INTERNATIONAL STANDARD

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2019-01

Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks —

Part 7: Lining with spically-wound pipes

Systèmes de canalisations en plastique pour la rénovation des réseaux de branchements et de collecteurs d'assainissement enterrés sans pression —

Partie 7: Tubage par enroulement hélicoïdal

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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 on 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 the following URL: 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*.

This second edition cancels and replaces the first edition (ISO 11296-7:2011), which has been technically revised. The following clause(s) have been revised:

— In 5.1, thermoplastics has been added as a separate seam sealant material category;

— In 5.3, the thickness range has been removed;

— In Table 2 the requirement for Modulus of Elasticity has been lowered to reflect current state of the art;

— In Clause 6, ISO 10467 replaces EN 14364 as normative reference for GRP saddles;

— In 8.5, Table 6, ISO 13262 replaces EN 1979 for tensile testing of a locked seam.

A list of all parts in the ISO 11296 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 the renovation of existing pipelines in a specified application area. System Standards for renovation deal with the following applications:

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

— 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*.

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".

Each of the System Standards comprises a

— *Part 1: General*

and all applicable renovation technique family-related parts, which for non-pressure drainage and sewerage 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*;

— *Part 5: Lining with discrete pipes*;

— *Part 7: Lining with spirally-wound pipes* (this document);

— *Part 8: Lining with pipe segments*;

— *Part 9: Lining with a rigidly anchored plastics inner layer*;

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

The requirements for any given renovation technique family are specified in Part 1, applied in conjunction with the relevant other part. For example, both ISO 11296-1 and this document together specify the requirements relating to lining with spirally-wound 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 11296, in order to facilitate direct comparisons across renovation technique families.

Figure 1 shows the common part and clause structure and the relationship between ISO 11296 and the System Standards for other application areas.

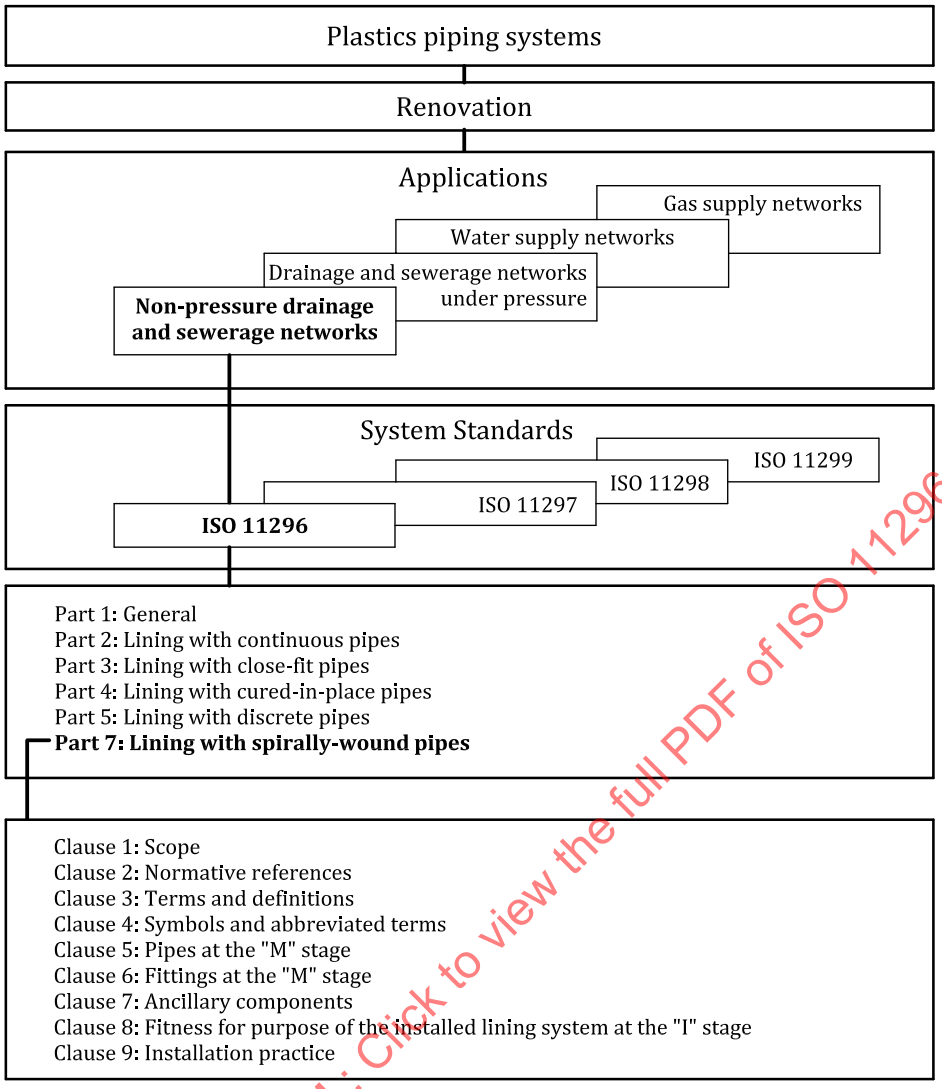


Figure 1 — Format of the renovation System Standards

Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks —

Part 7:
Lining with spirally-wound pipes

1 Scope

This document, in conjunction with ISO 11296-1, specifies requirements and test methods for pipes which are formed on site by spirally winding and jointing a pre-manufactured profiled plastics strip, or a profiled plastics strip and integral locking joiner strip, and used for the renovation of underground non-pressure drainage and sewerage networks.

It applies to spirally-wound pipes of fixed or variable diameter made of profiled plastics strips, with or without steel stiffening elements, and installed by one of two methods.

The first method employs a dedicated winding machine in front of the open end of an existing pipeline, e.g. in a manhole. The pipes thus formed are simultaneously inserted into the existing pipeline by the winding forces, and by certain techniques can also be expanded in diameter after or during insertion.

The second method employs a dedicated winding machine which forms the pipe as it traverses the existing pipeline from one manhole to the next.

It applies to profiled plastics strips of unplasticized poly(vinyl chloride) (PVC U) with integral locking mechanism, or of high density polyethylene (HDPE) with integrally welded joints.

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 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 4427-3, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 3: Fittings*

ISO 4435, *Plastics piping systems for non-pressure underground drainage and sewerage — Unplasticized poly(vinyl chloride) (PVC-U)*

ISO 4948-2, *Steels — Classification — Part 2: Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics*

ISO 6259-1, *Thermoplastics pipes — Determination of tensile properties — Part 1: General test method*

ISO 7619-1, *Rubber, vulcanized or thermoplastic — Determination of indentation hardness — Part 1: Durometer method (Shore hardness)*

ISO 9967, *Thermoplastics pipes — Determination of creep ratio*

ISO 9969, *Thermoplastics pipes — Determination of ring stiffness*

ISO 10467:2018, *Plastics piping systems for pressure and non-pressure drainage and sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin*

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 13262, *Thermoplastics piping systems for non-pressure underground drainage and sewerage — Thermoplastics spirally-formed structured-wall pipes — Determination of the tensile strength of a seam*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11296-1 and the following apply.

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

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

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

3.1
spirally-wound pipe
pipe formed by continuously winding and joining a profiled plastics strip, or a profiled plastics strip and integral locking joiner strip

3.2
seam
joint between adjacent profiled plastics strips formed by an integral locking mechanism and/or seam sealant

3.3
integral locking mechanism
mechanical interlock achieved by suitable design of the edges of the extruded profile

3.4
seam sealant
thermoplastic or adhesive material added to the integral locking mechanism or profiled plastics strip surface to make the seam leaktight

3.5
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

Note 1 to entry: Tolerances in the above definition refer to offsets and deformities in the existing pipeline. Spirally-wound liners are not subject to shrinkage.

3.6
close-fit spirally-wound pipe
continuous lining pipe wound from a profiled plastics strip, with or without steel reinforcement, expanded or wound in place to achieve a close fit to the existing pipeline

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in ISO 11296-1 and the following apply.

4.1 Symbols

A_w unit cross-sectional area of the profiled plastics strip

d_e outside diameter

e_a height of neutral axis of the profile plastics strip above its base

e_o overall profile height

$e_{w,min}$ minimum waterway wall thickness

e_w waterway wall thickness at any point

e_1 encapsulation thickness at any point

e_2 encapsulation thickness at any point

I_w second moment of area of the profiled plastics strip

l_s length of the sample for short-term tensile force resistance test of the locked seam

S ring stiffness of the pipe

w effective width of the profiled plastics strip

w_s width of the sample for short-term tensile force resistance test of the locked seam

4.2 Abbreviated terms

EPDM ethylene-propylene-diene monomer

GRP glass-reinforced thermosetting plastic

HDPE high density polyethylene

PE polyethylene

PVC-U unplasticized poly(vinyl chloride)

SWO spirally-wound

5 Pipes at the "M" stage

NOTE This clause specifies requirements for profiled plastics strips, and the material classification of any steel stiffening elements incorporated, prior to winding into a pipe. For requirements for the wound pipe, see Clause 8.

5.1 Materials

The material of the profiled plastics strip shall be unplasticized poly(vinyl chloride) (PVC-U) or high density polyethylene (HDPE), to which are added those additives needed to facilitate the manufacture and/or installation of pipes conforming to this document.

Depending on the design of the profiled plastics strip, the seam sealant shall comprise one or more of the following materials:

— thermoplastics (e.g. HDPE);

— thermoplastic elastomers (e.g. EPDM, silicone);

— adhesives (e.g. amorphous poly-alpha-olefin).

Only virgin and own reprocessable materials, as defined in ISO 11296-1, are permitted for the profiled plastics strips and seam sealant. The material(s) used for the seam sealant shall be declared by the manufacturer of the profiled plastics strips.

Any steel stiffening elements, including material grade classified in accordance with ISO 4948-2 or other equivalent international or national standard, shall be declared by the supplier. The material of any stiffening element, whether or not encapsulated, shall in all cases be approved by the client for the environment of its specific application.

NOTE 1 Detailed specification of non-plastics materials is outside the scope of this document.

NOTE 2 Some sewage effluents and groundwater contaminants potentially corrosive to steel can penetrate a thin protective layer of PVC-U or HDPE. Depending on the profile design and installation technique, such protective layers can also be exposed to risk of damage.

5.2 General characteristics

When viewed without magnification, the surfaces of the profiled plastics strips shall be smooth, clean and free from scoring, cavities and other defects which would prevent conformity to this document.

5.3 Material characteristics

The material of the profiled plastics strip when extruded to a flat plate shall conform to the requirements given in Tables 1 and 2.

Thermoplastics used as seam sealants shall conform to the material requirements of Tables 1 and 2 for PVC and HDPE respectively. Thermoplastic elastomers (e.g. EPDM) used as seam sealants shall conform to the material requirements of Table 3.

Table 1 — Material characteristics of PVC-U profiled plastics strips

Characteristics	Requirements	Test parameters		Test method
		Parameter	Value	
Modulus of elasticity, *E* (tensile)	≥2 000 MPa	Speed of testing Sample	(1 ± 0,2) mm/min Type 1B	ISO 527-2
Tensile strength longitudinal	≥35 MPa	Speed of testing	(5 ± 0,5) mm/min	ISO 527-1
Elongation at break	≥40 %	Sample	Type 1B	
Charpy Impact Strength	≥10 kJ/m^2	Specimen Direction of blow Notch	Type 1 Flatwise Double V, Type A	ISO 179-1

Table 2 — Material characteristics of HDPE profiled plastics strips

Characteristics	Requirements	Test parameters		Test method
		Parameter	Value	
Modulus of elasticity, E (tensile)	≥700 MPa	Speed of testing Sample	(1 ± 0,2) mm/min Type 1B	ISO 527-2
Tensile strength longitudinal	≥15 MPa	Speed of testing	(100 ± 10) mm/min	ISO 6259-1
Elongation at break	≥300 %	Sample	Type 1B	

Table 3 — Material characteristics of thermoplastic elastomer sealants

Characteristics	Requirements	Test parameters		Test method
		Parameters	Value	
Tensile strength longitudinal	≥1 MPa	Speed of testing	500 mm/min	ISO 37
Elongation at break	≥200 %	Sample	Type 1	
Shore hardness A	30 ± 5	—		ISO 7619-1

5.4 Geometric characteristics

The dimensions and section properties including tolerances of the profiled plastics strips shall be declared by the profiled plastics strips supplier.

The declared values shall conform to the requirements given in Table 4, where applicable.

Table 4 — Profiled plastics strip dimensions and section properties

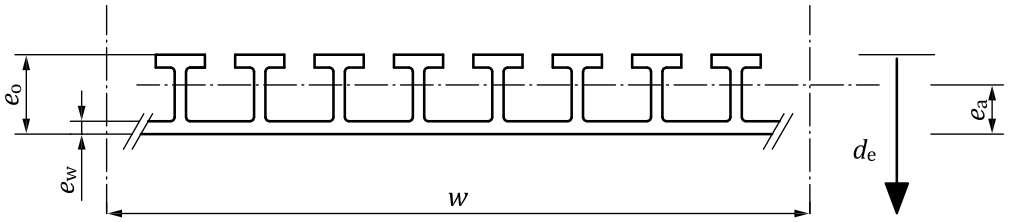
Characteristics	Symbol	Units	Requirements
Profiled plastics strip dimensions	e_o	mm	declared value but not less than 4,5 mm
	e_w	mm	declared value but not less than 1,4 mm
	e_a	mm	declared value
	e_1	mm	declared value but not less than 1,4 mm
	e_2	mm	declared value but not less than 1,4 mm
	w	mm	declared value
	A_w	mm^2/mm	declared value
	I_w	mm^4/mm	declared value
Minimum outside diameter of wound pipe	$d_{e,min}$	mm	declared value[a]
Maximum outside diameter of wound pipe	$d_{e,max}$	mm	declared value[b]

[a] $d_{e,min}$ shall be limited by the maximum allowable winding strain in the profiled plastics strip.

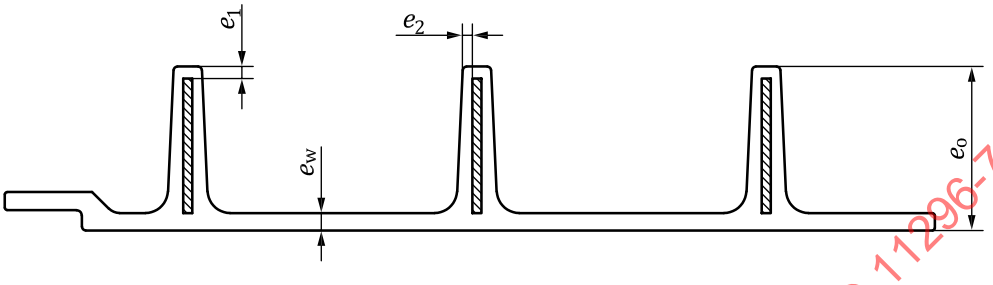
[b] $d_{e,max}$ shall be limited by the minimum pipe ring stiffness requirement (see 8.5).

The profiled plastics strip supplier shall assign to each profiled plastics strip a unique product code (see 5.8) for which the dimensions and section properties listed in Table 4 shall be declared.

An example of a profiled plastics strip excluding the seam is illustrated in Figure 2 a). An example of a profiled plastics strip with encapsulated steel is illustrated in Figure 2 b).



a) Example of a cross-section of a profiled plastics strip



b) Example of a cross-section of a profiled plastics strip with encapsulated steel

Figure 2 — Examples of profiled plastics strips

The overall profile height e_o and the waterway wall thickness e_w (see Figure 2) shall be measured with a micrometer accurate to within 0,1 mm, or by an equivalent method. The values of e_o and e_w at any point shall be determined as the respective averages of four measurements of each made within a 1 m length of the profiled plastics strip.

5.5 Mechanical characteristics

No mechanical requirements apply at the "M" stage.

5.6 Physical characteristics

The profiled plastics strip shall conform to the physical requirements of Table 5.

Table 5 — The Vicat softening temperature of profiled plastics strips

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
PVC				
Vicat B 50	Declared value but not less than 75 °C	Sample thickness	≥3 mm	ISO 306
HDPE				
Vicat A 50	Declared value but not less than 100 °C	Sample thickness	≥3 mm	ISO 306

5.7 Jointing

The renovation of long, large diameter pipelines can require jointing of the profiled plastics strip and this shall be performed in accordance with the manufacturer's specification.

5.8 Marking

The marking shall conform to ISO 11296-1:2018, 5.8.

The requirements of ISO 11296-1:2018, 5.8, items b) and c) shall be covered by marking the profiled plastics strip product code specified in 5.4.

6 Fittings at the "M" stage

External branch saddles shall be of PVC-U, PE or GRP meeting the requirements and test methods of ISO 4435, ISO 4427-3 or ISO 10467:2018, 6.5, respectively.

Installation of the fittings shall be in accordance with the lining system manufacturer's specifications. Fittings even where designed for electrofusion shall be fitted by adhesion and mechanical means.

Cured-in-place lateral connection collars shall conform to ISO 11296-4:2018, Clause 6 and 8.5.2.

NOTE For an illustration of an external saddle, see Figure B.1.

7 Ancillary components

This document is not applicable to any ancillary components.

8 Fitness for purpose of the installed lining system at the "I" stage

8.1 Materials

The spirally-wound pipe and any fittings may consist of different material components selected from the ranges defined in 5.1.

8.2 General characteristics

There shall be no damage to the profiled plastics strip due to the winding process which would prevent fitness for purpose of the installed lining system.

8.3 Material characteristics

The material characteristics shall conform to 5.3.

8.4 Geometric characteristics

The outside diameter d_e of SWO pipe shall be within the range $d_{e,min}$ to $d_{e,max}$, as declared by the profiled plastics strip supplier. It shall also be within the range of capability of the dedicated winding machine.

8.5 Mechanical characteristics

The ring stiffness and creep ratio values of the largest and smallest diameter SWO pipes which can be wound by the dedicated winding machine from each profiled plastic strip, including any integral steel stiffening elements, shall be declared by the profiled plastics strip supplier. Where the profiled plastics strip is designed to be used in conjunction with a separate steel stiffening element incorporated at the time of winding, the ring stiffness and creep ratio values of the largest and smallest SWO pipe wound from the profiled plastics strip on its own shall be declared in addition to those of the combined product.

When tested in accordance with the methods given in Table 6, as applicable, pipes, taken from actual or simulated installation in accordance with 9.4 shall have mechanical characteristics conforming to Table 6.

NOTE Due to the influence of winding stresses, ring stiffness values cannot be predicted by calculation from the I_w value and modulus of elasticity, E, of the profiled plastics strip.

Table 6 — Mechanical characteristics of SWO pipes as installed, including any stiffening elements

Characteristics	Requirements	Test parameters		Test method
		Parameters	Value	
Ring stiffness	Declared value, but not less than 0,5 kPa	ISO 9969[b]		
Creep ratio[a]	Declared value, but not greater than 2,5	ISO 9967[b]		
Tensile strength of a locked seam	Declared value, but not less than 4 N/mm	Sample width Distance between grips Speed of testing	(15 ± 0,5) mm Both grips at (10 ± 1) mm of the seam border 5 mm/min	ISO 13262

[a] The creep ratio required is a 50-year value.

[b] The test methods in ISO 9969 and ISO 9967 shall be applied to SWO pipes incorporating integral or separately wound steel stiffening elements in the same way as specified for pipes comprising thermoplastics material only.

8.6 Physical characteristics

The physical characteristics shall conform to 5.6.

8.7 Additional characteristics

No additional requirements apply.

8.8 Preparation of samples

The ends of samples cut from SWO pipes for testing purposes shall be secured as appropriate to prevent opening of the locked seam.

8.9 Adhesives

The adhesive shall be as specified by the manufacturer of the profiled plastics strip.

The adhesive shall have no detrimental effects on the properties of the SWO pipe and shall not cause the pipe to fail to conform to Table 6.

9 Installation practice

9.1 Preparatory work

No special requirements apply.

9.2 Storage, handling and transportation of profiled plastics strips and fittings

Storage, handling and transportation of profiled plastics strips, sealant materials and fittings shall conform to ISO 11296-1:2018, 9.2.

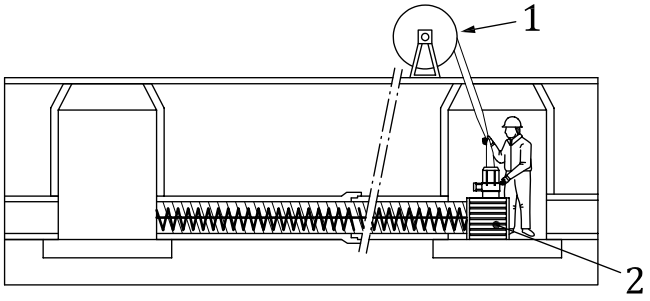
9.3 Equipment

All technique-specific equipment shall be documented in the installation manual. Only winding machines dedicated to the chosen profiled plastics strip shall be used.

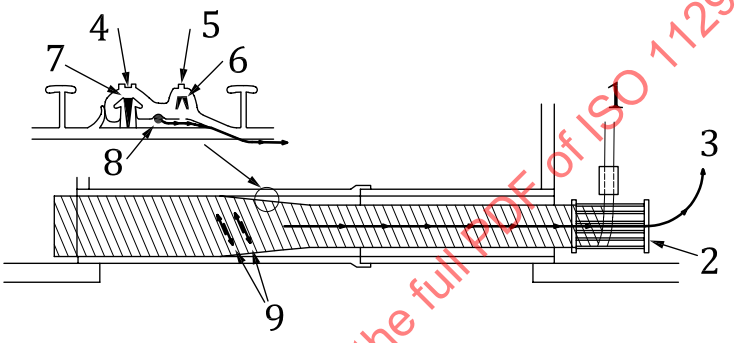
The relevant machine settings for each individual profiled plastics strip and external diameter d_e of the SWO pipe shall be documented in the installation manual.

9.4 Installation

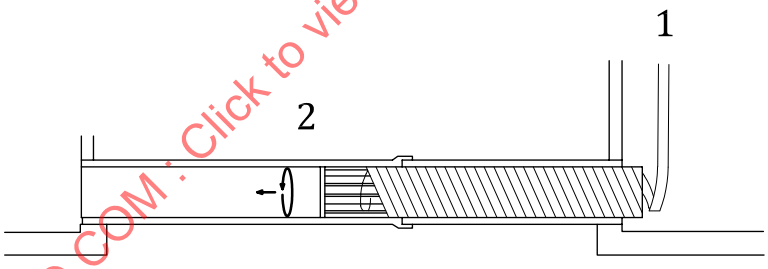
The SWO pipe shall be formed by spirally winding and jointing a pre-manufactured profiled plastics strip, with or without integral or separate steel-stiffening elements, using one of two methods.



a) Method 1a: Fixed diameter from the manhole



b) Method 1b: Expanded close-fit liner from the manhole



c) Method 2: Close-fit or fixed diameter liner from pipe traversing winding machine

Key

1 profiled plastics strip
2 winding machine
3 pulling wire
4 primary lock
5 secondary lock
6 elastomeric adhesives
7 lubricating sealant
8 wire
9 profiled plastics strip sliding behaviour

Figure 3 — Examples of methods of insertion of spirally-wound pipe

Method 1 employs a dedicated winding machine in front of the open end of an existing pipeline, e.g. in a manhole. The pipes thus formed are simultaneously inserted into the existing pipeline by the winding forces, e.g. in a manhole as illustrated in Figure 3. Pipes installed by this method can either be of fixed

diameter [see Figure 3 a)] or be progressively expanded to be in close contact with the existing pipeline [(see Figure 3 b)], depending on the SWO product employed.

Method 2 employs a dedicated winding machine that forms the pipe as it traverses the existing pipeline from one manhole to the next to install a liner in close contact with the host pipe or at a controlled fixed diameter within the host pipe (see Figure 3).

After insertion, fixed diameter SWO pipes shall be fixed in the existing pipeline by grouting the annular space using materials and procedures in accordance with manufacturer's specifications. SWO pipes installed as close-fit liners do not require grouting.

NOTE 1 Grouting here refers to filling of the annular space. Inappropriate grouting materials and/or procedures (which are outside the scope of this document) can lead to damage to the SWO pipe (excessive deformation and flotation of the pipe).

NOTE 2 SWO pipes installed as close-fit liners do not generally require grouting to fix their line and level but, where due to deflection offsets or other reasons the internal shape of the existing pipeline departs significantly from the outside diameter of the liner, filling of excessive annular space can be required for stability depending on structural design.

In all cases, measures shall be taken to prevent grout entering any lateral pipes. These measures shall be documented in the installation manual.

The installation manual shall specify all additional materials (e.g. sealants, fillers, adhesives) and operational details necessary to achieve a successful installation including the minimum temperature during the installation process.

9.5 Process-related inspection and testing

Process-related inspection and testing shall conform to ISO 11296-1:2018, 9.5.

9.6 Lining termination

The installation manual shall specify how the locked seam is secured when cutting the profiled plastics strip to remove the winding machine.

9.7 Reconnecting to existing manholes and laterals

Reconnections to existing manholes and laterals shall conform to the requirements of ISO 11296-1:2018, 9.7. Where cured-in-place lateral connection collars are used, their installation shall conform to ISO 11296-4:2018, 9.7.

Lateral connection fittings, in conjunction with any locally applied grout, shall in all cases be capable of replacing the structural function of any profile ribs and/or steel stiffening elements severed to create the lateral opening.

Proven methods for reconnecting and sealing lateral connections shall be documented in the installation manual for each SWO pipe system. Examples of such methods are described in Annex B.

9.8 Final inspection and testing

Final inspection and testing shall conform to ISO 11296-1:2018, 9.8.

9.9 Documentation

The documentation shall conform to ISO 11296-1: 2018, 9.9.

Annex A
(normative)

Spirally-wound pipe — Test method for watertightness in a deflected condition

A.1 Scope

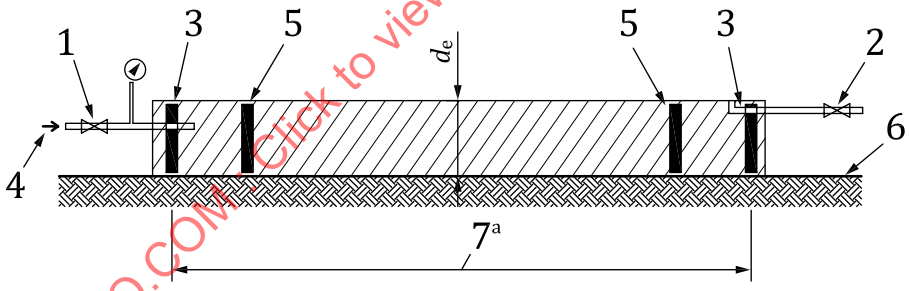
This annex specifies the test method regarding watertightness of SWO pipes in a deflected condition.

A.2 Principle

A sample of SWO pipe of minimum 5 m length is sealed at its ends, placed on a flat surface and filled with water. During the test, the SWO pipe is held at a predetermined longitudinal bending radius. The SWO pipe is subjected to internal water pressure for a certain period of time, during which it is continuously monitored for leakage. To pass the test, the SWO pipe shall exhibit no leakage during the specified test period.

A.3 Apparatus

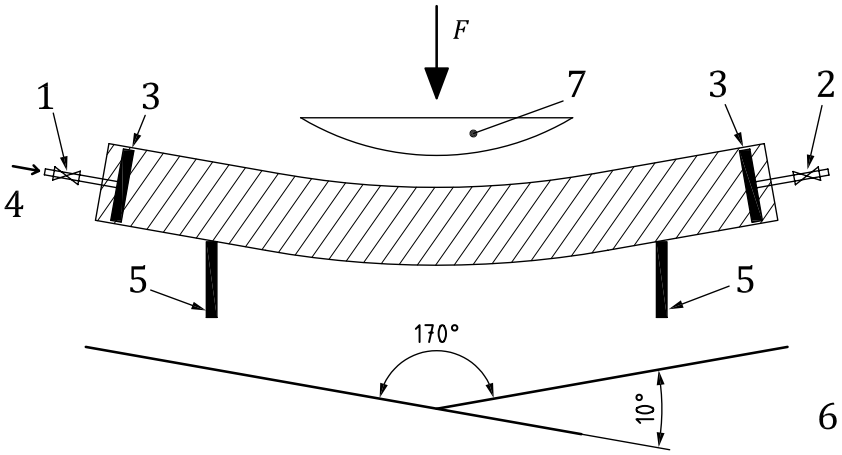
The apparatus is shown schematically in Figures A.1 and A.2.



Key

1 closure valve
2 air release valve
3 sealing device
4 pressurization device (e.g. pump)
5 pipe support
6 flat surface
7 length of sample between sealing devices
[a] Minimum: greater of $10d_e$ and 5 000 mm.

Figure A.1 — Cross-section of SWO pipe showing schematic layout for the watertightness test with a bending radius



Key

1 closure valve
2 air release valve
3 sealing device
4 pressurization device (e.g. pump), not shown
5 pipe support
6 flat surface
7 fixed radius loading element
F applied load

Figure A.2 — Horizontal projection of SWO pipe showing schematic layout for the watertightness test with a bending radius

The apparatus used for watertightness testing shall comprise:

a) **compression testing machine**, with a fixed radius loading element attached as shown in Figure A.2;

b) **flat surface**;

c) **internal sealing devices**, e.g. inflatable plugs, capable of carrying the force due to the internal test pressure;

d) **devices for filling with water and for releasing of air**, each including a closure valve;

e) **pressure gauge**, calibrated to be read accurately to the nearest 0,001 MPa;

f) **pressurization device**, e.g. a pump;

g) **chronometer**;

h) **ultraviolet light detection system**.

Alternative alignments of the full test apparatus are permissible for reasons of practicality and to ensure the proper support of the SWO pipe, as can be required for large diameter watertightness testing.

A.4 Sample

The minimum SWO pipe length between the sealing elements shall be the greater of $10d_{em}$ or 5 m. The length and radius of the loading element shall be such as to produce an angular deflection of 10° of the SWO pipe between its supports, as shown in Figure A.2. The length of the sample shall be limited to

20 m. This test shall be deemed to pass if the requirements are achieved with the required longitudinal bending radius but reduced bend angle.

A.5 Test procedure

The test shall be carried out at a temperature between 10 °C and 30 °C. The temperature at which the testing is conducted shall be recorded. Changes in ambient temperature during the test shall not exceed ±2 °C.

The sample shall be filled with water mixed with a fluorescent dye. The air shall be released during water filling to avoid internal pressure higher than atmosphere. The sample shall remain filled with water at atmospheric pressure for 5 min before the air release valve is closed. The internal pressure shall then gradually be raised in not less than 5 min until it reaches 0,05 MPa above atmospheric pressure at the air release valve.

The pressure of 0,05 MPa above atmospheric shall be maintained for 15 min. Pressure drop due to expansion of the sample shall be avoided by increasing the internal pressure so as to maintain a constant gauge reading of 0,05 MPa.

The outer surface of the SWO pipe shall be continuously monitored throughout the whole test procedure for leakage of the fluorescent dye under ultraviolet light during the test procedure.

The outer surface of the SWO pipe shall remain free of visible leakage or weeping for the whole of the test period.

A.6 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 11296-7:2019;

b) the name of the profiled plastics strip supplier and the dedicated winding machine;

c) type/code and declared values of the profiled plastics strip;

d) date of production of SWO pipe;

e) measured dimensions of the sample;

f) load and radius applied to the sample;

g) temperature during test;

h) graph of internal pressure versus time;

i) record of any leakage or weeping during the test period;

j) date of testing.