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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 3: Pipes and fittings with non-smooth external surface, Type B

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 3: Tubes et raccords avec une surface externe non lisse, type B

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation 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 21138-3:2007), 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.

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 non-smooth external surface, Type B

1 Scope

This document, together with ISO 21138-1, specifies the definitions and requirements for pipes with a non-smooth external surface and a smooth internal surface (Type B), 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 systems 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 Pipes, fittings and other components conforming to any plastics product standards referred to in Clause 2 are deemed to be suitable for use with pipes and fittings conforming to this document, when they conform to the requirements for joint dimensions given in ISO 21138-2 or ISO 21138-3 (this document) and to the performance requirements given in Clause 10.

NOTE 4 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 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 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 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 12091, *Structured-wall thermoplastics pipes — Oven test*

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

ISO 13260, *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 13263, *Thermoplastics piping systems for non-pressure underground drainage and sewerage — Thermoplastics fittings — Test method for impact strength*

ISO 13264, *Thermoplastics piping systems for non-pressure underground drainage and sewerage — Thermoplastics fittings — Test method for mechanical strength or flexibility of fabricated fittings*

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 13967, *Thermoplastics fittings — Determination of ring stiffness*

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 21138-2, *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 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
D_i	inside diameter of a socket
$D_{i,\,min}$	minimum value of D_i
d_e	outside diameter (of a pipe or a spigot)
$d_{em,\,max}$	maximum value of the mean d_e
$d_{em,\,min}$	minimum value of the mean d_e
d_i	inside diameter of a pipe
$d_{im,\,max}$	maximum value of the mean d_i
$d_{im,\,min}$	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)
$e_{4,min}$	minimum value of e_4
e_5	wall thickness of the inside layer under a hollow section
$e_{5,min}$	minimum value of e_5
F	distance from the end of a spigot to the effective sealing point
L_1	length of a spigot
$L_{1,min}$	minimum value of L_1
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

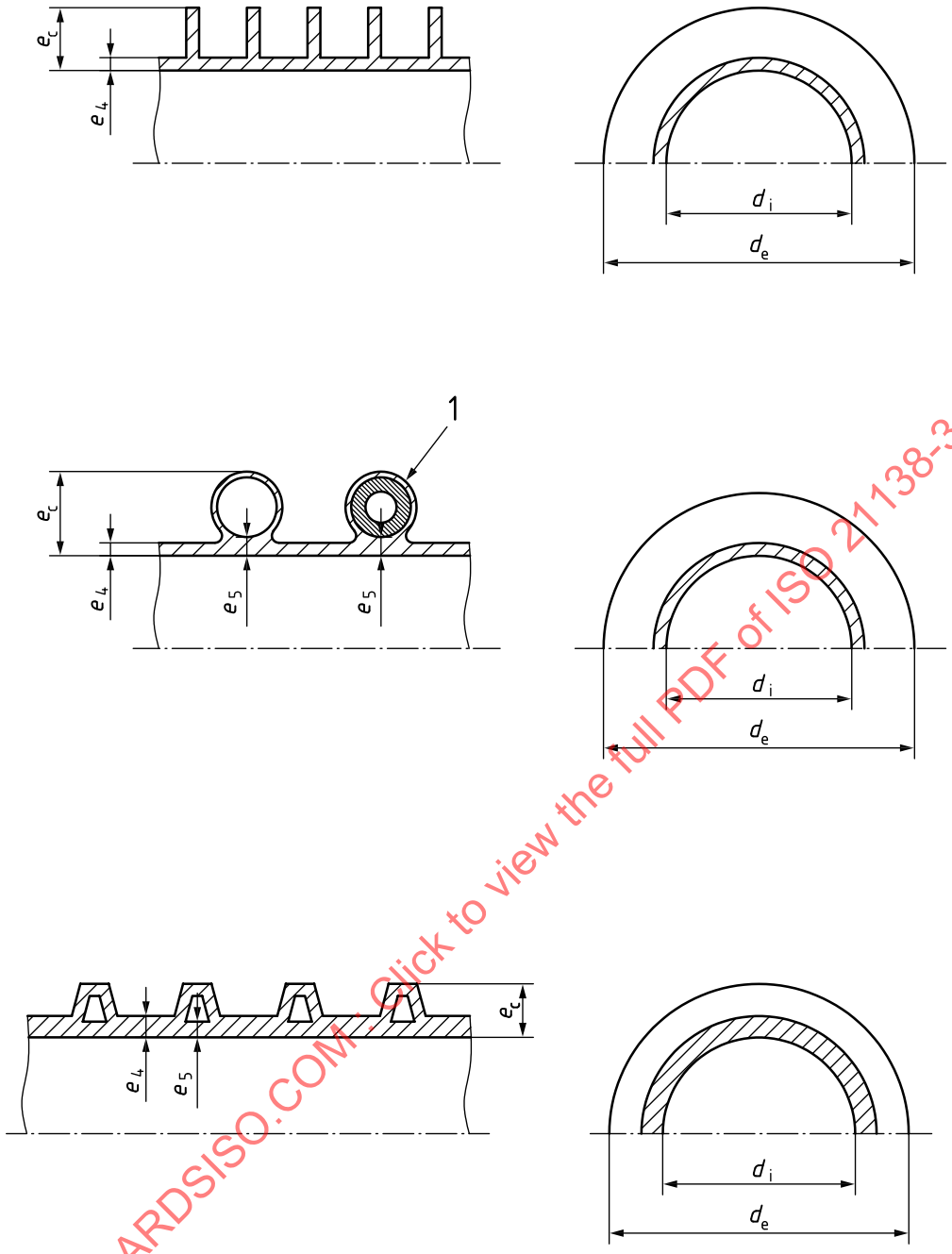
4 Material

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.

Spirally formed Type B pipes may include a support profile (see Figure 1) made from polymers other than PVC-U, PP or PE.

Spirally formed pipe constructions may include a continuous elastomeric sealing component of a material conforming to EN 681-1, EN 681-2 or EN 681-4 as applicable, or a continuous adhesive conforming to 4.8.



Key

1 supporting profile

Figure 1 — Typical examples of Type B wall construction

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]	No failure during the test period	Test temperature	60 °C	ISO 1167-1
		Circumferential stress — pipe material — fitting material	 10 MPa 6,3 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	

[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.

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]	No failure during the test period	Test temperature Circumferential stress Test period Type of test End caps Orientation Number of test pieces Conditioning period	80 °C 4,2 MPa 140 h Water-in-water Type A or B Free 3 In accordance with ISO 1167-1	ISO 1167-1 ISO 1167-2
Resistance to internal pressure 1 000 h[a,b]	No failure during the test period	Test temperature Circumferential stress Test period Type of test End caps Orientation Number of test pieces Conditioning period	95 °C 2,5 MPa 1 000 h Water-in-water Type A or B Free 3 In accordance with ISO 1167-1	ISO 1167-1 ISO 1167-2
Melt mass-flow rate (MFR)	≤1,5 g/10 min	Temperature Loading mass	230 °C 2,16 kg	ISO 1133-1
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.

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 ≤ 0,3 g/10 min;

— Class B: 0,3 g/10 min < MFR ≤ 0,6 g/10 min;

— Class C: 0,6 g/10 min < MFR ≤ 0,9 g/10 min;

— Class D: 0,9 g/10 min < MFR ≤ 1,5 g/10 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 of 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]	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]	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

[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.

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 Circumferential stress Test period Type of test End caps Orientation Number of test pieces Conditioning period	60 °C 3,9 MPa 165 h Water-in-water Type A or B Free 3 In accordance with ISO 1167-1	ISO 1167-1 ISO 1167-2
Resistance to internal pressure 1 000 h[a]	No failure during the test period	Test temperature Circumferential stress Test period Type of test End caps Orientation Number of test pieces Conditioning period	60 °C 3,2 MPa 1 000 h Water-in-water Type A or B Free 3 In accordance with ISO 1167-1	ISO 1167-1 ISO 1167-2
Melt mass-flow rate (MFR)	3 g/10 min ≤ MFR ≤ 16 g/10 min	Temperature Loading mass	190 °C 5 kg	ISO 1133-1
Thermal stability, (OIT)	≥10 min	Temperature	200 °C	ISO 11357-6
Reference density	≥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.

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 B

5.1.1 Ribbed or corrugated construction

A pipe or fitting with a plain inside surface and a solid or hollow spiral or annular ribbed external surface shall be designated Type B.

Typical examples of Type B constructions are shown in Figure 1.

5.1.2 Typical jointing methods for structured-wall Type B pipes

Relevant jointing dimensions for typical Type B joint constructions are shown in Figure 2 and Figure 3.

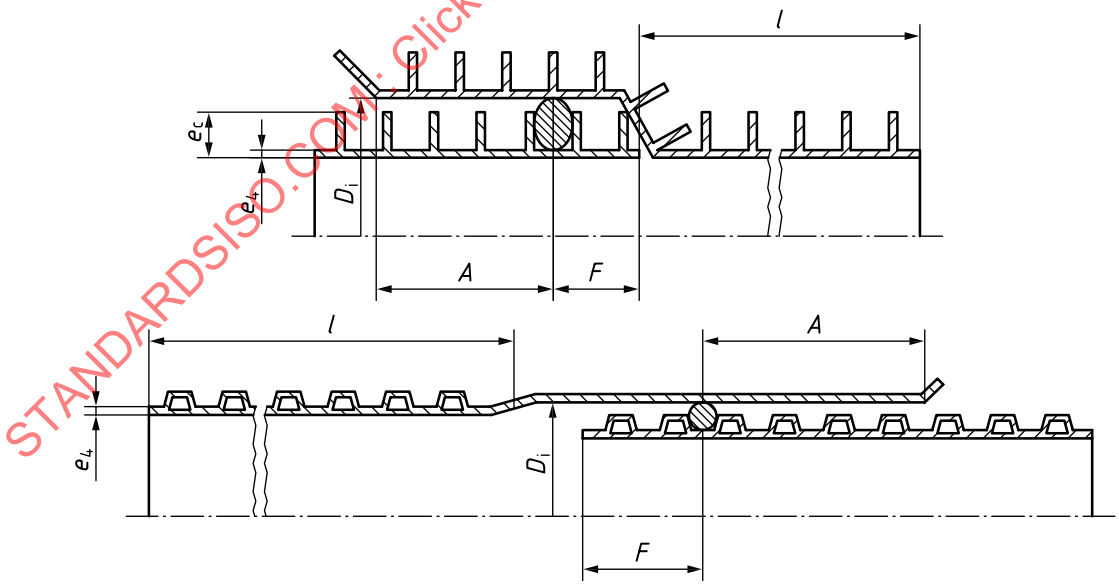


Figure 2 — Typical example of an elastomeric sealing ring joint with sealing ring located on the spigot, Type B

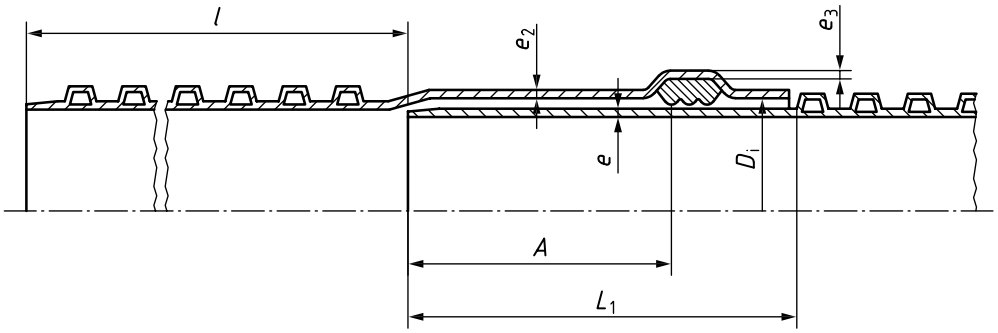


Figure 3 — Typical example of an elastomeric sealing ring joint with sealing ring located in the socket, Type B

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 plain. For definitions and specifications for Type A1 and Type A2 pipes, see ISO 21138-2.

NOTE Joints with elastomeric sealing rings are designed either with the sealing ring positioned on the spigot (see Figure 2) 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).

Type B DN/OD pipes and fittings with plain spigot jointing dimensions conforming to ISO 4435:2003, ISO 8772:2006 or ISO 8773:2006 for PVC-U, PE and PP respectively, and with larger d_e than the spigot, are permitted to be designated by the spigot dimension.

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 2 and/or Figure 3, as applicable.

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

The nominal sizes and minimum mean inside diameters for DN/OD and DN/ID series are specified in Table 5.

Other nominal sizes, greater than DN/ID 100 and DN/OD 110 and less than DN/OD and DN/ID 1200, than those given in Table 5, are permitted.

They should preferably be selected from ISO 161-1.

For DN/ODs and DN/IDs not specified in Table 5, the minimum inside diameter, $d_{im,min}$, shall be linearly interpolated between the adjacent values specified in the Table 5.

Table 5 — Nominal sizes, minimum mean inside diameters, thickness of inside layers and socket length

Dimensions in millimetres

Diameters					Minimum wall thickness		Socket[a]
	DN/OD series		DN/ID series				
	PVC-U[b]	PP/ PE[b,c]					
DN/OD	$d_{im,min}$	$d_{im,min}$	DN/ID	$d_{im,min}$	$e_{4,min}$	$e_{5,min}$	A_{min}
110	97	90	100	95	1,0	1,0	32
125	107	105			1,1	1,0	35
			125	120	1,2	1,0	38
160	135	134			1,2	1,0	42
			150	145	1,3	1,0	43
200	172	167			1,4	1,1	50
			200	195	1,5	1,1	54
250	216	209	225	220	1,7	1,4	55
			250	245	1,8	1,5	59
315	270	263			1,9	1,6	62
			300	294	2,0	1,7	64
400	340	335			2,3	2,0	70
			400	392	2,5	2,3	74
500	432	418			2,8	2,8	80
			500	490	3,0	3,0	85
630	540	527			3,3	3,3	93
			600	588	3,5	3,5	96
800	680	669			4,1	4,1	110
			800	785	4,5	4,5	118
1 000	864	837			5,0	5,0	130
			1 000	985	5,0	5,0	140
1 200	1 037	1 005			5,0	5,0	150
			1 200	1 185	5,0	5,0	162

[a] For selection of the A_{min} requirements for a socket, refer to the pipe material and construction. For pipes longer than 6 m it is recommended that one produce a larger A than is specified in this Table.

[b] 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.

[c] The minimum mean inside diameter 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 conform to this Table, whichever is the greater value.

DN/OD series pipes and spigots intended to have jointing dimensions as pipes and/or fittings according to ISO 4435:2003, ISO 8772:2006 or ISO 8773:2006 for PVC, PE or PP respectively, shall comply with whichever of those documents is relevant regarding the outside diameters and tolerances of the spigot.

For pipes and fittings not intended to have jointing dimensions as pipes and/or fittings according to ISO 4435:2003, ISO 8772:2006 or ISO 8773:2006 for PVC, PE or PP respectively, the tolerance of the outside diameter of pipe and spigot shall be:

— $d_{em,\,min} \geq 0{,}994 \times d_e$

— $d_{em,\,max} \leq 1{,}003 \times d_e$

where d_e equals either the nominal size of a DN/OD pipe or the outside diameter as specified by the manufacturer of a DN/ID pipe.

The results are to be rounded to the next higher 0,1 mm.

7.2.4 Diameters and jointing dimensions of sockets and spigots

7.2.4.1 Joints with the elastomeric sealing ring positioned in the socket (combined with Type B pipes or fittings)

For Type B pipes, the requirement regarding the socket dimension, A_{min}, specified in Table 5 applies.

In the case where other nominal sizes than those specified in Table 5 are selected for Type B pipes, the requirements regarding the socket dimension A_{min} shall be linearly interpolated between the adjacent values specified in Table 5.

$D_{i,min}$ shall be equal to $d_{e,max}$

For Type B pipes greater than DN/OD 630 and DN/ID 600 when they are designed for a specific project, A may be shorter than is specified in Table 5. However, it shall be not less than 85 mm. Such pipes shall be marked “SHORT SOCKET”.

7.2.4.2 Joints with the elastomeric sealing ring positioned on the spigot

The spigot length shall be equal or superior to the corresponding A_{min} as defined in Table 5.

In the case where other nominal sizes than those listed in Table 5 are selected, the requirement regarding A_{min} shall be linearly interpolated from the adjacent values specified in Table 5.

$L_{1,\,min}$ shall conform to the following:

— $L_{1,\,min} = A_{min} + F$

where F is the distance from the end of the spigot to the effective sealing point. See Figure 2.

The manufacturer should specify in which position the sealing ring shall be placed if there is more than one possibility.

$D_{i,min}$ shall be equal to $d_{e,max}$

For Type B pipes greater than DN/OD 630 and DN/ID 600 when they are designed for a specific project, A may be shorter than is specified in Table 5. However, it shall be not less than 85 mm. Such pipes shall be marked “SHORT SOCKET”.

7.2.5 Wall thicknesses

7.2.5.1 Wall thickness of sockets and joint design requirements

7.2.5.1.1 General

In addition to the minimum required wall thickness of sockets and spigots as specified below, their ring stiffness, when determined in accordance with ISO 9969, shall conform to Formula (1):

$$S_{so} + S_{sp} = SN_{pipe} \quad (1)$$

For the test it is permitted to use cut-off straight socket and spigot parts even if they do not conform to the length requirements specified in ISO 9969.

For dimensions ≥500 mm the stiffness may be calculated provided reliable information regarding the E-modulus is available.

7.2.5.1.2 Spigots

When the spigot has the same design as the pipe, the wall thickness requirements for the corresponding pipe dimension and construction apply.

In the case of a solid plain spigot design, the wall thickness, e, shall conform to Table 6. The values shall be calculated to the second decimal place and rounded to the next higher 0,1 mm.

Table 6 — Minimum required wall thicknesses of solid plain spigots

Dimensions in millimetres

Material	Outside diameter	e_{min}
PVC-U	$d_e \leq 500$	$d_e/51$ but not less than 3,2
	$d_e > 500$	9,8
PP	$d_e \leq 500$	$d_e/41$ but not less than 3,4
	$d_e > 500$	12,2
PE	$d_e \leq 500$	$d_e/33$ but not less than 4,2
	$d_e > 500$	15,2

7.2.5.1.3 Sockets in accordance with ISO 4435, ISO 8772 or ISO 8773

When a socket is intended to conform to one of the above-mentioned International Standards it shall comply with the wall thickness requirements of the appropriate document.

7.2.5.1.4 Sockets heat formed on the pipes

When a socket is heat formed on a pipe or pipe segment the following is permitted:

— for joints with the sealing ring positioned in the socket: a reduction of the wall thicknesses, as applicable, to 85 % in the cylindrical part of the socket and to 75 % in the groove area of a socket;

— for joints with the sealing ring positioned on the pipe: a reduction of the wall thicknesses e_4 and e_5, as applicable, to 75 %.

In both cases the manufacturer specifies the reference value for the wall thickness.

7.2.5.1.5 Other sockets with stiffness ≥4 kN/m²

For structured-wall designed sockets the wall thicknesses e_4 and e_5, as applicable, shall comply with the requirements given in Table 5.

7.2.5.1.6 Other sockets with stiffness <4 kN/m²

The thickness of the inner wall of the socket shall be at least 1,5 × e_4 as specified in Table 5.

7.2.5.2 Injection-moulded fittings

The minimum wall thickness in the body of injection-moulded fittings of Type B construction, $e_{4,min}$, for DN/OD ≤ 315 and DN/ID ≤ 300 shall be 2,0 mm. For larger sizes it shall conform to the requirements for $e_{4,\,min}$ as specified in Table 5.

The construction height of the body wall, e_c, for injection-moulded fittings up to 200 mm DN/OD and up to 200 mm actual outside diameter of pipes in the DN/ID series shall be at least as the minimum thickness specified for:

— the SDR 41 series in ISO 4435:2003,

— the SDR 33 series in ISO 8773:2006,

— the SDR 26 series in ISO 8772:2006,

for PVC-U, PP and PE respectively.

In the case of DN/ID series fittings the calculation shall be based on the actual outside diameter of the corresponding pipe.

The jointing design including socket and spigot dimensions shall conform to 7.2.5.1.

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 reductions due to the process are permitted provided the requirements in Table 16 are satisfied.

The jointing design including socket and spigot dimensions shall conform to 7.2.5.1.

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 × the values specified for injection-moulded fittings, rounded to the next higher 0,1 mm.

If a rotational-moulded fitting has a solid plain spigot and/or socket, the minimum required wall thicknesses e, e_2 and e_3 as applicable shall be 1,25 × the values derived from 7.2.5.

The socket and spigot dimensions shall comply with 7.2.5.1.

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 7, using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 7.

Table 7 — 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
Resistance to heating — Oven test	The pipe shall show no delaminations, cracks or bubbles	Temperature Immersion time[c] for: $e \leq 8$ mm $e > 8$ mm	(150 ± 2) °C 30 min 60 min	ISO 12091
Resistance to dichloromethane[d] (Alternative test method to assess degree of gelation)	No attack	Test temperature Immersion time Chamfering	15 °C 30 min No	ISO 9852
Uniaxial tensile test[d] (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[d,e] (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

[a] 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.

[b] In case of dispute, the method "liquid bath" shall be used.

[c] For the wall thickness, e, the maximum measured wall thickness of the pipe shall be taken, excluding e_c.

[d] 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.

[e] This test is not intended to be used for factory production control.

8.1.2 Physical characteristics of PVC-U fittings

When tested in accordance with the test methods specified in Table 8, using the indicated parameters, the fitting shall have physical characteristics conforming to the requirements given in Table 8.

Table 8 — 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, e, the maximum measured wall thickness of the pipe excluding e_c 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 9, using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 9.

Table 9 — Physical characteristics of PP pipes

Characteristic	Requirements	Test parameters		Test method
Resistance to heating - Oven test	The pipe shall show no delaminations, cracks or bubbles	Temperature Immersion time[a] for: $e \leq 8$ mm $e > 8$ mm	(150 ± 2) °C 30 min 60 min	ISO 12091

[a] For the wall thickness, e, the maximum measured wall thickness of the pipe excluding e_c shall be taken.

8.2.2 Physical characteristics of PP fittings

When tested in accordance with the test method specified in Table 10, using the indicated parameters, the fittings shall have physical characteristics conforming to the requirements given in Table 10.

Table 10 — 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, e, the maximum measured wall thickness of the fitting excluding e_c 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 11, using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 11.

Table 11 — Physical characteristics of PE pipes

Characteristic	Requirements	Test parameters		Test method
Resistance to heating - Oven test	The pipe shall show no delaminations, cracks or bubbles	Temperature Immersion time[a] for: $e \leq 8$ mm $e > 8$ mm	(110 ± 2) °C 30 min 60 min	ISO 12091

[a] For the wall thickness, e, the maximum measured wall thickness of the pipe excluding e_c shall be taken.

8.3.2 Physical characteristics of PE fittings

When tested in accordance with the test method specified in Table 12, using the indicated parameters, the fitting shall have physical characteristics conforming to the requirements given in Table 12.

Table 12 — 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, e, the maximum measured wall thickness of the fitting excluding e_c 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 13, using the indicated parameters, the pipe shall have mechanical characteristics conforming to the requirements given in Table 13.

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 13 — 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: $d_{im,max}$ ≤ 100 100 < $d_{im,max}$ ≤ 125 125 < $d_{im,max}$ ≤ 160 160 < $d_{im,max}$ ≤ 200 200 < $d_{im,max}$ ≤ 250 250 < $d_{im,max}$ ≤ 315 315 < $d_{im,max}$ Fall height of striker[a] for: $d_{em,min}$ ≤ 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
Ring flexibility	In accordance with 9.1.2 at 30 % of d_{em}	Deflection Length of test piece Position of test piece	30 % Shall incorporate at least 5 ribs/spirals[c] Mould split line, when applicable, at 0°, 45° and 90° from the upper plate	ISO 13968
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 < 375 ≥510 N for 400 ≤ DN < 560 ≥760 N for 600 ≤ DN < 710 ≥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 13, 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 except possible delamination between the outside and inside wall of double-wall pipes occurring in the reduced welding zone in the ends of the test piece; supporting profiles, see Figure 1, are not subject to this requirement;

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

When tested in accordance with Table 13, the minimum required tensile strength of the seam shall conform to Table 13.

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 14.

Table 14 — Low temperature installation performance test

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

9.2 Mechanical characteristics of fittings

When tested in accordance with the test methods specified in Table 15, using the indicated parameters, the fitting shall have mechanical characteristics conforming to the requirements given in Table 15.

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.

Table 15 — Mechanical characteristics of fittings

Characteristic	Requirements	Test parameters		Test method
Stiffness[a]	≥ relevant SN	In accordance with ISO 13967		ISO 13967
Impact test	No cracks through the wall; jumped-off sealing elements shall be able to be restored in correct position manually	Test temperature	0 °C	ISO 13263
		Drop height for:		
		$d_e \leq 125$ mm	1 000 mm	
		$d_e > 125$ mm	500 mm	
		Position of impact	Mouth of the socket	
Mechanical strength or flexibility[b]	No signs of splitting, cracking, separation and/or leakage	EITHER		ISO 13264
		Test period	15 min	
		Minimum moment for:		
		$d_e \leq 250$ mm	$0{,}15[DN]^3 \times 10^{-6}$ kNm	
		$d_e > 250$ mm	0,01[DN] kNm	
		OR		
		Minimum displacement	170 mm	

[a] When a fitting in accordance with this document has the same wall construction as a corresponding pipe, the stiffness of the fitting, because of its geometry, is equal to or greater than that of the pipe. Such fittings can be classified with the same stiffness class as that pipe without testing the stiffness.

[b] Only for fabricated fittings made from more than one piece (a sealing ring retaining component is not considered as a piece) or when the minimum wall thickness in the body, $e_{4,min}$, is less than $(0{,}9 \times d_{em}/51)$, $(0{,}9 \times d_{em}/41)$ or $(0{,}9 \times d_{em}/33)$ for PVC, PP and PE respectively.

10 Performance requirements

When tested in accordance with the test methods specified in Table 16, using the indicated parameters, the joints and the system shall have characteristics conforming to the requirements given in Table 16.

Table 16 — Performance requirements

Characteristic	Requirements	Test parameters		Test method
Tightness of elastomeric ring seal joint		Temperature Spigot deflection Socket deflection	(23 ± 2) °C 10 % 5 %	ISO 13259 Condition B
	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)	
Tightness of elastomeric ring seal joint		Temperature Joint deflection: d_e ≤ 315 mm 315 mm < d_e ≤ 630 mm 630 mm < d_e	(23 ± 2) °C 2° 1,5° 1°	ISO 13259 Condition C
	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} ≤ 160 mm: In accordance with ISO 13260:2010, Method A		ISO 13260 Method A, hot and cold water
		For d_{im} > 160 mm: In accordance with ISO 13260:2010, Method B		ISO 13260 Method B, hot water
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 Duration	50 kPa (0,5 bar) 1 min	ISO 13254
Tensile test of welded or fused joints[d]	No break in the joint	Minimum tensile force[e]	According to 9.1.3	In accordance with Table 14

[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 17.

Table 17 — Minimum required marking of pipes

Information	Marking or symbols
Number of this document	ISO 21138-3
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/ID 180/178[c]
Manufacturer's name and/or trade mark	XYZ
Stiffness class	e.g. SN 8
Material	Either PVC-U, PVC[d], PP or PE
Manufacturer's information	[e]
Low temperature installation performance	❄ (ice crystal symbol)[f]
Close tolerance class	CT[g]

[a] The marking of the guaranteed minimum mean inside diameter is voluntary, but if marked it shall be as shown.

[b] In this case interchangeability means use with pipes and/or fittings in accordance with ISO 4435:2003, ISO 8772:2006 or ISO 8773:2006.

[c] If a component is designed for both DN/OD and DN/ID series, one of them may be marked on a label.

[d] PVC-U is preferred to PVC.

[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.

[f] This marking is only applicable to pipes which by testing have proved to conform to 9.1.4.

[g] Only applicable for PE pipes with spigot as specified in ISO 8772:2006 and PP pipes with spigots as specified ISO 8773:2006.

11.2.2 Fittings

The minimum required marking of fittings shall conform to Table 18.

Table 18 — Minimum required marking of fittings

Information	Marking or symbols
Number of this document	ISO 21138-3
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]

[a] The marking of the guaranteed minimum mean inside diameter is voluntary, but if marked it shall be as shown.

[b] In this case interchangeability means use with pipes and/or fittings in accordance with ISO 4435:2003, ISO 8772:2006 or ISO 8773:2006.

[c] If a component is designed for both DN/OD and DN/ID series, one of them may be marked on a label.

[d] PVC-U is preferred to PVC.

[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.

[f] Only applicable for PE fittings with spigot as specified in ISO 8772 and PP fittings with spigots as specified ISO 8773:2006.

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 $CaCO_3$ ≥ 96 % in mass fraction;

      — content of $MgCO_3$ ≤ 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 D50 ≤ 2,5 µm;

      — top cut, D98 ≤ 20 µm.

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 EN 15346:2014, Annex D[d] and Annex E[e] .	
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.	

[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.

[b] The relevant requirements depend on the recycling process and on the end product.

[c] The particle size shall not be greater than 50 % of the minimum wall thickness of the end product.

[d] Only applicable for micronized recycled PVC compounds.

[e] Only applicable for recycled PVC crushes.

NOTE Attention is drawn to possible restrictions regarding heavy metals, e.g. cadmium.

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

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

B.4 External recycled materials not covered by an agreed specification

B.4.1 Material from PVC-U pipes and fittings

External 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) the maximum allowed 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;

d) the quantity of external 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 b), or talc conforming to c), 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 B the content of PP shall be at least 75 % in mass fraction for pipes and 80 % in mass fraction for injection-moulded fittings.

b) Specification for $CaCO_3$:

   — the composition of the $CaCO_3$, before coating, shall conform to the following:

      — content of $CaCO_3 \geq 96$ % in mass fraction;

      — content of $MgCO_3 \leq 4$ % 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, D50 ≤ 2,5 µm;

      — top cut, D98 ≤ 20 µm.

c) Specification for talc:

   — The content of magnesium silicate, $Mg_3Si_4O_{10}(OH_2)$ shall be at least 97 % in mass fraction;

   — the physical properties of the talc shall conform to the following:

      — mean particle size, D50 ≤ 7 µm;

      — top cut, D98 ≤ 30 µm.