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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 1: Material specification and performance criteria for pipes, fittings and systems

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 1: Spécification des matières et critères de performance des tubes, raccords et système

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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 21138-1:2007), 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 1: Material specification and performance criteria for pipes, fittings and systems

1 Scope

This document, together with ISO 21138-2 and ISO 21138-3, specifies the definitions and requirements for pipes, 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 covers a range of pipe and fitting sizes, materials, pipe constructions, 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 21138-2 and ISO 21138-3, 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 structured-wall 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 the Bibliography can be used with pipes and fittings conforming to this document when they conform to the requirements for joint dimensions given in ISO 21138-2 and ISO 21138-3 and to the performance requirements given in Clause 9.

NOTE 4 For dimensions larger than DN/OD 1200 or DN/ID 1200, this document can serve as a general guideline regarding appearance, colour, physical and mechanical characteristics as well as performance requirements.

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 472, *Plastics — Vocabulary*

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

ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

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 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 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 11922-1, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

ISO 12091, *Structured-wall thermoplastics pipes — Oven test*

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 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 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 A*

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 non-smooth external surface, Type B*

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*

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 472, ISO 1043-1, ISO 11922-1 and the following apply.

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

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1 General terms

3.1.1.1
structured-wall pipes and fittings
products that have an optimized design with regard to material usage to achieve the physical, mechanical and performance requirements of this document

Note 1 to entry: For a description of the particular designs covered by this document, see ISO 21138-2 for Type A and ISO 21138-3 for Type B. Type A pipes have an internal and external plain surface. Type B pipes have an internal plain surface and a hollow spiral or annular ribbed external surface.

3.1.1.2
fabricated fitting
fitting manufactured by heat forming and/or joining more than one piece of pipe and/or moulded component

Note 1 to entry: Sealing rings retaining components are not considered as a piece.

3.1.2 Geometrical terms

3.1.2.1
nominal size
DN
numerical designation of the size of a component, other than a component designated by thread size, which is approximately equal to the manufacturing dimension in millimetres

Note 1 to entry: The nominal size is either related to the outside diameter, or to the inside diameter

3.1.2.2
nominal diameter
d_n
specified diameter, in millimetres, assigned to a nominal size (DN/OD or DN/ID)

3.1.2.3
outside diameter
d_e
value of the measurement of the outside diameter through its cross-section at any point of a pipe or spigot, rounded to the next greater 0,1 mm

Note 1 to entry: For Type B constructions, see ISO 21138-3.

3.1.2.4
mean outside diameter
d_{em}
value of the measurement of the outer circumference of a pipe or spigot in any cross-section divided by π (= 3,142), rounded up to the nearest 0,1 mm

Note 1 to entry: For Type B constructions, see ISO 21138-3.

3.1.2.5
mean inside diameter
d_{im}
average value of a number of equally spaced measurements of inside diameter in the same cross-section of a pipe or fitting

3.1.2.6
minimum mean inside diameter of a socket
$D_{im,min}$
average value of equally spaced measurements of inside diameter in the same cross-section of a socket

3.1.2.7
wall thickness
e
measured wall thickness at any point of the body of a component

3.1.2.8
wall thickness of the inside layer
waterway wall thickness
e_4
<Type A1> thickness at any point of the inner layer of a pipe or fitting

Note 1 to entry: See ISO 21138-2, Figure 1.

3.1.2.9
wall thickness of the inside layer
waterway wall thickness
e_4
<Type B> thickness at any point of the wall between the ribs or corrugations of the pipe or fitting

Note 1 to entry: See ISO 21138-3, Figure 4.

3.1.2.10
wall thickness of the inside layer under a hollow section
e_5
thickness at any point of the inside wall between a hollow section and the inside surface of the Type A2 or Type B pipe or fitting

Note 1 to entry: See ISO 21138-2, Figure 2 and ISO 21138-3, Figure 4.

3.1.2.11
construction height
e_c
radial distance between the top of ribs or corrugation and the inside surface of the wall, in the case of Type B pipes and fittings or between the outside surface of the wall and the inside surface of the wall, in the case of Type A1 and Type A2 pipes and fittings

3.1.2.12
minimum length of a spigot
$L_{1,min}$
minimum permitted value for the length of a spigot of a pipe or fitting

3.1.2.13
nominal ring stiffness
SN
numerical designation of the ring stiffness of the pipe or fitting, which is a convenient round number, indicating the minimum required ring stiffness of the pipe or stiffness of the fitting

3.1.2.14
fitting stiffness
mechanical characteristic of a fitting, which is a measure of the resistance to ring deflection under an external force as determined in accordance with ISO 13967

3.1.3 Material terms

3.1.3.1
virgin material
material in form such as granules or powder that have not been subjected to use or processing other than that required for their manufacture and to which no reprocessed or recycled materials have been added

3.1.3.2
internal (own) reprocessed material
material prepared from rejected unused pipes or fittings, including trimmings from the production of pipes and fittings, that will be reprocessed in a manufacturer's plant after having been previously processed by the same manufacturer by a process such as moulding or extrusion and for which the complete formulation is known

3.1.3.3
external recycled material
material comprising either one of the following:

a) material from rejected unused pipes or fittings, or trimmings therefrom, that will be reprocessed and that were originally processed by another manufacturer;

b) material from used pipes or fittings that have been cleaned and crushed or ground;

c) material from the production of unused thermoplastics products other than pipes and fittings, regardless of where they are manufactured

d) material from used thermoplastics products other than pipes or fittings which have been cleaned and crushed or ground

3.2 Symbols

d_{n1}	nominal diameter of the main of a branch/saddle branch
d_{n2}	nominal diameter of the branch of a branch/saddle branch
L	axial cover by a saddle branch

L_1 length of a spigot

l effective length of a pipe

R radius to centroid of pipe wall

Z design length of a fitting

α nominal angle of a fitting

3.3 Abbreviated terms

DN/OD nominal size, related to the outside diameter

DN/ID nominal size, related to the inside diameter

PE polyethylene

PP polypropylene

PVC-U unplasticized poly(vinyl chloride)

S pipes series

SDR standard dimension ratio

4 Material

4.1 General

The material shall be one of those specified in the relevant Annexes of ISO 21138-2 and/or ISO 21138-3.

Information about general material characteristics is given in Annex A.

4.2 Sealing ring retaining components

It is permitted that sealing rings be retained using components made from polymers other than PVC-U, PP or PE.

4.3 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.

4.4 Fused or welded joints

When fused or welded joints are used, the manufacturer's instructions for jointing shall be followed.

5 Designation of wall construction

Designations of wall constructions including schematic sketches and examples of typical jointing methods are given in ISO 21138-2 for Type A pipes (inside and outside smooth) and in ISO 21138-3 for Type B pipes (inside smooth and outside structured).

6 Colour

The inner and outer layer of pipes and fittings shall be coloured throughout.

The outside layer of pipes and fittings should preferably be black, orange-brown (approximately RAL 8023 [12]) or dusty grey (approximately RAL 7037 [12]). Other colours may be used.

7 Geometrical characteristics

This document specifies the following nominal sizes. Other dimensions are permitted.

Table 1 — Nominal sizes

DN/ID	100, 125, 150, 200, 225, 250, 300, 400, 500, 600, 800, 1000, 1200
DN/OD	110, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1200

8 Types of fitting

8.1 General

This document is applicable for the following types of fitting. Other designs of fitting, including all sockets and all spigots, are permitted.

a) Bends, swept and unswept angle (see Figure 1 and Figure 2).

NOTE 1 Preferred nominal angles, α , are the following: 15°, 22,5°, 30°, 45° and between 87,5° and 90°.

b) Couplers and slip couplers (see Figure 3).

c) Reducers (see Figure 4).

d) Branches and reducing branches, swept and unswept entry (see Figure 5).

NOTE 2 Preferred nominal angles, α , are 45° and between 87,5° and 90°.

e) Saddle branches for solvent cementing, fusion or welding (see Figure 6):

— the axial cover, L, in millimetres, shall conform to Table 2;

— for saddles having $d_{n1} < 315$ mm, the circumferential cover shall be not less than half a circumference, see Figure 6;

— for saddles having $d_{n1} \geq 315$ mm, the circumferential cover shall not be less than 80 mm, see Figure 6.

NOTE 3 The preferred nominal angle, α, for saddle branches is 45°. When $(d_{n2}/d_{n1}) \leq 2/3$, the nominal angle, α, can be 90°.

f) Plugs (see Figure 7).

Table 2 — Requirement for axial cover length

Dimensions in millimetres

	$d_{n2} \leq 110$	$110 < d_{n2} \leq 125$	$125 < d_{n2} \leq 160$	$160 < d_{n2} \leq 200$
L	≥50	≥60	≥70	≥80

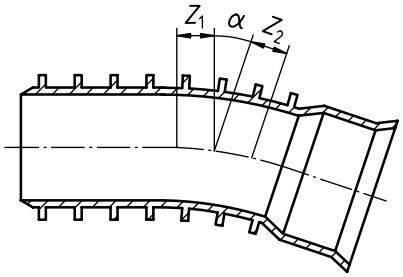


Figure 1 — Example of an unswept bend

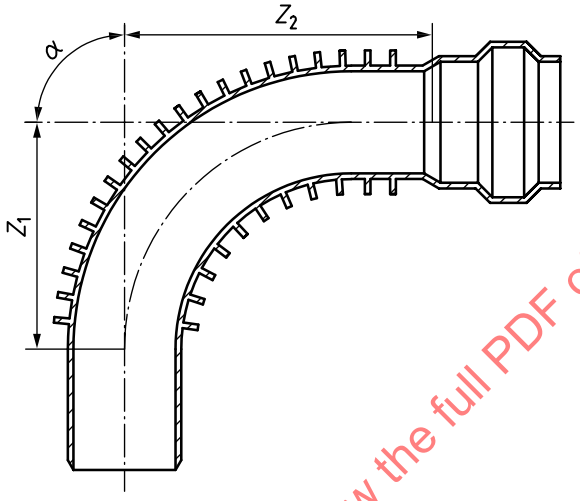


Figure 2 — Example of a swept bend

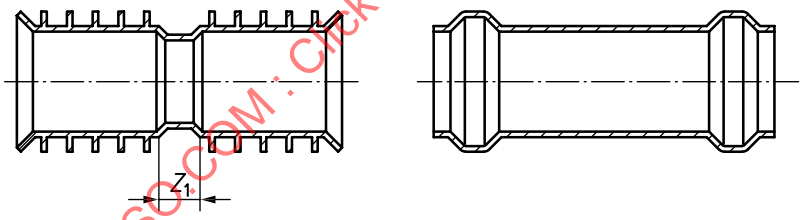


Figure 3 — Example of a coupler and slip coupler

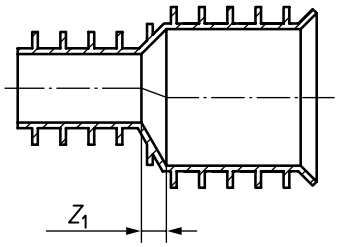


Figure 4 — Example of a reducer

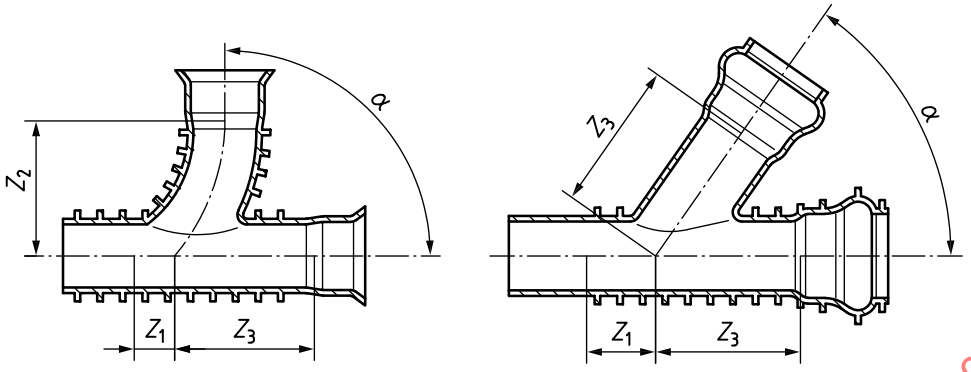
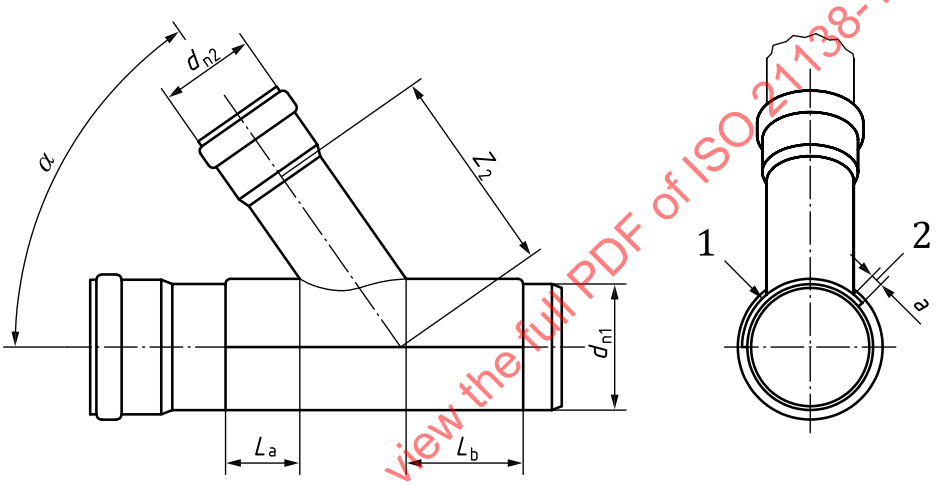


Figure 5 — Example of a swept entry and a straight branch



Key

1 $d_{n1} < 315$ mm

2 $d_{n1} \geq 315$ mm

Figure 6 — Example of a non-mechanical saddle

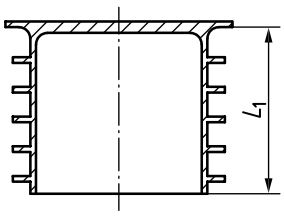


Figure 7 — Example of a plug

The length of the spigots, L_1, shall be such that it passes the ring seal by at least 10 mm.

8.2 Design length of fittings

The design length(s) (Z-lengths) of the fittings (see Figures 1 to 6) shall be declared by the manufacturer.

NOTE The design lengths (Z-lengths) are intended to assist in the design of moulds and are not intended to be used for quality control purposes; ISO 265-1 can be used for guidance.

9 Functional characteristics

In order to ensure good system performance, i.e. safe installation and proper functioning of the installed piping system, the components shall meet the test requirements specified in ISO 21138-2 or ISO 21138-3 as relevant.

The relation between the system performance and the tested characteristics is explained in Table 3.

Information about other functional characteristics is given in Annex B.

10 Relation between ring stiffness, installation technique and resulting deflection

Flexible pipes installed in the ground deflect during installation due to the forces exerted on them, as well as after installation due to further settlement of the soil. The amount of deflection reached after installation depends, to a great extent, on the quality of workmanship and, to a lesser extent, on the pipe stiffness.

The choice of nominal ring stiffness (SN) can be made based on the following existing reference situations:

— the same class of pipe used under acceptable similar or more severe conditions;

— the design graph and the structural design (see Annex C).

Table 3 — Relationship between system performance criteria and tested characteristics

System performance criterion	Tested characteristic	Test method/practice
System compatibility	Dimensions and tolerances	ISO 3126
Resistance to soil load	Ring stiffness — pipe	ISO 9969
	Ring stiffness — fitting	ISO 13967 (same nominal ring stiffness as pipe if same wall construction as pipe)
	Ring flexibility	ISO 13968
	Mechanical strength or flexibility of fabricated fitting	ISO 13264
	Tensile strength of seam	ISO 13262
Long term performance (durability)	Creep ratio	ISO 9967
Handling/robustness	Impact strength — pipe	ISO 3127
	Impact strength — fitting	ISO 13263
	Additional characteristics — cold climate	ISO 11173
	UV resistance	According to national practice
	Tensile strength of seam	ISO 13262
Ability to hold fluid (leaktightness)	Dimensions and tolerances	ISO 3126
	Tightness	ISO 13259
	Long term performance of TPE seals	ISO 13265
	Watertightness of fabricated fittings	ISO 13254
	Tensile test of welded and fused joints	ISO 13262
	Longitudinal reversion	ISO 2505
	Tensile strength of seam	ISO 13262
Identification	Colour	National preference

Table 3 *(continued)*

System performance criterion	Tested characteristic	Test method/practice
Cleaning	Roding Flushing — high volume, low pressure High pressure cleaning	According to national practice
Durability	UV resistance	According to national practice
	Vicat softening temperature	ISO 2507-1 and ISO 2507-2
	Resistance to dichloromethane	ISO 9852
	Resistance to internal pressure	ISO 1167-1 and ISO 1167-2
	Resistance to heating – oven test	ISO 12091
	Effect of heating	ISO 580
	Melt flow rate	ISO 1133-1
	Thermal stability	ISO 11357-6
	Density	ISO 1183-1

Annex A
(informative)

General material characteristics of PVC-U, PP and PE pipes and fittings

A.1 Material characteristics

The materials of pipes and fittings conforming to this document generally have the following characteristics. See Table A.1.

The values in Table A.1, whilst approximate, commonly suffice for design purposes. In instances where more accurate values are required, reference should be made to the pipe or fitting manufacturer.

Table A.1 — Material characteristics

Characteristic	Test method	PVC-U	PP	PE	Unit
Flexural modulus, $E_{(1\ min)}$	ISO 178	3 100 to 3 500	1 250 to 1 900	1 000 to 1 200	MPa
Density	ISO 1183-1	1 400	900	950	$kg{\cdot}m^{-3}$
Coefficient of linear thermal expansion	ISO 11359-2	8×10^{-5}	14×10^{-5}	17×10^{-5}	$mm{\cdot}mm^{-1}{\cdot}K^{-1}$
Thermal conductivity		0,16	0,2	0,4 to 0,50	$W{\cdot}K^{-1}.m^{-1}$
Poisson's Ratio		0,37	0,4	0,4	
Specific heat		1 000	1 700 to 1 900	2 300 to 2 900	$J{\cdot}kg^{-1}K^{-1}$

A.2 Chemical resistance

Piping systems conforming to this document are resistant to corrosion by water with a wide range of pH-values such as domestic waste water, surface water and ground water. If piping systems conforming to this document are to be used for chemically contaminated waste waters, such as industrial discharges, chemical and temperature resistance shall be taken into account.

Guidance on the chemical resistance of PVC-U, PP and PE materials is given in ISO/TR 10358 and of rubber materials in ISO/TR 7620.

Annex B
(informative)

General performance characteristics of PVC-U, PP and PE

B.1 Abrasion resistance

Pipes and fittings conforming to this document are resistant to abrasion. For special circumstances, the abrasion can be determined from the test method given in EN 295-3.

B.2 Hydraulic roughness

The internal surfaces of pipes and fittings conforming to this document are hydraulically smooth. The design of joints and fittings ensures good hydraulic performances. For further information about hydraulic capacity of pipes and fittings conforming to this document, refer to the manufacturer's instructions.

B.3 Diametric deflection

In normal installation conditions (well or moderate compaction in Annex C), the expected average deflection of the inside diameters of the pipes will be less than 8 %.