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Plastics piping systems for non-pressure underground conveyance and storage of non-potable water — Boxes used for retention, detention, storage and transportation systems — Specifications for storm water boxes made of PE, PP and PVC-U

Systèmes de canalisations en plastique pour le transport et le stockage souterrains sans pression de l'eau non potable — Structures alvéolaires ultra-légères utilisées pour les systèmes de rétention, de stockage et de transport — Spécifications relatives aux structures alvéolaires ultra-légères pour eaux pluviales fabriquées à partir de PE, PP et de PVC-U

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Foreword

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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).

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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)*.

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

This document specifies systems comprised of boxes made of PE, PP or PVC-U and used for retention, detention, storage and transportation of storm water.

This document is based on EN 17152-1, additionally including PE materials.

Guidance for installation can be found in CEN/TR 17179.[1]

Plastics piping systems for non-pressure underground conveyance and storage of non-potable water — Boxes used for retention, detention, storage and transportation systems — Specifications for storm water boxes made of PE, PP and PVC-U

1 Scope

This document gives the definitions and specifies the minimum requirements for injection moulded, extruded, compression moulded and thermoformed thermoplastics cuboid shaped boxes, including integral components, used in underground systems for retention, detention, storage and transportation of non-potable water (e.g. storm water) and manufactured from polyethylene (PE), polypropylene (PP) or unplasticized polyvinylchloride (PVC-U).

The boxes are intended for buried underground use, e.g. in landscape, pedestrian or vehicular traffic areas.

In the case of retention and detention systems, the main purpose of the boxes is to retain water, for later infiltration in the ground or for later use in non-potable applications (irrigation, cleaning, sanitary facilities, etc.) or to retain water during a storm, transferring it in a controlled way to the public storm water network.

Applications include commercial, residential, agricultural and highway drainage, including installation under parking lots and roadways.

Product performance is determined by a combination of material specification, product design and manufacturing process.

A box can either be factory-assembled or site-assembled from different components.

The boxes are intended to be used as elements in a modular system where the manufacturer has provided a clearly documented method specifying how the components are assembled to create a complete retention, detention, storage and transportation system. The boxes are installed as one or more horizontal layers on a firm foundation and embedded with fill around and above the complete system.

NOTE Non-load bearing component(s) can be manufactured by various methods (e.g. extrusion, injection moulding, rotational moulding, compression moulded, thermoforming and low-pressure injection moulding) and are not within the scope of 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 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

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

ISO 472, *Plastics — Vocabulary*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

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

ISO 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

ISO 580:2005, *Plastics piping and ducting systems — Injection-moulded thermoplastics fittings — Methods for visually assessing the effects of heating*

ISO 899-1, *Plastics — Determination of creep behaviour — Part 1: Tensile creep*

ISO 899-2, *Plastics — Determination of creep behaviour — Part 2: Flexural creep by three-point loading*

ISO 1043-1:2011, *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 1167-1:2006, *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 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

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

ISO 3451-5, *Plastics — Determination of ash — Part 5: Poly(vinyl chloride)*

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

ISO 11358-1, *Plastics — Thermogravimetry (TG) of polymers — Part 1: General principles*

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*

EN 17150, *Plastics piping systems for non-pressure underground conveyance and storage of non-potable water - Test method for determination of short-term compression strength of boxes*

EN 17151:2019, *Plastics piping systems for non-pressure underground conveyance and storage of non-potable water - Test method for determination of long-term compression strength of boxes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472, ISO 1043-1 and the following apply.

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

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

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

3.1
box
thermoplastic cuboid shaped element, with or without sidewalls, used to create a modular system

3.2
integral component
load bearing component contributing to the overall strength of the box

3.3
modular system
system made of repeating boxes

3.4
detention system
modular system designed to attenuate the peak flow from a given site by providing a temporary underground storm water storage facility

Note 1 to entry: Also known as 'Attenuation".

3.5
retention system
modular system designed to provide a temporary underground storage facility from which storm water infiltrates into the surrounding ground.

Note 1 to entry: Also known as 'Infiltration".

3.6
storage system
modular system designed to provide an underground storage facility for storm water

3.7
porosity
total available volume for water storage divided by the total envelope cuboid volume for a box

3.8
long-term compression strength
maximum applied compression stress for which the box will survive without creep rupture for 50 years determined as the lower 95 % confidence limit (LCL) for the stress leading to a failure at the extrapolated lifetime, in kN/m^2

3.9
virgin material
material in the 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 material has been added

3.10
non-virgin material
material from used or unused retention, detention, storage and transportation boxes which have been cleaned and crushed or ground, or material from used or unused PE, PP or PVC-U products other than retention, detention, storage and transportation boxes, regardless of where they are manufactured

3.11
agreed specification
relevant material characteristics agreed between the supplier of the material and the box manufacturer

3.12
type testing
initial testing performed according to the testing requirements in this document, the results of which are the specified requirements of the specific product being tested

Note 1 to entry: See ISO/IEC 17000:2020, 5.1, for a definition of "specified requirements".

4 Symbols and abbreviated terms

4.1 Symbols

For the purposes of this document, the following symbols apply.

e	maximum thickness of the component tested
h	height, i.e. the vertical distance (in the "z" direction) between the outer surfaces of the unit
w	width, i.e. the smallest horizontal distance (in the "y" direction) between the outer surfaces of the unit
l	length, i.e. the biggest horizontal distance (in the "x" direction) between the outer surfaces of the unit
P	porosity
W	weight
V_{total}	total volume of the unit measured
$V_{material}$	volume taken by the material
V_{closed}	volume not accessible to water or from which water cannot be retrieved
ρ	material density (as specified by the material supplier in Table A.2)

4.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

OIT	oxidation induction time
PE	polyethylene
PP	polypropylene
PVC-U	unplasticized polyvinylchloride
IR	infrared
P	porosity

5 Material

5.1 General

The material shall be either PE, PP or PVC-U, to which may be added:

— mineral modifier(s) of known specification;

— additives needed to facilitate the manufacture of components conforming to this document.

The material used to manufacture the boxes and integral components shall consist of a material or mixtures of different materials each of which shall have an agreed specification between the supplier and manufacturer (see Clause A.2).

5.2 Polypropylene (PP) material

5.2.1 General

The material shall be either PP virgin, PP modified or PP non-virgin material, conforming to 5.2.2 – 5.2.4 as appropriate.

5.2.2 Polypropylene (PP) virgin material

The material for boxes and integral components shall be a compound of PP virgin material and those additives that are needed to facilitate the manufacture of box or integral components conforming to the requirements of this document.

When reworked material is added to a level of less than 10 %, the material for boxes can still be considered as virgin.

5.2.3 Polypropylene (PP) modified with minerals

The material for boxes and integral components shall be a compound of PP virgin material modified with minerals and those additives that are needed to facilitate the manufacture of box or integral components conforming to the requirements of this document.

If calcium carbonate is used, only coated calcium carbonate shall be used. The content of minerals in the final compound shall be less than 50 % by mass.

When reworked material is added to a level of less than 10 %, the material for boxes can still be considered as modified.

5.2.4 Polypropylene (PP) non-virgin material

The material for boxes and integral components shall be a compound of non-virgin PP material and those additives that are needed to facilitate the manufacture of box or integral components conforming to the requirements of this document.

Non-virgin materials shall be permitted to be used up to 100 % or added to virgin or reworked material or a mixture of those two materials.

The content of minerals in the final compound shall be less than 50 % by mass.

5.3 Polyethylene (PE) material

5.3.1 General

The material shall be either PE virgin, PE modified or PE non-virgin material, conforming to 5.3.2 – 5.3.4 as appropriate.

5.3.2 Polyethylene (PE) virgin material

The material for boxes and integral components shall be a compound of PE virgin material and those additives that are needed to facilitate the manufacture of box or integral components conforming to the requirements of this document.

When reworked material is added to a level of less than 10 %, the material for boxes can still be considered as virgin.

5.3.3 Polyethylene (PE) modified with minerals

The material for boxes and integral components shall be a compound of PE virgin material modified with minerals and those additives that are needed to facilitate the manufacture of box or integral components conforming to the requirements of this document.

If calcium carbonate is used, only coated calcium carbonate shall be used.

The content of minerals in the final compound shall be less than 50 % by mass.

When reworked material is added to a level of less than 10 %, the material for boxes can still be considered as modified.

5.3.4 Polyethylene (PE) non-virgin material

The material for boxes and integral components shall be a compound of non-virgin PE material, and those additives that are needed to facilitate the manufacture of box or integral components conforming to the requirements of this document.

Non-virgin materials shall be permitted to be used up to 100 % or added to virgin or reworked material or a mixture of those two materials.

The content of minerals in the final compound shall be less than 50 % by mass.

5.4 Unplasticized polyvinylchloride (PVC-U) material

5.4.1 General

The material shall be either PVC-U virgin or PVC-U non-virgin material, conforming to 5.4.2 and 5.4.3 as appropriate.

5.4.2 Unplasticized polyvinylchloride (PVC-U) virgin material

The material for boxes or integral components shall be a formulation of PVC-U virgin material and those additives that are needed to facilitate the manufacture of box or integral components conforming to the requirements of this document.

When reworked material is added to a level of less than 10 %, the material can still be considered as virgin.

5.4.3 Unplasticized polyvinylchloride (PVC-U) non-virgin material

The material for boxes or integral components shall be a formulation of PVC-U non-virgin material and those additives that are needed to facilitate the manufacture of box and integral components conforming to the requirements of this document.

Recycled materials from PVC-U products that 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 reworked material or a mixture of those two materials.

5.5 Box and integral components material characteristics

A product in this document is formed by a combination of a material specification, a design and a manufacturing process. Table 1 specifies the minimum required tests to fingerprint the material and to specify the material requirements.

In conformance with the results in type testing, a product-specific material specification with specified requirements shall be defined by the manufacturer.

When tested after type testing in accordance with the test methods as specified in Table 1, using the indicated parameters, the material used for the boxes shall have the characteristics conforming to the requirements given in Table A.1.

Table 1 — Material characteristics for boxes and integral components

Characteristic	Material	Requirement	Test parameters	Test method
Resistance to internal pressure (if tensile creep rupture is not tested)	PP	The values obtained shall meet or exceed the specific requirement for the product being tested.[a] See Annex A.	End caps: type A (ISO 1167-1:2006) Type: water-in-water or water-in-air Test temperature; 95 °C Circumferential stress: 2,5 MPa	ISO 1167-1 and ISO 1167-2
	PE		End caps: type A (ISO 1167-1:2006) Type: water-in-water or water-in-air Test temperature: 80 °C Circumferential stress: 2,8 MPa	ISO 1167-1 and ISO 1167-2
	PVC-U		End caps: type A (ISO 1167-1:2006) Type: water-in-water or water-in-air Test temperature: 60 °C Circumferential stress: 6,3 MPa	ISO 1167-1 and ISO 1167-2
Tensile creep rupture (if resistance to internal pressure is not tested)	PP	The values obtained shall meet or exceed the specific requirement for the product being tested.[a] See Annex A.	Test stress: 2,5 MPa Temperature: 95 °C	ISO 899-1
	PE		Test stress: 2,8 MPa Temperature: 80 °C	ISO 899-1
	PVC-U		Test stress: 6,3 MPa Temperature: Vicat −15 °C	ISO 899-1
Melt mass-flow rate Before processing	PP	The values obtained shall meet or exceed the specific requirement for the product being tested.[a] See Annex A.	Temperature; 230 °C Loading mass: 2,16 kg	ISO 1133-1
	PE		Temperature: 190 °C Loading mass: 5,0 kg	ISO 1133-1
K-value (only for virgin PVC-U)	PVC-U	The values obtained shall meet or exceed the specific requirement for the product being tested.[a] See Annex A.	ISO 13229	ISO 13229
Vicat softening temperature (VST)	PVC-U		Force: 50 N Heating rate: 50 K/h	ISO 306
OIT	PP	The values obtained shall meet or exceed the specific requirement for the product being tested.[a] See Annex A.	Temperature: 200 °C	ISO 11357-6
	PE		Temperature: 200 °C	ISO 11357-6

[a] The specified requirement is generated from type testing of the product using the tests and parameters given in this table.

Table 1 *(continued)*

Characteristic	Material	Requirement	Test parameters	Test method
Flexural – creep modulus 500 h	PP	The values obtained shall meet or exceed the specific requirement for the product being tested.[a] See Annex A.	Duration: 500 h Test stress: 2 MPa Temperature: (23 ± 2) °C	ISO 899-2
	PE		Duration: 500 h Test stress: 2 MPa Temperature: (23 ± 2) °C	ISO 899-2
	PVC-U		Duration: 500 h Test stress: 2 MPa Temperature: (23 ± 2) °C	ISO 899-2

[a] The specified requirement is generated from type testing of the product using the tests and parameters given in this table.

6 General characteristics

6.1 Appearance

When viewed without magnification, the internal and external surfaces of boxes and components shall be clean and free from defects likely to prevent conformity with this document. Sharp edges in the external surface should be avoided.

6.2 Colour

Any colour may be used.

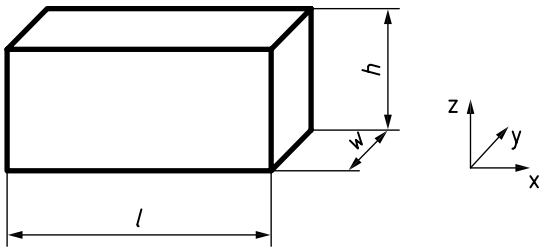
6.3 Box covered by this document

Boxes can be assembled from more than 1 component. A tested box shall include all integral components.

7 Geometrical characteristics

7.1 Shape

The boxes, once assembled, should have a cubic shape of dimensions *h* (height), *w* (width) and *l* (length) as shown in Figure 1.



Key

h height = vertical distance (in the "z" direction) between the outer surfaces of the unit

w width = smallest horizontal distance (in the "y" direction) between the outer surfaces of the unit

l length = biggest horizontal distance (in the "x" direction) between the outer surfaces of the unit

Figure 1 — Box dimensions

The maximum height of a box, which is equivalent to one layer of installation, shall be limited to 1 000 mm.

7.2 Dimensions

The dimensions *l*, *w* and *h* from Figure 1 shall be measured in accordance with ISO 3126.

The dimensions shall be according to the specification given by the manufacturer.

7.3 Total volume

The total or "apparent" volume of each unit, V_{total}, shall be calculated according to Formula (1):

$$V_{total} = l \times w \times h \quad (1)$$

The total volume shall be expressed in m^3.

7.4 Material volume

The material volume, $V_{material}$, is the volume taken by the material and it shall be calculated according to Formula (2):

$$V_{material} = W / \rho \quad (2)$$

where:

W is the weight measured in 7.5;

ρ is the material density (as specified by the material supplier in Table A.2).

7.5 Weight

The weight shall be measured with an accuracy of 0,1 %.

The reference weight shall be the mean weight of the boxes and integral components used for the test specimen for the long-term test according to EN 17151.

7.6 Porosity

The porosity, P, is the ratio of the total available volume for water storage and the total volume for a box, expressed in %. It is calculated according to Formula (3):

$$P = \frac{V_{total} - V_{material} - V_{closed}}{V_{total}} \quad (3)$$

where

V_{total} is the total volume of the unit measured according to 7.3;

$V_{material}$ is the volume taken by the material according to 7.4;

V_{closed} is the volume not accessible to water or from which water cannot be retrieved.

The porosity shall be declared to the nearest 1 %.

8 Physical characteristics of boxes

8.1 Physical characteristics of injection moulded PP boxes

When tested in accordance with the test methods as specified in Table 2 using the indicated parameters, boxes shall have the physical characteristics conforming to the requirements given in Table 2.

Table 2 — Physical characteristics of PP boxes

Characteristic	Requirements	Test parameters		Test method
Effects of heating [a,b,c]	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	Temperature: Heating time:	(150 ± 2) °C in accordance with ISO 580:2005, Clause 3	Method A: Air oven, in accordance with ISO 580:2005, Clause 4
[a] Large test pieces may be cut to fit the oven. [b] All integral components shall be tested. [c] Only applicable for injection moulded components.				

8.2 Physical characteristics of injection moulded PE boxes

When tested in accordance with the test methods as specified in Table 3 using the indicated parameters, boxes shall have the physical characteristics conforming to the requirements given in Table 3.

Table 3 — Physical characteristics of PE boxes

Characteristic	Requirements	Test parameters		Test method
Effects of heating [a,b,c]	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	Test temperature: Heating time:	(110 ± 2) °C in accordance with ISO 580:2005, Clause 3	Method A: Air oven, in accordance with ISO 580:2005, Clause 4
[a] Large test pieces may be cut to fit the oven. [b] All integral components shall be tested. [c] Only applicable for injection moulded components.				

8.3 Physical characteristics of injection moulded PVC-U boxes

When tested in accordance with the test methods as specified in Table 4 using the indicated parameters, boxes shall have the physical characteristics conforming to the requirements given in Table 4.

Table 4 — Physical characteristics of PVC-U boxes

Characteristic	Requirements	Test parameters		Test method
Resistance to heating – Oven test [a,b,c]	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	Test temperature Heating time for:	(150 ± 2) °C in accordance with ISO 580:2005, Clause 3	Method A: Air oven, in accordance with ISO 580:2005, Clause 4
[a] Large test pieces may be cut to fit the oven. [b] All integral components shall be tested. [c] Only applicable for injection moulded components.				

9 Mechanical characteristics of boxes including integral components

When tested in accordance with the test methods as specified in Table 5 using the indicated parameters, the boxes including integral components shall have mechanical characteristics conforming to the requirements given in Table 5.

Conforming with the results from type testing of the mechanical characteristics, the specified requirements for each specific product shall be defined by the manufacturer.

Table 5 — Mechanical characteristics of boxes — Short and long-term compression strength

Characteristic	Requirements	Test parameters		Test method
Short-term compression strength	z-direction is the vertical direction of installation. y-direction shall give the lowest compression strength (See Figure 1) The value obtained shall meet or exceed the specified requirements for the product being tested.[a]	Method	A or B	EN 17150
		Test direction	x, y and z	
		Number of test samples	At least 3 for each direction	
Long-term compression strength vertical direction	The long-term compression strength shall be ≥ 50 kN/m^2. The value obtained shall meet or exceed the specified requirements for the product being tested.[a]	Test direction	z	EN 17151
		Test duration	EN 17151:2019, 8.1	
		Number of test samples	EN 17151:2019, 8.1	
[a] The specified requirement generated from type testing of the product using the tests and parameters given in this table.				

Table 5 *(continued)*

Characteristic	Requirements	Test parameters		Test method
Long-term compression strength lateral direction (only for storage, transportation, and detention boxes)	The value obtained shall meet or exceed the specified requirements for the product being tested.[a]	Test direction	y	EN 17151
		Test duration	EN 17151:2019, 8.1	
		Number of test samples	EN 17151:2019, 8.1	

[a] The specified requirement generated from type testing of the product using the tests and parameters given in this table.

10 Marking

10.1 General

Marking elements shall be printed or formed directly on the component or be on a label, in such a way that after storage, weathering, handling and installation, the required legibility is maintained. The legibility shall be durable in use.

Marking shall not initiate cracks or other types of defects which adversely influence the performance of the retention, detention, storage and transportation boxes.

The size of the marking shall be such that the marking is legible without magnification.

10.2 Minimum required marking of boxes

The minimum required marking of retention, detention, storage and transportation boxes is given in Table 6.

Table 6 — Minimum required marking of boxes

Aspects	Marking or symbols
Number of this document	ISO 4981
Manufacturer's name and/or trade mark	
Material	PE, PP or PVC-U
Optional Long-term structural strength vertical direction [a]	 e.g. 100
Optional Long-term structural strength vertical direction / lateral direction [a]	 e.g. 100 / 17
Optional Porosity	 e.g. 90 %
Manufacturer's information (permanent marked)	name or code for the production site and production period (year and month).

[a] Values shall be given in integer values in kPa.

Annex A
(normative)

Characteristics of materials used in boxes and integral components for PP, PE and PVC-U

A.1 Material characteristics

The durability of boxes and integral components is carried out as a check of the material characteristics used in boxes and integral components fulfilling the requirements for the long-term compression strength test described in Table 5.

When determining the material characteristics, as described in Table A.1 during the type testing, the material samples shall be taken from the same production batch of material used to carry out the long-term compression strength test according to EN 17151:2019.

NOTE A selection of these material characteristics will be used when defining the test to be carried out for the assessment of conformity.

Table A.1 — Material characteristics of boxes and integral component made of PP, PE and PVC-U

Characteristic	Material	Requirement [a]
Resistance to internal pressure (if tensile creep is not tested)	PP	≥ the value obtained on material used for boxes and integral components obtained when type testing the product for long-term compression strength,[b] as specified in the material specification
	PE	≥ the value obtained on material used for boxes and integral components obtained when type testing the product for long-term compression strength,[b] as specified in the material specification
	PVC-U	≥ the value obtained on material used for boxes and integral components obtained when type testing the product for long-term compression strength,[b] as specified in the material specification
Tensile creep rupture (if resistance to internal pressure is not tested)	PP	≥ the value obtained on material used for boxes and integral components fulfilling the long-term compression strength test,[b] as specified in the material specification
	PE	≥ the value obtained on material used for boxes and integral components fulfilling the long-term compression strength test,[b] as specified in the material specification
	PVC-U	≥ the value obtained on material used for boxes and integral components fulfilling the long-term compression strength test,[b] as specified in the material specification

[a] The characteristic value determined shall be the 95 % lower confidence limit.

[b] The characteristic value determined shall be the 95 % higher confidence limit.

[c] Due to the fact that these characteristics only fingerprint the used material, the values can be declared. The durability is tested via compression tests on material/design. This is a different approach to ensure the quality or strength than in other plastic piping systems standards, where the material characteristics are determining the durability.