For BIS Use Only

Doc: CED 50 (13686)
February 2019

BUREAU OF INDIAN STANDARDS

Preliminary Draft for

POLYETHYLENE-ALUMINIUM-POLYETHYLENE COMPOSITE PRESSURE PIPES FOR HOT AND COLD WATER SUPPLIES — SPECIFICATIONS

(*first revision* of IS 15450)

FOREWORD

(Formal clauses to be added later.)

This standard was first published in 2004 to cover requirements for polyethylene-aluminium-polyethylene composite pressure pipes for hot and cold water supplies. As ISO Standard on the subject did not exist at that time, therefore the standard was substantially based on other international standards like ASTM 1282.

The multilayer PE-AL-PE composite pipe comprises one metallic layer, tie layers of polymeric adhesive and inner and outer layers of polyethylene (PE). The inner and outer PE layers are bonded to metallic layer (welded aluminium tube) by polymeric adhesive during extrusion process.

ISO 21003- Multilayer piping systems for hot and cold water installations inside buildings was published in the year 2008. However, it is a system specification standard rather than a product specification and PE-AL-PE composite pipes are not covered by this standard.

ASTM standard has been amended in the year 2017. Based on this latest version of ASTM F 1282 – 2017 and the wide experience gained by the Indian industry over a period of time, this revision has been formulated and the following changes have been incorporated in this revision of the standard.

a) New sizes of 63 mm (OD) and 75 mm (OD) outside diameter pipes which are being used in India have been added in the standard.

b) The pipe designation are defined based on the outside diameter as against nominal inside and outside diameter followed earlier, as per standard practice in plastics piping systems, and all relevant tables have been modified accordingly.

c) The aluminium strip thickness as well as total wall thicknesses have been revised.

d) The grade of aluminium strips have been specified.

e) The UV stabilizer clause has been elaborated to clearly define the UV stabilizer content in case of pipes using carbon black as UV stabilizer and in case of coloured pipes using other UV stabilizers.

f) The grade of PE material used for the manufacture of these pipes has been mentioned as PE 80 as defined in Table 1 of IS 4984:2016.

g) Layer separation test has been included for pipe sizes 40 mm outside diameter and above.

h) The guideline for outside storage has been updated and guidelines for supply, handling, transportation and storage of PE-AL-PE composite pipes has been added.

j) Requirements of connectors and fittings for use with polyethylene/aluminium/polyethylene composite pressure pipes have been updated and additional tests have been included.

The requirements and test methods in this standard cover PE-AL-PE pipes. Tests on the individual layers that comprise this composite pipe are outside the scope of this standard.

This standard relates only to metal and plastic composite pipes incorporating a welded metallic tube. The welded metallic tube itself is capable of sustaining internal pressures. The pipes consisting of metallic layers not welded together are outside the scope of this standard. This standard excludes cross-linked polyethylene-aluminium-cross-linked polyethylene (PEX-AL-PEX) pipes.

This standard does not purport to address all the safety problems associated with the use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability or regulatory safety and health practices and determines the applicability of regulatory limitation prior to use.

In the formulation of this standard considerable assistance has been derived from the following International Standards:

ASTM F 1282:2017	Specification for polyethylene/aluminium/polyethylene (PE-AL-PE) composite pressure pipe

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of test or analysis, shall be rounded off in accordance with IS 2:1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

For BIS Use Only

Doc: CED 50 (13686)
February 2019

BUREAU OF INDIAN STANDARDS

Preliminary Draft for

POLYETHYLENE-ALUMINIUM-POLYETHYLENE COMPOSITE PRESSURE PIPES FOR HOT AND COLD WATER SUPPLIES — SPECIFICATIONS

(*first revision* of IS 15450)

1 SCOPE

1.1 This standard covers coextruded polyethylene composite pressure pipes with an aluminium welded tube reinforced between the inner and outer layers of polyethylene (PE). The inner and outer polyethylene layers are bonded to the aluminium tube by melt adhesive. The sizes of pipes are ranging from 12 mm to 75 mm in outside diameter. These pipes are used for conveyance of hot and cold water supply for domestic and industrial purposes, potable water supply, municipal water services including internal and external plumbing, air conditioning and heating installations within buildings, underground irrigation systems, gases and chemicals that are compatible with pipe. This standard includes a system of nomenclature for PE-AL-PE pipes, the requirements and test methods for materials, the dimensions and strengths of finished pipe, adhesion test and the burst and sustained pressure performance test alongwith requirements and methods for marking.

1.2 This standard relates only to metal and plastic composite pipes incorporating a welded metallic tube. The welded metallic tube itself is capable of sustaining internal pressures. The pipes consisting of metallic layers not welded together are outside the scope of this specification.

1.3 This standard excludes cross-linked polyethylene-aluminium-cross-linked polyethylene (PEX-AL-PEX) pipes.

1.4 Recommendatory information on storage and handling of these pipes and performance requirements of connectors/fittings for these pipes are included in this standard.

2 REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provision of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
IS 737:2008	Wrought aluminium and aluminium alloy sheet and strip for general engineering purposes — Specification (*fourth revision)*
IS 2530:1963	Methods of test for polyethylene moulding materials and polyethylene compounds
IS 4905:2015	Random sampling and randomization procedures (*first revision*)
IS 4984:2016	Polyethylene pipes for water supply — Specification (*fifth revision*)
IS 7328:1992	High density polyethylene materials for moulding and extrusion (*first revision*)
IS 9845:1998	Determination of overall migration of constituents of plastics materials and articles intended to come in contact with foodstuffs — Method of analysis (*second revision*)
IS 10146:1982	Specification for polyethylene for its safe use in contact with foodstuff, pharmaceuticals and drinking water

3 TERMINOLOGY

For the purpose of this standard, terms and definitions given in IS 4984 shall apply.

4 PIPE DESIGNATION

PE-AL-PE composite pipes are designated by outside diameters.

NOTE — The concept of dimension ratio is not relevant to PE-AL-PE pipe and are not used to relate pressure rating with total wall thickness.

5 MATERIALS

5.1 The material from which PE-AL-PE pipe is manufactured shall comprise of polyethylene plastic and aluminium strip.

5.2 Polyethylene

5.2.1 The grade of polyethylene material used for manufacture of these pipe shall be PE 80 as defined in Table 1 of IS 4984.

The raw material characteristics like melt flow rate, base density, thermal stability and anti-oxidant content of polyethylene material used for the manufacture of these pipes shall conform to the material characteristics as mentioned in Table 3. In addition the resin shall conform to the requirements of IS 10146 and to those of **5.6.2** of IS 7328.

The material grade classification and conformity to Table 3, 5.6.2 of IS 7328 and IS 10146 shall be provided by the raw material (resin) manufacture with documentation duly certified by resin manufacturer.

5.2.1.1 The other constituents used should be from the positive list of constituents of PE in contact with foodstuff and pharmaceuticals as per IS 16738 and should not constitute a toxic hazard, shall not support microbial growth and shall not give rise to an unpleasant taste or odour, cloudiness or discolouration of the water.

5.3 UV Stabiliser

Outer PE layer of black coloured pipes shall be added with carbon black to a proportion of 2.5 ± 0.5 percent for having better UV resistance.

Outer PE layer of coloured pipes are to be suitably UV stabilized. The percentage of UV stabilizer shall not be more than 0.5 percent by mass of finished resin. Raw material supplier shall provide a certificate in this regard.

5.4 Aluminium

The material shall confirm to Grade 31200 as per IS 737 and have the following properties when tested as per IS 737,

a) Minimum elongation : 20 percent
b) Ultimate tensile strength : 95 MPa (minimum)

The aluminium strip shall have minimum thickness and tolerance thereon as specified in Table 1.

Table 1 Aluminium Thickness and Tolerances for PE-AL-PE Pipe
(*Clause* 5.4)

Sl No.	Nominal Pipe size mm	Minimum Aluminium Thickness mm	Tolerance on minimum Aluminium Thickness mm
(1)	(2)	(3)	(4)
i)	12	0.18	+0.03
ii)	14	0.18	+0.03
iii)	16	0.18	+0.03
iv)	20	0.23	+0.03

v)	25	0.23	+0.03
vi)	32	0.28	+0.03
vii)	40	0.33	+0.03
viii)	50	0.47	+0.04
ix)	63	0.57	+0.04
x)	75	0.67	+0.05

5.5 Rework Material

Clean reprocess able material generated from the manufacturer's own production, may be used by the same manufacturer, as long as the pipe produced meets all the requirements of this specification. Rework material containing aluminium or reprocessed or recycled plastics shall not be used for the production of pipe.

6 PRESSURE RATING

The PE-AL-PE composite pipe meeting the requirements of this specification shall be pressure rated for maximum water pressures of 1.38 MPa at 23°C and 1.10 MPa at 60 °C or 0.69 MPa at 82 ºC .

7 NOMINAL DIAMETERS

The nominal outside diameter of pipes covered in the standard are 12, 14, 16, 20, 25, 32, 40, 50, 63 and 75 mm. Respective nominal inside diameters for the above pipe sizes are 9, 10, 12, 16, 20, 25, 32, 40, 50 and 63 mm, respectively.

8 COLOUR

Colour of pipe shall be black. The pipe may be manufactured in other colours according to the requirement of customer.

9 DIMENSIONS OF PIPE

9.1 Pipe diameter, out-of-roundness, total wall thickness and thickness of outer PE layer shall be as given in Table 2. The thickness of aluminium layer shall be as given in Table 1. The thickness of the outer layer of polyethylene, when tested as per Annex B, in the PE-AL-PE pipe shall have a minimum value as specified in Table 2, except for polyethylene material overlaying the weld, which shall have a minimum thickness of half that specified in Table 2. Tolerances of nominal OD shall be as given in Table 2.

9.2 Method of Measurements

9.2.1 The outside diameter of pipe shall be taken as the average of two measurements taken at right angles. The wall thickness shall be measured by a dial vernier or ball ended micrometer. The resulting dimension shall be expressed to the nearest 0.1 mm.

9.2.2 Ovality shall be measured as the difference between maximum outside diameter and minimum outside diameter measured at the same cross section of the pipe. For pipes to be coiled, the ovality shall be measured prior to coiling. For coiled pipes, however, re-rounding of pipes shall be carried out prior to the measurement of ovality.

Table 2 Overall Pipe Dimensions
(*Clause* 9.1)

All dimensions

Sl. No.	Nominal Pipe Size	Pipe Nominal Outside Diameter (OD)	Tolerance on Outside Diameter	Maximum Out of Roundness	Total Wall Thickness		Outer PE layer Thickness Min
					Minimum	Maximum	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	12	12.00	$+0.30$ -0.00	0.30	1.60	2.00	0.40
ii)	14	14.00	$+0.30$ -0.00	0.40	1.60	2.00	0.40
iii)	16	16.00	$+0.30$ -0.00	0.40	1.70	2.10	0.40
iv)	20	20.00	$+0.30$ -0.00	0.60	1.90	2.30	0.40
v)	25	25.00	$+0.30$ -0.00	0.60	2.30	2.80	0.40
vi)	32	32.00	$+0.50$ -0.00	0.80	2.90	3.50	0.40
vii)	40	40.00	$+0.50$ -0.00	1.00	3.90	4.50	0.40
viii)	50	50.00	$+0.50$ -0.00	1.30	4.40	5.00	0.40
ix)	63	63.00	$+0.60$ -0.00	1.40	5.80	6.40	0.40
x)	75	75.00	$+0.60$ -0.00	1.50	7.30	7.90	0.40

9.3 Length of Straight Pipe

The pipe shall be supplied in straight lengths as agreed upon with the purchaser between 3 to 20 m.

9.4 Coiling

While coiling, the inside diameter of coils in mm, shall be not less than 20 times the outside diameter of pipe.

10 VISUAL APPEARANCE

The internal and external surfaces of the pipe shall be smooth, clean and free from grooving and other defects. The ends shall be cleanly cut and shall be square with the axis of the pipes. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided that the wall thickness remains within the permissible limits.

11 PERFORMANCE REQUIREMENTS

11.1 Density

When tested as per IS 7328 on a composite sample of PE material generated from layers of minimum 3 pipes, the base density shall meet the requirement as given in Table 3.

11.2 Melt Flow Rate

When tested as per IS 2530 at 190°C with nominal load of 5 kgf, on a composite sample of PE material generated from layers of minimum 3 pipes, it shall meet the requirement of MFR as given in Table 3 and also the MFR of the pipe shall not differ by more than 30 percent of the MFR of the material used in manufacturing pipes.

11.3 Overall Migration

When tested as per IS 9845 on samples of PE material generated from layers of minimum 3 pipes, the overall migration of constituents shall be within the limits stipulated in IS 10146.

NOTE — The test mentioned at **11.3** is to be carried out only on the polyethylene layer of the pipe.

11.4 Thermal Stability to Oxidation

The minimum oxidation induction time (OIT) of the PE material from the pipe when tested in accordance with the method given in Annex B of IS 4984 (*see* Table 3) shall not be less than 20 min.

NOTE — The test mentioned at **11.4** is to be carried out only on the polyethylene layer of the pipe.

11.5 Carbon Black Content and Dispersion

When tested as per IS 2530, on a composite sample of black PE material generated from outer layers of minimum 3 pipes, it shall meet the carbon black content requirement as given in Table 3. When tested as per Annex E of IS 14885, on a composite sample of black PE material generated from outer layers of minimum 3 pipes, the grade of dispersion of carbon black shall be ≤ 3.

11.6 Pigment Dispersion (For Coloured Pipes)

When tested as per Annex E of IS 14885, on a composite sample of coloured PE material (other than black) generated from outer layers of minimum 3 pipes, the grading shall be ≤ 3.

NOTE — The tests mentioned at **11.1**, **11.2**, **11.3, 11.4** and **11.5** above are to be carried out only on the polyethylene layer of the pipe.

Table 3 PE Compound Characteristics
(*Clauses* 11.1, 11.2, 11.4, 11.5, 11.6)

Sl No.	Characteristics	Units	Requirement	Test Parameter	Method of Test, Ref to	
					IS No.	Annex
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Base Density	kg/m^3	940.4 to 946.4	27 °C	IS 7328	-
			942.0 to 948.0	23 °C	IS 7328	-
ii)	Melt flow rate	g/10 min	0.4 to 0.8	190 °C/5kg	IS 2530	-
iii)	Carbon black content	By mass	2.5 ± 0.5	-	IS 2530	-
iv)	Carbon black dispersion (black pipes)	Grade	≤ 3			Annex E of IS 14885
v)	Pigment dispersion (coloured pipes other than black)	Grade	≤ 3	-	-	Annex E of IS 14885
vi)	Thermal stability (oxidation induction time)	min	≥ 20	200 °C	-	Annex B of IS 4984
vii)	Anti-oxidant	By mass	≤ 0.3 percent	-	IS 2530	-

11.7 Adhesion Test

11.7.1 *De-lamination Test* (*Pipe Size 12 mm to 32 mm*)

When tested in accordance with C-1, there shall be no delamination of the PE and AL, either on bore side or the outside.

11.7.2 *Layer Separation Test* (*Pipe Size* 40 mm *and Above*)

When tested in accordance with C-2, minimum adhesive force per 10 mm length of pipe strip shall be as specified in Table 4.

Table 4 Layer Separation Test – Minimum Adhesive Force
(*Clause* 11.7.2)

Sl. No.	**Nominal Pipe Size**	**Minimum Adhesive Force per 10 mm Pipe Section ,** *N*
(1)	(2)	(3)
i)	40	40
ii)	50	50
iii)	63	60
iv)	75	70

11.8 Apparent Tensile Strength of Pipe

The pipe rings when tested in accordance with Annex D, shall meet the minimum requirement as specified in Table 5.

11.9 Minimum Burst Pressure

The minimum burst pressure for PE-AL-PE pipe shall be as given in Table 5, when determined in accordance with Annex E.

Table 5 Minimum Pipe Ring Strengths at 23 °C
Burst Pressure of PE-AL-PE Pipe
(*Clauses* 11.8 and 11.9)

Sl No.	**Nominal Pipe Size** (mm)	**Minimum Pipe Ring Strength** (N)	**Minimum Burst Pressure** (MPa)
(1)	(2)	(3)	(4)
i)	12	2 000	7.0
ii)	14	2 000	7.0
iii)	16	2 100	6.0
iv)	20	2 400	5.0
v)	25	2 400	4.0
vi)	32	2 650	4.0
vii)	40	3 200	4.0
viii)	50	3 500	3.8
ix)	63	5 200	3.8
x)	75	6 000	3.8

11.10 Hydraulic Characteristics

11.10.1 *Short Term Hydrostatic Tests*

When subjected to internal pressure creep rupture test in accordance with procedure given in Annex F, the pipe under test shall show no sign of localized swelling, leakage or weeping, and shall not burst during the prescribed test duration. The temperatures, duration of test and pressure for the test shall conform to those specified in Table 6.

Table 6 Hydraulic Pressure Test Conditions and Requirements for PE-AL-PE Pipe
(*Clause* 11.10.1)

Sl. No.	**Nominal Pipe Size** (mm)	**Test Temperature** (°C)	**Test Pressure** (MPa)	**Minimum Test duration** (h)
(1)	(2)	(3)	(4)	(5)
i)	12	27	3.2	1
		60	2.5	10
ii)	14	27	3.0	1
		60	2.5	10
iii)	16	27	3.0	1
		60	2.5	10
iv)	20	27	2.7	1
		60	2.5	10
v)	25	27	2.6	1
		60	2.5	10
vi)	32	27	2.8	1
		60	2.5	10
vii)	40	27	2.6	1
		60	2.1	10
viii)	50	27	2.4	1
		60	2.1	10
ix)	63	27	2.4	1
		60	2.1	10
x)	75	27	2.4	1
		60	2.1	10

11.10.2 *Long Term Hydrostatic Test*

When subjected to internal pressure creep rupture test in accordance with procedure given in Annex F, the pipe under test shall show no sign of localized swelling, leakage or weeping, and shall not burst during the prescribed test duration. The temperatures, duration of test and pressure for the test shall conform to those specified in Table 7.

Table 7 Long Term Hydrostatic Test
(*Clause* 11.10.2)

Sl No.	Nominal Pipe Size (mm)	Test Temperature (°C)	Test Pressure (MPa)	Minimum test duration (h)
(1)	(2)	(3)	(4)	(5)
i)	12	95	1.3	170
ii)	14	95	1.3	170
iii)	16	95	1.2	170
iv)	20	95	1.0	170
v)	25	95	1.0	170
vi)	32	95	0.9	170
vii)	40	95	0.9	170
viii)	50	95	0.9	170
ix)	63	95	0.9	170
x)	75	95	0.9	170

12 SAMPLING, FREQUENCY OF TESTS AND CRITERIA FOR CONFORMITY

12.1 Type Test

Type tests are intended to prove the suitability and performance of a new composition, a new manufacturing technique or a new size of pipe. Such test, need to be applied only when a change is made in polymer composition or method of manufacture, or when a new size is to be introduced. Even if no change is envisaged, type test shall be done at least once in three years of the highest size manufactured during the period.

Type tests shall include the following:

a) Long term hydrostatic test as per Table 7 and in accordance with Annex F;
b) Overall migration test as per IS 9845; and
c) Thermal stability to oxidation as per Annex B of IS 4984.

12.1.1 *Long Term Hydrostatic Test*

Three samples of same size selected at random from the regular production lot shall be tested for compliance with the requirement of the type test as per **11.8.2** and Table 7.

12.1.2 *Overall Migration Test*

Three samples of the smallest size of the pipe manufactured from each of the machines shall be selected at random from the regular production lot and tested for compliance as per **11.3**.

12.1.3 *Thermal Stability to Oxidation*

Three samples of same size selected at random from the regular production lot shall be tested for compliance with the requirement of the type test as per **11.4**.

12.1.4 If all the samples pass the requirements of the type test, the size of the pipe under consideration shall be considered eligible for the type approval.

12.1.5 In case any of the samples fails in the type test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to the type test again. If in repeat test, no single failure occurs, the size of the pipe under consideration shall be considered eligible for the type approval. If any of the samples fails in the repeat tests, the size of the pipe under consideration shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

12.1.6 At the end of validity period (normally 3 years) or earlier as may be necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

12.2 Acceptance Test

12.2.1 Acceptance tests are carried out on samples selected from a lot for the purpose of acceptance of the lot.

12.2.2 *Lot*

All pipes of the same size and manufactured essentially under similar conditions of manufacture shall constitute a lot. For ascertaining the conformity of the lot to the requirement of this specification, samples shall be selected in accordance with the provision as mentioned under **12.2.3** and **12.2.4** and tested for compliance.

12.2.3 *Dimensional and Visual Requirements*

12.2.3.1 The number of test samples shall be in accordance with Table 8.

12.2.3.2 These pipes shall be selected at random from the lot and in order to ensure the randomness of selection a random number table shall be used. For guidance and use of random number table, IS 4905 may be referred. In absence of a random number table the following procedure may be adopted:

Starting from any pipe in the lot, count them as 1, 2, 3, 4, etc, up to r and so on where r is the integral part of N/n, N being the number of pipes in the lot and n is the number of pipes in the samples. Every rth pipe so counted shall be drawn so as to constitute the required sample size.

Table 8 Scale of Sampling for Visual and Dimensional Requirements
(*Clauses* 11.2.3.1 *and* 11.2.3.3)

Sl No.	No. of Pipes/Coils in the Lot	Sample No.	Sample Size	Cumulative Sample Size	Acceptance No.	Rejection No.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Up to 25	First	3	3	0	2
		Second	3	6	1	2
ii)	26 to 150	First	13	13	0	2
		Second	13	26	1	2
iii)	151 to 280	First	20	20	0	3
		Second	20	40	3	4
iv)	281 to 500	First	32	32	1	4
		Second	32	64	4	5
v)	501 to 1 200	First	50	50	2	5
		Second	50	100	6	7

NOTE — Pipes are usually manufactured in coils only. Pipes in straight lengths are seldom manufactured. Same sampling will be applicable for pipes manufactured in straight length.

12.2.3.3 The number of pipes given for the first sample in col 3 of Table 8 shall be examined for dimensional and visual requirements given in **9.1**, **9.2**, **9.3** and **10**. A pipe failing to satisfy any of these requirements shall be considered as defective. The lot shall be deemed to have satisfied these requirements, if the number of defectives found in the first sample are less than or equal to the corresponding acceptance number given in col 6 of Table 8. The lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col 7 of Table 8. If however, the number of defectives found in the first sample lies between the corresponding acceptance and rejection numbers given in col 6 and col 7 of Table 8, second sample of size given in col 4 of Table 8 shall be taken and examined for these requirements. The lot shall be considered to have satisfied these requirements if the number of defectives found in the cumulative samples is less than or equal to the corresponding acceptance number given in col 6 of Table 8; otherwise not.

12.2.4 The lot having satisfied dimensional and visual requirements shall be tested for hydraulic characteristics, density, MFR, carbon black content/dispersion, adhesion,

apparent tensile strength, minimum burst pressure and pigment dispersion tests requirements.

12.2.4.1 A separate sample size for each of the tests shall be taken as stipulated in Table 9 and selected at random from the sample already examined for dimensional and visual inspection. All the pipes in each of the sample size shall be tested for compliance in the requirement for density (*see* **10.1**), MFR (*see* **10.2**), carbon black content/dispersion (*see* **10.3**), pigment dispersion (*see* **10.4**)**,** adhesion (*see* **10.5**), apparent tensile strength (*see* **10.6**), minimum burst pressure (*see* **10.7**) and hydraulic characteristics (*see* **10.8**). The lot shall be considered to have met the requirements of these tests, if none of the sample tested fails.

Table 9 Scale of Sampling for Tests for Hydraulic Characteristics, Density, MFR, Carbon Black Content/Dispersion, Adhesion, Apparent Tensile Strength, Minimum Burst Pressure and Pigment Dispersion

(*Clause* 12.2.4.1)

Sl No. (1)	**No. of Pipes/Coils** (2)	**Sample Size** (3)
i)	Up to 100	3
ii)	101 to 150	4
iii)	151 to 200	5
iv)	201 and above	8

13 MARKING

13.1 The marking shall be repeated at intervals of 1 m and shall consist of the following information:

a) Manufacturer's name or trade-mark;
b) Pipe designation; and
c) Lot number/Batch number containing information of date of manufacture.

13.1.1 The lot number/batch number shall include the details of production in the following manner:

Year	Month	Day	Machine No.	Shift
XXXX	XX	XX	XXX	XXX

13.2 Two labels of suitable dimensions should be carefully attached to each coil indicating:

a) Suppliers name;

b) Manufacturing standard;
c) Pipe designation;
d) Weight of coil, in kg; and
e) Length of coil, in meters.

13.3 BIS Certification Marking

13.3.1 Each pipe may also be marked with the Standard Mark.

13.3.2 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act,* 2016 and the Rules and Regulations made thereunder. The details of conditions under which a license for the use of the Standard Mark may be granted to manufacturers or the producers may be obtained from the Bureau of Indian Standards.

ANNEX A
(*Foreword and Clause* 1.3)

RECOMMENDATORY INFORMATION

A-1 SUPPLY, HANDLING, TRANSPORTATION AND STORAGE

A-1.1 Supply

The PE-AL-PE composite pipes shall be supplied as self-supporting coils, straight length either independent or bundled together, or as agreed between supplier and purchaser.
Their ends shall be cleanly cut, square with the axis of pipe and protected against shocks and ingress of foreign bodies by appropriate end caps.

A-1.1.1 *Coils*

PE-AL-PE composite pipes shall be coiled and coils should be stored flat or vertically in purpose-built racks or cradles, if desired by purchaser. Consideration should be given for facilities, which avoid single point contact of the coils.

A-1.1.1.1 All coiled pipe shall be constrained in a stable configuration by banding with PP/HDPE strap at least three equi-spaced positions during production. The banding shall be sufficiently stable to prevent movement.

A-1.1.1.2 Coiled pipe shall preferably be packed in woven fabric bags or wrapped with woven fabrics. The woven fabric shall be HDPE or PP.

A-1.1.2 *Bundles*

The distance (X) between the supporting frames shall be equally spaced in order to allow stacking (*see* Fig. 1). The PE-AL-PE composite straight length pipe shall rest evenly over their whole length. The supporting frame must not be nailed together and must be constructed such as to lead the pressure load directly through the supporting frame and not through the multilayer pipes.

The pipe bundles may be packed in woven fabric lay flat tube. The woven fabric shall be HDPE or PP.

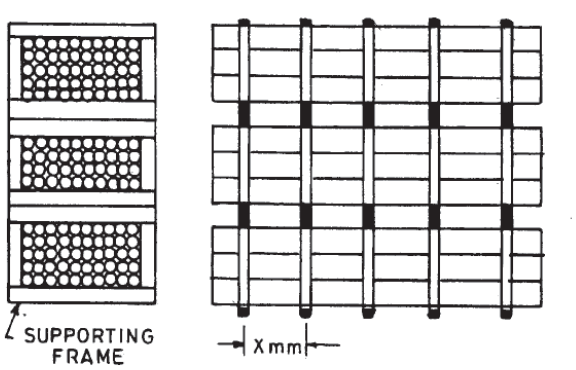


Fig. 1 Stacking Arrangement of Straight Length Pipes

A-1.2 Handling

A-1.21 *General*

Do not drag or throw the pipes along the ground. If handling equipment is not used, choose techniques which are not likely to damage the pipe.

A-1.2.2 *Coils*

Individual coils must not be rolled off the edge of the loading platforms or trailers. These coils may be kept on pallets and loaded, off-loaded using forklifts, pallet trolley, etc.

A-1.2.3 *Straight Pipe*

Initial handling and storage of composite straight pipes should be made with the pipe in packaged form, thus minimizing damage during this phase. When loading, unloading or handling, it is preferable to use mechanical equipment to move or stack the packs.

A-1.3 Transportation

A-1.3.1 *Coiled Pipe*

Coiled pipe may be supplied on pallets. The coils should be firmly strapped to the pallets, which should in turn be firmly secured to the vehicle. There should be facilities to restrain each coil securely throughout transit and the loading process.

To save on transport cost nesting of coils/straight length can be considered if agreed between the purchaser and the supplier.

A-1.3.2 *Straight Lengths*

When transporting straight PE-AL-PE composite pipes, use flatbed vehicles with a partition. The bed shall be free from nails and other protuberances. The pipes or pipe bundles shall rest uniformly in the vehicle over their whole length. The vehicles shall have side supports appropriately spaced 2 m apart, and the multilayer pipes shall be secured effectively during transportation. All posts shall be flat with no sharp edges. During transportation, the multilayer pipes should be continuously supported such as to minimize movement between the pipes and their supports. Also being relatively soft outer layer, poor handling techniques may result in scratches, cuts or puncture.

A-1.4 Storage

The composite pipes, other than black coloured pipe, shall not be stored outside, open to the sun for more than 2 years. Where individual pipe lengths and coils are stacked in pyramidal fashion, deformation may occur in the lower layers, particularly in warm weather. Therefore, such stacks should not exceed a height of 1 500 mm.

The composite pipes shall be stacked on a reasonably flat surface, free from sharp objects, stones or projections likely to deform or damage them.

A-2 CONNECTORS AND FITTINGS

A-2.1 General

A-2.1.1 Connectors or fittings shall be made from brass or any other material found to be suitable for the service conditions.

A-2.1.2 The connectors or fittings shall be so designed that a seal is effected on the internal wall surface of the pipe so that the medium contained in the pipe is barred from coming in contact with the cross section of the pipe.

A-2.1.3 PE-AL-PE pipes manufactured to this specification shall be capable of being jointed with the connectors or fittings provided that the connector or fitting alone or in assembly with PE-AL-PE pipe complies with the requirements as given in **A-2.2**, **A-2.3** and **A-2.4**.

A-2.2 Hydrostatic Burst Pressure

The connector or fitting assembled with PE-AL-PE pipe, shall meet the minimum hydrostatic burst pressure requirement at 60 ± 2 ºC as given in Table 10.

Table 10 Minimum Hydrostatic Burst Pressure at 60 ºC
(*Clause* A-2.2)

Sl No.	Pipe Size	Test Pressure (Bar)
(1)	(2)	(3)
i)	12	40
ii)	14	40
iii)	16	40
iv)	20	38
v)	25	32
vi)	32	32
vii)	40	25
viii)	50	23
ix)	63	20
x)	75	20

A-2.3 Internal Pressure Test

The fitting or connector, when assembled with PE-AL-PE pipe, shall not fail or weep at the test pressure and ambient temperatures for the specified duration as given in Table 11. The joint shall not have any leakage during the test.

Table 11 Test Pressure and Duration for Internal Pressure Test
(*Clause* A-2.3)

Sl No.	Pipe Size	Test Pressure (Bar)	Duration (h)
(1)	(2)	(3)	(4)
i)	12	36.0	1
ii)	14	36.0	1
iii)	16	34.3	1
iv)	20	26.7	1
v)	25	26.7	1
vi)	32	23.0	1
vii)	40	22.3	1
viii)	50	22.0	1
ix)	63	22.0	1
x)	75	22.0	1

A-2.4 Pull Out Test

A-2.4.1 *Apparatus*

The apparatus shall consist of one of the following:

a) A tensile testing machine together with grips capable of subjecting the test assembly to a constant longitudinal force; and

b) A frame with means for suspending a test piece together with stirrup at the lower end to hold sufficient weight(s) with which to apply the specified force.

A-2.4.2 *Test Assembly*

The test assembly shall comprise a straight coupling or any other fitting which can join two pipe pieces assembled in accordance with the manufacturer's instructions with two pieces of pipe of the appropriate nominal size. Separate combinations shall be assembled for each type of pipe for which fitting is designed. Each pipe shall be at least 100 mm in length.

A-2.4.3 *Procedure*

Secure the test assembly in the apparatus and apply gradually over a period of 30 s the appropriate force at ambient temperature as given in Table 12 as applicable. Hold the specimen in constant tension for the specified duration.

Table 12 Test Force and Duration for Pull Out Test
(*Clause* A-2.4.3)

Sl No.	Pipe Size (mm)	Test Force (*N*)	Duration (h)
(1)	(2)	(3)	(4)
i)	12	494	
ii)	14	589	1
iii)	16	722	1
iv)	20	1021	1
v)	25	1550	1
vi)	32	2506	1
vii)	40	4180	1
viii)	50	5957	1
ix)	63	9851	1
x)	75	14674	1

NOTE — The pull out test forces have been calculated using the following formula:

$$F = 1.5\,\pi\,\sigma_{\emptyset}\,(D^2 - d^2)/4$$

where

F = applied force in N;

$\sigma_{\emptyset}$ = design circumferential stress = 6.3 MPa;
D = nominal outside diameter of the pipe in mm; and
d = internal diameter of the pipe with minimum wall thickness in mm.

ANNEX B
(*Clause* 9.1)

OUTER POLYETHYLENE LAYER THICKNESS

B-1 SAMPLE PREPARATION

Select the sample of pipe at random. Cut the pipe with a sharp knife or other suitable cutter, ensuring that the pipe after cutting is not more than 1 percent out-of-roundness.

B-2 THICKNESS DETERMINATION

Use a hand held magnifying glass equipped with graduated reticule or a laboratory microscope with graduated reticule. The reticule should measure to the nearest 0.10 mm. Determine the thickness of outer coating of polyethylene at six points around the circumference. Only one of the points should be at the aluminium weld.

ANNEX C
(*Clause* 11.5)

ADHESION TEST

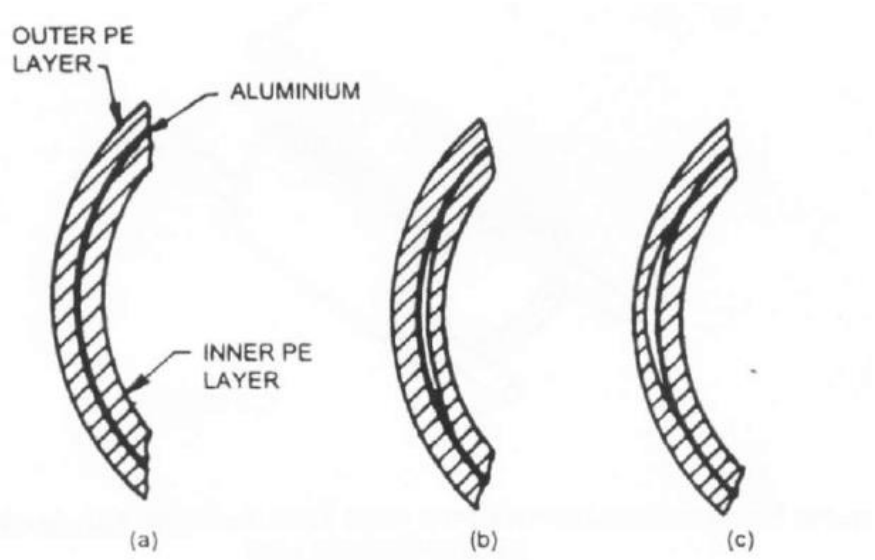
C-1 DE-LAMINATION TEST

C-1.1 Cutting of the Spiral

Mount a sharp but razor like blade within a protective housing and angle to cut a 45 ± 5° spiral in the pipe. Choose a PE-AL-PE pipe at random and insert into the housing and rotate to form the spiral cut. The cut goes through the complete wall on one side of the pipe only. Run the spiral along the pipe for a minimum distance along the pipe axis equal to five times the outside diameter.

C-1.2 Examining for Delamination

Hold pipe with the spiral cut firm at the uncut end and create a ribbon of pipe material by opening out the spiral cut pipe. Pliers can be used to grip the spiral cut pipe. Examine the wall of the pipe visually side-on for evidence of delamination between metal and plastic layers (*see* Fig. 3).



a) Good pipes showing no delamination.
b) Delamination between the inner PE layer and the aluminium.
c) Delamination between the outer PE layer and the aluminium.

Fig. 3 Delamination between Metal and Plastic Layers

C-2 LAYER SEPARATION TEST

The layer separation test shall be conducted at 23 ± 2 ºC.

C- 2.1 Test Apparatus

The test apparatus for the layer separation test shall consist of a tension device with suitable pull of device (*see* Fig. 4)

C-2.2 Test Specimen

The test specimen for the layer separation test shall consist of five sections of PE-AL-PE pipe, each approximately 10 mm long, cut at random intervals from one section of pipe.

C-2.3 Test Procedure

a) Mechanically separate, to about 5 mm and on the opposite side to the welding seam, the outside PE layer, together with aluminium layer, from the inside PE layer of the test specimens using the pull off device.

    Note — Separating the layer 5 mm allows clamping.

b) Examine the adhesion of the outside PE layer to the aluminium tube.

c) Mount the test specimen and clamp the 5 mm tab in the tension testing device.

d) Remove the outside layer with linear speed of 50 mm/min

e) Record the force diagram.

C-2.4 Test Performance Requirement

The minimum adhesive force per 10 mm pipe strip shall be as specified in Table 4 and there shall be no delamination or separation between the outside PE layer and the aluminium tube.

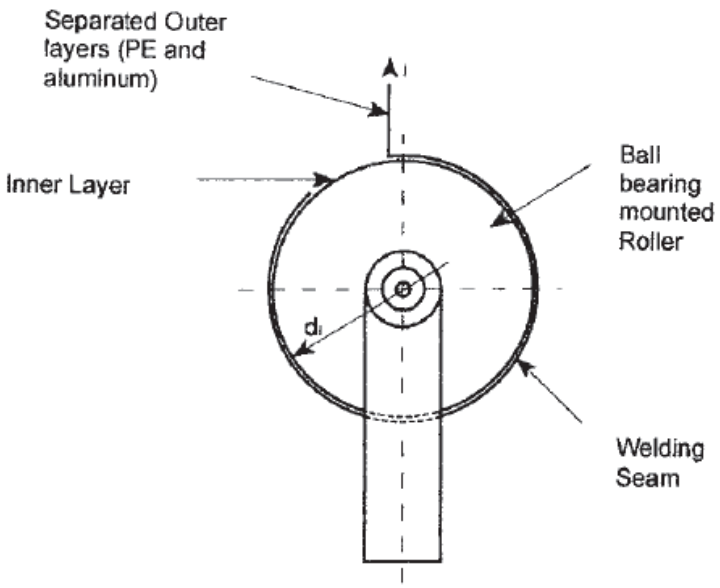


Fig. 4 Setup for Layer separation Test

ANNEX D
(*Clause* 11.6)

APPARENT TENSILE STRENGTH TEST

D-1 SAMPLE SIZE AND SHAPE

Cut the rings of the PE-AL-PE pipe so that two sides are parallel and at 90 ± 2° to the pipe axis. The length of each ring will be 25 ± 1 mm. Cut minimum of 15 samples consecutively along the axis of the pipe.

D-2 RING TESTS

Test the consecutively cut samples individually using a tensile testing machine. Arrange the rings so that the aluminium weld is at 90° to the tensile axis as shown in Fig. 5. The crosshead speed shall be at 50 ± 2.5 mm/min. Mount the rings of pipe on two steel rods of minimum diameter of 4 mm. Record the peak force.

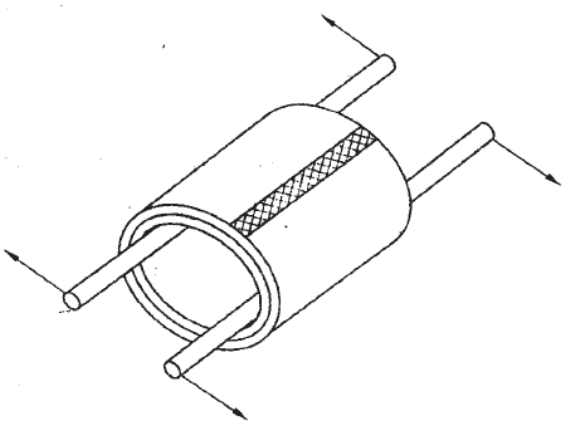


Fig. 5 Schematic Presentation of the Pipe Ring Test Showing the Aluminium Weld at 90° to the Tensile Axis

ANNEX E
(*Clause* 11.7)

MINIMUM BURST PRESSURE

E-1 PIPE SAMPLE

Select a length of PE-AL-PE pipe at random and prepare 5 consecutive lengths of required length (200 mm minimum). Seal samples at the ends with appropriate fittings and test either free or fixed end.

E-2 TEST TEMPERATURE

The test should be carried out at ambient temperature inside the laboratory. The temperature should preferably be 25 ± 5 °C.

E-3 BURST PRESSURE

Increase the pressure inside the pipe in such a way that the time required to reach the burst pressure is between 60 to 70 s.

ANNEX F
(*Clauses* 11.8 *and* 12.1)

HYDRAULIC PRESSURE TEST

F-1 SAMPLES

Each test sample of PE-AL-PE pipe shall have a minimum length between end closures of at least ten times the average outside diameter of the pipe, but not less than 250 mm. Seal specimens at both ends with appropriate fittings and fill the sample with water.

F-2 TEST PROCEDURES

Test each sample individually in a temperature controlled water bath. Condition the test samples for at least 2 h in the water bath when the water bath is at the required test temperature. Maintain the pressure indicated in Table 5 within 0.07 MPa of the set pressures for the duration of the test.

F-3 FAILURE

Any continuous loss of pressure of the test sample shall constitute failure of the test.