
**Plastics piping systems for non-
pressure underground drainage and
sewerage — Structured-wall piping
systems of unplasticized poly(vinyl
chloride) (PVC-U), polypropylene (PP)
and polyethylene (PE) —**

**Part 2:
Pipes and fittings with smooth
external surface, Type A**

*Systèmes de canalisations en plastique pour les branchements et les
collecteurs d'assainissement sans pression enterrés — Systèmes de
canalisations à parois structurées en poly(chlorure de vinyle) non
plastifié (PVC-U), polypropylène (PP) et polyéthylène (PE) —*

Partie 2: Tubes et raccords avec une surface externe lisse, type A



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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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 1, *Plastics pipes and fittings for soil, waste and drainage (including land drainage)*.

This second edition cancels and replaces the first edition (ISO 21138:2007), which has been technically revised. The main changes compared to the previous edition are as follows:

- the normative references have been updated;
- references to EN test methods have been updated to ISO test methods, when applicable;
- editorial improvements have been made for clarification.

A list of all parts in the ISO 21138 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 21138 series of standards covers plastics piping systems for non-pressure underground drainage and sewerage, in particular thermoplastics structured-wall piping systems.

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Plastics piping systems for non-pressure underground drainage and sewerage — Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) —

Part 2: Pipes and fittings with smooth external surface, Type A

1 Scope

This document, together with ISO 21138-1, specifies the definitions and requirements for pipes with smooth external and internal surfaces (Type A), fittings and systems based on unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) structured-wall piping systems intended to be used in non-pressure underground drainage and sewerage applications.

NOTE 1 Pipes, fittings and the system complying with this document can also be used for highway drainage and surface water.

This document specifies test methods and test parameters.

This document covers a range of pipe and fitting sizes, materials, pipe constructions and nominal ring stiffnesses, and gives recommendations concerning colours.

NOTE 2 It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and installation practices or codes.

In conjunction with ISO 21138-1, this document is applicable to structured-wall pipes and fittings, to their joints and to joints with components of other plastics and non-plastics materials.

It is applicable to pipes and fittings with or without an integral socket with elastomeric ring seal joints as well as welded and fused joints.

NOTE 3 For dimensions larger than DN/OD 1200, or DN/ID 1200, this document can serve as general guidance regarding appearance, colour, physical and mechanical characteristics as well as performance requirements.

Test methods are not included in this document.

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 161-1, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series*

ISO 178, *Plastics — Determination of flexural properties*

ISO 306:2013, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

ISO 527-2:2012, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 21138-2:2020(E)

ISO 580, *Plastics piping and ducting systems — Injection-moulded thermoplastics fittings — Methods for visually assessing the effects of heating*

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

ISO 1158, *Plastics — Vinyl chloride homopolymers and copolymers — Determination of chlorine content*

ISO 1167-1, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method*

ISO 1167-2, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces*

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 2505, *Thermoplastics pipes — Longitudinal reversion — Test method and parameters*

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

ISO 2507-2, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 2: Test conditions for unplasticized poly(vinyl chloride) (PVC-U) or chlorinated poly(vinyl chloride) (PVC-C) pipes and fittings and for high impact resistance poly(vinyl chloride) (PVC-HI) pipes*

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

ISO 3127, *Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method*

ISO 3451-1, *Plastics — Determination of ash — Part 1: General methods*

ISO 4435:2003, *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 6259-2, *Thermoplastics pipes — Determination of tensile properties — Part 2: Pipes made of unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) and high-impact poly(vinyl chloride) (PVC-HI)*

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

ISO 8773:2006, *Plastics piping systems for non-pressure underground drainage and sewerage — Polypropylene (PP)*

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 11173, *Thermoplastics pipes — Determination of resistance to external blows — Staircase method*

ISO 11357-6, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*

ISO 13229, *Thermoplastics piping systems for non-pressure applications — Unplasticized poly(vinyl chloride) (PVC-U) pipes and fittings — Determination of the viscosity number and K-value*

ISO 13254, *Thermoplastics piping systems for non-pressure applications — Test method for watertightness*

ISO 13259:2018, *Thermoplastics piping systems for underground non-pressure applications — Test method for leaktightness of elastomeric sealing ring type joints*

ISO 13260:2010, *Thermoplastics piping systems for non-pressure underground drainage and sewerage — Test method for resistance to combined temperature cycling and external loading*

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

ISO 13265, *Thermoplastics piping systems for non-pressure underground drainage and sewerage — Joints for buried non-pressure applications — Test method for the long-term sealing performance of joints with elastomeric seals by estimating the sealing pressure*

ISO 13968, *Plastics piping and ducting systems — Thermoplastics pipes — Determination of ring flexibility*

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

ISO 21138-1, *Plastics piping systems for non-pressure underground drainage and sewerage — Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) — Part 1: Material specifications and performance criteria for pipes, fittings and the system*

ISO 21138-3, *Plastics piping systems for non-pressure underground drainage and sewerage — Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) — Part 3: Pipes and fittings with a non-smooth external surface, Type B*

ISO 22088-3, *Plastics — Determination of resistance to environmental stress cracking (ESC) — Part 3: Bent strip method*

EN 681-1, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 1: Vulcanized rubber*

EN 681-2, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 2: Thermoplastic elastomers*

EN 681-4, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 4: Cast polyurethane sealing elements*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 12099, *Plastics piping systems — Polyethylene piping materials and components — Determination of volatile content*

EN 15344, *Plastics — Recycled plastics — Characterisation of polyethylene (PE) recyclates*

EN 15345, *Plastics — Recycled plastics — Characterisation of polypropylene (PP) recyclates*

EN 15346:2014, *Plastics — Recycled plastics — Characterisation of poly(vinyl chloride) (PVC) recyclates*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21138-1 apply.

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.2 Symbols

A	length of engagement, or maximum pull-out whilst maintaining tightness
A_{\min}	minimum value of A
C	depth of sealing zone
C_{\max}	maximum value of C
D_i	inside diameter of a socket
$D_{\text{im, min}}$	minimum mean inside diameter of a socket
d_e	outside diameter (of a pipe or a spigot)
$d_{\text{em, max}}$	maximum value of the mean d_e
$d_{\text{em, min}}$	minimum value of the mean d_e
d_i	inside diameter of a pipe
$d_{\text{im, max}}$	maximum value of the mean d_i
$d_{\text{im, min}}$	minimum value of the mean d_i
e	wall thickness (at any point)
e_c	construction height
e_2	wall thickness of the socket
e_3	wall thickness of the groove
e_4	wall thickness of the inside layer (waterway wall thickness)
e_5	wall thickness of the inside layer under a hollow section
l	effective length of a pipe

3.3 Abbreviated terms

CaCO_3	calcium carbonate
CT	close tolerance
DSC	differential scanning calorimetry
MgCO_3	magnesium carbonate
MFR	melt mass-flow rate
OIT	oxidation induction time
TIR	true impact rate
TPE	thermoplastic elastomer
VST	Vicat softening temperature

4 Material

4.1 General

The material shall be one of the following: unplasticized poly (vinyl chloride) (PVC-U), polypropylene (PP) or polyethylene (PE) to which are added those additives that are needed to facilitate the manufacture of components conforming to this document, including the relevant annexes.

4.2 Unplasticized poly (vinyl chloride) (PVC-U)

4.2.1 General

The raw material shall be PVC-U to which are added those additives that are needed to facilitate the manufacture of components conforming to the requirements of this document (see also [Annex A](#)).

NOTE Additional information on the characteristics of PVC-U material or components made thereof is given in ISO 21138-1:2020, Annex A.

4.2.2 Pipe and fitting material characteristics

When tested in accordance with the test method specified in [Table 1](#), using the indicated parameters, the material shall have characteristics conforming to the requirements given in [Table 1](#).

Table 1 — Material characteristics of PVC-U pipes and injection-moulded fittings

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure ^{a,b,c}	No failure during the test period	Test temperature	60 °C	ISO 1167-1
		Circumferential stress		ISO 1167-2
		— pipe material	10 MPa	
		— fitting material	6,3 MPa	
		Test period	1 000 h	
		Type of test	Water-in-water	
		End caps	Type A or B	
		Orientation	Free	
		Number of test pieces	3	
Conditioning period	In accordance with ISO 1167-1			
^a For extrusion compounds, this test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.				
^b For injection-moulding compounds, this test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.				
^c Not required for the intermediate layer of Type A1 pipes.				

4.2.3 Utilization of non-virgin materials

For the utilization of non-virgin PVC-U materials, conditions and requirements are given in [Annex B](#), and the non-virgin materials shall conform to the characterization specified in EN 15346.

NOTE [Annex G](#) gives a survey of the possible uses of reprocessed and recycled materials.

4.3 Polypropylene (PP)

4.3.1 General

The base material shall be polypropylene (PP) to which are added those additives that are needed to facilitate the manufacture of components conforming to the requirements of this document (see also [Annex C](#)).

NOTE Additional information on the characteristics of PP material or components made thereof is given in ISO 21138-1:2020, Annex A.

4.3.2 Pipe and fitting material characteristics

When tested in accordance with the test methods specified in [Table 2](#), using the indicated parameters, the material shall have characteristics conforming to the requirements given in [Table 2](#).

Table 2 — Material characteristics of PP pipes and injection-moulded fittings

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure 140 h ^{a,b,c}	No failure during the test period	Test temperature	80 °C	ISO 1167-1
		Circumferential stress	4,2 MPa	ISO 1167-2
		Test period	140 h	
		Type of test	Water-in-water	
		End caps	Type A or B	
		Orientation	Free	
		Number of test pieces	3	
		Conditioning period	In accordance with ISO 1167-1	
Resistance to internal pressure 1 000 h ^{a,b,c}	No failure during the test period	Test temperature	95 °C	ISO 1167-1
		Circumferential stress	2,5 MPa	ISO 1167-2
		Test period	1 000 h	
		Type of test	Water-in-water	
		End caps	Type A or B	
		Orientation	Free	
		Number of test pieces	3	
		Conditioning period	In accordance with ISO 1167-1	
Melt mass-flow rate (MFR)	≤1,5 g/10 min	Temperature	230 °C	ISO 1133-1
		Loading mass	2,16 kg	
Thermal stability, (OIT)	≥8 min	Temperature	200 °C	ISO 11357-6
^a For extrusion compounds, this test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material. ^b For injection-moulding compounds, this test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material. ^c Not required for the intermediate layer of Type A1 pipes.				

4.3.3 Melt mass-flow rate classification

Materials for pipes and fittings intended for jointing in the field by fusion or welding shall be designated by the following MFR classes:

- Class A: $MFR \leq 0,3 \text{ g}/10 \text{ min}$;
- Class B: $0,3 \text{ g}/10 \text{ min} < MFR \leq 0,6 \text{ g}/10 \text{ min}$;
- Class C: $0,6 \text{ g}/10 \text{ min} < MFR \leq 0,9 \text{ g}/10 \text{ min}$;
- Class D: $0,9 \text{ g}/10 \text{ min} < MFR \leq 1,5 \text{ g}/10 \text{ min}$.

In the case where a raw material, because of its MFR tolerance, arbitrarily falls in one of two adjacent classes, the manufacturer of the components may mark the MFR class on the product as follows:

- for an MFR value across the border between A and B it is permitted to classify as class A;
- for an MFR value across the border between B and C it is permitted to classify as class C;
- for an MFR value across the border between C and D it is permitted to classify as class D.

4.3.4 Utilization of non-virgin materials

For the utilization of non-virgin PP materials, conditions and requirements are given in [Annex D](#), and the non-virgin materials shall conform to the characterization specified in EN 15345.

NOTE [Annex G](#) gives a survey of the possible uses of reprocessed and recycled materials.

4.4 Polyethylene (PE)

4.4.1 General

The base material shall be polyethylene (PE) to which are added those additives that are needed to facilitate the manufacture of components conforming to this document. See also [Annex E](#).

NOTE Additional information on the characteristics of PE material or components made thereof is given in ISO 21138-1:2020, Annex A.

4.4.2 Material characteristics of pipes and injection-moulded fittings

When tested in accordance with the test method specified in [Table 3](#), using the indicated parameters, the material shall have characteristics conforming to the requirements given in [Table 3](#).

Table 3 — Material characteristics of PE pipes and injection-moulded fittings

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure 165 h ^{a,b,c}	No failure during the test period	Test temperature	80 °C	ISO 1167-1
		Circumferential stress	4,0 MPa	ISO 1167-2
		Test period	165 h	
		Type of test	Water-in-water	
		End caps	Type A or B	
		Orientation	Free	
		Number of test pieces	3	
		Conditioning period	In accordance with ISO 1167-1	
Resistance to internal pressure 1 000 h ^{a,b,c}	No failure during the test period	Test temperature	80 °C	ISO 1167-1
		Circumferential stress	2,8 MPa	ISO 1167-2
		Test period	1 000 h	
		Type of test	Water-in-water	
		End caps	Type A or B	
		Orientation	Free	
		Number of test pieces	3	
		Conditioning period	In accordance with ISO 1167-1	
Melt mass-flow rate (MFR)	≤1,6 g/10 min	Temperature	190 °C	ISO 1133-1
		Loading mass	5 kg	
Thermal stability (OIT)	≥20 min	Temperature	200 °C	ISO 11357-6
Reference density ^d	≥930 kg/m ³	ISO 1183-1		ISO 1183-1
<p>^a For extrusion compounds, this test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.</p> <p>^b For injection-moulding compounds, this test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.</p> <p>^c Not required for the intermediate layer of Type A1 pipes.</p> <p>^d To be measured on the base polymer.</p>				

4.4.3 Material characteristics of rotational-moulded fittings

When tested in accordance with the test methods specified in [Table 4](#), using the indicated parameters, the material shall have characteristics conforming to the requirements given in [Table 4](#).

Table 4 — Material characteristics of PE rotational-moulded fittings

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure 165 h ^a	No failure during the test period	Test temperature	60 °C	ISO 1167-1
		Circumferential stress	3,9 MPa	ISO 1167-2
		Test period	165 h	
		Type of test	Water-in-water	
		End caps	Type A or B	
		Orientation	Free	
		Number of test pieces	3	
		Conditioning period	In accordance with ISO 1167-1	
Resistance to internal pressure 1 000 h ^a	No failure during the test period	Test temperature	60 °C	ISO 1167-1
		Circumferential stress	3,2 MPa	ISO 1167-2
		Test period	1 000 h	
		Type of test	Water-in-water	
		End caps	Type A or B	
		Orientation	Free	
		Number of test pieces	3	
		Conditioning period	In accordance with ISO 1167-1	
Melt mass-flow rate (MFR)	3 g/10 min ≤ MFR ≤ 16 g/10 min	Temperature	190 °C	ISO 1133-1
		Loading mass	5 kg	
Thermal stability, (OIT)	≥10 min	Temperature	200 °C	ISO 11357-6
Reference density ^b	≥925 kg/m ³	Temperature	(23 ± 2) °C	ISO 1183-1
^a This test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.				
^b To be measured on the base polymer.				

4.4.4 Utilization of non-virgin materials

For the utilization of non-virgin PE materials, conditions and requirements are given in [Annex F](#), and the non-virgin materials shall conform to the characterization specified in EN 15344.

NOTE [Annex G](#) gives a survey of the possible uses of reprocessed and recycled materials.

4.5 Sealing ring retaining components

It is permitted that sealing rings be retained using components made from any polymer.

4.6 Sealing rings

The sealing ring material shall conform to EN 681-1, EN 681-2 or EN 681-4, as applicable.

The sealing ring shall have no detrimental effects on the properties of the components and shall not cause the test assembly to fail the performance requirements given in [Clause 10](#).

4.7 Fused or welded joints

The design of fused or welded joints together with the manufacturer's instructions for the jointing process shall not cause the test assembly to fail the performance requirements given in [Clause 10](#).

4.8 Adhesives for PVC-U

The adhesive for solvent cement jointing of PVC-U shall be solvent cement and shall be as specified by the manufacturer of the pipes or fittings, where appropriate.

The adhesive shall have no detrimental effects on the properties of components and shall not cause the test assembly to fail the performance requirements given in [Clause 10](#).

5 Designation of wall construction and examples of typical jointing methods

NOTE The figures are schematic sketches only to indicate the relevant dimensions. They do not necessarily represent the manufactured components.

5.1 Wall constructions designated as Type A

5.1.1 Multilayer construction or hollow-wall construction with axial hollow sections, Type A1 constructions

A pipe or fitting with smooth inside and outside surfaces and in which the outer and inner walls are connected by internal axial ribs or a foamed or non-foamed intermediate layer of thermoplastics shall be designated Type A1. Typical examples of Type A1 constructions are shown in [Figure 1](#).

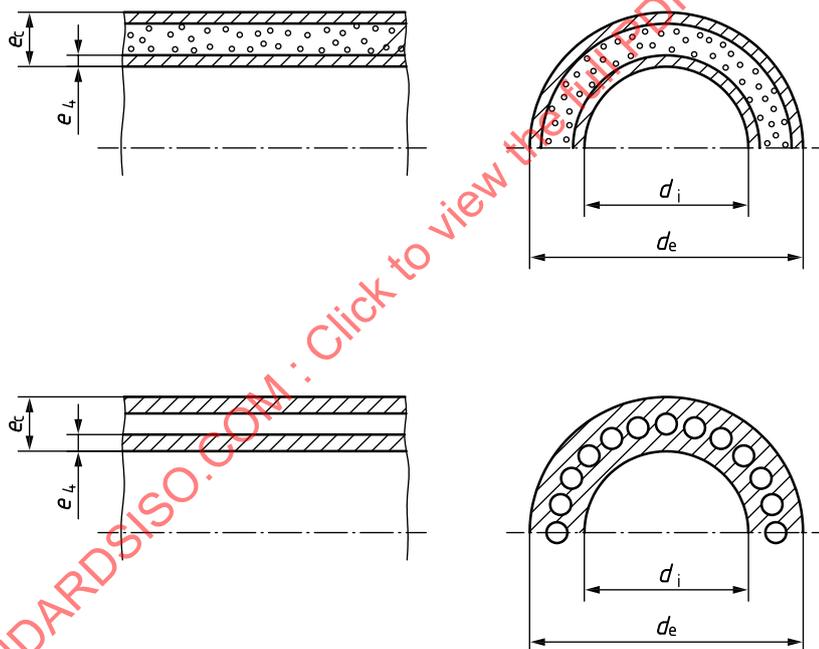


Figure 1 — Typical examples of wall construction Type A1

5.1.2 Hollow-wall construction with spirally or radially formed hollow sections, Type A2 constructions

A pipe or fitting with smooth inside and outside surfaces and in which the outer and inner walls are connected by internal spirally or radially formed ribs shall be designated Type A2. A typical example of Type A2 constructions is shown in [Figure 2](#).

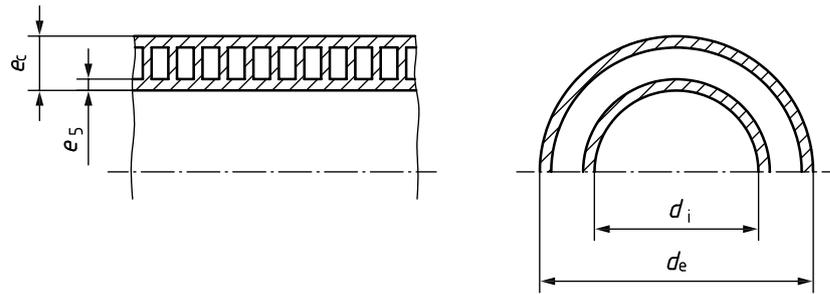


Figure 2 — Typical example of wall construction Type A2

5.1.3 Typical jointing methods for Type A structured-wall pipes

Relevant dimensions for typical joints of Type A pipes are shown in Figure 3. When factory-mounted sealing rings are used, the dimensions A and C may be defined relative to the effective sealing point.

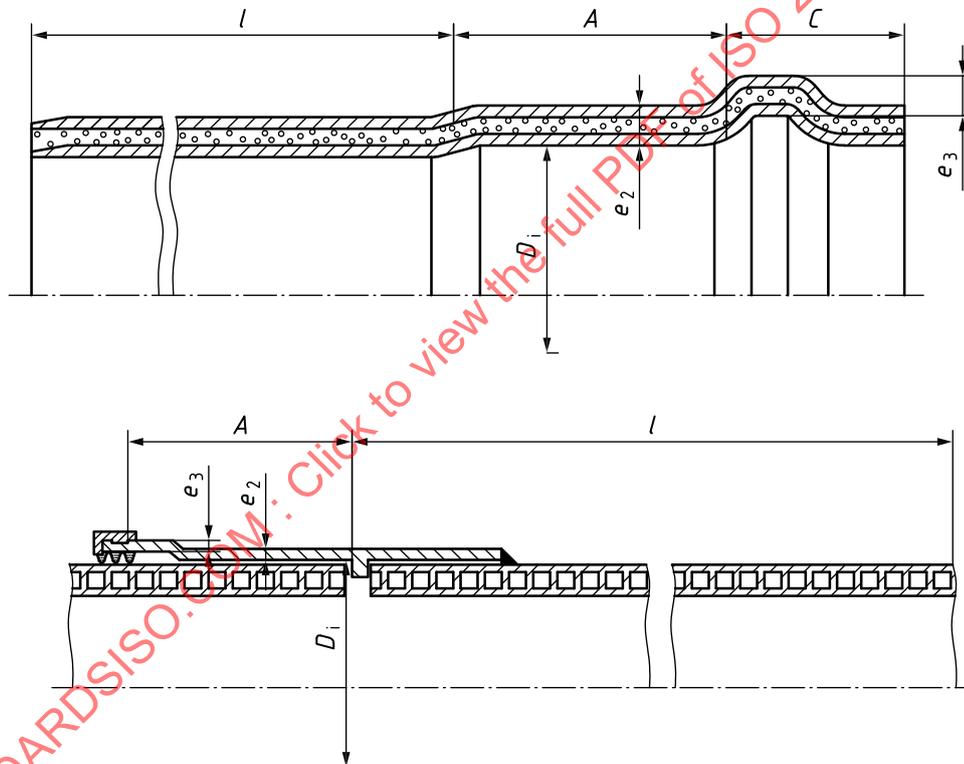


Figure 3 — Typical examples of joints for Type A constructions

5.2 Designation and design of joints

Pipes and fittings may be designed with spigot ends and sockets of another construction than the pipe or fitting body. Such constructions may be Type A1, Type A2 or Type B or solid wall. For definitions and specifications for Type B, see ISO 21138-3.

NOTE Joints with elastomeric sealing rings are designed either with the sealing ring positioned on the spigot or in the socket. See Figure 3.

6 General characteristics for pipes and fittings — Colour

Colour and appearance are specified in ISO 21138-1.

7 Geometrical characteristics

7.1 General

All dimensions shall be measured in accordance with ISO 3126.

7.2 Dimensions

7.2.1 Designation

Pipes and fittings are sized according to their outside diameter (DN/OD series) and/or according to their inside diameter (DN/ID series).

7.2.2 Lengths of pipe

The effective length of pipe, l , shall be not less than that specified by the manufacturer when measured as shown in [Figure 3](#).

7.2.3 Diameters of Type A pipes and Type A spigots of pipes or fittings

The outside diameters and the tolerances of Type A pipes and plain spigots for DN/OD series of pipes and fittings intended to have jointing dimensions conforming to ISO 4435, ISO 8772 or ISO 8773 for PVC, PE or PP respectively, shall conform to [Table 5](#).

The nominal sizes and minimum mean inside diameters are specified in [Table 9](#).

Dimensions lower than DN/ID 100 and DN/OD 110 are not permitted.

Other dimensions greater than DN/OD 110 and not included in [Table 5](#) are permitted and shall be selected from ISO 161-1. The minimum inside diameter, $d_{im,min}$, shall be linearly interpolated between the adjacent values specified in [Table 9](#).

Table 5 — Mean outside diameters and tolerances

Dimensions in millimetres

Nominal size DN/OD	Mean outside diameter		
	$d_{em,min}$	Close tolerances (CT) $d_{em,max}$	Enlarged tolerances ^a $d_{em,max}$
110	110,0	110,3	111,0
125	125,0	125,3	126,2
160	160,0	160,4	161,5
200	200,0	200,5	201,8
250	250,0	250,5	252,3
315	315,0	315,6	317,9
400	400,0	400,7	403,6
500	500,0	500,9	504,5
630	630,0	631,1	635,7
800	800,0	801,3	807,2
1 000	1 000,0	1 001,6	1 009,0
1 200	1 200,0	1 202,0	1 210,0

^a Enlarged tolerances are permitted for PP for DN/OD ≥ 200 and for DN/OD ≥ 110 for PE.

7.2.4 Diameters and jointing dimensions of sockets and spigots

Diameters and jointing dimensions of sockets and spigots shall conform to [Table 6](#), [Table 7](#) and [Table 8](#) as appropriate.

Table 6 — Diameters and lengths of elastomeric ring seal sockets and spigots of PVC-U pipes and fittings

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Socket			Spigot $L_{1,min}$
		$D_{im,min}$	A_{min}	C_{max}	
110	110,0	110,4	32	26	60
125	125,0	125,4	35	26	67
160	160,0	160,6	42	32	81
200	200,0	200,6	50	40	99
250	250,0	250,8	55	70	125
315	315,0	316,0	62	70	132
400	400,0	401,2	70	80	150
500	500,0	501,5	80	80 ^a	160
630	630,0	631,9	93	95 ^a	188
800	800,0	802,4	110	110 ^a	220
1 000	1 000,0	1 003,0	130	140 ^a	270
1 200	1 200,0	—	150	—	—

^a Higher values for C are allowed, provided the manufacturer states in his documentation the actual value of $L_{1,min}$ required by the formula $L_{1,min} = A_{min} + C$.

Other dimensions are permitted and shall be selected from ISO 161-1.

Table 7 — Diameters and lengths of elastomeric ring seal sockets and spigots of PP pipes and fittings

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Socket			Spigot $L_{1,min}$
		$D_{im,min}$	A_{min} ^a	C_{max} ^b	
110	110,0	110,4	40	22	62
125	125,0	125,4	43	26	68
160	160,0	160,5	50	32	82
200	200,0	200,6	58	40	98
250	250,0	252,4	68	50	118
315	315,0	318,0	81	63	144
400	400,0	403,7	98	80	178
500	500,0	504,6	118	100	218
630	630,0	635,8	144	126	270
800	800,0	807,4	160	160	338

^a The socket is designed for an effective length of pipe of 6 m.

^b Higher values for C are allowed, provided the manufacturer states in his documentation the actual value of $L_{1,min}$ required by the formula $L_{1,min} = A_{min} + C$.

Table 7 (continued)

Nominal size DN/OD	Nominal outside diameter d_n	Socket			Spigot $L_{1,min}$
		$D_{im,min}$	A_{min}^a	C_{max}^b	
1 000	1 000,0	1 009,0	180	200	418
1 200	1 200,0	1 211,0	200	240	498

^a The socket is designed for an effective length of pipe of 6 m.

^b Higher values for C are allowed, provided the manufacturer states in his documentation the actual value of $L_{1,min}$ required by the formula $L_{1,min} = A_{min} + C$.

For pipes lengths longer than 6 m, the length of engagement, A , in the socket, expressed in millimetres, shall be calculated from the formula $A = (0,2d_n + 3l)$, where l is the effective pipe length, in metres.

Table 8 — Diameters and lengths of elastomeric ring seal sockets and spigots of PE pipes and fittings

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Socket			Spigot $L_{1,min}$
		$D_{im,min}$	A_{min}^a	C_{max}	
110	110,0	111,1	40	22	62
125	125,0	126,3	43	26	68
160	160,0	161,6	50	32	82
200	200,0	201,9	58	40	98
250	250,0	252,4	68	50	118
315	315,0	318,0	81	63	144
400	400,0	403,7	98	80	178
500	500,0	504,6	118	100	218
630	630,0	635,8	144	126	270
800	800,0	807,4	160	160	338
1 000	1 000,0	1 009,0	180	200	418
1 200	1 200,0	1 211,0	200	240	498

^a The socket is designed for an effective length of pipe of 6 m.

For pipes lengths longer than 6 m, the length of engagement, A , in the socket, expressed in millimetres, shall be calculated from the equation $A = (0,2d_n + 3l)$, where l is the effective pipe length, in metres.

7.2.5 Wall thicknesses

7.2.5.1 Pipes — Type A1 or A2 construction

The wall thickness of the inside layer, e_4 and/or e_5 , as applicable, of pipes and spigots (see Figures 1 and 2) shall conform to Table 9.

For pipes and fittings up to DN/OD 200 and up to 200 mm actual outside diameter of pipes of DN/ID series, the construction height, e_c , shall be at least as specified for e_{min} in:

- a) the SDR 41 series in ISO 4435:2003, for PVC-U;
- b) the SDR 33 series in ISO 8773:2006, for PP;
- c) the SDR 26 series in ISO 8772:2006, for PE.

In the case of DN/ID series pipes, the calculation shall be based on the actual outside diameter of the pipes. For sizes not specified in those standards, the values shall be linearly interpolated between the adjacent dimensions.

In the case where a pipe or fitting is designed with a solid-wall spigot, the requirements in 7.2.5.2 apply.

Table 9 — Nominal sizes, minimum mean inside diameters, thickness of inside layers and socket length

Dimensions in millimetres

Diameters ^{a,b}					Minimum wall thickness		
DN/OD series			DN/ID series		Type A1		Type A2
DN/OD	PVC-U $d_{im,min}$	PP/PE $d_{im,min}$	DN/ID	$d_{im,min}$	Multi-layer $e_{4,min}$	Hollow wall $e_{4,min}$	$e_{5,min}$
110	97	90	100	95	0,4	0,6	1,0
125	107	105	—	—	0,4	0,6	1,1
—	—	—	125	120	—	—	1,2
160	135	134	—	—	0,5	0,8	1,2
—	—	—	150	145	—	—	1,3
200	172	167	—	—	0,6	1,0	1,4
—	—	—	200	195	—	—	1,5
250	216	209	225	220	0,7	1,1	1,7
—	—	—	250	245	—	—	1,8
315	270	263	—	—	0,8	1,2	1,9
—	—	—	300	294	—	—	2,0
400	340	335	—	—	1,0	1,5	2,3
—	—	—	400	392	—	—	2,5
500	432	418	—	—	1,3	2,1	2,8
—	—	—	500	490	—	—	3,0
630	540	527	—	—	1,6	2,6	3,3
—	—	—	600	588	—	—	3,5
800	680	669	—	—	2,0	3,0	4,1
—	—	—	800	785	—	—	4,5
1 000	864	837	—	—	2,5	3,5	5,0
—	—	—	1 000	985	—	—	5,0
1 200	1 037	1 005	—	—	2,8	4,7	5,0
—	—	—	1 200	1 185	—	—	5,0

^a The actual inside diameter of a pipe depends on the material, construction and stiffness. It may be considerably higher than the minimum specified in this table. For more information see the manufacturer's documentation.

^b The minimum mean inside diameter, $d_{im,min}$, of a fitting shall be not less than 98 % of the specified minimum mean inside diameter of the pipe for which it is designed or it shall conform to this table, whichever is the greater value.

Other dimensions are permitted and shall be selected from ISO 161-1.

7.2.5.2 Wall thickness of sockets and joint design requirements

Sockets of Type A1 and A2 pipes and fittings shall have a minimum wall thickness, e_2 , of $0,9e$.

When a socket contains a groove, e_3 shall have a minimum value of $0,75e$.

Fittings or ancillaries based on Type B and adapted to Type A components shall conform with the minimum dimensions given in ISO 21138-3.

7.2.5.3 Fabricated fittings

The wall thickness of the body of fittings fabricated from pipes shall conform to the requirements of the corresponding pipe. Wall thickness reduction due to the process is permitted provided there is conformance with the performance requirements in [Table 19](#).

The jointing design shall conform to [7.2.5.2](#).

The socket and spigot dimensions shall comply with [7.2.4](#).

7.2.5.4 Rotational-moulded fittings

The minimum wall thickness in the body of rotational-moulded fittings, $e_{4,min}$, shall be 1,25 x the values specified for injection-moulded fittings, rounded to the next higher 0,1 mm.

If a rotational-moulded fitting has a solid wall spigot and/or socket, the minimum required wall-thicknesses e_1 , e_2 and e_3 as applicable shall be 1,25 x the values derived from [7.2.5.2](#).

7.3 Types of fitting

The types of fitting covered by this document are specified in ISO 21138-1.

8 Physical characteristics

8.1 Unplasticized poly(vinyl chloride) (PVC-U)

8.1.1 Physical characteristics of PVC-U pipes

When tested in accordance with the test methods specified in [Table 10](#), using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in [Table 10](#).

Table 10 — Physical characteristics of PVC-U pipes

Characteristic	Requirements	Test parameters		Test method
Vicat softening temperature (VST) ^a	≥79 °C	In accordance with ISO 2507-1 and ISO 2507-2		ISO 2507-1 and ISO 2507-2
Longitudinal reversion ^b	≤5 % The pipe shall show no delaminations, cracks or bubbles ^c	Temperature	(150 ± 2) °C	ISO 2505 Method A, liquid
		Immersion time ^d for: e ≤ 8 mm e > 8 mm	15 min 30 min	
		Or		
		Temperature	(150 ± 2) °C	ISO 2505 Method B, air
		Immersion time ^d for: e ≤ 8 mm e > 8 mm	30 min 60 min	
Resistance to dichloromethane ^e (Alternative test method to assess degree of gelation)	No attack	Test temperature Immersion time Chamfering	15 °C 30 min No	ISO 9852

Table 10 (continued)

Characteristic	Requirements	Test parameters		Test method
Uniaxial tensile test ^e (Alternative test method to assess degree of gelation)	Strain at break ≥80 %	Test speed Test temperature	5 ± 1 mm/min (23 ± 2) °C	ISO 6259-1 and ISO 6259-2
DSC ^{e,f} (Alternative test method to assess degree of gelation)	B-onset temperature ≥185 °C	Shall conform to ISO 18373-1 Number of test pieces	4	ISO 18373-1
<p>^a Not applicable to the foamed part of a pipe. If e_4 is less than 1,8 mm the test shall be carried out on a profile extruded from the material; indirect testing may be carried out using the pipe sample.</p> <p>^b In case of dispute, the method “liquid bath” shall be used.</p> <p>^c Bubbles in the foamed structure are exempt from this requirement.</p> <p>^d For the wall thickness, e, the maximum measured wall thickness of the pipe shall be taken.</p> <p>^e The appropriate test method shall be chosen by the producer for factory production control, taking into account national regulation or internal health and safety policy. In case of dispute, the DSC method shall be used.</p> <p>^f This test is not intended to be used for factory production control.</p>				

8.1.2 Physical characteristics of PVC-U fittings

When tested in accordance with the test methods specified in [Table 11](#), using the indicated parameters, the fitting shall have physical characteristics conforming to the requirements given in [Table 11](#).

Table 11 — Physical characteristics of PVC-U injection-moulded fittings

Characteristic	Requirements	Test parameters		Test method
Vicat softening temperature (VST) ^a	≥77 °C	In accordance with ISO 2507-1 and ISO 2507-2		ISO 2507-1 and ISO 2507-2
Effect of heating	^b	Test temperature Heating time	(150 ± 2) °C In accordance with ISO 580 ^c	ISO 580, air
^a Only applicable to injection-moulded fittings and injection-moulded components for fabricated fittings. ^b 1) Within a radius of 15 × the wall thickness around the injection point(s), the depth of cracks, delamination or blisters shall not exceed 50 % of the wall thickness at that point. 2) Within a distance of 10 × the wall thickness from the diaphragm zone, the depth of cracks, delamination or blisters shall not exceed 50 % of the wall thickness at that point. 3) Within a distance of 10 × the wall thickness from the ring gate, the length of cracks running through the overall thickness of the wall shall not exceed 50 % of the wall thickness at that point. 4) The weld line shall not have opened more than 50 % of the wall thickness at that line. 5) In all other parts of the surface, the depth of cracks and delaminations shall not exceed 30 % of the wall thickness at that point. Blisters shall not exceed a length of 10 × the wall thickness. ^c For the wall thickness, <i>e</i> , the maximum measured wall thickness of the pipe excluding <i>e_c</i> shall be taken.				

8.2 Polypropylene (PP)

8.2.1 Physical characteristics of PP pipes

When tested in accordance with the test methods specified in [Table 12](#), using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in [Table 12](#).

Table 12 — Physical characteristics of PP pipes

Characteristic	Requirements	Test parameters		Test method
Longitudinal reversion ^a	≤2 % The pipe shall show no delaminations, cracks or bubbles ^b	Temperature	(150 ± 2) °C	ISO 2505 Method A, liquid
		Immersion time ^c for: <i>e</i> ≤ 8 mm <i>e</i> > 8 mm	15 min 30 min	
		Or		
		Temperature	(150 ± 2) °C	ISO 2505 Method B, air
		Immersion time ^c for: <i>e</i> ≤ 8 mm <i>e</i> > 8 mm	30 min 60 min	
^a In case of dispute, the method “liquid bath” shall be used. ^b Bubbles in the foamed structure are exempt from this requirement. ^c For the wall thickness, <i>e</i> , the maximum measured wall thickness of the pipe shall be taken.				

8.2.2 Physical characteristics of PP fittings

When tested in accordance with the test method specified in [Table 13](#), using the indicated parameters, the fittings shall have physical characteristics conforming to the requirements given in [Table 13](#).

Table 13 — Physical characteristics of PP injection-moulded components

Characteristic	Requirements	Test parameters		Test method
Effect of heating ^a	^b	Test temperature Heating time	(150 ± 2) °C In accordance with ISO 580 ^c	ISO 580, air
^a Only applicable to injection-moulded fittings and injection-moulded components for fabricated fittings. ^b The depth of cracks, delamination or blisters shall not be more than 20 % of the wall thickness around the injection point(s). No part of the weld line shall open to a depth of more than 20 % of the wall thickness. ^c For the wall thickness, <i>e</i> , the maximum measured wall thickness of the fitting excluding <i>e_c</i> shall be taken.				

8.3 Polyethylene (PE)

8.3.1 Physical characteristics of PE pipes

When tested in accordance with the test methods specified in [Table 14](#), using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in [Table 14](#).

Table 14 — Physical characteristics of PE pipes

Characteristic	Requirements	Test parameters		Test method
Longitudinal reversion ^a	≤3 % The pipe shall show no delaminations, cracks or bubbles ^b	Temperature	(110 ± 2) °C	ISO 2505 Method A, liquid
		Immersion time ^c for: <i>e</i> ≤ 8 mm <i>e</i> > 8 mm	15 min 30 min	
		Or		
		Temperature	(110 ± 2) °C	ISO 2505 Method B, air
		Immersion time ^c for: <i>e</i> ≤ 8 mm <i>e</i> > 8 mm	30 min 60 min	
^a In case of dispute, the method “liquid bath” shall be used. ^b Bubbles in the foamed structure are exempt from this requirement. ^c For the wall thickness, <i>e</i> , the maximum measured wall thickness of the pipe shall be taken.				

8.3.2 Physical characteristics of PE fittings

When tested in accordance with the test method specified in [Table 15](#), using the indicated parameters, the fitting shall have physical characteristics conforming to the requirements given in [Table 15](#).

Table 15 — Physical characteristics of PE injection-moulded components

Characteristic	Requirements	Test parameters		Test method
Effect of heating ^a	^b	Test temperature Heating time	(110 ± 2) °C In accordance with ISO 580 ^c	ISO 580, air
^a Only applicable to injection-moulded fittings and injection-moulded components for fabricated fittings. ^b The depth of cracks, delamination or blisters shall not be more than 20 % of the wall thickness around the injection point(s). No part of the weld line shall open to a depth of more than 20 % of the wall thickness. ^c For the wall thickness, <i>e</i> , the maximum measured wall thickness of the fitting excluding <i>e_c</i> shall be taken.				

9 Mechanical characteristics

9.1 Mechanical characteristics of pipes

9.1.1 General

When tested in accordance with the test methods specified in [Table 16](#), using the indicated parameters, the pipe shall have mechanical characteristics conforming to the requirements given in [Table 16](#).

The pipes shall be designated in one of the following nominal ring stiffness classes (SN):

- DN ≤ 500: SN 4, SN 8 or SN 16;
- DN > 500: SN 2, SN 4, SN 8 or SN 16.

For DN ≥ 500 the manufacturer's guaranteed minimum stiffness, between the SN values, of a component may be used for calculation purposes only. Such pipes shall be classified and marked as the next lower stiffness class.

Table 16 — Mechanical characteristics of pipes

Characteristic	Requirements	Test parameters		Test method
Ring stiffness	≥ relevant SN	In accordance with ISO 9969		ISO 9969
Impact strength	TIR ≤ 10 %	Test temperature Conditioning medium Type of striker Mass of striker ^a for: $d_{im,max} \leq 100$ $100 < d_{im,max} \leq 125$ $125 < d_{im,max} \leq 160$ $160 < d_{im,max} \leq 200$ $200 < d_{im,max} \leq 250$ $250 < d_{im,max} \leq 315$ $315 < d_{im,max}$ Fall height of striker ^a for: $d_{em,min} \leq 110$ $d_{em,min} > 110$	(0 ± 1) °C Water or air d90 0,5 kg 0,8 kg 1,0 kg 1,6 kg 2,0 kg 2,5 kg 3,2 kg 1 600 mm 2 000 mm	ISO 3127
^a Refer to the specified $d_{em,min}$. ^b Only applicable to spirally formed pipes.				

Table 16 (continued)

Characteristic	Requirements	Test parameters		Test method
Ring flexibility	In accordance with 9.1.2 at 30 % of d_{em}	Deflection	30 %	ISO 13968
		Length of test piece	Shall incorporate at least 5 ribs/spirals ^b	
		Position of test piece	Mould split line, when applicable, at 0°, 45° and 90° from the upper plate	
Creep ratio	PVC-U: ≤2,5 at 2 year extrapolation PP and PE: ≤4 at 2 year extrapolation	In accordance with ISO 9967		ISO 9967
Tensile strength of seam ^b	Minimum required tensile strength of the seam shall be: ≥380 N for DN < 400 ≥510 N for 400 ≤ DN < 600 ≥760 N for 600 ≤ DN < 800 ≥1 020 N for DN ≥ 800	Rate of movement	15 mm/min	ISO 13262
^a Refer to the specified $d_{em,min}$. ^b Only applicable to spirally formed pipes.				

9.1.2 Ring flexibility

When tested in accordance with the test method described in Table 16, using the indicated parameters, and visually inspected without magnification, a) and b) shall be satisfied during the test:

- a) there shall be no decrease of the measured force;
- b) there shall be no cracking in any part of the wall structure.

Also, c) to e) shall be satisfied after the test:

- c) there shall be no wall delamination;
- d) there shall be no other types of rupture in the test piece;
- e) permanent buckling in any part of the structure of the pipe wall including depressions and craters shall not occur in any direction.

9.1.3 Tensile strength of seams (Type A2)

When tested in accordance with Table 16, the minimum required tensile strength of the seam shall conform to Table 16.

9.1.4 Additional requirements

Pipes intended to be used in areas where installation is carried out at a temperature less than -10 °C shall conform to the requirements of an impact test (staircase method) as specified in Table 17.

Table 17 — Low temperature installation performance test

Characteristic	Requirements	Test parameters		Test method
Impact resistance (Staircase method)	H50 ≥ 1 000 mm	Test and conditioning temperature	(-10 ± 1) °C	ISO 11173
	No break below 500 mm	Type of striker	d90	
		Mass of striker ^a for:		
		$d_{em,min} \leq 110$ mm	4,0 kg	
		$110 \text{ mm} < d_{em,min} \leq 125$ mm	5,0 kg	
		$125 \text{ mm} < d_{em,min} \leq 160$ mm	6,25 kg	
		$160 \text{ mm} < d_{em,min} \leq 200$ mm	8,0 kg	
		$200 \text{ mm} < d_{em,min} \leq 225$ mm	10,0 kg	
		$225 \text{ mm} < d_{em,min}$	12,5 kg	
^a Refer to the specified $d_{em,min}$.				

9.2 Mechanical characteristics of fittings

The mechanical characteristics of fittings shall conform to the requirements given in ISO 4435, ISO 8772 and ISO 8773 as relevant

The fittings shall be designated in one of the following nominal stiffness classes (SN):

- DN ≤ 500: SN 4, SN 8 or SN 16;
- DN > 500: SN 2, SN 4, SN 8 or SN 16.

NOTE For DN ≥ 500 the manufacturer’s guaranteed minimum stiffness, between the SN nominal values of a component, can be used for calculation purposes.

10 Performance requirements

When tested in accordance with the test methods specified in [Table 18](#), using the indicated parameters, the joints and the system shall have characteristics conforming to the requirements given in [Table 18](#).

Table 18 — Performance requirements

Characteristic	Requirements	Test parameters		Test method
Tightness of elastomeric ring seal joint		Temperature	(23 ± 2) °C	ISO 13259:2018 Condition B
		Spigot deflection	10 %	
		Socket deflection	5 %	
	No leakage	Water pressure	5 kPa (0,05 bar)	
Tightness of elastomeric ring seal joint	No leakage	Water pressure	50 kPa (0,5 bar)	ISO 13259:2018 Condition C
	≤ -27 kPa (-0,27 bar)	Air pressure	-30 kPa (-0,3 bar)	
		Temperature	(23 ± 2) °C	
		Joint deflection:	2° 1,5° 1°	
Tightness of elastomeric ring seal joint		$d_e \leq 315$ mm		ISO 13260:2010 Method A, hot and cold water
	No leakage	Water pressure	5 kPa (0,05 bar)	
	No leakage	Water pressure	50 kPa (0,5 bar)	
	≤ -27 kPa (-0,27 bar)	Air pressure	-30 kPa (-0,3 bar)	
Resistance to combined temperature cycling and external loading ^a	b	For $d_{im} \leq 160$ mm: In accordance with ISO 13260:2010, Method A		ISO 13260:2010 Method B, hot water
		For $d_{im} > 160$ mm: In accordance with ISO 13260:2010, Method B		
Long-term performance of TPE seals	Tube pressure, extrapolated to 100 years: ≥150 kPa (1,5 bar)	Test temperature	(23 ± 2) °C	ISO 13265
Watertightness ^c	No leakage	Water pressure	50 kPa (0,5 bar)	ISO 13254
		Duration	1 min	
Tensile test of welded or fused joints ^d	No break in the joint	Minimum tensile force	In accordance with Table 16	ISO 13262 ^e
^a Only for components in accordance with this document with DN/OD ≤ 335 and DN/ID ≤ 300. ^b The following requirements apply: — vertical deformation: ≤9 % — deviation from surface evenness in bottom: ≤ 3 mm — radius of bottom: ≥80 % of original — opening of weld line: ≤20 % of wall thickness — tightness at 35 kPa (0,35 bar)/15 min: no leakage allowed ^c Only for fabricated fittings made from more than one piece. A sealing ring retaining component is not considered as a piece. ^d This test is applicable for all pipe and fitting constructions when jointed by fusion or welding. ^e The test pieces shall be cut longitudinally in the fusion area. The length of the test piece shall include the joint plus a length at each end sufficient to ensure a proper grip in the tensile testing machine.				

11 Marking

11.1 General

Marking elements shall be labelled or printed or formed directly on the pipe or the fitting, in such a way that after storage, weathering, handling and installation, legibility is maintained.

Marking shall not initiate cracks or other types of defect that adversely influence the performance of the pipe or the fitting.

11.2 Minimum required marking

11.2.1 Pipes

Pipes shall be marked at intervals of maximum 2 m and at least once per pipe.

The minimum required marking of pipes shall conform to [Table 19](#).

Table 19 — Minimum required marking of pipes

Information	Marking or symbols
Number of this document	ISO 21138-2
Diameter series, nominal size/actual guaranteed min. inside diameter ^a for: DN/OD series DN/ID series	DN/OD 200/178 DN/ID 180/178
Manufacturer's name and/or trade mark	XYZ
Stiffness class	e.g. SN 8
Material	Either PVC-U, PVC ^b , PP or PE
MFR class ^c	e.g. MFR-B
Manufacturer's information	d
Low temperature installation performance	* (ice crystal symbol) ^e
Close tolerance class	CT ^f
^a The marking of the guaranteed minimum mean inside diameter is voluntary, but if marked it shall be as shown. ^b PVC-U is preferred to PVC. ^c Only applicable for PP pipes intended to be jointed by butt fusion. ^d Shall be given in clear figures or in a code providing traceability to the following details: — the production period year and month; — the production site if the manufacturer is producing in different sites, nationally and/or internationally. ^e This marking is only applicable to pipes which by testing have proved to conform to 9.1.4 . ^f Only applicable for PE pipes with spigot as specified in ISO 8772 and PP pipes with spigots as specified ISO 8773.	

11.2.2 Fittings

The minimum required marking of fittings shall conform to [Table 20](#).

Table 20 — Minimum required marking of fittings

Information	Marking or symbols
Number of this document	ISO 21138-2
Diameter series, nominal size/actual guaranteed min. inside diameter ^a for: DN/OD series, interchangeable ^b DN/OD series, not interchangeable ^b DN/ID series	DN/OD 200/178 ^c DN/OD 200/178 ^c DN/ID 180/178 ^c
Manufacturer's name and/or trade mark	XYZ
Nominal angle	e.g. 45°
Stiffness class	e.g. SN 8
Material	Either PVC-U, PVC ^d , PP or PE
Manufacturer's information	e
Close tolerance class	CT ^f
<p>^a The marking of the guaranteed minimum mean inside diameter is voluntary, but if marked it shall be as shown.</p> <p>^b In this case interchangeability means use with pipes and/or fittings in accordance with ISO 4435, ISO 8772 or ISO 8773.</p> <p>^c If a component is designed for both DN/OD and DN/ID series, one of them may be marked on a label.</p> <p>^d PVC-U is preferred to PVC.</p> <p>^e Shall be given in clear figures or in a code providing traceability to the following details: — the production period year and month; — the production site if the manufacturer is producing in different sites, nationally and/or internationally.</p> <p>^f Only applicable for PE fittings with spigot as specified in ISO 8772 and PP fittings with spigots as specified ISO 8773.</p>	

Annex A (normative)

Virgin PVC-U material

The virgin material shall be PVC-U to which are added those additives that are needed to facilitate the manufacture of components conforming to the requirements of this document.

When calculated on the basis of a known formulation or, in case of dispute/unknown formulation, determined in accordance with ISO 1158, the PVC-U content shall conform as applicable to item a) or item b) as follows:

- a) the content of PVC-U shall be at least 80 % in mass fraction for pipes and 85 % in mass fraction for injection-moulded fittings;
- b) a further reduction of the PVC-U content (for pipes only) is permitted provided the PVC-U is substituted by CaCO_3 conforming to item c) as follows;
- c) CaCO_3 can be used with or without coating as follows:
 - the composition of the CaCO_3 , before coating if any, shall conform to the following:
 - content of $\text{CaCO}_3 \geq 96$ % in mass fraction;
 - content of $\text{MgCO}_3 \leq 4$ % in mass fraction;
 - content of CaCO_3 and MgCO_3 in total ≥ 98 % in mass fraction;
 - the physical properties of the material shall conform to the following:
 - mean particle size $D_{50} \leq 2,5 \mu\text{m}$;
 - top cut, $D_{98} \leq 20 \mu\text{m}$.

Annex B (normative)

Utilization of non-virgin PVC-U material

B.1 General

For the purpose of this annex, the term “pipes” means extruded pipes and any parts of a fabricated fitting which is made from an extruded pipe. The term “fitting” means injection-moulded fittings and injection-moulded parts of a fabricated fitting

B.2 Own reprocessed material from pipes and fittings

The use of clean own reprocessed material from components in conformity with this document for the production of pipes and fittings is permitted without limitations. If fitting material is used for the production of pipes it shall be considered as recycled material.

B.3 Recycled materials with agreed specification

B.3.1 Material from PVC-U pipes and fittings

Recycled material with an agreed specification from PVC-U pipes and fittings that are available in relevant quantities and intervals of time shall be permitted to be used alone or added to virgin or own reprocessed material or a mixture of those two materials for the production of pipes provided that all the following conditions are met.

- a) A specification for each material shall be agreed between the supplier of external recycled material, the pipe manufacturer and, if applicable, the certification body. It shall at least cover the characteristics in accordance with EN 15346:2014 given in [Table B.1](#).
- b) When determined in accordance with the test methods given in [Table B.1](#), the actual values for these characteristics shall conform to the agreed value and the permitted deviations shall conform to those given in [Table B.1](#).
- c) the quality plan of the supplier of external non-virgin material shall not be less stringent than the relevant requirements of ISO 9001;

NOTE If the supplier is certified ISO 9001, this requirement is deemed to be fulfilled.

- d) Each delivery shall be covered by a certificate according to EN 10204:2004, 3.1 showing conformity to the agreed specification.
- e) Where a certificate of conformity is not provided with external recycled material, the manufacturer shall conduct verification testing on all material to confirm it conforms to the requirements.
- f) The maximum quantity of external recycled material that is intended to be added shall be specified by the pipe manufacturer.
- g) The quantity of external recycled material that is actually added in each production series shall be recorded by the pipe manufacturer.
- h) The PVC-U content of the end product shall conform to the requirements specified in [Annex A](#).

- i) Type testing shall be carried out on the end product with the maximum specified amount and with each form of external recycled material with an agreed specification. Approved results shall be taken as proving conformity also of components containing lower levels of external or recycled material.

Table B.1 — Specification of characteristics to be covered by the agreement and maximum permitted deviations for these characteristics

Characteristic	Test method	Maximum permitted deviations
PVC-U content ^a	ISO 1158	±4 % absolute in mass fraction
K-value ^a	ISO 13229	±3 units
Density ^a	ISO 1183-1	±20 kg/m ³
Vicat softening temperature ^a (VST)	ISO 2507-1 and ISO 2507-2 or ISO 306:2013, Method B 50	±2 °C
Particle size and distribution ^{b,c}	Requirements shall be agreed and stated in the specification. Test methods in accordance with Annexe D ^d and Annexe E ^e of EN 15346:2014.	
Type of stabiliser ^{a,b}	Requirements and test method shall be agreed and stated in the specification.	
Impurities ^b	Based on the source of material and the recycling process the requirements shall be agreed and stated in the specification. Test method in accordance with EN 15346:2014, Annex C.	
<p>^a If the source of the material is pipes and fittings produced under a national or European quality mark, it is not required to test those material characteristics if the requirement covered by the quality mark conforms to the requirement given in this table.</p> <p>^b The relevant requirements depend on the recycling process and on the end product.</p> <p>^c The particle size shall not be greater than 50 % of the minimum wall thickness of the end product.</p> <p>^d Only applicable for micronized recycled PVC compounds.</p> <p>^e Only applicable for recycled PVC crushes.</p>		

B.3.2 Material from PVC-U products other than pipes and fittings

Recycled materials with an agreed specification from PVC-U products, which are available in relevant quantities and intervals of time, shall be permitted to be used up to 100 % by mass or added to virgin or own reprocessed materials or a mixture of those two materials for the specified intermediate layer of Type A1 pipes provided that all the following conditions are met:

- the material shall conform to all the conditions given in a) to f) of [B.3.1](#) and to all of the additional specifications given in [Table B.2](#);
- the material shall be clean and dry;
- the quantity of external recycled material that is actually added in each production series shall be recorded by the pipe manufacturer;
- the pipe manufacturer shall test the material for impurities before using the material.

Table B.2 — Specifications for external recycled material from PVC-U products other than pipes and fittings

Characteristic	Requirements	Test method
PVC-U content	≥80 % by mass	ISO 1158
K-value	$56 \leq K\text{-value} \leq 70$	ISO 13229
Density	$1\,390 \text{ kg/m}^3 \leq \text{density} \leq 1\,500 \text{ kg/m}^3$	ISO 1183-1
Vicat softening temperature (VST)	≥62 °C	ISO 2507-1 and ISO 2507-2 or ISO 306:2013 Method B 50
Impurities	≤1 500 mg/kg for particle size ≤1 000 µm ≤1 500 mg/kg for 1 000 µm < particle size <1 400 µm	^a
Particle size	>1 000 µm: maximum 15 % in mass fraction <1 400 µm: 100 % in mass fraction	Test methods in accordance with EN 15346:2014, Annexes D and E.
Source of the material	PVC-U products	
^a Based on the source of material and the recycling process, the requirements shall be agreed and stated in the specification. Test method in accordance with EN 15346:2014, Annex C. NOTE Attention is drawn to possible restrictions regarding heavy metals, e.g. cadmium.		

B.4 Recycled materials not covered by an agreed specification

B.4.1 Material from PVC-U pipes and fittings

Recycled materials not covered by an agreed specification from PVC-U pipes and fittings, which are available in relevant quantities and intervals of time, shall be permitted to be used alone or added to virgin or own reprocessed material or a mixture of those two materials for the production of pipes provided that all of the following conditions are met:

- a) when such materials are used, the production shall be considered as at least one batch and shall be tested accordingly;
- b) the materials shall be clean and dry;
- c) for specified intermediate layers of a pipe of Type A1, up to 100 % by mass of external recycled material is permitted to be used;
- d) in other cases, the maximum permitted amount of recycled material shall depend on the difference in K-value of the virgin material and the recycled material as follows:
 - if the difference in K-value, when determined in accordance with ISO 13229, is equal to or less than four units, then up to 10 % in mass fraction may be added;
 - if the difference in K-value is greater than 4 units or not determined, then up to 5 % in mass fraction may be added;
- e) the quantity of recycled materials that is actually added in each production series shall be recorded by the pipe manufacturer.

B.4.2 Material from PVC-U products other than pipes and fittings

External recycled material not covered by an agreed specification from PVC-U products other than pipes and fittings shall not be used for the production of pipes and fittings conforming to this document.

Annex C (normative)

Virgin PP material

The virgin material shall be PP to which are added those additives that are needed to facilitate the manufacture of components conforming to the requirements of this document. Coated calcium carbonate (CaCO_3) conforming to c), or talc conforming to d), may be added as mineral modifiers under the following conditions.

When calculated on the basis of a known formulation or, in case of dispute/unknown formulation, determined in accordance with ISO 3451-1, the PP content shall conform as applicable to item a) as follows:

- a) For outside and single layers of Type A the content of PP shall be at least 75 % in mass fraction for pipes and 80 % in mass fraction for injection-moulded fittings.
- b) For a specified intermediate layer of Type A1 pipes, the PP content shall be at least 60 % in mass fraction.
- c) Specification for CaCO_3 :
 - the composition of the CaCO_3 , before coating, shall conform to the following:
 - content of $\text{CaCO}_3 \geq 96$ % in mass fraction;
 - content of $\text{MgCO}_3 \leq 4$ % in mass fraction;
 - content of CaCO_3 and MgCO_3 in total ≥ 98 % in mass fraction;
 - the physical properties of the CaCO_3 shall conform to the following:
 - mean particle size, $D_{50} \leq 2,5 \mu\text{m}$;
 - top cut, $D_{98} \leq 20 \mu\text{m}$.
- d) Specification for talc:
 - The content of magnesium silicate, $\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$ shall be at least 97 % in mass fraction;
 - the physical properties of the talc shall conform to the following:
 - mean particle size, $D_{50} \leq 7 \mu\text{m}$;
 - top cut, $D_{98} \leq 30 \mu\text{m}$.