MATERIAL STANDARD

FOR

THERMOPLASTICS PIPINGS

FOR

HOT AND COLD WATER IN BUILDINGS

ORIGINAL EDITION

JAN. 2007

This standard specification is reviewed and updated by the relevant technical committee on Oct. 2015. The approved modifications are included in the present issue of IPS.

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

Standards and Research department

No.17, Street14, North kheradmand

Karimkhan Avenue, Tehran, Iran .

Postal Code- 1585886851

Tel: 88810459-60 & 66153055

Fax: 88810462

Email: Standards@ nioc.ir

GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPAN:

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER:

Means the “Company” where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract document.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR:

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR:

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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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.

Note:

This standard specification is reviewed and updated by the relevant technical committee on Oct. 2015. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 463 on Oct. 2015. These modifications are included in the present issue of IPS.

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 F1281	"Standard Specification for Cross Linked Polyethylene/Aluminum /Cross linked Polyethylene (PEX-AL-PEX) Pressure Pipe"
ASTM D3350	"Standard 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 EN ISO 3126	"Plastics Piping Systems – Plastics Components – Determination of Dimensions"
BS 7291-3	"Thermoplastics Pipe and Fitting Systems for Hot and Cold Water for Domestic Purposes and Heating Installations in Buildings – Part 3: Specification for Cross Linked Polyethylene (PE–X) Pipe and Associated Fitting"
BS 7291-1	"Thermoplastics Pipe and Fitting Systems for Hot and Cold Water for Domestic Purposes and Heating Installations in Buildings – Part 1: General Requirements"
BS EN 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"
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 Plastics Pipes"

DIN (DOUTSCHES INSTITUTE FOR NORMUNG)

DIN 16892 "Cross Linked High – Density Polyethylene (PE–X) Pipes – General Quality Requirements and Testing"

IPS (IRNANIAN PETROLEUM STANDARDS)

IPS-E-GN-100 "Engineering Standard for 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 Oxygen 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 0.1 mm.

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, melt 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/cm^3) = low density

Type II (0.925 to 0.940 g/cm^3) = medium density

Type III (0.941 to 0.965 g/cm^3) = 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 layers 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 polymeric adhesive, and two layers of crosslinked polyethylene. For pipe made to this specification the constituent 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.)	Maximum Out-of-Roundness,[A] mm (in.)	Minimum Aluminum Thickness, mm (in.)	Tolerance on Thickness, mm (in.)
09-12 (3⁄8)	12.00 (0.472)	+0.30 (0.012)	0.3 (0.012)	0.18 (0.007)	+0.09 (+0.0035)
12-16 (1⁄2)	16.00 (0.630)	+0.30 (0.012)	0.4 (0.016)	0.18 (0.007)	+0.15 (+0.006)
16-20 (5⁄8)	20.00 (0.787)	+0.30 (0.012)	0.5 (0.020)	0.23 (0.009)	+0.23 (+0.009)
20-25 (3⁄4)	25.00 (0.984)	+0.30 (0.012)	0.5 (0.020)	0.23 (0.009)	+0.09 (+0.0035)
20-26 (7⁄8)	26.00 (1.022)	+0.30 (0.012)	0.5 (0.020)	0.53 (0.021)	+0.10 (+0.004)
25-32 (1)	32.00 (1.260)	+0.30 (0.012)	0.5 (0.020)	0.28 (0.011)	+0.09 (+0.0035)
32-40 (1 1⁄4)	39.95 (1.573)	+0.30 (0.012)	0.5 (0.020)	0.33 (0.013)	...
41-50 (1 1⁄2)	49.90 (1.964)	+0.30 (0.012)	0.5 (0.020)	0.47 (0.018)	...
51-63 (2)	62.90 (2.484)	+0.40 (0.016)	0.5 (0.020)	0.57 (0.022)	...
60-75 (2 1⁄2)	75.10 (2.957)	+0.60 (0.024)	1.0 (0.039)	0.67 (0.026)	...

A: The out-of- roundness specification applies only to tubing prior to coiling. ASTM F1281- 2011

5.2.2 Melt adhesive

The material shall be in accordance with specification ASTM D3350.

5.2.3 Polyethylene

Polyethylene plastics used to make pipe meeting the requirements of this specification shall be virgin resin meeting the requirements of either Grade PE20A, B, or C; Grade PE23A, B, or C; Grade PE30A, B, or C; or Grade PE33A, B, or C in accordance with Specification 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.)	Wall Tolerance (+) mm	Outer PEX Layer Thickness, Min, mm (in.)	Inner PEX Layer Thickness, min, mm (in.)
09-12 (3⁄8)	1.60 (0.063)	0.40 (0.016)	0.40 (0.016)	0.70 (0.028)
12-16 (1⁄2)	1.65 (0.065)	0.65 (0.022)	0.40 (0.016)	0.90 (0.035)
16-20 (5⁄8)	1.90 (0.075)	0.40 (0.016)	0.40 (0.016)	0.96 (0.038)
20-25 (3⁄4)	2.25 (0.089)	0.50 (0.020)	0.40 (0.016)	1.10 (0.043)
20-26 (7⁄8)	3.00 (0.118)	0.33 (0.013)	0.40 (0.016)	1.32 (0.052)
25-32 (1)	2.90 (0.114)	0.60 (0.024)	0.40 (0.016)	1.34 (0.053)
32-40 (1 1⁄4)	3.40 (0.134)	0.60 (0.024)	0.40 (0.016)	1.45 (0.057)
41-50 (1 1⁄2)	4.00 (0.157)	0.60 (0.024)	0.40 (0.016)	1.75 (0.069)
51-63 (2)	4.60 (0.181)	0.60 (0.024)	0.40 (0.016)	1.75 (0.069)
60-75 (2 1⁄2)	7.25 (0.285)	0.60 (0.024)	0.40 (0.016)	2.80 (0.110)

(ASTM F1281 -2011)

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 tolerance as specified in table 2, except for the polyethylene 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 ¼) to 6075(2 ½) 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 PEX-AL-PEX COMPOSITE PIPE

Nominal Pipe Size, mm (in.)	Minimum Adhesive Force per 10-mm (0.394-in.) Pipe Strip, N (lbf)
32-40 (1¼)	40 (9.0)
41-50 (1½)	50 (11.2)
51-63 (2)	60 (13.5)
60-75 (2½)	70 (15.7)

(ASTM F1281- 2011)

5.9 Apparent Tensile Strength of Pipe

The pipe rings 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)
09-12 (⅜)	2000 (448)	2100 (470)	7000 (1020)
12-16 (½)	2100 (470)	2300 (515)	6000 (880)
16-20 (⅝)	2400 (538)	2500 (560)	5000 (730)
20-25 (¾)	2400 (538	2500 (560)	4000 (580)
20-26 (⅞)	2400 (538)	2500 (560)	4000 (580)
25-32 (1)	2650 (598)	2500 (560)	4000 (580)
32-40 (1¼)	3200 (719)	3500 (789)	4000 (580)
41-50 (1½)	3500 (789)	3700 (832)	3800 (554)
51-63 (2)	5200 (1169)	5500 (1236)	3800 (554)
60-75 (2½)	6000 (1349)	6000 (1349)	3800 (554)

(ASTM F1281- 2011)

5.11 Sustained Pressure

The PEX-AL-PEX pipe shall not fail, ballon, 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 PEX-AL-PEX, kPa (psi)
09-12 (⅜)	2720 (395)
12-16 (½)	2720 (395)
16-20 (⅝)	2720 (395)
20-25 (¾)	2720 (395)
20-26 (⅞)	2720 (395)
25-32 (1)	2720 (395)
32-40 (1¼)	2000 (295)
41-50 (1½)	2000 (295)
51-63 (2)	2000 (295)
60-70 (2½)	2000 (295)

(ASTM F1281- 2011)

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 protective 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 second and third parts of BS 7291 applicable to the pipe material.

6.5 Diameter and Wall Thickness

When measured in accordance with BS EN ISO 3126, the diameter and wall thickness of the pipe shall conform to the limits given in Table 6 or Table 7, as applicable (see BS 7291‑1: 2010, Clause 5).

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 BS EN ISO 6259-1 using an ISO 6259-3 type 2 test piece, subject to the following conditions, the elongation at break from each of four test 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 pieces is parallel with that of the pipe and offset by 90º circumferentially from the axis of the preceding test piece. The thickness of the narrow parallel portion of each test piece cut from the pipe wall shall not deviate at any point by more than ±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 - 2010)

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

Nominal size[a]	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.o	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 - 2010)

6.9 Short-term Hydrostatic Pressure Resistance at 20ºC of Assembled Fittings and Pipes

6.9.1 When one or more fittings are tested in accordance with BS EN ISO 1167-1 and BS EN ISO 1167-2, subject to the conditions in 6.9.2, the assembly shall withstand for at least 1 h at 20ºC without bursting or leaking a pressure that subjects the largest size of pipe for which the fitting is intended to a circumferential stress of 12 MPa.

6.9.2 Water or air (air in the case of dispute) shall be used as the external environment. The assembly shall consist of test pieces comprising the fitting(s) and lengths of pipe of at least 100 mm, having terminal fittings that subject the assembly to the end thrusts induced by the internal pressure. The individual test pieces and the assembly shall be conditioned at the test temperature for at least 1 h immediately prior to pressurization.

6.10 Short-term hydrostatic pressure resistance of pipe at 95ºC

When one or more test pieces are tested in accordance with BS EN ISO 1167-1 and BS EN ISO 1167-2, using a test temperature of (95 ±1) C, pipe shall not burst when subjected to either:

a) a circumferential stress of 4.9 MPa for a least 22 h;

or, and in case of dispute,

b) a circumferential stress of 4.7 MPa for at least 170 h.
Water or, and in the case of dispute, air shall be used as the external environment. Test pieces shall have terminal fittings that subject the test piece to the end thrust induced by the internal pressure.

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) 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.

d) 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.