INTERNATIONAL STANDARD

ISO 11296-3

Second edition
2018-08

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

Part 3: Lining with close-fit pipes

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

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.

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 11296-3:2009) which has been technically revised. It also incorporates the Corrigendum ISO 11296-3:2009/Cor 1:2011.

The main changes compared to the previous edition are as follows:

— Clauses 3, 5, 6, 8 and 9 have been technically revised;

— the previous Annex B has been deleted.

A list of all parts in the ISO 11296 series can be found on the ISO website.

Introduction

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

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

— 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 system standards 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 verification of characteristics of plastics piping systems "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* (this document)

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

— *Part 5: Lining with discrete pipes*

— *Part 7: Lining with spirally-wound pipes*

— *Part 8: Lining with pipe segments*

— *Part 9: Lining with 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 close-fit 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 to facilitate direct comparisons across renovation technique families.

Figure 1 shows the common part and clause structure and the relationship between ISO 11296 and system standards for other applications.

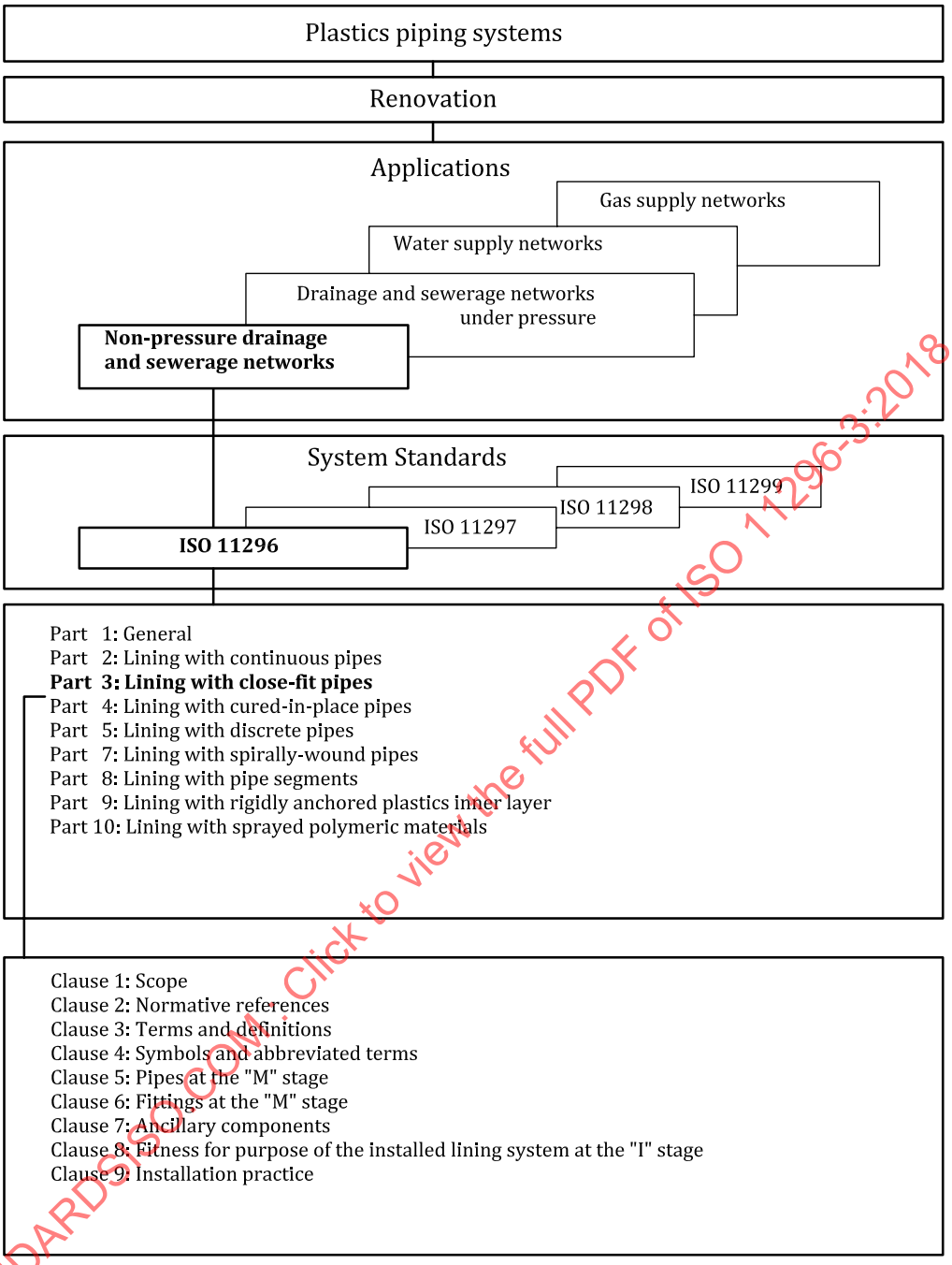

Figure 1 — Format of the renovation system standards

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

Part 3:
Lining with close-fit pipes

1 Scope

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

It applies to pipes and fittings made of polyethylene (PE) or unplasticized poly(vinyl chloride) (PVC-U) as manufactured, as well to the installed lining system with its associated 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 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

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

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

ISO 11296-1:2018, *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 12176-2, *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 1: Electrofusion*

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.

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 https://www.iso.org/obp

3.1 General

3.1.1
close fit
situation 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

3.1.2
close-fit pipe
continuous lining pipe of thermoplastic material reshaped or otherwise expanded after insertion to achieve a close fit to the existing pipeline

3.2 Techniques

No additional definitions apply.

3.3 Characteristics

3.3.1
MFR
melt mass-flow rate
rate of extrusion of a molten resin through a die of specified length and diameter under prescribed conditions of temperature, load and piston position in the cylinder of an extrusion plastometer, the rate being determined as the mass extruded over a specified time

Note 1 to entry: MFR is expressed in units of grams per 10 min.

[SOURCE: ISO 1133-1:2011, 3.1, modified - the second sentence in the NOTE has been deleted.]

3.4 Materials

3.4.1
crazing
microstructural phenomenon associated with the short-term application of tensile bending strain exceeding the material-related critical yield strain

3.5 Product stages

No additional definitions apply.

3.6 Service conditions

No additional definitions apply.

3.7 Joints

3.7.1
butt fusion joint
joint made by heating the planed ends of matching surfaces by holding them against a flat heating plate until the PE material reaches fusion temperature, quickly removing the heating plate and pushing the two softened ends against one another

3.7.2
fusion compatibility
ability of two similar or dissimilar PE materials to be fused together to form a joint which conforms to the performance requirements of this document

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 document.

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 79 °C as specified by ISO 4435. For the purposes of this document 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 9.

5.1.3 Virgin material

Virgin material, as defined in ISO 11296-1, may be used without limitations.

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

5.2.1 Appearance

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 document.

5.2.2 Colour

No additional requirements apply.

5.3 Material characteristics

The material from which the pipes are made shall conform to the requirements specified in Table 1 or Table 2, as applicable.

Table 1 — Material characteristics of PE pipes

Characteristic	Requirement	Test parameter		Test method
		Parameter	Value	
Density	ISO 8772			
Longitudinal tensile stress at yield point	>15 MPa	Speed of testing for $e \leq 12$ mm $e > 12$ mm Test piece shape and initial gauge length	(100 ± 10) mm/min (25 ± 2,5) mm/min Specimen type 1B in accordance with ISO 527-2	ISO 6259-1
Elongation at break	>350 %			
Thermal stability (OIT)	ISO 8772			
MFR				
Resistance to internal pressure (long-term behaviour)				

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. This is acceptable, as long as the folded pipe has the property to obtain a wall thickness in accordance with 8.4 when the installation is complete.

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 specified 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 (VST)	Declared value[a], but not less than 55 °C	Number of test pieces[b] Conditioning temperature	3 50 °C below the expected VST or (23 ± 2) °C, whichever is greater	ISO 2507-1
Longitudinal reversion	ISO 4435			
Resistance to dichloromethane 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	

Butt fusion joints shall not be made between folded pipes prior to reversion.

5.8 Marking

Pipes shall be marked in accordance with ISO 11296-1: 2018, 5.8.

The nominal size shall be marked as DN/OD.

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. Where required for compatibility with pipe dimensions in accordance with Table 8, fittings with other geometric characteristics are acceptable.

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

Any compatible combination of pipes and fittings conforming to Clauses 5 and 6, respectively, may be used, provided that fusion compatibility has been demonstrated.

8.2 General characteristics

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

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

There are no additional requirements for material characteristics.

8.4 Geometric characteristics

Samples of pipes, taken from actual or simulated installations, shall have wall thicknesses conforming to the requirements of Table 6 or Table 7, as applicable, whereby relevant dimensions shall be measured in accordance with ISO 3126 at a temperature of (23 ± 2) °C.

Table 6 — Pipe wall thicknesses 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;

$e_{m,max} = 1{,}12e_{min} + 0{,}5$ mm, rounded to the next greater 0,1 mm.

Table 7 — 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;

$e_{m,max} = 1{,}12e_{min} + 0{,}5$ mm, rounded to the next greater 0,1 mm.

After installation and reversion, the liner shall have attained a cross-section within the host pipe such that the curvature is positive at all points around the circumference.

This is to limit the size of shape memory imperfection affecting resistance of the liner to buckling under net external hydrostatic pressure, and, where applicable, to enable connections to be made. Design considerations shall also provide that in the long term, the positive curvature is maintained under the normal operating conditions.

If required by the client, the maximum degree of deformation remaining after reversion shall be agreed on and included in the project-specific installation manual.

8.5 Mechanical characteristics

When tested in accordance with the methods given in Table 8 or Table 9, 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, 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 8 — 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 (2-year)	Declared value, but not greater than 4,0	ISO 9967		

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

Characteristic	Requirement	Test parameters		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
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		

Where liners are folded/unfolded (either in the factory or on site), there is a risk that crazing may occur at the tips of the folds, which in the long term can result in through-wall cracks and thus leakage. The possible occurrence depends on pipe material, folding technique, wall thickness and temperature. The risk of cracks increases with increasing wall thickness and decreasing temperature. The technique supplier should demonstrate that crazing would not occur with the pipe proposed to be applied with the technique under the prevailing ambient conditions.

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

There are no requirements for additional characteristics of the installed lining system.

8.8 Sampling

The sampling of the installed pipe shall conform to ISO 11296-1:2018, 8.8.

NOTE For process verification testing, samples can conveniently be taken either from the exposed end of an installed liner where this emerges from the host pipe or from a section of the liner installed in a length of simulated host pipe; see the relevant clause of ISO 11296-1:2018.

9 Installation practice

9.1 Preparatory work

There are no additional requirements for preparatory work.

9.2 Storage, handling and transport of pipes and fittings

Precautions shall be taken to ensure that no excessive damage is caused to the lining pipe during unloading, site handling and storage. In this context, excessive damage shall mean any scratch which is more than 10 % of the wall thickness in depth or the imposition of any severe bending operation, which results in a permanent kink, crease or fold.

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

When assessing damage to the pipe wall caused by scratches, the installer should be aware that further scratch damage can occur during installation.

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 conform to ISO 12176-1.

In addition to the heater plate, the equipment shall include such clamping, re-rounding and trimming systems as to 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 shall 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 shall 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 could damage the internal or external surfaces of the pipe during deformation.

NOTE Damage can also be caused by debris passing undetected into the reduction equipment. This can be avoided by continuous inspection of the lining pipe immediately before and after it passes through reduction equipment, and before it enters the host pipe.

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 and rod-pulling equipment

Winching equipment usually consists of a powered winch connected to the lining pipe by a winch cable and appropriate nose cone connection.

Rod pulling equipment usually consists of a hydraulic ram-driven carriage, connected to the lining pipe by a string of rods which screw or hook together, and an appropriate nose cone connection.

All pulling equipment shall have a means of displaying in real time, and recording graphically or numerically, the force applied to the pipe during installation. In the case of a winch, this shall be by directly measuring the load on the winch wire. In the case of a rod puller, this shall be by directly measuring either the load applied to the rods or the load applied to the nose cone.

For site-reduced pipes a swivel shall be incorporated between the winch wire or rods and the nose cone. To achieve direct measurement of the force on the pipe a load cell is also generally required.

WARNING — All pulling operations are potentially dangerous and any exposed winch cable or puller rods should be guarded.

9.3.5 Pipe entry guides

Pipe entry guides shall be designed to prevent damage to the lining pipe during insertion in such a way that no part of the guide can become detached and pass accidentally into the host pipe.

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.

9.3.7 Electrofusion equipment

Electrofusion equipment shall conform to ISO 12176-2. The power supply/controller and associated alignment and fixing clamps shall be such as to ensure fusion when following the manufacturer's guidelines for surface preparation and fusion.

9.3.8 Inspection equipment

Inspection equipment [closed-circuit television (CCTV)] shall provide a full colour picture and recording/replay facilities complete with slow motion and frame by frame replay and shall provide a clear picture of all parts of the installed pipe. The recording shall be labelled on screen with full location, metreage, lining type and size and date information.

Inspection equipment (profiling) shall additionally provide calibrated profiles of the liner at any required location, and shall be capable of automatically identifying and recording all locations where the liner profile exhibits a negative curvature and/or exceeds a preset deformation agreed between the client and the installer. Each profile shall be labelled on screen with location and degree of deformation.

All equipment to be introduced into the installed pipe shall be constructed and maintained so as to prevent any damage or contamination to the installed pipe.

The equipment shall conform to all relevant safety standards.

9.3.9 Lifting equipment

All lifting equipment shall be covered by current test certification and shall be operated only by trained personnel.

9.4 Installation

Full details of installation and future connection methodologies shall be included in the installation manual.

The 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 shall be specified. The method statement shall 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.

Where squeeze-off is used during the installation process, the squeezed-off section shall, if instructed by the client, be removed before the liner is put into service. Otherwise, the squeezed-off section shall be re-rounded and marked to prevent repeated squeezing of the same section.

NOTE Stainless steel support bands can be fitted to permanently reinforce squeezed-off positions, where appropriate.