minimum sampling frequencies for PVT-I: light-initiated curing systems

Characteristic	Reference to subclause of ISO 11296-4:2018 and ISO 11296-4:2018/Amd 1:2021	Minimum sampling frequency [a]
Rate of insertion	9.4.2	Each lining tube
Longitudinal force [b]	9.4.2	Each lining tube
Installation pressure [c]	9.4.2	Each lining tube
Radiation intensity of the lamps	9.4.2	As recommended by the lamp manufacturer
On-off-status of individual lamps	9.4.2	Each lining tube
Speed of advance of lamps	9.4.2	Each lining tube
Temperatures	9.4.2	Each lining tube
Installation according to manual	9.4.2	Each lining tube

[a] Sampling procedures include checking documentation.

[b] Recording required only for lining tubes installed by winched-in-place method, or where inverted lining tubes are subject to exceptional longitudinal load, e.g. during lifting operations.

[c] Pressures include those at insertion, inflation, curing and cool-down stages.

A.4 CPVT

A.4.1 CPVT for liners

CPVT is achieved by testing of samples of the installed product and indirectly by monitoring key process parameters relevant to the installation technique as carried out in PVT-I.

CPVT shall be conducted on samples taken from actual installations of CIPP, either from within the pipe being lined or as off-cuts from a section of simulated host pipeline (e.g. in an intermediate manhole or at one or other end) through which the same CIPP unit passes. See ISO 11296-4:2018, 8.8

or ISO 11297-4:2018, 8.8, as applicable, for detailed requirements for acquiring non-destructive off-cut samples representative of the liner within the renovated pipeline.

Sampling frequency shall conform to client requirements, subject to the minima specified in Table A.5 as a function of the number of CIPP units installed by the same contractor as part of a single contract in the same area and under demonstrably similar site conditions.

Table A.5 — Sampling frequencies as function of number of CIPP units

Total number of CIPP units	Minimum number of CIPP units to be sampled
1	1
2 – 10	2
> 10	20 %, rounded up to the nearest integer

For each sample the number of individual test pieces prepared and tested shall be as specified for each characteristic in ISO 11296-4:2018, Tables 5 and 6 and ISO 11296-4:2018/Amd 1:2021, Tables 5 and 6, and the mean result for the set of test pieces compared with the associated declared value to determine whether the sample as a whole conforms.

Where the CPVT on any CIPP unit does not conform to all relevant requirements, sampling frequency shall be increased as specified in Table A.6, until at least 20 consecutive samples have subsequently been shown to conform.

Table A.6 — Increased sampling frequencies following any non-conformity

Total number of CIPP units	Minimum number of CIPP units to be sampled
1 – 4	every unit
5 – 10	4
> 10	25 %, rounded up to the nearest integer

The characteristics of liners subject to CPVT and their associated minimum sampling frequencies are itemized in Table A.7.

Table A.7 — Characteristics of liners and minimum sampling frequencies for CPVT

Characteristic	Reference to applicable subclause of ISO 11296-4:2018 and ISO 11296-4:2018/Amd 1:2021	Minimum sampling frequency
Minimum wall thickness of the composite	8.4.3	According to Table A.5 or Table A.6, as applicable
Short-term flexural modulus, E_0 or Section bending stiffness, EI	8.5 or B.5.5	According to Table A.5 or Table A.6, as applicable
Flexural stress at first break, σ_{fb} or Section moment capacity, M	8.5 or B.5.5	According to Table A.5 or Table A.6, as applicable
Installation manual compliance [a]	9.4.2	Every lining tube
[a] Sampling procedures include checking declarations.		

A.4.2 CPVT for fittings

CPVT of lateral connection collars of classes A and B as defined by ISO 11296-4:2018, Table 3, shall be as specified for CPVT of liners according to Tables A.5, A.6 and A.7.

For lateral connection collars of class C and external saddles CPVT is not applicable.

A.5 Audit tests

ATs are only performed where certification is involved.

Those characteristics listed in Table A.8 are intended to be audit tested with minimum sampling frequencies as given in Table A.8, as applicable.

A test performed as an AT can be used as a CPVT and does not need to be repeated.

Samples at "I" stage may be taken from either actual or simulated installations. The detailed method of sampling shall be recorded and, wherever possible, match that used to acquire samples for the original type testing.

Table A.8 — Characteristics of lining tubes and CIPP products that require audit tests (AT)

Characteristic	Reference to applicable subclause of ISO 11296-4:2018 and ISO 11296-4:2018/Amd 1:2021	Sampling frequency [a]
Lining tube components at the "M" stage		
Resin type	5.1	Once per year per resin type
Filler type	5.1	Once per year per filler type
Curing agent type	5.1	Once per year per agent
Carrier material/reinforcement type	5.1	Once per year per carrier /reinforcement type
Membranes	5.1	Once per year per membrane
Colour	5.2	Once per year per resin type
Temperature of deflection under load	5.3	Once every 5 years per resin type
Marking	5.8	Once per year per CIPP product
CIPP product at the "I" stage, short-term		
Material class of composite	8.1	Once per year per CIPP product
Surface irregularities	8.2	Once per year per CIPP product
CIPP wall structure	8.4.2	Once per year per CIPP product
Mean wall thickness, $e_{c,m}$,	8.4.3	Once per year per CIPP product
Minimum wall thickness, $e_{c,min}$,	8.4.3	Once per year per CIPP product
Initial specific ring stiffness, S_0	8.5	Once per 5 years per CIPP product
Short-term flexural modulus, E_0 and Section bending stiffness, EI	8.5 and B.5.5	Once per year per CIPP product
Flexural stress at first break, σ_{fb} and Section moment capacity, M	8.5 and B.5.5	Once per year per CIPP product
Flexural strain at first break, ε_{fb}	8.5	Once per year per CIPP product
Ultimate longitudinal tensile stress, σ_L	8.5	Once per 5 years per CIPP product
Ultimate elongation	8.5	Once per 5 years per CIPP product
CIPP product at the "I" stage, long-term [b]		
Dry creep factor, $\alpha_{x,dry}$	8.5	Once per 5 years per CIPP product [c]
Long-term flexural modulus under dry conditions, $E_{x,dry}$	8.5	Once per 5 years per CIPP product [c]
Wet creep factor, $\alpha_{x,wet}$	8.5	Once per 5 years per CIPP product [c]

[a] Sampling includes checking declarations.

[b] The same methods shall be used for audit testing of long-term stiffness and strength characteristics as applied for type testing.

[c] Limited to a single test on a single size group with reduced duration in accordance with C.6.2.

Table A.8 *(continued)*

Characteristic	Reference to applicable subclause of ISO 11296-4:2018 and ISO 11296-4:2018/Amd 1:2021	Sampling frequency [a]
Long-term flexural modulus under wet conditions, $E_{x,wet}$	8.5	Once per 5 years per CIPP product [c]
Long-term flexural strength under dry conditions, $\sigma_{x,dry}$	8.5	Once per 5 years per CIPP product [c]
Long-term flexural strength under wet conditions, $\sigma_{x,wet}$	8.5	Once per 5 years per CIPP product [c]
Resistance to chemical attack in a deflected condition	8.5	Once per 5 years per CIPP product [c]
Long-term flexural strength under acid conditions, $\sigma_{x,\,acid}$	8.5	Once per 5 years per CIPP product [c]

[a] Sampling includes checking declarations.

[b] The same methods shall be used for audit testing of long-term stiffness and strength characteristics as applied for type testing.

[c] Limited to a single test on a single size group with reduced duration in accordance with C.6.2.

Annex B
(normative)

Test procedures for plastics piping systems for the rehabilitation of networks for water supply and for drainage and sewerage under pressure

B.1 Type testing

B.1.1 General

For the purposes of this document, the material specification consists of various thermosetting resin systems, in combination with compatible fibrous carrier materials, reinforcement, and other process-related plastics components.

Type testing shall demonstrate that the products conform to all requirements for the characteristics given in A.1 and B.1, as applicable.

Samples at "I" stage may be taken from either actual or simulated installations. The detailed method of sampling shall in all cases be recorded along with the results of type testing.

B.1.2 Type testing, lining tube and CIPP product

Lining tubes and CIPP products shall fulfil the TT requirements of Table A.1 and of Table B.1.

Table B.1 — Characteristics of lining tubes and CIPP products that require type testing (TT)

Characteristic	Reference to applicable sub-clause of ISO 11297-4: 2018 and ISO 11298-4:2021	Conditions requiring test [a]				Sampling procedure [b]	
		N	D	M	E	Manufacturer	Certification body [c]
CIPP product at the "I" stage, short-term							
Initial circumferential tensile wall strength	8.5	+	+	+	+	Once per wall strength group	Once per wall strength group
CIPP product at the "I" stage, long-term							
Long-term failure pressure, $p_{50,min}$	8.5	+	o	o	o	Once per CIPP product	Once per CIPP product

[a] Explanation in 6.2 and Annex C;

\+ test to be carried out

o reduced long-term test (RLTT) acceptable, see Table D.2

[b] Sampling procedures include checking declarations.

[c] Recommended sampling procedure for a testing laboratory working for a certification body.

B.1.3 Type testing, fittings

Type testing of flange adapters is limited to the requirements in ISO 11297-4:2018, Clause 6 or ISO 11298-4:2021, Clause 6, and should be carried out once per fitting group.

B.2 Batch release tests

B.2.1 General

Those characteristics specified in ISO 11297-4 and ISO 11298-4 and listed in Table A.2 shall be subject to BRTs with the minimum sampling frequencies as given in Table A.2.

The manufacturer shall specify a batch in their quality plan.

A batch shall only be released for supply when all the relevant tests and inspections have been carried out at least once at the specified frequencies and the requirements have been met.

If a batch fails in respect of any characteristic for BRT, as applicable, the batch shall be rejected or the retest procedures shall be performed for the characteristic on which the product failed. The procedure is specified in the quality plan.

The retest procedure shall be as follows:

— Find the last lining tube which conforms to the requirements as specified in ISO 11297-4 or ISO 11298-4 and listed in Table A.2. Release all products produced before that point and reject the products produced after that point.

— Procedures for dealing with rejected products shall be detailed in the manufacturer's quality plan.

B.2.2 BRT of lining tubes

BRT batches of lining tubes shall be in accordance with A.2.2.

B.2.3 BRT of fittings

BRT does not apply to fittings since there are no relevant requirements in ISO 11297-4 or ISO 11298-4.

B.3 PVT-I

PVT-I of lining pipes shall be in accordance with A.3.

PVT-I does not apply to fittings since there are no relevant requirements in ISO 11297-4 or ISO 11298-4.

B.4 CPVT

CPVT of lining pipes shall be in accordance with A.4.

Additionally a leak tightness test according to ISO 11297-4:2018, 8.7.2, or ISO 11298-4:2021, 8.7.1, as applicable, shall be performed on every CIPP unit.

CPVT does not apply to fittings since there are no relevant requirements in ISO 11297-4 and ISO 11298-4.

B.5 Audit tests

ATs are only performed where certification is involved.

Those characteristics listed in Table B.2 are intended to be audit tested with minimum sampling frequencies as given in Table B.2, as applicable.

A test performed as an AT can be used as a CPVT and does not need to be repeated. Samples at "I" stage can be from either actual or simulated installations. The detailed method of sampling shall be recorded and, wherever possible, match that used to acquire samples for the original type testing.

Table B.2 — Characteristics of lining tubes and CIPP products that require audit tests (AT)

Characteristic	Reference to subclause of ISO 11297-4:2018 and ISO 11298-4:2021	Sampling frequency [a]
Lining tube components at the "M" stage		
Resin type	5.1	Once per year per resin type
Filler type	5.1	Once per year per filler type
Curing agent type	5.1	Once per year per agent
Carrier material/reinforcement type	5.1	Once per year per carrier/reinforcement type
Membranes	5.1	Once per year per membrane
Colour	5.2	Once per year per resin type
Temperature of deflection under load	5.3	Once every 5 years per resin type
Marking	5.8	Once per year per CIPP product
CIPP product at the "I" stage, short-term		
Material class of composite	8.1	Once per year per CIPP product
Surface irregularities	8.2	Once per year per CIPP product
CIPP wall structure	8.4.2	Once per year per CIPP product
Mean wall thickness, $e_{c,m}$,	8.4.3	Once per year per CIPP product
Minimum wall thickness, $e_{c,min}$,	8.4.3	Once per year per CIPP product
Initial circumferential tensile wall strength	8.5	Once per 5 years per CIPP product
Short-term flexural modulus, E_0 and Section bending stiffness, EI	8.5 and B.5.5	Once per year per CIPP product
Flexural stress at first break, σ_{fb} and Section moment capacity, M	8.5 and B.5.5	Once per year per CIPP product
Ultimate longitudinal tensile stress, σ_L	8.5	Once per 5 years per CIPP product
Ultimate elongation	8.5	Once per 5 years per CIPP product
Installation practice compliance		
Marking	5.8	Once per year per CIPP product
[a] Sampling includes checking declarations.		

Annex C
(normative)

Specification of new system (N), change in design (D), change in material (M) and extension of the product range (E)

C.1 General

The objective of this annex is to define what constitutes a new CIPP product or a change in its material or design or extension of its range, and consequently requires a certain degree of reassessment of conformity.

The manufacturer shall define the following parameters, which have been assessed and accepted by type testing for use in production:

— materials used in lining tube manufacture;

— design of the product;

— method of installation as documented in the installation manual.

For products supplied for use in networks supplying water intended for human consumption, any changes of material, whether or not defined in this annex, require notification to the relevant national health and/or water authorities.

C.2 New CIPP product (N)

Any CIPP product produced for the first time by any manufacturer or installer, including combinations of carrier material/reinforcement and resin system (defined by resin type, filler type and curing agent type) not previously type tested, shall be deemed to constitute a new CIPP product classified as 'N' in the tables of Annex A or B.

C.3 Change in design (D)

A change classified as (D) in the tables of Annex A or B is deemed to have occurred where, as a result of a change in the CIPP wall structure, as defined by ISO 11296-4:2018, 8.4.2, or ISO 11298-4:2021, 8.4.2, the following condition applies:

— the mean value of any short-term mechanical characteristic, determined from tests on no less than 10 samples (where the coefficients of variation of the tested values for the original and modified wall structures respectively are both less than 0,3) in accordance with ISO 11296-4:2018, Table 5, ISO 11296-4:2018/Amd 1:2021, Table 5, ISO 11297-4:2018, Table 2, or ISO 11298-4:2021, Table 4, as applicable, differs by more than one standard deviation from the corresponding value determined by the type testing of the original wall structure.

C.4 Change in materials (M)

When any of the following conditions apply, then a change classified as 'M' in the tables of Annex A or B is deemed to have occurred.

Change of any declared material type, as defined by:

— ISO 11296-4:2018, Table 1 and ISO 11296-4:2018/Amd 1:2021, Table 1 for drainage and sewerage applications (both non-pressure and pressure);

— ISO 11298-4:2021, Table 1 for water applications.

EXAMPLE Addition of PA fibres to carrier material comprising only PET fibres, or change of reinforcing glass from Type 'E' to Type 'E-CR', would each constitute a change of material.

NOTE Each broad classification of resin type specified in ISO 11296-4:2018, Table 1, ISO 11296-4:2018/Amd 1:2021, Table 1 and ISO 11298-4:2021, Table 1 includes a wide range of possible chemical formulations delivering a correspondingly wide range of CIPP product characteristics. Any change in formulation of the resin system can potentially therefore create the need for additional testing. A change of supplier does not necessarily constitute a change of formulation.

C.5 Extension of product range (E)

Defined as extension of product range into a new size group as defined by Table 2 or wall strength group as defined by Table 3.

C.6 Evaluation of test results

C.6.1 Initial properties

The results of the short-term tests listed in Tables A.1 and B.1 shall fulfil the applicable requirements detailed in the relevant standard.

C.6.2 Long-term properties

The results of the long-term tests listed in Tables A.1 and B.1 shall likewise fulfil the applicable requirements detailed in the relevant standard. At any stage subsequent to initial type testing of a new CIPP product, these may however be determined from tests of reduced duration in accordance with the parameters and criteria for RLTT specified in Annex D.