INTERNATIONAL STANDARD

ISO 8779

Third edition
2010-03-01

Plastics piping systems — Polyethylene (PE) pipes for irrigation — Specifications

Systèmes de canalisations en plastique — Tubes en polyéthylène (PE) pour l'irrigation — Spécifications

Reference number
ISO 8779:2010(E)

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Published in Switzerland

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8779 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*.

This third edition cancels and replaces the second edition (ISO 8779:2001), which has been technically revised. The scope of this third edition has been enlarged to cover the mains and sub-mains of irrigation piping systems, which were previously specified in ISO 4427.

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Plastics piping systems — Polyethylene (PE) pipes for irrigation — Specifications

1 Scope

This International Standard specifies the pipes (mains, sub-mains and laterals) with nominal outside diameters from 12 mm up to and including 63 mm made from polyethylene (PE) intended to be used for the conveyance of water for irrigation.

It also specifies the general properties of PE and the test parameters for the pipes designated as PE 32 and PE 40 by checking referenced points as given in 4.4, to be used under the following conditions:

— nominal pressures of PN 2,5, PN 4, PN 6, PN 8 and PN 10, as applicable,

— at temperatures up to and including 45 ºC, as specified in Annex A.

NOTE Pipes with a diameter of 75 mm and nominal pressure (PN) of 4 bar[1)] are also included in this International Standard.

2 Normative references

The following referenced documents are indispensable for the application 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 1133-1, *Plastics — Determination of the melt volume-flow rate (MVR) and melt mass-flow rate (MFR) of thermoplastics materials — 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 2505, *Thermoplastics pipes — Longitudinal reversion — Test method and parameters*

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

ISO 4065:1996, *Thermoplastics pipes — Universal wall thickness table*

ISO 4427-2:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 2: Pipes*

ISO 6964, *Polyolefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis — Test method and basic specification*

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

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ISO 8796, *Polyethylene PE 32 and PE 40 pipes for irrigation laterals — Susceptibility to environmental stress cracking induced by insert-type fittings — Test method and requirements*

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

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

ISO 18553, *Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
irrigation main
main supply line within an irrigation system, including sub-mains

3.2
irrigation lateral
branch supply line within an irrigation system on which water distribution devices are mounted directly or by means of fittings, risers or tubes

NOTE Examples of water distribution devices are sprinklers, emitters and drippers.

3.3
melt mass-flow rate
MFR
value relating to the viscosity of the molten material at a specified temperature and load measured in accordance with ISO 1133-1

NOTE MFR is expressed in units of grams per 10 min (g/10 min).

3.4
nominal outside diameter
d_n
specified outside diameter, in millimetres, assigned to a nominal size DN/OD

3.5
outside diameter at any point
d_e
value of the measurement of the outside diameter through its cross-section at any point of the pipe rounded to the next greater 0,1 mm

3.6
mean outside diameter
d_{em}
value of the measurement of the outer circumference of the pipe or spigot end of a fitting in any cross-section divided by π (= 3,142), rounded to the next greater 0,1 mm

3.7
minimum mean outside diameter
$d_{em,\,min}$
minimum value of the outside diameter as specified for a given nominal size

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3.8
maximum mean outside diameter
$d_{em,max}$
maximum value of the outside diameter as specified for a given nominal size

3.9
out-of-roundness
ovality
difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-section of the pipe or spigot end of a fitting

3.10
nominal wall thickness
e_n
numerical designation of the wall thickness of a component, which is a convenient round number approximately equal to the manufacturing dimension in millimetres

3.11
wall thickness at any point
e
value of the measurement of the wall thickness at any point around the circumference of a component

3.12
minimum wall thickness at any point
e_{min}
minimum value of the wall thickness at any point around the circumference of a component as specified

3.13
maximum wall thickness at any point
e_{max}
maximum value of the wall thickness at any point around the circumference of a component as specified

3.14
mean wall thickness
e_m
arithmetic mean of a number of measurements regularly spaced around the circumference of the component in the same cross-section of the component, including the measured minimum and the measured maximum values of the wall thickness

3.15
pipe series
S
dimensionless number for pipe designation conforming to ISO 4065

NOTE 1 The relationship between the pipe series, S, and the standard dimension ratio, SDR, is given by Equation (1):

$$S = \frac{SDR - 1}{2} \quad (1)$$

NOTE 2 Adapted from ISO 4065:1996, definition 3.6.

3.16
standard dimension ratio
SDR
ratio of the nominal outside diameter, d_n, of a pipe to its nominal wall thickness, e_n

[ISO 4065:1996, definition 3.5]

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3.17
tolerance
permissible variation of the specified value of a quantity expressed as the difference between the permissible maximum and permissible minimum values

3.18
nominal pressure
PN
numerical designation used for reference purposes related to the mechanical characteristics of the component of a piping system

NOTE For plastic piping systems conveying water, it corresponds to the maximum continuous operating pressure, expressed in bar, which can be sustained with water at 20 °C, based on the minimum design coefficient.

3.19
maximum operating pressure
MOP
maximum effective pressure of the fluid in the piping system, expressed in bar, which is allowed in continuous use

NOTE 1 It takes into account the physical and the mechanical characteristics of the components of a piping system.

NOTE 2 It is calculated using Equation (2):

$$\mathrm{MOP} = \frac{20\,(\mathrm{MRS})}{C \times [\mathrm{SDR} - 1]} \tag{2}$$

3.20
lower prediction limit
σ_{LPL}
quantity, with the dimensions of stress expressed in megapascals, which can be considered as a property of the material, and which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at 20 °C for 50 years with internal water pressure

3.21
minimum required strength
MRS
value of σ_{LPL} rounded down to the next smaller value of the R10 series or R20 series, depending on the value of σ_{LPL}

NOTE R10 and R20 series are the Renard number series according to ISO 3[1] and ISO 497[2].

3.22
design stress
σ_{S}
allowable stress, expressed in megapascals, for a given application derived by dividing MRS by the coefficient C and rounding to the next lower value in the R20 series

NOTE It is expressed as Equation (3):

$$\sigma_{\mathrm{S}} = \frac{\mathrm{MRS}}{C} \tag{3}$$

3.23
overall service coefficient
design coefficient
C
overall coefficient with a value greater than 1, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confidence limit

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3.24
working conditions
operation of pipes for an expected life of 10 years, considering the temperature and the manipulation, and the functionality of the pipes defined by this International Standard as 1 500 h/yr, and the rest of the time without pressure, installed in the fields

4 Material

4.1 General

The pipes shall be manufactured from polyethylene containing only those antioxidants, additives, colorants and carbon black necessary for manufacture in accordance with this International Standard.

The pipes shall, insofar as possible, not support the growth of algae and bacteria.

Pipes that are exposed to light shall be opaque.

The pipes shall be UV protected against degradation.

All additives shall be uniformly dispersed.

Layered pipes are allowed and shall comply with Annex A of ISO 4427-2:2007.

4.2 Use of reprocessable and recyclable material

Clean reprocessable material generated from a manufacturer's own production may be used, if it is derived from the same resin as used for the relevant production.

4.3 Physical characteristics of the material

The material used for the manufacture of pipes shall conform to the requirements given in Table 1.

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Table 1 — Characteristics of the PE material

Characteristics	Requirements	Test parameter		Test method
		Parameter	Value	
Carbon black content (black compound only)	(2 to 2,5) % mass fraction	Shall conform to ISO 6964		ISO 6964
Carbon black dispersion (black compound only)	⩽ grade 3	Shall conform to ISO 18553[a]		ISO 18553
Oxidation induction time	⩾ 20 min	Test temperature	200 °C[b]	ISO 11357-6
		Number of test pieces[c]	3	
Pigment dispersion (non-black compound only)	⩽ grade 3	Shall conform to ISO 18553[a]		ISO 18553
Melt mass-flow rate (MFR) for PE 32 and PE 40	0,2 – 1,4 g/10 min Maximum deviation of ± 25 % of the nominated value[d]	Load	2,16 kg	ISO 1133-1 condition D
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces[c]	As specified in ISO 1133-1	

[a] In case of dispute, the test pieces for carbon black dispersion and pigment dispersion shall be prepared by the compression method.

[b] The test may be carried out as an indirect test at 210 °C, providing there is a clear correlation to the results at 200 °C. In case of dispute, the test temperature shall be 200 °C.

[c] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in this table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan.

[d] Nominated value given by the compound producer.

4.4 Designation and classification

The material shall be designated by the material type (PE) and the classification related to the reference points established in accordance with Table 2.

Table 2 — Material designation and testing in accordance with reference points

Designation	100 h at 20 °C	165 h at 80 °C	1 000 h at 80 °C
	MPa	MPa	MPa
PE 32	6,5	2,0	1,5
PE 40	7,0	2,5	2,0

NOTE Reference points are taken from existing national documents[3][4].

5 Geometrical characteristics

5.1 Measurements

The dimensions of the pipe shall be measured in accordance with ISO 3126. In the case of dispute, the measurements of dimensions shall be made not less than 24 h after manufacture after being conditioned for at least 4 h at (23 ± 2) °C.

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5.2 Mean outside diameter and out-of-roundness

The mean outside diameters, d_{em}, and the out-of-roundness (ovality) shall be in accordance with Table 3.

Table 3 — Mean outside diameters and out-of-roundness

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter d_n	Mean outside diameter[a]		Maximum out-of-roundness (ovality)[b]
		$d_{em, min}$	$d_{em, max}$	
12	12	12,0	12,3	1,2
16	16	16,0	16,3	1,2
20	20	20,0	20,3	1,2
25	25	25,0	25,3	1,2
32	32	32,0	32,3	1,3
40	40	40,0	40,4	1,4
50	50	50,0	50,5	1,4
63	63	63,0	63,6	1,5
75	75	75,0	75,7	1,6

[a] In accordance with ISO 11922-1, grade A.

[b] In accordance with ISO 11922-1, grade N.

NOTE For coiled pipe, the manufacturer and the purchaser shall come to an agreement on the maximum out-of-roundness.

5.3 Wall thicknesses and their tolerances

The wall thickness shall be in accordance with Table 4.

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Table 4 — Wall thicknesses

Dimensions in millimetres

	Pipe series											
	S 4		S 5		S 6,3		S 8		S 10		S 12,5	
	SDR 9		SDR 11		SDR 13,6		SDR 17		SDR 21		SDR 26	
	Nominal pressure, PN[a] in bar											
PE 32	PN 6		—		PN 4		—		PN 2,5		—	
PE 40	PN 8		PN6		—		PN 4		—		PN 2,5	
Nominal Size	Wall thicknesses[b]											
	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
12	1,4	1,7	1,1	1,4	—	—	—	—	—	—	—	—
16	1,8	2,1	1,5	1,8	1,2	1,5	1,0	1,3	—	—	—	—
20	2,3	2,7	1,9	2,3	1,5	1,8	1,2	1,5	1,0	1,3	—	—
25	2,8	3,2	2,3	2,7	1,9	2,3	1,5	1,8	1,2	1,5	1,0	1,3
32	3,6	4,1	2,9	3,3	2,4	2,8	1,9	2,2	1,6	1,9	1,3	1,6
40	4,5	5,1	3,7	4,2	3,0	3,4	2,4	2,8	1,9	2,2	1,6	1,9
50	5,6	6,3	4,6	5,2	3,7	4,2	3,0	3,4	2,4	2,8	2,0	2,3
63	7,1	8,0	5,8	6,5	4,7	5,3	3,8	4,3	3,0	3,4	2,5	2,9
75	—	—	—	—	—	—	—	—	—	—	2,9	3,3

[a] PN values are based on C = 1,25.

[b] Tolerances in accordance with grade V of ISO 11922-1.

When the piping system is to be operated at temperatures above 35 °C operating pressures should be reduced (see A.3).

Pipes shall be coiled such that localized deformation, e.g. buckling and kinking, is prevented.

The length of straight pipes and coils shall not be less than that agreed on by the manufacturer and the customer.

6 Mechanical characteristics

6.1 Requirements

When tested in accordance with the test method as specified in Table 5 using the indicated parameters, the pipe shall have mechanical characteristics conforming to the requirements given in Table 5.

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Table 5 — Mechanical characteristics

Characteristics	Requirements	Test parameter		Test method
		Parameters	Value	
Hydrostatic strength at 20 °C	No failure during test period of any test pieces	End caps	Type a)	ISO 1167-1 ISO 1167-2
		Conditioning period	As specified in ISO 1167-1	
		Number of test pieces[a]	3	
		Type of test	Water-in-water	
		Test temperature	20 °C	
		Test period	100 h	
		Circumferential (hoop) stress for:		
		PE 32	6,5 MPa	
		PE 40	7,0 MPa	
Hydrostatic strength at 80 °C	No failure during test period of any test pieces	End caps	Type a)	ISO 1167-1 ISO 1167-2
		Conditioning period	As specified in ISO 1167-1	
		Number of test pieces[a]	3	
		Type of test	Water-in-water	
		Test temperature	80 °C	
		Test period	165 h[b]	
		Circumferential (hoop) stress for:		
		PE 32	2,0 MPa	
		PE 40	2,5 MPa	
Hydrostatic strength at 80 °C	No failure during test period of any test pieces	End caps	Type a)	ISO 1167-1 ISO 1167-2
		Conditioning period	As specified in ISO 1167-1	
		Number of test pieces[a]	3	
		Type of test	Water-in-water	
		Test temperature	80 °C	
		Test period	1 000 h	
		Circumferential (hoop) stress for:		
		PE 32	1,5 MPa	
		PE 40	2,0 MPa	

[a] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in this table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan.

[b] Premature ductile failures are not taken into account. For the retest procedure, see 6.2.

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6.2 Retest in cases of failure at 80 °C

A fracture in a brittle mode in less than 165 h shall constitute a failure, however if a sample in the 165 h test fails in a ductile mode in less than 165 h, a retest shall be performed at a selected lower stress in order to achieve the minimum required time for the selected stress obtained from the line through the stress/time points given in Table 6.

Table 6 — Test parameters for the retest of the hydrostatic strength at 80 °C

PE 32		PE 40	
Stress MPa	**Test period** h	**Stress** MPa	**Test period** h
2,0	165	2,5	165
1,9	227	2,4	230
1,8	319	2,3	323
1,7	456	2,2	463
1,6	667	2,1	675
1,5	1 000	2,0	1 000

7 Physical characteristics

7.1 Requirements

When tested in accordance with the test methods as 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

Characteristics	**Requirements**	**Test parameters**		**Test method**
Longitudinal reversion	$\leqslant$ 3 %, no effect on surface	Shape and number of test pieces Test temperature PE 32 and PE 40 Time	See ISO 2505 (100 $\pm$ 2) °C See ISO 2505	ISO 2505
Environmental stress cracking (for PE 32 and PE 40 pipes intended for connection to insert-type fittings)	Not more than 10 % of the bends tested failed	Number of test pieces and test conditions	See ISO 8796	ISO 8796

8 Marking

8.1 General

All pipes shall be permanently and legibly marked in such a way that the marking does not initiate cracks or other types of failure and that normal storage, weathering, handling, installation and use shall not affect the legibility of the marking.

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If printing is used, the colour of the printed information shall differ from the basic colour of the product.

The marking shall be such that it is legible without magnification.

8.2 Minimum required marking of pipes

The minimum required marking shall conform to Table 8, with the frequency of marking being not less than once per metre.

Table 8 — Minimum required marking

Aspect	Marking or symbol
Number of this International Standard	ISO 8779
Manufacturer's identification	Name or symbol
Dimensions ($d_n \times e_n$)	e.g. 40 × 2,4
Material and designation	e.g. PE 40
Pressure rating in bars	e.g. PN 6
Production period (date or code)	e.g. 0801[a]
Intended use[b]	I
Coils should be sequentially marked with the metrage, which will indicate the length remaining on the coil.	

[a] In clear figures or in code providing traceability to the production period to within the year and month, and the production site, if the manufacturer is producing at different sites.

[b] Guidance for coding can be found in CEN/TR 15438:2007 [5].

EXAMPLE **(Manufacturer's name) – 40 × 2,4 – PE 40 – PN 6 – ISO 8779 – (Date) – I**

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Annex A
(normative)

Principles for the selection of irrigation pipes

A.1 General working conditions

The normal working conditions of the pipes shall be the following.

a) Operation for a maximum of 1 500 h/yr at pressures up to the nominal pressure of the pipe and at a water temperature up to 45 °C. To provide additional safety when these working conditions are exceeded, the next lower pipe series, i.e. pipe with a greater wall thickness, shall be chosen.

b) When the pipe is not in use, the pressure shall be released.

NOTE Under these working conditions, the expected lifetime of the pipe is 10 years or less, depending on the mechanical stresses and external abrasion to which the pipe is subjected.

A.2 Factors other than working pressure affecting choice of pipe

A.2.1 Type of connection between the pipe and fittings and between the pipe and distribution devices

A.2.1.1 The type of connection does not affect the choice of pipe in the following cases:

a) when the connecting fitting or the distribution device is of the insert type (serrated insert with or without outside reinforcing clamps);

b) when a distribution device inserted into the pipe is used, whether it is secured by a clamp or not.

A.2.1.2 The type of connection does affect the choice of pipe in the following cases:

a) when the distribution device is threaded from the side into the pipe wall. In this case, the wall thickness shall be not less than 1,5 mm;

NOTE For greater accuracy, a relationship has to be found between nominal wall thickness, the hole diameter and the inside diameter of the pipe. This is necessary for both cases c) and d).

b) when a compression type fitting with an external grip ring is used, the wall thickness of the pipe shall be no less than 2 mm unless a suitable reinforcing insert is used.

A.2.2 The type of irrigation system to which the lateral is linked

A.2.2.1 In a semi-mobile sprinkler system, the lateral shall be no less than a PN 4 pipe.

A.2.2.2 In a trailer-type drip irrigation system, the lateral shall be no less than a PN 4 pipe.

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A.3 Effect of water temperature on choice of nominal pressure (PN) of pipe

For temperatures up to 35 °C, the nominal pressure (PN) of the pipe is determined by the maximum operating pressure required (see A.1).

For temperatures above 35 °C and up to and including 45 °C, the pipe shall be selected from the next lower pipe series (i.e. the next higher PN). See example in Table A.1.

Table A.1 — Effect of water temperature — Example for PE 40 pipe

Choice	Temperature range	
	up to 35 °C	from 36 °C to 45 °C
Pipe series	S 8/SDR 17	S 6,3/SDR 13,6
Nominal pressure PN	4	4
Maximum operating pressure MOP	4	4

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Bibliography

[1] ISO 3, *Preferred numbers — Series of preferred numbers*

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

[3] UNE 53367:2000, *Plásticos — Tubos de Polietileno PE 32 y PE 40 para micro irrigación — Características y métodos de ensayo*

[4] SI 499:2000, *Polyethylene Pipes for water supply* (in Hebrew)

[5] CEN/TR 15438:2007, *Plastics piping systems — Guidance for coding of products and their intended uses*

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ICS 23.040.20; 65.060.35

Price based on 14 pages

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