INTERNATIONAL STANDARD

ISO 11297-3

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

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 sous 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.

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 11297-3 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*.

ISO 11297 consists of the following parts, under the general title *Plastics piping systems for renovation of underground drainage and sewerage networks under pressure*:

— *Part 1: General*

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

Lining with continuous pipes is to form the subject of a future part 2; lining with cured-in-place pipes is to form the subject of a future part 4; lining with discrete pipes is to form the subject of a future part 5; and lining with adhesive-backed hoses is to form the subject of a future part 6.

This corrected version of ISO 11297-3:2013 incorporates the following corrections:

— Clause 2: correction of the title of EN 12201-4.

— Table 2: addition of an explanation for table footnote “a”.

Introduction

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

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

— Plastics piping systems for renovation of underground drainage and sewerage networks under pressure (this application);

— 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 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.

This System Standard ISO 11297 comprises a:

— Part 1: General

and the following technique family-related parts:

— 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 6: Lining with adhesive-backed hoses

The requirements for any given renovation technique family are given in part 1 applied in conjunction with the relevant other part. For example, both ISO 11297-1 and this part of ISO 11297 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 of ISO 11297, in order to facilitate direct comparisons across renovation technique families.

Figure 1 shows the common part and clause structure and the relationship between ISO 11297 and the system standards for other application areas.

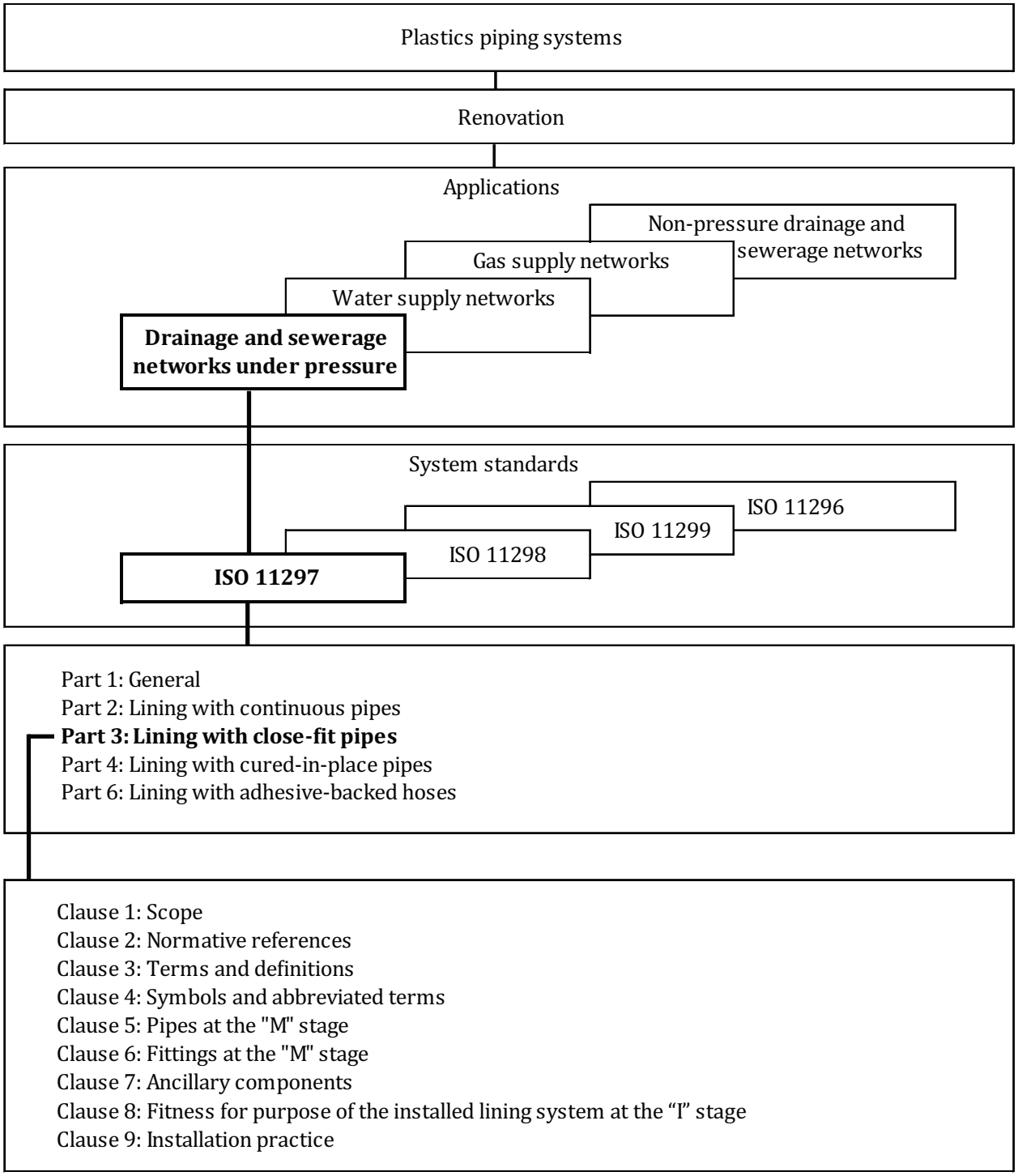

Figure 1 — Format of the renovation system standards

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

Part 3: Lining with close-fit pipes

1 Scope

This part of ISO 11297, in conjunction with ISO 11297-1, specifies requirements and test methods for close-fit lining systems intended to be used for the renovation of underground drainage and sewerage networks under pressure. It is applicable to pipes and fittings, as manufactured, as well as to the installed lining system. It is applicable to polyethylene (PE) pipe for both independent and interactive pressure pipe liners as well as associated fittings and joints for the construction of the lining system.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3, *Preferred numbers — Series of preferred numbers*

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

ISO 4427-1:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 1: General*

ISO 4427-2, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 2: Pipes*

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

ISO 4427-5:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 5: Fitness for purpose of the system*

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

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

ISO 11297-1:2013, *Plastics piping systems for renovation of underground drainage and sewerage networks under pressure — 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 2: Electrofusion*

EN 12201-2:2011, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 2: Pipes*

EN 12201-4, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 4: Valves*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11297-1 and the following apply.

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
maximum mean outside diameter
$d_{em,max}$
maximum value of the outside diameter as specified for a given nominal size

3.3.2
minimum required strength
MRS
value of σ_{LPL} rounded down to the next smaller value of the R10 series or R20 series, depending on the value of σ_{LPL}

Note 1 to entry: R10 and R20 series are the Renard number series according to ISO 3 and ISO 497.

3.3.3
melt mass-flow rate
MFR
value relating to the viscosity of the molten material at a specified temperature and rate of shear

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

3.6.1
nominal pressure
PN
numerical designation used for reference purposes related to the mechanical characteristics of the component of a piping system

Note 1 to entry: For thermoplastics piping systems conveying water or sewage, it corresponds to the allowable operating pressure (PFA) in bar[1)], which can be sustained with water at 20 °C with a design basis of 50 years, and based on the minimum design coefficient:

$$\mathrm{PN} = \frac{20 \times (\mathrm{MRS})}{C \times (\mathrm{SDR} - 1)}$$

3.6.2
design coefficient
C
coefficient with a value greater than 1, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confidence limit

3.7 Joints

3.7.1
electrofusion joint
joint between a PE socket or saddle electrofusion fitting and a pipe or fitting with spigotted ends, made by heating the electrofusion fittings by the Joule effect of the heating element incorporated at their jointing surfaces, causing the material adjacent to them to melt and pipe and fitting surfaces to fuse

3.7.2
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

3.7.3
mechanical joint
joint made by assembling a PE pipe to another PE pipe or any other element of the piping system, using a fitting that generally includes a compression part to provide for pressure integrity and leaktightness and a gripping part to provide resistance to end loads

Note 1 to entry: A support sleeve inserted into the pipe bore can be used to provide a permanent support for the PE pipe to prevent creep in the pipe wall under radial compressive forces.

3.7.4
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 part of ISO 11297

1) 1 bar =0,1 MPa = 0,1 N/mm^2 = 10^5·N/m^2.

4 Symbols and abbreviated terms

4.1 Symbols

For the purpose of this document, the symbols given in ISO 11297-1 and the following apply.

C	overall service (design) coefficient
d_e	outside diameter (at any point)
$d_{em,max}$	maximum mean outside diameter
d_{manuf}	original circular outside diameter of the pipe (before processing for insertion)
$e_{m,max}$	maximum mean wall thickness
T	temperature at which stress rupture data have been determined
t	time to occurrence of a leak in the pipe
σ_{LPL}	quantity with the dimensions of stress, which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at a temperature, T, and time t

4.2 Abbreviated terms

LPL	lower confidence limit of the predicted hydrostatic strength
MFR	melt mass-flow rate
MRS	minimum required strength
PE	polyethylene
R	series of preferred numbers, conforming to the Renard series

5 Pipes at the "M" stage

5.1 Materials

5.1.1 Virgin material

The virgin material used shall be in accordance with one of the PE compound designations given in Table 1.

Table 1 — PE compound designations

Designation	**Classification by MRS** MPa
PE 80	8
PE 100	10

The compound shall conform to ISO 4427-1.

5.1.2 Reprocessable and recyclable material

In accordance with ISO 4427-1, own reprocessable material may be used, provided that it is derived from the same compound as used for the relevant production.

Reprocessable material obtained from external sources and 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 part of ISO 11297.

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 Tables 1 and 2 of ISO 4427-1:2007 with the exception of the requirement regarding effect on water quality.

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

5.5 Mechanical characteristics

When tested in accordance with the method given in Table 2, the pipe shall conform to the requirements in the table.

Table 2 — Mechanical characteristics of pipes

Characteristic	Requirement	Test parameters Parameter, Value	Test method
Hydrostatic strength at 80°C (165 h)	ISO 4427-2 [a]		
[a] The pipe shall be reverted in the case of factory-folded pipes.			

5.6 Physical characteristics

Physical characteristics shall conform to those specified in ISO 4427-2, with the exception of the requirement regarding effect on water quality.

In the case of factory-folded heat-reverted pipes, the pipe shall additionally conform to the requirement for memory ability specified in Annex A.

5.7 Jointing

Butt fusion joints shall conform to ISO 4427-2 and ISO 4427-5.

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

NOTE The joining of circular pipes to form a string prior to site processing is considered as part of the "M"-stage.

5.8 Marking

Pipes shall be marked in accordance with ISO 11297-1:2013, 5.8.

Under item c) specified in ISO 11297-1:2013, 5.8, the nominal size marked shall be DN/OD.

Under item d) specified in ISO 11297-1:2013, 5.8, the dimension marked shall be SDR.

In addition, the pipe can be marked with the following optional information: MFR.

6 Fittings at the "M" stage

Fittings shall conform to the requirements of ISO 4427-3. Where required for compatibility with pipe dimensions in accordance with Table 3, fittings with other geometric characteristics are acceptable.

7 Ancillary components

Plastic bodied valves shall conform to the requirements of EN 12201-4. If valves constructed of other materials are specified, full details including applicable reference standards shall be documented in the installation manual.

NOTE Interactive pressure pipe liners can rely on the use of technique-dependent, mechanical fittings for end connections and service connections. The mechanical fittings provide the connection between the liner, which is generally thin walled, and the rest of the pipeline system, by clamping the liner wall inside/outside. By means of a compression part, the fitting provides pressure integrity and leaktightness, and by means of a gripper part provides resistance to end loads. A support sleeve is generally incorporated to resist any hoop tension or compression created by the compression or gripper parts of the fitting. The mechanical fitting can be supplied for field assembly.

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

8.1 Materials

Any combination of pipes and fittings for heat fusion conforming to Clauses 5 and 6, respectively may be used, provided that fusion compatibility has been demonstrated in accordance with ISO 4427-5:2007, Clause 4.

8.2 General characteristics

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

NOTE A feature of close-fit pipe 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 3, whereby relevant dimensions are to be measured in accordance with ISO 3126 at a temperature of (23 ± 2) °C.

Table 3 — Pipe wall thicknesses after installation

Dimensions in millimetres

Maximum mean outside diameter[a] $d_{em,max}$	Standard dimension ratio[a]							
	SDR 11		SDR 17		SDR 26		SDR 33[c]	
	Wall thickness[b]							
	e_{min}	$e_{m,max}$	e_{min}	$e_{m,max}$	e_{min}	$e_{m,max}$	e_{min}	$e_{m,max}$
100	9,1	10,7	5,9	7,1	3,9	4,9		
125	11,4	13,3	7,4	8,8	4,8	5,9		
150	13,7	15,9	8,9	10,5	5,8	7,0	4,7	5,8
200	18,2	20,9	11,9	13,9	7,7	9,2	6,2	7,5
225	20,5	23,5	13,4	15,6	8,6	10,2	7,0	8,4
250	22,7	26,0	14,8	17,1	9,6	11,3	7,7	9,2
300	27,3	31,1	17,7	20,4	11,6	13,5	9,3	11,0
350	31,9	36,3	20,6	23,6	13,5	15,6	10,8	12,6
400			23,7	27,1	15,3	17,7	12,3	14,3
500			29,7	33,5	19,1	21,9	15,3	17,7
600					23,1	26,4	18,5	21,2
700							21,6	24,7
800							24,5	28,0
1 000							30,6	34,8
1 200							36,7	41,7

a Outside diameters and SDRs are examples; other sizes and SDRs are acceptable.

b Wall thickness requirements calculated as installed, both rounded up to the next 0,1 mm:

$e_{min} = d_{em,max} / SDR$,

$e_{m,max} = 1{,}12 e_{min} + 0{,}5$ mm

c Pipes with SDR values > 26 may only be applied as interactive linings.

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 pressure regime, including surge cycles.

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.

NOTE If appropriate, a higher pressure than the operating pressure can be applied to achieve complete reversion.

If the installation of connections requires the use of dedicated fittings and assembly equipment, the installation manual should provide details of these.

8.5 Mechanical characteristics

When tested in accordance with the methods given in Table 4, pipes taken from actual or simulated installations in accordance with 8.8, shall have mechanical characteristics conforming to Table 4.

Table 4 — Mechanical characteristics of pipes

Characteristic	Requirement	Test parameters [ab] Parameters, Value	Test method
Hydrostatic strength at 20 °C (100 h)		ISO 4427-2	
Hydrostatic strength at 80 °C (1000 h)			
Ring stiffness	Declared value but not less than 1,0 kPa	ISO 8772	
Creep ratio	Declared value but not greater than 5	ISO 9967	

[a] Where the test parameters cannot be met with a particular technique (e.g. limited product range, not including SDR 11), the test parameters shall be re-calculated accordingly.

[b] Where electrofusion saddles are offered as part of the lining system, the long-term integrity of the saddle/reverted pipe assembly shall be demonstrated in accordance with ISO 4427-5.

When a PE piping system is to be operated at a continuous constant temperature higher than 20 °C, up to 40 °C, a pressure reduction coefficient as specified in Annex A of ISO 4427-1:2007shall be applied to the nominal pressure rating PN (taken as a value) to determine the allowable operating pressure PFA.

NOTE 1 Where a PE piping system may be exposed to sewage effluent or sewer cleaning chemicals which could impair its long-term performance relative to that expected when transporting clean water, this can be accounted for by applying an additional derating factor, also defined by Annex A of ISO 4427-1:2007, in the determination of PFA as a function of PN. Alternatively the design coefficient used to evaluate PN (see 3.6.1) can be increased to a value higher than the minimum 1.25 commonly applied for clean water applications (see Annex B of ISO 4427-2:2007).

NOTE 2 The determination of material-related surge factors is outside the scope of ISO 11297.

NOTE 3 Annex D of EN 12201-2:2011provides values of initial ring stiffness of PE pipes as a function of SDR applicable for calculation of resistance to internal vacuum associated with negative surge pressure.

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 his technique under the prevailing ambient conditions.

Mechanical characteristics of the assembly, including all electrofusion joints, butt fusion joints and mechanical joints between pipes, fittings and ancillary components, shall conform to those specified in ISO 4427-5.

Where a mechanical joint applies radial compression, a cylindrical metal sleeve shall be inserted into the pipe end, providing permanent internal support to prevent creep.

8.6 Physical characteristics

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

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 ISO 11297-1:2013, 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; ISO 11297-1:2013, 9.4.3.

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.

NOTE Storing the lining pipe on reasonably level ground, free of large sharp stones, debris or litter, helps 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 flat-bed vehicle, free of nails or other projections or on a purpose-built trailer designed to carry the lining pipe as a free-standing coil or wound on to a drum. Before being loaded onto a trailer, 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 under storage, handling and transport.

For pipes of 600 mm diameter or larger, a suitable plug or other closure, which also prevents ovalization or other deformation, is recommended.

Pipes that do not meet the above stated specifications shall be rejected, clearly marked and removed to a separate stock.

9.3 Equipment

9.3.1 Butt-fusion and debeading equipment

Butt fusion equipment, used for inter-connecting individual pipes and fittings, shall conform to ISO 12176-1 and shall be capable of producing joints under site conditions and, in addition to the heater plate, shall include such clamping, re-rounding and trimming facilities as will ensure alignment and matching of the pipe ends and an external debeader, able to remove the bead cleanly in one continuous strip without damage to the pipe.

A shelter should be provided to avoid weld contamination from water and dust and to generally maintain a clean and warm working environment. 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 could damage 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 liner 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 have no adverse effects on the lining.

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 butt-fusion and installation processes.

9.3.4 Winching and rod-pulling equipment

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

Rod pulling equipment normally 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. The rod puller should be provided with a gauge measuring the hydraulic pressure applied to the ram, calibrated to give a direct reading of the force applied to the rods.

All pulling equipment shall have a means of recording, graphically or numerically, the load applied to the winch cable or puller rods during installation.

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

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

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 rerounding 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, 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.

NOTE Attention is drawn to any legislation applicable to lifting equipment.

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. If applicable, the description of the reforming method and the installation parameters shall specify, according to the requirements of the technique concerned:

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

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

c) maximum pulling forces; the maximum stress applied to the liner pipe during insertion shall not exceed the pipe manufacturer's stated value;

d) minimum installation bending radii;

e) permitted ambient temperature range.

The manual shall also include details of the type of fittings to be used and any special requirements for these.

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:

— 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 repeat squeezing of the same section.

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

For pipes expanded to fit an electrofusion coupler, a stiff internal supporting sleeve shall be installed to maintain melt pressure during fusion. The supporting sleeve shall have a design and dimensions which have been proved to give satisfactory joints, in accordance with ISO 4427-3, with the make and type of electrofusion couplers used.

9.5 Process-related inspection and testing

If required by the client, the finished liner shall be inspected internally to verify that it is continuous over the length of the installation, in accordance with ISO 11297-1:2013, 9.8, and exhibits a cross-section complying with the requirements of 8.4 throughout.

Inspection shall be made at the leading end, and where possible, at other places along the installed lengths when the pipe is exposed (e.g. service connections windows), to verify that the external surface of the pipe is not scratched to a depth greater than 10 % of the wall thickness.

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 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.

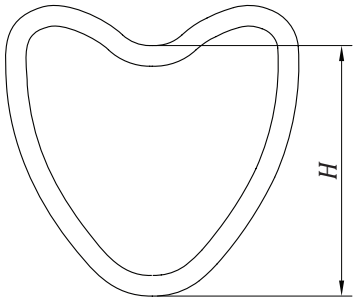

Figure A.1 — Memory effect

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
$e_{min} \leq 8$ mm	(120 ± 2) °C	(60 ± 1) min
$8 < e_{min} \leq 16$ 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: $H \geq 0{,}75\ d_{manuf}$

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

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

A.4 Test Report

The test report shall include the following information:

a) reference to this part of ISO 11297, i.e. ISO 11297-3:2013;

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) temperature and duration of heating of each test piece;

h) 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.

Bibliography

[1] ISO 497, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

[2] ISO 11295, *Classification and information on design of plastics piping systems used for renovation*

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