

MATERIAL STANDARD

FOR

THERMOPLASTICS PIPINGS

FOR

HOT AND COLD WATER IN BUILDINGS

ORIGINAL EDITION

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1. SCOPE

This standard covers the minimum requirements for Cross-Linked polyethylene/Aluminum/Cross-linked polyethylene (PEX-AL-PEX) and for Cross-Linked Polyethylene (PE-X) and fittings intended for conveyance of cold water, including drinking water and heated water for use in domestic hot and cold water distribution and heating installations within buildings.

2. REFERENCES

Throughout this standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the company and the vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIAL)

- ASTM F128 "Standard Specification for Cross Linked Polyethylene/Aluminum /Cross linked Polyethylene (PEX-AL-PEX) Composite Pressure Pipe"
- ASTM D3350 "Specification for Polyethylene Plastics Pipe and Fittings Materials"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

- ISO 4065 "Thermoplastics Pipes – Universal Wall Thickness Table"

BSI (BRITISH STANDARD INSTITUTION)

- BS 3412 "Methods of Specifying General Purpose Polyethylene Materials for Moulding and Extrusion"
- BS 2782 "Methods of Testing Plastics"
- BS 7291-3 "Thermoplastics Pipes and Associated Fittings for Hot and Cold Water for Domestic Purposes and Heating Installations in Buildings"
- BS 7291-1 "Thermoplastics Pipes and Associated Fitting for Hot and Cold Water for Domestic Purposes and Heating Installations in Buildings"
- BS EN 921 1995 "Plastics Piping Systems – Thermoplastics Pipes – Determination of Resistance to Internal Pressure at Constant Temperature "
- BS EN 1057 "Copper and Copper Alloys - Seamless, Round Copper Tubes for Water and Gas in Sanitary and Heating Applications"
- BS EN 1254-2 "Copper and Copper Alloys- Plumbing Fittings –Part 2 : Fittings With Compression Ends for use With Copper Tubes"
- BS EN 1254-3, "Copper and Copper Alloys - Plumbing Fittings –Part 3 : Fittings with Compression Ends for use With Copper Tubes"

IPS (IRNANIAN PETROLEUM STANDARDS)

- [IPS-E-GN-100](#) "Units"

3. DEFINITIONS AND TERMINOLOGY

3.1 Flexible Pipes

Pipes available in coil form

3.2 Rigid Pipes

Pipes only available in straight lengths

3.3 Barrier Pipes

Pipes incorporating a polymeric barrier layer to prevent or greatly diminish the diffusion of oxygen into or through the pipe where the design stress requirements are totally met by base polymer

3.4 Wall Thickness at any Point

The measured wall thickness at any point around the circumference of the pipe, rounded up to the nearest 0.1mm.

3.5 Minimum Wall Thickness

The minimum wall thickness for the pipe specified in the applicable pipe standard.

3.6 Maximum Wall Thickness

The maximum wall thickness for the pipe specified in the applicable pipe standard.

3.7 Coextrusion

A process whereby two or more heated or unheated plastic material streams forced through one or more shaping orifice (s) become one continuously formed piece.

3.8 Extrusion

A process whereby heated or unheated plastic forced through a shaping orifice becomes one continuously formed piece.

3.9 Quick Burst Test:

An internal pressure test designed to produce failure of a piping component over a relatively short period of time, usually measured in second .

3.10 Thermoplastic Piping Compound

A mixture of a thermoplastic – polymer with other ingredients such as fillers, stabilizers catalysts processing aids, lubricants, modifiers, pigments, or curing agents but not plasticizers.

3.11 Cross- Linking

The formation of a three dimensional polymer by means of interchain reaction resulting in change in physical properties.

3.12 Polyethylene Classification

Polyethylene plastic pipe and fitting compounds are classified in accordance with density met index, flexural modulus tensile strength at yield, environmental stress – crack resistance , the following terms in describing polyethylene plastic .

Type I (0.910 to 0.925 g/cm³) = low density

Type II (0.925 to 0.940 g/cm³) = medium density

Type III (0.941 to 0.965 g/cm³) = high density

3.13 Mean Wall Thickness

The arithmetic mean of at least four measurements regularly spaced around the some cross-sectional plan of the pipe, including the measured minimum and maximum values obtained , rounded up to the nearest 0.1mm

3.14 Nominal wall thickness

The wall thickness in millimeters tabulated in ISO 4065 , corresponding to the minimum wall thickness at any point .

3.15 Plastics

Plastics containing polymers or blends of polymers , or both , in which the minimum butadiene content is 6% the minimum acrylonitrile content is 15% the minimum styrene or substituted styrene content . or both , is 15% and the maximum content of all other monomers is not more than 5 % plus lubricants stabilizers as colorants.

3.16 Adhesive

A substance capable of holding material together by surface attachments .

4. UNITS

This Standard is based on International System of Units (SI) , As per IPS-E-GN-100 except where otherwise specified

5. GENERAL SPECIFICATION OF PEX-AL-PEX PIPE

5.1 PEX-AL-PEX pipe

Composite pipe produced by coextrusion or extrusion of layer of polyethylene aluminum/polyethylene bonded together with a melt adhesive and Cross- Linked by irradiation or chemical means in combination heat and moisture.

5.2 Materials

General: the PEX-AL-PEX pipe is composed of one metallic layer, two layers of the same polymeric adhesive, and two layers of the same polyethylene. For pipe made to this specification the constitute materials must meet the following requirements.

5.2.1 Aluminum

The aluminum shall have a thickness as specified in Table 1. The material shall have minimum elongations and ultimate tensile strengths of 20% and 100 MPa (14600 psi), respectively.

TABLE 1- OUTSIDE DIAMETERS, ALUMINUM THICKNESS, AND TOLERANCES FOR PEX-AL-PEX

Nominal pipe size , mm(in.)	Minimum Outside Diameter, mm(in)	Tolerance on Minimum, mm(in.) (OD)	Maximum Out-of-Roundness. ^A mm(in.)	Minimum Aluminum Thickness, mm(in.)	Tolerance on Thickness , mm(in.)
0912(³ / ₈)	12.00(0.472)	+0.30(0.012)	0.3(0.012)	0.18 (0.007)	+0.09(+0.0035)
1216(1/2)	16.00(0.630)	+0.30(0.012)	0.4(0.016)	0.18 (0.007)	+0.09(+0.0035)
1620(5/8)	20.00(0.787)	+0.30(0.012)	0.5(0.020)	0.23 (0.009)	+0.09(+0.0035)
2025(3/4)	25.00(0.984)	+0.30(0.012)	0.5(0.020)	0.23 (0.009)	+0.09(+0.0035)
2532(1)	32.00(1.260)	+0.30(0.012)	0.5(0.020)	0.28(0.0011)	+0.09(+0.0035)
3240(1 1/4)	40.10(1.579)	+0.30(0.012)	0.5(0.020)	0.33 (0.0013)	
4150(1 1/2)	50.10(1.972)	+0.30(0.012)	0.5(0.020)	0.47 (0.0018)	
5163 (2)	63.10(2.484)	+0.40(0.016)	0.5(0.020)	0.57 (0.0022)	
6075(2 1/2)	75.10(2.957)	+0.6 (0.024)	1.0(0.039)	0.67 (0.0026)	

A: The out-of- roundness specification applies only to tubing prior to coiling. ASTM F1281-2002

5.2.2 Melt adhesive

The material shall be in accordance with specification ASTM D3350.

5.2.3 Polyethylene

Polyethylene plastic used to make pipe shall be virgin resin meeting the requirements of either grade PE20/PE30, PE33 A,B or C in accordance with specification ASTM D3350.

5.3 Pipe Diameter

The minimum outside diameter and tolerances of the pipe shall meet the requirements given in table 1.

5.4 Pipe Wall Thickness

The total pipe wall thickness shall meet the requirements given in table 2. The minimum wall thickness at any point of measurement of the pipe shall not be less than the value specified in table 2.

TABLE 2- WALL THICKNESS FOR PEX-AL-PEX COMPOSITE PIPE

Nominal pipe size mm(in.)	Total wall Thickness min. mm(in.)	Outer PE Layer Thickness. Min , mm(in.)	Inner PE Layer Thickness min. mm(in.)
0912(3/8)	1.60(0.063)	0.40(0.016)	0.70(0.028)
1216(1/2)	1.65 (0.065)	0.40(0.016)	0.90(0.035)
1620(5/8)	1.90 (0.075)	0.40(0.016)	1.00(0.039)
2025(3/4)	2.25(0.089)	0.40(0.016)	1.10(0.043)
2532(1)	2.90 (0.114)	0.40(0.016)	1.20(0.047)
3240(1 1/4)	3.85(0.152)	0.40(0.016)	1.70(0.067)
4150(1 1/2)	4.35(0.171)	0.40(0.016)	1.70(0.067)
5163(2)	5.80(0.228)	0.40(0.016)	2.05 (0.081)
6075(2 1/2)	7.25(0.285)	0.40(0.016)	2.80 (0.110)

(ASTM F 1281 -2002)

5.5 Outer Cross- Linked Polyethylene Layer Thickness

The thickness of the outer layer of cross linked polyethylene in the PEX-AL-PEX pipe shall have a minimum value and material overlaying the weld which shall have a minimum thickness of half that specified in table 2.

5.6 Pipe Length

The pipe shall be supplied coiled or in straight lengths as agreed upon with the purchaser and with an allowable tolerance of- 0 mm(-0 in).

5.7 Degree of Cross-Linking

The degree of cross linking of the pipe material according to DIN 16892 and shall be achieved at least the following values:

- a) peroxide Cross- Linked pipes : 75%
- b) hydro silicon Cross-Linked pipes : 65%
- c) electron beam Cross-Linked pipes:60%

5.8 Adhesion Test

The adhesion Test of the PEX-Layer to the aluminum for sizes 3240(1 1/4) to 6075(2 1/2) is carried out by a separation test .The minimum adhesive force is specified in table 3. The adhesive force shall not fall below these levels.

TABLE 3-MINIMUM ADHESIVE FORCE FOR PE-AL-PE COMPOSITE PIPE

Nominal pipe size mm(in.)	Minimum Adhesive force per 10-mm (0.394-in.)Pipe Strip, N(lbf)
3240(1 1/4)	40(9.0)
4150(1 1/2)	50(11.2)
5163(2)	50(13.5)
6075(2 1/2)	70(15.7)

(ASTM F 1281 2002)

5.9 Apparent Tensile Strength of Pipe

Shall meet the minimum strength specifications defined in table 4 .

5.10 Burst Pressure

The minimum burst pressure for PEX-AL –PEX pipe shall be as defined in table 4

TABLE 4- MINIMUM PIPE RING STRENGTHS and 23 °C (73.4 °F) BURST PRESSURE OF PEX-AL-PEX COMPOSITE PIPE

Nominal pipe Size mm(in.)	Minimum pipe Ring Strength, Type II PE, N (lb)	Minimum pipe Ring Strength, Type III PE, N (lb)	Minimum 23°C(73.4°F) Burst Pressure kPa(Psi)
0912(3/8)	2000(448)	2100(470)	7000(1020)
1216(1/2)	2100(470)	2300(515)	6000(880)
1620(5/8)	2400(538)	2500(560)	5000(730)
2025(3/4)	2400(538)	2500(560)	4000(580)
2532(1)	2650(598)	2500(560)	4000(580)
3240(1 1/4)	3200(719)	3500(789)	4000(580)
4150(1 1/2)	3500(789)	3700(832)	3800(554)
5163(2)	5200(1169)	5500(1236)	3800(554)
6075(2 1/2)	6000(1349)	6000(1349)	3800(554)

(ASTM F 1281 , 2002)

5.11 Sustained Pressure

The pex-al pipe shall not fail, balloon, burst or weep when tested at the test pressure given in table 5 at a temperature of 82 °C (180 °F)

TABLE 5- MINIMUM SUSTAINED PRESSURE FOR PEX-AL-PEX COMPOSITE PIPE

Nominal Pipe Size ,mm(in.)	Minimum Sustained Pressure PE-AL-PE, KPa(psi)
0912(3/8)	2720(395)
1216(1/2)	2720(395)
1620(5/8)	2720(395)
2025(3/4)	2720(395)
2332(1)	2720(395)
3240(1 1/4)	2100(305)
4150(1 1/2)	2100(305)
5163(2)	2100(305)
6075(2 1/2)	2100(305)

(ASTM F 1281 ,2002)

6. Cross – Linked Polyethylene (PE-X)

6.1 General

6.2 PE-X Material

The material from which the PE-X pipe is manufactured shall comprise a polyethylene plastic specified in accordance with BS 3412

6.3 Opacity

The percentage of light passing through the wall of the pipe or fitting shall not exceed 0.2%. In the case of pipe supplied in a sleeve , this requirement shall relate to the performance of the combination of both pipe and sleeve .

6.4 Coating

If pipe is coated, the coating shall be sufficiently thin and / or removable to enable jointing with fittings and materials as specified in the part of BS 7291 applicable to the pipe material.

6.5 Diameter and Wall Thickness

When determined in accordance with BS 2782: Method 1101 A, the wall thickness of pipe shall be not less than one eleventh of the outside diameter, subject to a minimum value of 1.5mm.

6.6 Coil Diameter

The inside of coils in millimeters, shall be not less than 20 times the nominal size of the pipe .

6.7 Elongation

When tested in accordance with ISO 6529-3 test piece Type 2, subject to the following conditions, the elongation at break from each of four pieces shall be not less than 100% Testing shall be carried out using a rate of grip separation of (50 ± 5) mm/min .The four test pieces shall be punched from slit pipe such that the longitudinal axis of successive test piece .The thickness of the narrow parallel portion of each test piece, which shall correspond to the full wall thickness of the pipe , shall not deviate at any point more than $\pm 2 \%$ from its arithmetic mean .

6.8 Nominal Sizes

PE-X pipe shall have a nominal size selected from those in accordance with BS EN 1057, in which case it shall be one of sizes given in table 6, or from those in accordance with ISO 4065 , in which case it shall be one of the sizes given in table7.

TABLE 6 – DIMENSIONS OF PE-X PIPES HAVING NOMINAL SIZES AND OUTSIDE DIAMETERS CONSISTENT WITH THOSE SPECIFIED IN BS EN 1057^a

Nominal size	Mean Outside diameter		Wall thickness	
	Minimum mm	Maximum mm	Minimum Mm	Maximum mm
10	9.9	10.1	1.5	1.8
12	11.9	12.1	1.5	1.8
15	14.9	15.1	1.5	1.8
18	17.9	18.1	1.7	2.0
22	21.9	22.1	2.0	2.3
28	27.9	28.1	2.6	2.9
35	34.9	35.1	3.2	3.5

^a Pipes conforming to the dimensions given in Table 6 are intended to be compatible with compression . Fittings which conform to BS EN 1254-2 and/or BS EN 1254-3 and which are suitable for pipes sized in accordance with BS EN 1057.

(BS 7291 Part 3 2001)

TABLE 7– DIMENSIONS OF PE-X PIPES HAVING NOMINAL SIZES AND OUTSIDE DIAMETERS CONSISTENT WITH THOSE SPECIFIED IN ISO 4065

Nominal size ^a	ISO 4065 Mean Outside diameter		Wall thickness	
	Minimum mm	Maximum mm	Minimum Mm	Maximum mm
10	10.0	10.2	1.5	1.8
12	12.0	12.3	1.5	1.8
16	16.0	16.3	1.8	2.1
20	20.0	20.3	1.9	2.2
25	25.0	25.3	2.3	2.7
32	32.0	32.3	2.9	3.3
40	40.0	40.4	3.7	4.2
50	50.0	50.5	4.6	5.2
63	63.0	63.6	5.8	6.5
75	75.0	75.7	6.8	7.6
90	90.0	90.9	8.2	9.2
110	110.0	111.0	10.0	11.2

Corresponds to the nominal outside diameter(in mm).

(BS 7291 Part 3 2001)

6.9 Short-term hydrostatic pressure resistance of pipe at 20 °C

When tested in accordance with BS EN 921:1995 subject to the following conditions , the pipe shall withstand a circumferential stress of 12 MPa at a test temperature of $(20 \pm 1) ^\circ\text{C}$ for at least 1h without failure by bursting .

Water or, and in the case of dispute, air shall be used as the external environment. Test pieces shall have terminal fittings that subject to the test piece to the end thrust induced by the internal pressure. (See BS EN 921:1995).

6.10 Short-term hydrostatic pressure resistance of pipe at 95 °C

When tested in accordance with BS EN 921:1995 using a test temperature of $(95 \pm 1) ^\circ\text{C}$, the pipe shall not fail by bursting when subjected to a circumferential stress of 4.7 MPa least 170h.

Water or , and in the case of dispute, air shall be used at the external environment , test pieces shall have terminal fittings that subject the test piece to the end thrust induced by the internal pressure.

(See BS EN 921:1995.)

6.11 Fittings for Pex Pipes

6.11.1 Jointing

PE-X Pipes shall be jointed with one or more of the following types of fittings according to requirements of part one and three of BS 7291

- a) Fittings made from a plastic material corresponding to that from which pipe is made accordance with any part of BS 7291.
- b) Fittings made from any other plastics material, provided that the material comprises a virgin material and/or the manufacturer's own clean reworked material of the same grade as any material to which it is added and conform to BS 7291 part one and three
- c) Other metallic fittings, subject to their suitability by design for a service life of not less than 50 years under the service condition given in BS 7291 part one
- d) Compression fittings, conforming to BS EN-1254-2 and or BS EN 1254-3 together with internal pipe support sleeves if specified by the pipe manufacturer.