INTERNATIONAL STANDARD

ISO 11296-3

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

Part 3: Lining with close-fit pipes

Systèmes de canalisations en matières plastiques pour la rénovation des réseaux d'assainissement gravitaires enterrés —

Partie 3: Tubage par tuyau continu sans espace annulaire

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 11296-3 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*.

ISO 11296 consists of the following parts, under the general title *Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks*:

— *Part 1: General*

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

— *Part 4: Lining with cured-in-place pipes*

Lining with continuous pipes is to form the subject of a part 2, lining with discrete pipes is to form the subject of a part 5 and lining with spirally-wound pipes is to form the subject of a part 7.

Introduction

The System Standard, of which this is part 3, specifies the requirements for plastics piping systems of various materials used for the renovation of existing pipelines in a specified application area. System Standards for renovation specify procedures for the following applications:

— plastics piping systems for renovation of underground non-pressure drainage and sewerage networks (this application);

— plastics piping systems for renovation of underground drainage and sewerage networks under pressure;

— plastics piping systems for renovation of underground water supply networks;

— plastics piping systems for renovation of underground gas supply networks.

These System Standards are distinguished from those for conventionally installed plastics piping systems because they set requirements for 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 from 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.

The requirements for any given renovation technique family are given in part 1, applied in conjunction with the other relevant part. For example, parts 1 and 2 specify the requirements relating to lining with continuous pipes. For complementary information, see ISO 11295. Not all technique families are applicable 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 to facilitate direct comparisons across renovation technique families.

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

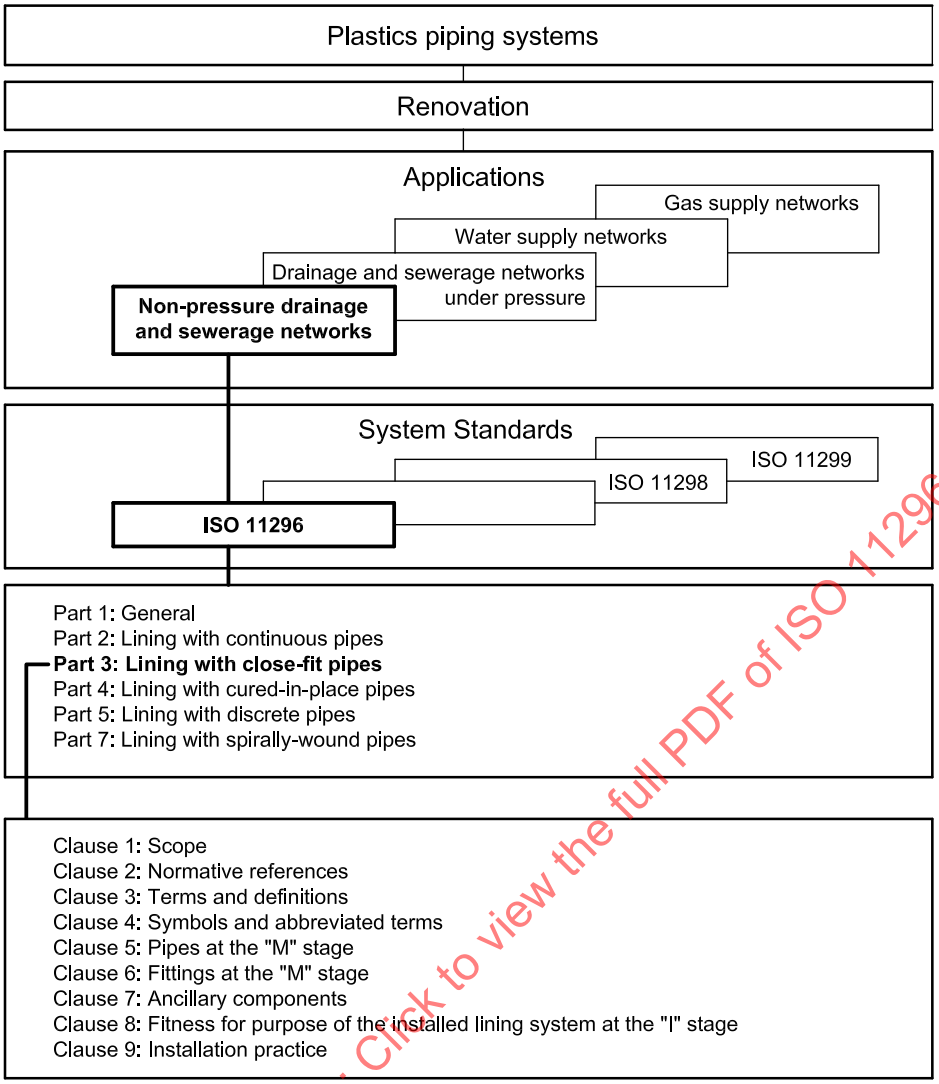

Figure 1 — Format of the renovation System Standards

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

Part 3:
Lining with close-fit pipes

1 Scope

This part of ISO 11296, in conjunction with ISO 11296-1, specifies requirements and test methods for close-fit lining systems intended to be used for the renovation of non-pressure drainage and sewerage networks.

It applies to pipes and fittings made of polyethylene (PE) or unplasticized poly(vinyl chloride) (PVC-U). It is applicable to the plastic lining system only. It is not applicable to the requirements for the existing pipeline.

2 Normative references

The following referenced documents are indispensable for the application 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 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 899-1:2003, *Plastics — Determination of creep behaviour — Part 1: Tensile creep*

ISO 2507-1, *Thermoplastics pipes and fittings – Vicat softening temperature — Part 1: General test method*

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

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

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

ISO 8772:2006, *Plastics piping systems for non-pressure underground drainage and sewerage — Polyethylene (PE)*

ISO 9852, *Unplasticized poly(vinyl chloride) (PVC-U) pipes — Dichloromethane resistance at specified temperature (DCMT) — Test method*

ISO 9967:2007, *Thermoplastics pipes — Determination of creep ratio*

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

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

ISO 12176-1, *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 1: Butt fusion*

ISO 13953, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

ISO 18373-1:2007, *Rigid PVC pipes — Differential scanning calorimetry (DSC) method — Part 1: Measurement of the processing temperature*

3 Terms and definitions

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

3.1
close fit
location of the outside of the installed liner relative to the inside of the existing pipeline, which may either be an interference fit or include a small annular gap resulting from shrinkage and tolerances only

3.2
close-fit pipe
continuous lining pipe of thermoplastic material reshaped or otherwise expanded after insertion to achieve a close fit to the existing pipeline

3.3
melt mass-flow rate
value relating the viscosity of the molten material at a specified temperature and rate of shear

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.

d_{manuf}	original circular outside diameter of the pipe (before processing for insertion)
$e_{m,\,max}$	maximum mean wall thickness
MFR	melt mass-flow rate
OIT	oxidation induction time

5 Pipes at the "M" stage

5.1 Materials

5.1.1 General

The material shall be either polyethylene (PE) or unplasticized poly(vinyl chloride) (PVC-U), to which are added those additives needed to facilitate the manufacture and/or installation of pipes conforming to this part of ISO 11296.

1) To be published.

5.1.2 Distinction between PVC-U types

PVC-U materials used for liner pipes may have PVC content less than the minimum of 80 %, and/or Vicat softening temperature less than the 79 °C specified by ISO 4435. For the purposes of this part of ISO 11296, distinction shall be made between PVC-U conforming to ISO 4435 (designated standard PVC-U) and PVC-U modified for lining applications.

NOTE This distinction is reflected in the requirements given in Table 4 and Table 11.

5.1.3 Virgin material

Virgin material, as defined in ISO 11296-1, may be used without limitations. Fusion compatibility of PE pipes shall conform to ISO 8772:2006, 4.6.

5.1.4 Reprocessable material and recyclable material

5.1.4.1 Reprocessable material

Own reprocessable material may be used, provided that it is derived from the same compound used for the relevant production. External reprocessable material shall not be used.

5.1.4.2 Recyclable material

Recyclable material shall not be used.

5.2 General characteristics

When viewed without magnification the internal and external surfaces of the pipe shall be smooth, clean and free from scoring, cavities and other defects, which would prevent conformity to this part of ISO 11296.

5.3 Material characteristics

When tested in accordance with the methods given in Table 1 or Table 2, as applicable, the material from which the pipes are made shall conform to the requirements given in the relevant table.

Table 1 — Material characteristics of PE pipes

<table>
<tr><th rowspan="2">Characteristic</th><th rowspan="2">Requirement</th><th colspan="2">Test parameter</th><th rowspan="2">Test method</th></tr>
<tr><th>Parameter</th><th>Value</th></tr>
<tr><td>Density</td><td colspan="4">ISO 8772</td></tr>
<tr><td>Longitudinal tensile stress at yield point</td><td>> 15 MPa</td><td rowspan="2">Speed of testing
for $e \leqslant 12$ mm
$e > 12$ mm
Test piece shape and initial gauge length</td><td rowspan="2">(100 ± 10) mm/min
(25 ± 2,5) mm/min
Specimen type 1B in accordance with ISO 527-2</td><td rowspan="2">ISO 6259-1</td></tr>
<tr><td>Elongation at break</td><td>> 350 %</td></tr>
<tr><td>Thermal stability (OIT)</td><td colspan="3" rowspan="3">ISO 8772</td></tr>
<tr><td>Melt mass-flow rate</td></tr>
<tr><td>Resistance to internal pressure (long-term behaviour)</td></tr>
<tr><td>Resistance to circumferential tensile stress[a]</td><td>No failure during the test period</td><td colspan="3">Annex B</td></tr>
<tr><td colspan="5">[a] Applies to folded pipes only, see Annex B.</td></tr>
</table>

Table 2 — Material characteristics of PVC-U pipes

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
E-modulus (tensile)	Declared value[a] [b], but not less than 1 200 MPa	Speed of testing Test piece shape and initial gauge length	(5 ± 0,5) mm/min Specimen type 1B	ISO 527-2
Longitudinal tensile strength	Declared value[a], but not less than 20 MPa	Speed of testing	(5 ± 0,5) mm/min	ISO 6259-1
Elongation at break	Declared value[a], but not less than 70 %	Test piece shape and initial gauge length	Specimen type 1B in accordance with ISO 527-2	
Impact strength	ISO 4435			

[a] Some PVC-U close-fit pipe products have declared values considerably higher than the minima specified.

[b] The declared value of E-modulus determines the relationship between ring stiffness and SDR (see 8.4 and 8.5).

5.4 Geometric characteristics

The pipe diameter, wall thickness and shape in the “M” stage depend on the specific close-fit lining technique. “M” stage dimensions needed to obtain specified “I” stage dimensions (see 8.4) shall be declared, with their tolerances, by the manufacturer.

NOTE In the case of factory-folded pipes, variations in wall thickness in one cross-sectional area can be present at the “M” stage.

5.5 Mechanical characteristics

No mechanical requirements of pipes at the “M” stage apply.

5.6 Physical characteristics

When tested in accordance with the methods given in Table 3 or Table 4, as applicable, the pipe shall conform to the requirements given in the relevant table. In the case of factory-folded, heat-reverted PE pipes, the pipe shall additionally conform to the requirement for memory ability specified in Annex A.

Table 3 — Physical characteristics of PE pipes

Characteristic	Requirement	Test parameter	Test method
Longitudinal reversion	⩽ 3,5 % The pipe shall exhibit no bubbles or cracks	ISO 8772	

Table 4 — Physical characteristics of PVC-U pipes

Characteristic	Requirement	Test parameter		Test method
		Parameter	Value	
Vicat softening temperature	Declared value[a], but not less than 55 °C	Number of test pieces[b]	3	ISO 2507-1
Longitudinal reversion	ISO 4435			
Resistance to dichloro-methane at elevated temperatures (degree of gelation)	No attack at any part of the surface of the test piece	Temperature of bath Number of test pieces[b] Immersion time Min. wall thickness	(15 ± 1) °C 1 30 min 1,5 mm	ISO 9852
DSC (alternative test method to resistance to dichloromethane)[c]	B onset temperature ⩾ 185 °C	Number of test pieces[b]	4	ISO 18373-1:2007

[a] For standard PVC-U conforming to ISO 4435, the requirement for Vicat softening temperature is ⩾ 79 °C.

[b] The number of test pieces given indicates the number required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan.

[c] In case of dispute, the resistance to dichloromethane shall be used.

5.7 Jointing

When tested in accordance with the methods given in ISO 13953, the butt-fusion joints between PE pipes shall conform to the requirements given in Table 5.

Table 5 — Jointing characteristics of PE pipes

Characteristic	Requirement	Test parameter	Test method
Failure mode	Ductile failure	ISO 13953	

5.8 Marking

Pipes shall be marked in accordance with ISO 11296-1:—, 5.8.

The nominal size shall be marked as DN/OD.

NOTE In addition, PE pipes can be marked with the following optional information: MFR.

6 Fittings at the "M" stage

Fittings shall be either polyethylene (PE) conforming to ISO 8772 or unplasticized poly(vinyl chloride) (PVC-U) conforming to ISO 4435.

7 Ancillary components

This part of ISO 11296 is not applicable to any ancillary components.

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

8.1 Materials

Any compatible combination of pipes and fittings conforming to Clauses 5 and 6, respectively, may be used.

8.2 General characteristics

The internal surface of the pipe shall be smooth, and free from scoring and other defects.

NOTE A feature of close-fit pipes is that the lining can conform to the surface characteristics of the existing pipe.

8.3 Material characteristics

When tested in accordance with the methods given in Table 6 or Table 7, as applicable, the pipe shall conform to the requirements given in the relevant table.

Table 6 — Material characteristics of PE pipes as installed

Characteristic	Requirement	Test parameter	Test method
Resistance to internal pressure (long-term behaviour)	ISO 8772		

Table 7 — Material characteristics of PVC-U pipes as installed

Characteristic	Requirement	Test parameter		Test method
		Parameter	Value	
Longitudinal tensile strength	Not less than value declared at "M" stage (see Table 2)	Speed of testing Test piece shape and initial gauge length	(5 ± 0,5) mm/min Specimen type 1B in accordance with ISO 527-2	ISO 6259-1

8.4 Geometric characteristics

Samples of pipes, taken from actual or simulated installations in accordance with 9.8, shall have geometric characteristics conforming to Table 8 or Table 9, as applicable, whereby relevant dimensions shall be measured in accordance with ISO 3126 at a temperature of (23 ± 2) °C.

Table 8 — Geometric characteristics of PE pipes as installed

Dimensions in millimetres

Nominal outside diameter[a]	Standard dimension ratio[b]					
	SDR 33		SDR 26		SDR 17,6	
	Wall thickness[c]					
d_n	e_{min}	$e_{m,\,max}$	e_{min}	$e_{m,\,max}$	e_{min}	$e_{m,\,max}$
100	—	—	3,9	4,9	5,7	6,9
125	—	—	4,8	5,9	7,1	8,5
150	4,7	5,8	5,8	7,0	8,6	10,2
200	6,2	7,5	7,7	9,2	11,4	13,3
225	7,0	8,4	8,7	10,3	12,8	14,9
250	7,7	9,2	9,6	11,3	14,2	16,4
300	9,3	11,0	11,6	13,5	17,1	19,7
350	10,8	12,6	13,5	15,6	19,9	22,8
400	12,3	14,3	15,4	17,8	22,7	26,0
450	13,9	16,1	17,3	19,9	25,6	29,2
500	15,4	17,8	19,3	22,2	28,4	32,3

a Nominal diameters are preferred diameters, other nominal diameters may be used.

b SDRs are preferred dimension ratios, other dimension ratios may be used.

c Wall thickness requirements are calculated as:

$e_{min} = d_n/SDR$, rounded to the next greater 0,1 mm;
$e_{m,\,max} = (1{,}12\ e_{min} + 0{,}5)$ mm, rounded to the next greater 0,1 mm.

Table 9 — Geometric characteristics of PVC-U pipes as installed

Dimensions in millimetres

Nominal outside diameter[a]	Standard dimension ratio[b]							
	SDR 51		SDR 41		SDR 34		SDR24	
	Wall thickness[c]							
d_n	e_{min}	$e_{m,\,max}$	e_{min}	$e_{m,\,max}$	e_{min}	$e_{m,\,max}$	e_{min}	$e_{m,\,max}$
100	—	—	—	—	3,0	3,9	4,2	5,2
150	—	—	3,7	4,7	4,5	5,6	6,3	7,5
200	4,0	5,0	4,9	5,9	5,9	7,1	8,3	9,9
225	4,5	5,6	5,5	6,7	6,7	8,0	9,4	11,1
250	4,9	6,0	6,1	7,3	7,4	8,8	10,4	12,2
300	5,9	7,1	7,4	8,8	8,9	10,5	12,5	14,5
350	6,9	8,2	8,6	10,2	10,3	12,1	14,6	16,9
400	7,9	9,4	9,8	11,5	11,8	13,8	16,7	19,2
450	8,9	10,5	11,0	12,9	13,3	15,4	18,8	21,5
500	9,8	11,5	12,2	14,2	14,7	17,0	20,8	23,9

a Nominal diameters are preferred diameters, other nominal diameters may be used.

b SDRs are preferred dimension ratios, other dimension ratios may be used.

c Wall thickness requirements are calculated as:

$e_{min} = d_n/SDR$, rounded to the next greater 0,1 mm;
$e_{m,\,max} = (1{,}12\ e_{min} + 0{,}5)$ mm, rounded to the next greater 0,1 mm.

8.5 Mechanical characteristics

When tested in accordance with the methods given in Table 10 or Table 11, as applicable, pipes, taken from actual or simulated installations in accordance with 8.8, shall have mechanical characteristics conforming to the relevant table.

NOTE As explained in the Introduction to ISO 9967:2007, the two-year creep ratio normally obtained by testing in accordance with ISO 9967 is relevant to the design of thermoplastics pipes installed directly in soil, whereas for the long-term structural design of liners subjected to sustained external groundwater pressure, as described in ISO 11295, a creep ratio corresponding to the full duration of the product design life (typically 50 years) applies.

Table 10 — Mechanical characteristics of PE pipes as installed

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Ring stiffness	Declared value, but not less than 1,0 kPa	ISO 8772		ISO 9969
Creep ratio	Declared value, but not less than 4,0	ISO 9967		

Table 11 — Mechanical characteristics of PVC-U pipes as installed

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Ring stiffness	Declared value, but not less than: — 0,5 kPa for standard PVC-U — 1,0 kPa for modified PVC-U	ISO 9969		
Creep ratio	Declared value, but not greater than: — 2,5 for standard PVC-U — 4,0 for modified PVC-U	ISO 9967		

8.6 Physical characteristics

In the case of liners of modified PVC-U, the technique supplier shall declare the maximum temperature and duration of short-term discharges which can be safely resisted without collapse.

8.7 Additional characteristics

No additional characteristics apply.

8.8 Sampling

The sampling of the installed pipe shall conform to ISO 11296-1:2009, 8.8.

9 Installation practice

9.1 Preparatory work

No special requirements apply.

9.2 Storage, handling and transport of pipes and fittings

Precautions shall be taken to ensure that no damage is caused to the lining pipe during unloading, site handling and storage.

The lining pipe should be stored on reasonably level ground, free of large sharp stones, debris or litter, to avoid potentially damaging point-loading.

In general and in the absence of any specific handling requirements, these precautions shall include the use of webbing slings in place of wire rope or chains, and the use of spreader beams for pipe lengths in excess of 12 m. Where the system designer specifies handling requirements, these shall prevail.

The lining pipe shall be transported on a flatbed vehicle, free from nails or other projections, or on a purpose-built trailer designed to carry the lining pipe as a freestanding coil or wound on to a drum. Before being loaded, the lining pipe shall be visually checked for any damage.

Pipe ends shall be securely sealed to prevent contamination of the pipe by moisture and/or dirt during storage, handling and transport.

9.3 Equipment

9.3.1 Butt-fusion equipment and debeading equipment

Butt-fusion equipment shall be capable of producing joints between PE pipes or PE pipes and fittings under site conditions and shall comply with ISO 12176-1.

In addition to the heater plate, the equipment shall include such clamping, re-rounding and trimming systems as ensure alignment and matching of the pipe ends, and an external debeader capable of removing the bead cleanly in one continuous strip without damage to the pipe surface. If an internal debeader is used, this shall not cause damage to the internal pipe surface.

A shelter should be provided to avoid weld contamination from water and dust and to generally maintain a clean and warm working environment. The ends of the lining pipe string should be plugged to prevent cold air blowing through, which could otherwise adversely affect the weld.

9.3.2 Reduction equipment

Depending on the lining technique, a reduction of the lining pipe may take place at the site. The reduction equipment shall be operated in accordance with the technique's specification.

Reduction or deformation equipment for use on site shall be free from sharp edges which can damage the internal or external surfaces of the pipe during deformation.

Any lubricant used in the reduction process shall be compatible with the lining material.

9.3.3 Pipe skids/rollers

Depending on the technique, pipe skids or rollers shall be used. These shall minimize frictional loads and prevent damage to the pipe as it is moved during the jointing and/or installation processes.

9.3.4 Winching equipment

The winching equipment shall have a means of recording, graphically or numerically, the load applied to the winch cable during installation.

DANGER — All winching operations are potentially dangerous and any exposed winch cable should be guarded.

NOTE Attention is drawn to any national health and safety regulations applicable to winching equipment and operations.

Winching equipment normally consists of a powered winch connected to the lining pipe by a winch cable and appropriate nose cone connection. The force in the winch cable should be measured directly and not inferred from the hydraulic pressure on the drive motors or by other such indirect means.

9.3.5 Pipe entry guides

Guides should be used at the ends of the host pipe to prevent damage to the lining pipe during insertion.

9.3.6 Reforming equipment

Any equipment used to carry out the reforming or re-rounding process shall be capable of providing the required conditions of pressure and temperature and shall be in accordance with the technique's specification.

9.4 Installation

Installation shall follow the procedures detailed in the installation manual.

The installation manual shall specify all necessary parameters and details of the method of reforming the lining pipe to achieve a close fit. Where applicable, the description of the reforming method and the installation parameters shall specify, according to the requirements of the technique concerned:

a) the maximum and/or minimum values of any internal pressure to be applied;

b) the maximum and/or minimum values of temperatures to be reached on the inside and/or outside surfaces of the pipe;

c) the maximum pulling forces;

d) the minimum installed bending radii;

e) the permitted ambient temperature range.

The manual shall also include details of the methods of jointing and of the type of fittings to be used, together with any special requirements.

Where pipes are jointed to form one string on site using butt fusion, the method of external debeading should be specified. The method statement should specify at least the following:

— how the bead is removed;

— how the bead and the related joint are identified;

— how the bead should be examined for quality control purposes and stored for future reference.

9.5 Process-related inspection and testing

Process-related inspection and testing shall conform to ISO 11296-1:2009, 9.5.

9.6 Lining termination

The ends of the pipe shall be anchored and sealed in such a way as to provide a watertight connection to the existing pipeline. The method of anchoring the pipe ends shall take account of the residual effects of installation, especially unrelieved winching and thermal stresses, and be capable of resisting the associated longitudinal forces without movement.

9.7 Reconnection to existing manholes and laterals

Reconnection shall conform to ISO 11296-1:2009, 9.7.

9.8 Final inspection and testing

The finished close-fit lining pipe shall be inspected internally to verify that it is continuous over the entire length of the installation.

Annex A
(normative)

Factory-folded heat-reverted polyethylene (PE) pipe — Determination of memory ability

A.1 General

A PE pipe supplied from the factory in folded shape is manufactured first as a circular pipe and then, in a second step of the process, folded along its length.

The memory ability of a factory-folded PE pipe, as defined by the following test, provides information on the quality of production of such a pipe.

A.2 Principle

A sample of folded PE pipe is heated in an oven at a specified temperature and for a specified time, and allowed to revert (unfold) by its memory. After cooling down, the smallest dimension, H, indicated in Figure A.1, is measured and compared to the outside diameter of the pipe as manufactured before folding.

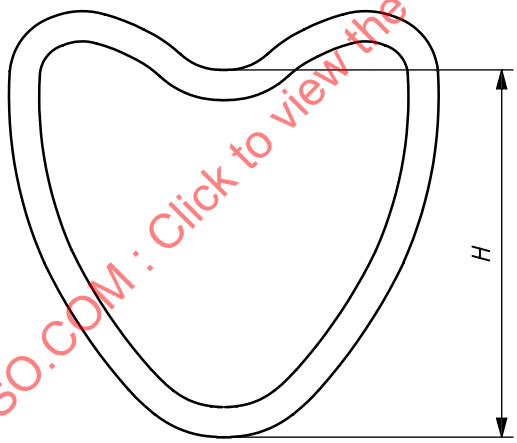

Figure A.1 — Memory effect

A.3 Testing

A.3.1 Sampling

Cut-off sections of pipe, as manufactured (folded) with a length of at least 50 mm, shall be taken.

A.3.2 Procedure

Testing shall be done using a hot air oven. Prior to testing, the oven shall be conditioned at a temperature of (120 ± 2) °C. The test pieces shall be positioned at random in the oven and heated at a temperature of (120 ± 2) °C in accordance with Table A.1.

Table A.1 — Test parameters

Pipe wall thickness	Temperature PE 80/PE 100	Heating time
$e_{min} \leqslant 8$ mm	(120 ± 2) °C	(60 ± 1) min
$8 < e_{min} \leqslant 16$ mm	(120 ± 2) °C	(90 ± 2) min
$e_{min} > 16$ mm	(120 ± 2) °C	(120 ± 2) min

On completion of the specified heating time, the test pieces shall be removed from the oven and allowed to cool to within 10 °C of ambient temperature. The smallest dimension, H, of each test piece, as indicated in Figure A.1, shall then be measured, and compared with the manufactured outside diameter, d_{manuf}, of the pipe.

A.3.3 Requirements

PE 80: $H \geqslant 0{,}75 d_{manuf}$

PE 100: $H \geqslant 0{,}65 d_{manuf}$

where d_{manuf} is the original circular diameter of the pipe (before folding).

Values for d_{manuf} shall be declared by the manufacturer.

A.4 Test report

The test report shall include the following information:

a) a reference to this part of ISO 11296, i.e. ISO 11296-3:2009;

b) the complete identification of the sample;

c) the type of material;

d) the manufactured outside diameter, d_{manuf}, of the pipe;

e) the date of pipe production;

f) the date of sampling;

g) the temperature and duration of heating of each test piece;

h) the measured dimension, H, of the test piece after cooling;

i) any factor which may have affected the results, such as any incident or any operating detail not specified in this annex;

j) the date of testing.

Annex B
(normative)

Folded polyethylene (PE) pipe — Determination of resistance to circumferential tensile stress at constant temperature

B.1 General

This annex specifies a test for use as a production control test on folded pipes, to demonstrate batch compliance with the established strength of the pipe in the circumferential direction.

This test is not intended to replace the determination of resistance to internal pressure, in accordance with Table 6, of pipes at the "l" stage. It is intended as a quick and simple means of detecting any variation in material strength between batches, without the need to re-round an entire pipe and apply an internal pressure test for each batch.

B.2 Principle

Take test samples from the area of the folded pipe ring subjected to the greatest bending and pressed flat after heating. After conditioning, the test pieces prepared from these flattened samples are subjected to a specified constant load in the axial direction, for a specified period of time or until the test piece(s) fail(s).

Throughout the test, keep the test pieces in a water or air environment at a specified constant temperature. The test conditions should be similar to those of the hydrostatic internal pressure test.

B.3 Apparatus

The apparatus shall consist of the following:

B.3.1 **Air oven**, capable of heating the samples prior to flattening and for the conditioning of the test pieces.

B.3.2 **Two steel plates** and a **compression device**, capable of flattening the samples.

B.3.3 **Gripping device**, designed so as to ensure that the direction of the applied load coincides as closely as possible with the longitudinal axis of the test piece.

B.3.4 **Loading system**, allowing a smooth and reproducible application of load within between 1 s and 5 s and designed such that throughout the period of testing the load acting on the test piece does not deviate by more than ± 1 % from the specified load.

B.3.5 **Water bath** or **heated air chamber**, capable of maintaining the test pieces at constant temperature during loading, including a thermometer or equivalent capable of checking conformity to the specified test conditions.

B.3.6 **Timer**, capable of recording the duration of the load application up to the moment of failure of the test piece.