# PS:3580-2014

**ICS No. ICS No.23.040.20**

## PAKISTAN STANDARD

# PLASTIC PIPING SYSTEMS- POLYETHYLENE (PE) PIPES AND FITTINGS FOR WATER SUPPLY

**(1st Revision)**





**PAKISTAN STANDARDS AND QUALITY CONTROL AUTHORITY**
**STANDARDS DEVELOPMENT CENTRE**
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**GULISTAN-E-JAUHAR**
**Karachi**

**PAKISTAN STANDARDS SPECIFICATION**

**FOR**

**PLASTIC PIPING SYSTEMS- POLYETHYLENE (PE) PIPES AND FITTINGS FOR WATER SUPPLY**

# (1st Revision)

0 FOREWORD:

0.1 This Standard was adopted by Pakistan Standard & Quality Control Authority after recommendations of the Technical Committee for "BUILDER'S & HARDWARE & SANITARY FITTINGS" (BDC-6) on 30-01-2014. The same had been approved and endorsed by the Civil Engineering National Standards Committee on 28-02-2014.

0.2 This Standard has been prepared after taking into consideration the views and suggestions of the manufacturers, technologists, suppliers and utilizing agencies.

0.3 This Pakistan Standard No.3580-1997 (1st Revision in 2014) was prepared with the help of foreign specification which has been since revised/modified. Hence to keep up a par with the latest technology, it has been revised accordingly. In preparation of this Standard the Technical Committee acknowledges with thanks the assistance drawn from the standard ISO:4427-2 First Edition 2007-2008-1.

0.4 This Standard is subject to periodical review in order to keep pace with development in industry. Any suggestions for improvement will be recorded and placed before the committee in due course.

**PAKISTAN STANDARDS SPECIFICATION**

**FOR**

**PLASTIC PIPING SYSTEMS- POLYETHYLENE (PE) PIPES AND FITTINGS FOR WATER SUPPLY**

## 1 SCOPE

This Pakistan Standard specifies the pipes made from polyethylene (PE) intended for the conveyance of water for human consumption, including raw water prior to treatment and water for general purposes.

It also specifies the test parameters for the test methods to which it refers.

In conjunction with the other parts of Pakistan Standard, it is applicable to PE pipes, their joints, to joints with components of PE and to mechanical joints with components of other materials, intended to be used under the following conditions:

a) A maximum operating pressure (MOP) up to and including 25 bar[1]);
b) An operating temperature of 20°C as the reference temperature

NOTE 1: For applications operating at constant temperatures greater than 20°C and up to 40°C, see ISO 4427-1:2007 (PS…) , Annex A.

NOTE 2: This Pakistan Standard covers a range of maximum operating pressures and gives requirements concerning colours and additives. It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national guidance or regulations and installation practices or codes.

Three types of pipe are specified:

- PE pipes (outside diameter $d_n$), including any identification stripes;
- PE pipes with co-extruded layers on either or both the outside and/or inside of the pipe (total outside diameter $d_n$), as specified in annex A, where all layers have the same MRS rating.
- PE pipes (outside diameter $d_n$) having a peelable, contiguous, thermoplastics additional layer on the outside of the pipe ("coated pipe"), see Annex A.

1) 1 bar = 0,1 MPa = $10^5$ Pa; 1 MPa = 1 N/mm$^2$

## 2 NORMATIVE REFERENCES

The following reference 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 1133:2005, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics (PS…)*

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

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 (PS…)*

ISO 2505, *Thermoplastics pipes — Longitudinal reversion — Test method and parameters (PS…)*

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions (PS…)*

ISO 4065, *Thermoplastics pipes — Universal wall thickness table (PS…)*

ISO 4427-1:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 1: General (PS…)*

ISO 4427-5:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 5: Fitness for purpose of the system (PS…)*

ISO 4433-1:1997, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 1: Immersion test method (PS…)*

ISO 4433-2:1997, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 2: Polyolefin pipes (PS…)*

ISO 6259-1:1997, *Thermoplastics pipes — Determination of tensile properties — Part 1: General test method (PS…)*

ISO 6259-3:1997, *Thermoplastics pipes — Determination of tensile properties — Part 3: Polyolefin pipes (PS…)*

ISO 11357-6:2002, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (PS…)*

ISO 11922-1:1997, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series (PS…)*

**3 Terms, definitions, symbols and abbreviated terms**
For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in ISO 4427-1 *(PS…)* apply.

**3 Material**

**4.1 Compound**

The material from which the pipes are made shall be in accordance with ISO 4427-1 *(PS…)*.

**4.2 Identification compound**

Where applicable, the compound used for identification stripes and co-extruded layers (see 5.2) shall be manufactured from a PE polymer manufactured from the same type of base polymer as used in the compound for pipe production.
For co-extruded layers used for identification purposes, Annex A applies.

**5 General characteristics**

**5.1 Appearance**
When viewed without magnification, the internal and external surfaces of pipes shall be smooth, clean and free from scoring, cavities and other surface defects such as would prevent conformity of the pipe to this Pakistan Standard. The pipe ends shall be cut cleanly and square to the axis of the pipe.

**5.2 Colour**
The pipes shall be either blue or black, or black with blue stripes. For coated pipes in accordance with Annex A, this applies to the coating.

Blue pipes or black pipes with blue stripes are intended for drinking water only.

For above-ground installations, all blue components and components with non-black layers should be protected from direct UV light.

**5.3 Effect on water quality**
Attention is drawn to the requirements of national regulations (see also the Introduction). See ISO 4427-1:2007 , Clause 5 *(PS…)*.

**6 Geometrical characteristics**
**6.1 Measurements**
The dimensions of the pipe shall be measured in accordance with ISO 3126 *(PS…)*. In case of dispute, the measurements of dimensions shall be made not less than 24 h after manufacture and after conditioning for at least 4 h at (23 ± 2) °C.

**6.2 Mean outside diameter and out-of-roundness (ovality)**
The mean outside diameters, $d_{em}$, and the out-of-roundness (ovality) shall be in accordance with Table 1.

**Table 1 — 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] |
|---|---|---|---|---|
| | | $d_{em\ min}$ | $d_{em\ max}$ | |
| 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 | 50,4 | 1,4 |
| 63 | 63 | 63,0 | 63,4 | 1,5 |
| 75 | 75 | 75,0 | 75,5 | 1,6 |
| 90 | 90 | 90,0 | 90,6 | 1,8 |
| 110 | 110 | 110,0 | 110,7 | 2,2 |
| 125 | 125 | 125,0 | 125,8 | 2,5 |
| 140 | 140 | 140,0 | 140,9 | 2,8 |
| 160 | 160 | 160,0 | 161,0 | 3,2 |
| 180 | 180 | 180,0 | 181,1 | 3,6 |
| 200 | 200 | 200,0 | 201,2 | 4,0 |
| 225 | 225 | 225,0 | 226,4 | 4,5 |
| 250 | 250 | 250,0 | 251,5 | 5,0 |
| 280 | 280 | 280,0 | 281,7 | 9,8 |
| 315 | 315 | 315,0 | 316,9 | 11,1 |
| 355 | 355 | 355,0 | 357,2 | 12,5 |
| 400 | 400 | 400,0 | 402,4 | 14,0 |
| 450 | 450 | 450,0 | 452,7 | 15,6 |
| 500 | 500 | 500,0 | 503,0 | 17,5 |
| 560 | 560 | 560,0 | 563,4 | 19,6 |
| 630 | 630 | 630,0 | 633,8 | 22,1 |
| 710 | 710 | 710,0 | 716,4 | — |
| 800 | 800 | 800,0 | 807,2 | — |
| 900 | 900 | 900,0 | 908,1 | — |
| 1 000 | 1 000 | 1 000,0 | 1 009,0 | — |
| 1 200 | 1 200 | 1 200,0 | 1 210,8 [c] | — |
| 1 400 | 1 400 | 1 400,0 | 1 412,6 [c] | — |
| 1 600 | 1 600 | 1 600,0 | 1 614,4 [c] | — |
| 1 800 | 1 800 | 1 800,0 | 1 816,2 [c] | — |
| 2 000 | 2 000 | 2 000,0 | 2 018,0 [c] | — |

For coiled pipe and for straight lengths with diameters ⩾ 710, the maximum out-of-roundness shall be agreed between manufacturer and purchaser.

[a] In accordance with ISO 11922-1:1997, grade B, for sizes ⩽ 630 and grade A for sizes ⩾ 710.

[b] In accordance with ISO 11922-1:1997, grade N, for sizes ⩽ 630, is measured at the point of manufacture.

[c] Tolerance calculated as 0,009 $d_{em}$ and does not conform to grade A in ISO 11922-1:1997.

NOTE: Tolerance bands in accordance with ISO 11922-1 are calculated as follows, as applicable.

a) Grade A: 0,009$d_n$ rounded to the next greater 0,1 mm with a minimum value of 0,3 mm and a maximum value of 10,0 mm.

b) Grade B: 0,006$d_n$ rounded up to the next greater 0,1 mm with a minimum value of 0,3 mm and a maximum value of 4,0 mm.

c) Grade N:

– for diameters ≤ 75 mm (0,008 $d_n$+ 1) mm,

– for diameters W 90 mm and ≤ 250 mm (0,02 $d_n$) mm,

– for diameters > 250 mm (0,035 $d_n$ ) mm,

rounded up to the next 0,1 mm.

**6.3 Wall thicknesses and their tolerances**

The wall thickness shall be in accordance with Table 2.

NOTE: The relationship between PN, MRS, S and SDR is given in Annex B.

**Table 2 — Wall thicknesses**

| | Pipe series | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SDR 6 | | SDR 7,4 | | SDR 9 | | SDR 11 | | SDR 13,6 | | SDR 17 | |
| | S 2,5 | | S 3,2 | | S 4 | | S 5 | | S 6,3 | | S 8 | |
| | Nominal pressure (PN) [a] bar | | | | | | | | | | | |
| PE 40 | — | | PN 10 | | PN 8 | | — | | PN 5 | | PN 4 | |
| PE 63 | — | | — | | — | | PN 10 | | PN 8 | | — | |
| PE 80 | PN 25 | | PN 20 | | PN 16 | | PN 12,5 | | PN 10 | | PN 8 | |
| PE 100 | — | | PN 25 | | PN 20 | | PN 16 | | PN 12,5 | | PN 10 | |
| Nominal size | Wall thicknesses [b] mm | | | | | | | | | | | |
| | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ |
| 16 | 3,0 | 3,4 | 2,3 [c] | 2,7 | 2,0 [c] | 2,3 | — | — | — | — | — | — |
| 20 | 3,4 | 3,9 | 3,0 | 3,4 | 2,3 [c] | 2,7 | 2,0 [c] | 2,3 | — | — | — | — |
| 25 | 4,2 | 4,8 | 3,5 | 4,0 | 3,0 | 3,4 | 2,3 [c] | 2,7 | 2,0 [c] | 2,3 | — | — |
| 32 | 5,4 | 6,1 | 4,4 | 5,0 | 3,6 | 4,1 | 3,0 | 3,4 | 2,4 | 2,8 | 2,0 [c] | 2,3 |
| 40 | 6,7 | 7,5 | 5,5 | 6,2 | 4,5 | 5,1 | 3,7 | 4,2 | 3,0 | 3,5 | 2,4 | 2,8 |
| 50 | 8,3 | 9,3 | 6,9 | 7,7 | 5,6 | 6,3 | 4,6 | 5,2 | 3,7 | 4,2 | 3,0 | 3,4 |
| 63 | 10,5 | 11,7 | 8,6 | 9,6 | 7,1 | 8,0 | 5,8 | 6,5 | 4,7 | 5,3 | 3,8 | 4,3 |
| 75 | 12,5 | 13,9 | 10,3 | 11,5 | 8,4 | 9,4 | 6,8 | 7,6 | 5,6 | 6,3 | 4,5 | 5,1 |
| 90 | 15,0 | 16,7 | 12,3 | 13,7 | 10,1 | 11,3 | 8,2 | 9,2 | 6,7 | 7,5 | 5,4 | 6,1 |
| 110 | 18,3 | 20,3 | 15,1 | 16,8 | 12,3 | 13,7 | 10,0 | 11,1 | 8,1 | 9,1 | 6,6 | 7,4 |
| 125 | 20,8 | 23,0 | 17,1 | 19,0 | 14,0 | 15,6 | 11,4 | 12,7 | 9,2 | 10,3 | 7,4 | 8,3 |
| 140 | 23,3 | 25,8 | 19,2 | 21,3 | 15,7 | 17,4 | 12,7 | 14,1 | 10,3 | 11,5 | 8,3 | 9,3 |
| 160 | 26,6 | 29,4 | 21,9 | 24,2 | 17,9 | 19,8 | 14,6 | 16,2 | 11,8 | 13,1 | 9,5 | 10,6 |
| 180 | 29,9 | 33,0 | 24,6 | 27,2 | 20,1 | 22,3 | 16,4 | 18,2 | 13,3 | 14,8 | 10,7 | 11,9 |
| 200 | 33,2 | 36,7 | 27,4 | 30,3 | 22,4 | 24,8 | 18,2 | 20,2 | 14,7 | 16,3 | 11,9 | 13,2 |
| 225 | 37,4 | 41,3 | 30,8 | 34,0 | 25,2 | 27,9 | 20,5 | 22,7 | 16,6 | 18,4 | 13,4 | 14,9 |
| 250 | 41,5 | 45,8 | 34,2 | 37,8 | 27,9 | 30,8 | 22,7 | 25,1 | 18,4 | 20,4 | 14,8 | 16,4 |
| 280 | 46,5 | 51,3 | 38,3 | 42,3 | 31,3 | 34,6 | 25,4 | 28,1 | 20,6 | 22,8 | 16,6 | 18,4 |
| 315 | 52,3 | 57,7 | 43,1 | 47,6 | 35,2 | 38,9 | 28,6 | 31,6 | 23,2 | 25,7 | 18,7 | 20,7 |
| 355 | 59,0 | 65,0 | 48,5 | 53,5 | 39,7 | 43,8 | 32,2 | 35,6 | 26,1 | 28,9 | 21,1 | 23,4 |

**Table 2** (*continued*)

| | Pipe series | | | | | |
|---|---|---|---|---|---|---|
| | SDR 6 | SDR 7,4 | SDR 9 | SDR 11 | SDR 13,6 | SDR 17 |
| | S 2,5 | S 3,2 | S 4 | S 5 | S 6,3 | S 8 |
| | Nominal pressure (PN) [a] bar | | | | | |
| PE 40 | — | PN 10 | PN 8 | — | PN 5 | PN 4 |
| PE 63 | — | — | — | PN 10 | PN 8 | — |
| PE 80 | PN 25 | PN 20 | PN 16 | PN 12,5 | PN 10 | PN 8 |
| PE 100 | — | PN 25 | PN 20 | PN 16 | PN 12,5 | PN 10 |

| Nominal size | Wall thicknesses [b] mm | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ |
| 400 | — | — | 54,7 | 60,3 | 44,7 | 49,3 | 36,3 | 40,1 | 29,4 | 32,5 | 23,7 | 26,2 |
| 450 | — | — | 61,5 | 67,8 | 50,3 | 55,5 | 40,9 | 45,1 | 33,1 | 36,6 | 26,7 | 29,5 |
| 500 | — | — | — | — | 55,8 | 61,5 | 45,4 | 50,1 | 36,8 | 40,6 | 29,7 | 32,8 |
| 560 | — | — | — | — | 62,5 | 68,9 | 50,8 | 56,0 | 41,2 | 45,5 | 33,2 | 36,7 |
| 630 | — | — | — | — | 70,3 | 77,5 | 57,2 | 63,1 | 46,3 | 51,1 | 37,4 | 41,3 |
| 710 | — | — | — | — | 79,3 | 87,4 | 64,5 | 71,1 | 52,2 | 57,6 | 42,1 | 46,5 |
| 800 | — | — | — | — | 89,3 | 98,4 | 72,6 | 80,0 | 58,8 | 64,8 | 47,4 | 52,3 |
| 900 | — | — | — | — | — | — | 81,7 | 90,0 | 66,2 | 73,0 | 53,3 | 58,8 |
| 1 000 | — | — | — | — | — | — | 90,2 | 99,4 | 72,5 | 79,9 | 59,3 | 65,4 |
| 1 200 | — | — | — | — | — | — | — | — | 88,2 | 97,2 | 67,9 | 74,8 |
| 1 400 | — | — | — | — | — | — | — | — | 102,9 | 113,3 | 82,4 | 90,8 |
| 1 600 | — | — | — | — | — | — | — | — | 117,6 | 129,5 | 94,1 | 103,7 |
| 1 800 | — | — | — | — | — | — | — | — | — | — | 105,9 | 116,6 |
| 2 000 | — | — | — | — | — | — | — | — | — | — | 117,6 | 129,5 |

Table 2 (*continued*)

| | Pipe series | | | |
|---|---|---|---|---|
| | SDR 21 | SDR 26 | SDR 33 | SDR 41 |
| | S 10 | S 12,5 | S 16 | S 20 |
| | Nominal pressure (PN) [a] bar | | | |
| PE 40 | PN 3,2 | PN 2,5 | — | — |
| PE 63 | PN 5 | PN 4 | PN 3,2 | PN 2,5 |
| PE 80 | PN 6 [d] | PN 5 | PN 4 | PN 3,2 |
| PE 100 | PN 8 | PN 6 [c] | PN 5 | PN 4 |

| Nominal size | Wall thicknesses [b] mm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ |
| 16 | — | — | — | — | — | — | — | — |
| 20 | — | — | — | — | — | — | — | — |
| 25 | — | — | — | — | — | — | — | — |
| 32 | — | — | — | — | — | — | — | — |
| 40 | 2,0 [c] | 2,3 | — | — | — | — | — | — |
| 50 | 2,4 | 2,8 | 2,0 | 2,3 | — | — | — | — |
| 63 | 3,0 | 3,4 | 2,5 | 2,9 | — | — | — | — |
| 75 | 3,6 | 4,1 | 3,0 | 3,3 | — | — | — | — |
| 90 | 4,3 | 4,9 | 3,5 | 4,0 | — | — | — | — |
| 110 | 5,3 | 6,0 | 4,2 | 4,8 | — | — | — | — |
| 125 | 6,0 | 6,7 | 4,8 | 5,4 | — | — | — | — |
| 140 | 6,7 | 7,5 | 5,4 | 6,1 | — | — | — | — |
| 160 | 7,7 | 8,6 | 6,2 | 7,0 | — | — | — | — |
| 180 | 8,6 | 9,6 | 6,9 | 7,7 | — | — | — | — |
| 200 | 9,6 | 10,7 | 7,7 | 8,6 | — | — | — | — |
| 225 | 10,8 | 12,0 | 8,6 | 9,6 | — | — | — | — |
| 250 | 11,9 | 13,2 | 9,6 | 10,7 | — | — | — | — |
| 280 | 13,4 | 14,9 | 10,7 | 11,9 | — | — | — | — |
| 315 | 15,0 | 16,6 | 12,1 | 13,5 | 9,7 | 10,8 | 7,7 | 8,6 |
| 355 | 16,9 | 18,7 | 13,6 | 15,1 | 10,9 | 12,1 | 8,7 | 9,7 |

**Table 2** (*continued*)

| | Pipe series | | | |
|---|---|---|---|---|
| | SDR 21 | SDR 26 | SDR 33 | SDR 41 |
| | S 10 | S 12,5 | S 16 | S 20 |
| | Nominal pressure (PN) [a] bar | | | |
| PE 40 | PN 3,2 | PN 2,5 | — | — |
| PE 63 | PN 5 | PN 4 | PN 3,2 | PN 2,5 |
| PE 80 | PN 6 [d] | PN 5 | PN 4 | PN 3,2 |
| PE 100 | PN 8 | PN 6 [c] | PN 5 | PN 4 |

| Nominal size | Wall thicknesses [b] mm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ | $e_{min}$ | $e_{max}$ |
| 400 | 19,1 | 21,2 | 15,3 | 17,0 | 12,3 | 13,7 | 9,8 | 10,9 |
| 450 | 21,5 | 23,8 | 17,2 | 19,1 | 13,8 | 15,3 | 11,0 | 12,2 |
| 500 | 23,9 | 26,4 | 19,1 | 21,2 | 15,3 | 17,0 | 12,3 | 13,7 |
| 560 | 26,7 | 29,5 | 21,4 | 23,7 | 17,2 | 19,1 | 13,7 | 15,2 |
| 630 | 30,0 | 33,1 | 24,1 | 26,7 | 19,3 | 21,4 | 15,4 | 17,1 |
| 710 | 33,9 | 37,4 | 27,2 | 30,1 | 21,8 | 24,1 | 17,4 | 19,3 |
| 800 | 38,1 | 42,1 | 30,6 | 33,8 | 24,5 | 27,1 | 19,6 | 21,7 |
| 900 | 42,9 | 47,3 | 34,4 | 38,3 | 27,6 | 30,5 | 22,0 | 24,3 |
| 1 000 | 47,7 | 52,6 | 38,2 | 42,2 | 30,6 | 33,5 | 24,5 | 27,1 |
| 1 200 | 57,4 | 63,1 | 45,9 | 50,6 | 36,7 | 40,5 | 29,4 | 32,5 |
| 1 400 | 66,7 | 73,5 | 53,5 | 59,0 | 42,9 | 47,3 | 34,3 | 37,9 |
| 1 600 | 76,2 | 84,0 | 61,2 | 67,5 | 49,0 | 54,0 | 39,2 | 43,3 |
| 1 800 | 85,7 | 94,4 | 69,1 | 76,2 | 54,5 | 60,1 | 43,8 | 48,3 |
| 2 000 | 95,2 | 104,9 | 76,9 | 84,7 | 60,6 | 66,8 | 48,8 | 53,8 |

NOTE 1 bar = 0,1 MPa = $10^5$ Pa; 1 MPa = 1 N/mm$^2$.

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

[b] Tolerances in accordance with ISO 11922-1:1997, grade V, calculated from (0,1$e_{min}$ + 0,1) mm rounded up to the next 0,1 mm. For certain applications for $e$ > 30 mm, ISO 11922-1:1997, grade T, tolerances may be used calculated from 0,15 $e_{min}$ rounded up to the next 0,1 mm.

[c] The calculated value of $e_{min}$ according to ISO 4065 is rounded up to the nearest value of either 2,0, 2,3 or 3,0. This is to satisfy certain national requirements. For practical reasons, a wall thickness of 3,0 mm is recommended for electrofusion jointing and lining applications.

[d] Actual calculated values are 6,4 bar for PE 100 and 6,3 bar for PE 80.

### 6.4 Coiled pipe

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

The minimum internal diameter of the coil shall be not less than $18d_n$.

### 6.5 Lengths

No requirements have been set concerning particular lengths of coiled or straight pipe or the tolerance thereon; hence, it is necessary for lengths of pipe to be supplied by agreement between purchaser and manufacturer.

## 7 Mechanical characteristics

### 7.1 Conditioning

Unless otherwise specified in the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C prior to testing.

### 7.2 Requirements

The test pieces shall be tested in accordance with Table 3. When tested using the test method and parameters specified therein, the pipe shall have mechanical characteristics conforming to the requirements of Table 3.

**Table 3 — Mechanical characteristics**

| Characteristic | Requirement | Test parameters | | Test method(s) |
|---|---|---|---|---|
| | | Parameter | Value | |
| Hydrostatic strength at 20 °C | No failure of any test piece during test period | End caps | Type a) [a] | ISO 1167-1<br>ISO 1167-2 |
| | | Conditioning period | According to ISO 1167-1 | |
| | | Number of test pieces [b] | 3 | |
| | | Type of test | Water-in-water | |
| | | Test temperature | 20 °C | |
| | | Test period | 100 h | |
| | | Circumferential (hoop) stress for: | | |
| | | PE 40 | 7,0 MPa | |
| | | PE 63 | 8,0 MPa | |
| | | PE 80 | 10,0 MPa | |
| | | PE 100 | 12,4 MPa | |



**Table 3** (*continued*)

| Characteristic | Requirement | Test parameters | | Test method(s) |
|---|---|---|---|---|
| | | Parameter | Value | |
| Hydrostatic strength at 80 °C | No failure of any test piece during test period | End caps | Type a) [a] | ISO 1167-1<br>ISO 1167-2 |
| | | Conditioning period | According to ISO 1167-1 | |
| | | Number of test pieces [b] | 3 | |
| | | Type of test | Water-in-water | |
| | | Test temperature | 80 °C | |
| | | Test period | 165 h [c] | |
| | | Circumferential (hoop) stress for: | | |
| | | PE 40 | 2,5 MPa | |
| | | PE 63 | 3,5 MPa | |
| | | PE 80 | 4,5 MPa | |
| | | PE 100 | 5,4 MPa | |

| | | | | |
|---|---|---|---|---|
| Hydrostatic strength at 80 °C | No failure of any test piece during test period | End caps | Type a) [a] | |
| | | Conditioning period | According to ISO 1167-1 | |
| | | Number of test pieces [b] | 3 | |
| | | Type of test | Water-in-water | |
| | | Test temperature | 80 °C | |
| | | Test period | 1 000 h | ISO 1167-1 |
| | | Circumferential (hoop) stress for: | | ISO 1167-2 |
| | | PE 40 | 2,0 MPa | |
| | | PE 63 | 3,2 MPa | |
| | | PE 80 | 4,0 MPa | |
| | | PE 100 | 5,0 MPa | |

NOTE The characteristic resistance to slow crack growth is dealt with in ISO 4427-1 as a material property measured in the form of pipe.

[a] Type b) end caps may be used for batch release tests for diameters ⩾ 500 mm.

[b] 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.

[c] Premature ductile failures are not to be taken into account. For retest procedure, see 7.3.

### 7.3 Retest in case 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 4.



**Table 4 — Test parameters for the retest of the hydrostatic strength at 80°C**

| PE 40 | | PE 63 | | PE 80 | | PE 100 | |
|---|---|---|---|---|---|---|---|
| Stress MPa | Test period h | Stress MPa | Test period h | Stress MPa | Test period h | Stress MPa | Test period h |
| 2,5 | 165 | 3,5 | 165 | 4,5 | 165 | 5,4 | 165 |
| 2,4 | 230 | 3,4 | 295 | 4,4 | 233 | 5,3 | 256 |
| 2,3 | 323 | 3,3 | 538 | 4,3 | 331 | 5,2 | 399 |
| 2,2 | 463 | 3,2 | 1 000 | 4,2 | 474 | 5,1 | 629 |
| 2,1 | 675 | | | 4,1 | 685 | 5,0 | 1 000 |
| 2,0 | 1 000 | | | 4,0 | 1 000 | | |

## 8 Physical characteristics

### 8.1 Conditioning

Unless otherwise specified in the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C prior to testing.

### 8.2 Requirements

The test pieces shall be tested in accordance with Table 5. When tested using the test method and parameters specified therein, the pipe shall have physical characteristics conforming to the requirements of Table 5.

**Table 5 — Physical characteristics — All pipes**

| Characteristic | Requirement | Test parameters | | Test method(s) |
|---|---|---|---|---|
| | | Parameter | Value | |
| Elongation at break for $e \leqslant 5$ mm | ⩾ 350 % | Test piece shape<br>Test speed<br>Number of test pieces [b] | Type 2<br>100 mm/min<br>According to ISO 6259 | ISO 6259-1<br>ISO 6259-3 |
| Elongation at break for 5 mm < $e \leqslant 12$ mm | ⩾ 350 % | Test piece shape<br>Test speed<br>Number of test pieces [b] | Type 1 [a]<br>50 mm/min<br>According to ISO 6259 | ISO 6259-1<br>ISO 6259-3 |
| Elongation at break for $e > 12$ mm | ⩾ 350 % | Test piece shape<br>Test speed<br>Number of test pieces [b]<br>OR<br>Test piece shape<br>Test speed<br>Number of test pieces [b] | Type 1 [a]<br>25 mm/min<br>According to ISO 6259<br><br>Type 3 [a]<br>10 mm/min<br>According to ISO 6259 | ISO 6259-1<br>ISO 6259-3 |
| Longitudinal reversion | ⩽ 3 %<br>No effect on surface | Shape and number of test pieces [c]<br>Test temperature:<br>PE 40<br>PE 63, PE 80, PE 100<br>Time | According to ISO 2505<br><br>100 ± 2 °C<br>110 ± 2 °C<br>See ISO 2505 | ISO 2505 |
| Melt mass-flow rate<br>MFR for PE 40 | Change of MFR by processing ± 20 % [d] | Load<br>Test temperature<br>Time<br>Number of test pieces [b] | 2,16 kg<br>190 °C<br>10 min<br>According to ISO 1133 | ISO 1133:2005, Condition D |
| Melt mass-flow rate<br>MFR for PE 63, PE 80, PE 100 | Change of MFR by processing ± 20 % [d] | Load<br>Test temperature<br>Time<br>Number of test pieces [b] | 5,0 kg<br>190 °C<br>10 min<br>According to ISO 1133 | ISO 1133:2005, Condition T |
| Oxidation induction time | ⩾ 20 min | Test temperature<br>Number of test pieces [b, f] | 200 °C [e]<br>3 | ISO 11357-6:2002 |
| Effect on water quality | National regulations apply | | | |

[a] Where practical, machined type 2 test pieces may be used for pipe wall thicknesses ⩽ 25 mm. The test may be terminated when the requirement is met, without continuing until the rupture of the test piece.

[b] 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.

[c] For pipes with an outside diameter > 200 mm, longitudinally cut segments may be used.

[d] Value as measured on the pipe relative to the value measured on the compound used.

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

[f] Samples are to be taken from the inner wall surface.

## 9 Chemical characteristics of pipes in contact with chemicals

If, for a particular installation, it is necessary to evaluate the chemical resistance of the pipe, then the pipe shall be classified in accordance with ISO 4433-1 and ISO 4433-2.

NOTE Guidance for the resistance of polyethylene pipes to chemicals is given in ISO/TR 10358

## 10 Performance requirements

When pipes conforming to this part of ISO 4427 are assembled to each other or to components conforming to other parts of ISO 4427, the joints shall be in accordance with ISO 4427-5.

## 11 Marking

### 11.1 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 such that normal storage, weathering, handling, installation and use does not affect the legibility of the marking.

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.

### 11.2 Minimum required marking of pipes

The minimum required marking shall be in accordance with Table 6, with the frequency of marking being not less than once per metre.

**Table 6 — Minimum required marking**

| Aspect | Marking |
|---|---|
| Standard number | ISO 4427 |
| Manufacturer's identification | Name or symbol |
| Dimensions ($d_n \times e_n$) | e.g. 110 × 10 |
| SDR series (for DN > 32) | e.g. SDR 11 |
| Material and designation | e.g. PE 80 |
| Pressure rating in bar | e.g. PN 12,5 |
| Production period (date or code) | e.g. 0204 [a] |
| Coils shall be sequentially marked with the metreage, indicating the length remaining on the coil.<br>The word "water" or code "W" may also be included if the pipe is intended for drinking water. | |

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



# Annex A
(normative)

# Layered pipes

## A.1 General

This annex specifies the additional geometrical, mechanical and physical properties of layered polyethylene (PE) pipes intended to be used for the supply of water. Additional marking requirements are given in A.3.4.

Two types of layered pipes are covered:

a) PE pipes with a co-extruded black or pigmented layer of the same MRS rating on the outside of the pipe (total outside diameter $d_n$) (see A.2);

b) PE pipes (outside diameter $d_n$ with a non-bonded, contiguous, thermoplastics additional layer on the outside of the pipe ("coated pipe") and thus having a total outside diameter of $d_n + 2e_{coating}$ (see A.3).

NOTE: Other types of layered pipes could be covered by other standards (e.g. References [3] and [4]).

## A.2 Pipe with coloured identification layer

### A.2.1 Geometrical characteristics

The geometrical characteristics of the pipe, inclusive of the coloured identification layer, shall be in accordance with Clause 6.

### A.2.2 Mechanical characteristics

The mechanical characteristics of the pipe, inclusive of the coloured identification layer, shall be in accordance with Clause 7.

### A.2.3 Physical characteristics

The physical characteristics shall be in accordance with Clause 8. The requirements for thermal stability (OIT) and for melt-flow rate shall apply to the individual layers respectively. Longitudinal heat reversion shall be applicable to the pipe, inclusive of the coloured identification layer.

### A.2.4 Marking

The marking of pipes with coloured identification layers shall be in accordance with Clause 11.

## A.3 Coated pipe

### A.3.1 Geometrical characteristics

The geometrical characteristics of the pipe, exclusive of the coating, shall be in accordance with Clause 6.

### A.3.2 Mechanical characteristics

The mechanical characteristics of the pipe, exclusive of the coating, shall be in accordance with Clause 7. The coating shall not have a detrimental effect on the ability of the pipe to conform to Clause 7.

It is preferred that the pipe be tested exclusive of the coating. If the pipe is tested with the coating attached, it shall be ensured that the conditions selected result in the pipe being subjected to the specified test stress. In case of dispute, the pipe shall be tested exclusive of its coating.

### A.3.3 Physical characteristics

The physical characteristics of the pipe, exclusive of the coating, shall be in accordance with Clause 8. The coating shall not have a detrimental effect on the pipe or vice versa.

### A.3.4 Marking

Marking shall be applied to the coating and shall be in accordance with Clause 11.

In addition, the coating shall be provided with marking clearly distinguishing the pipe from non-coated pipe in service (e.g. by broad colour bands). The coating shall also carry marking warning that the coating must be removed prior to fusion and mechanical jointing.



# Annex B
(informative)

## Relationship between PN, MRS, S and SDR

The relationship between nominal pressure, PN, design stress, $\sigma_s$, and the series S/SDR is given by the following equation:

$$PN = \frac{10\sigma_S}{S} \text{ or } PN = \frac{20\sigma_S}{SDR - 1}$$

Examples of the relationship between PN, MRS, S, and SDR based on

$$\sigma_S = \frac{MRS}{C}$$

are given in Table B.1, where $C = 1{,}25$.

NOTE The nominal pressures (PN) given in Table B.1 are based on the use of an overall design coefficient of $C = 1{,}25$. However, if a higher value for $C$ is required, the PN values will have to be recalculated using the above equations and based on the calculated design stress, $\sigma_s$, for each material class. A higher value for $C$ can also be obtained by choosing a higher PN class.

Table B.1 —Examples of the relationship between PN, MRS, S and SDR at 20 °C ($C = 1,25$)

| SDR | S | Nominal pressure for material class bar | | | |
|---|---|---|---|---|---|
| | | PE 40 | PE 63 | PE 80 | PE 100 |
| 41 | 20 | — | 2,5 | 3,2 | 4 |
| 33 | 16 | — | 3,2 | 4 | 5 |
| 26 | 12,5 | 2,5 | 4 | 5 | 6 [a] |
| 21 | 10 | 3,2 | 5 | 6 [a] | 8 |
| 17 | 8 | 4 | 6 [a] | 8 | 10 |
| 13,6 | 6,3 | 5 | 8 | 10 | 12,5 |
| 11 | 5 | — | 10 | 12,5 | 16 |
| 9 | 4 | 8 | — | 16 | 20 |
| 7,4 | 3,2 | 10 | — | 20 | 25 |
| 6 | 2,5 | — | — | 25 | — |

NOTE 1 bar = 0,1 MPa = $10^5$ Pa; 1 MPa = 1 N/mm$^2$.

[a] Actual calculated values are 6,4 bar for PE 100 and 6,3 bar for PE 80 and PE 63.

# AMENDMENT

*Pages 6 to 7, 6.3*

Restore "PN 6" column titles in Table 2; replace:

**Table 2 — Wall thicknesses**

| | Pipe series | | | | | |
|---|---|---|---|---|---|---|
| | SDR 6 | SDR 7,4 | SDR 9 | SDR 11 | SDR 13,6 | SDR 17 |
| | S 2,5 | S 3,2 | S 4 | S 5 | S 6,3 | S 8 |
| | Nominal pressure (PN)[a] bar | | | | | |
| PE 40 | — | PN 10 | PN 8 | — | PN 5 | PN 4 |
| PE 63 | — | — | — | PN 10 | PN 8 | — |
| PE 80 | PN 25 | PN 20 | PN 16 | PN 12,5 | PN 10 | PN 8 |
| PE 100 | — | PN 25 | PN 20 | PN 16 | PN 12,5 | PN 10 |

with the following:

**Table 2 — Wall thicknesses**

| | Pipe series | | | | | |
|---|---|---|---|---|---|---|
| | SDR 6 | SDR 7,4 | SDR 9 | SDR 11 | SDR 13,6 | SDR 17 |
| | S 2,5 | S 3,2 | S 4 | S 5 | S 6,3 | S 8 |
| | Nominal pressure (PN)[a] bar | | | | | |
| PE 40 | — | PN 10 | PN 8 | PN 6 | PN 5 | PN 4 |
| PE 63 | — | — | — | PN 10 | PN 8 | PN 6 |
| PE 80 | PN 25 | PN 20 | PN 16 | PN 12,5 | PN 10 | PN 8 |
| PE 100 | — | PN 25 | PN 20 | PN 16 | PN 12,5 | PN 10 |