INTERNATIONAL STANDARD

ISO 4427-3

Second edition
2019-08

Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) —

Part 3: Fittings

Systèmes de canalisations en plastique destinés à l'alimentation en eau et aux branchements et collecteurs d'assainissement sous pression — Polyéthylène (PE) —

Partie 3: Raccords

Reference number
ISO 4427-3:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword v
Introduction vi
1 Scope 1
2 Normative references 2
3 Terms and definitions 3
4 Symbols and abbreviated terms 4
5 Material 4
5.1 PE compound 4
5.2 Material for non-polyethylene parts 4
5.2.1 General 4
5.2.2 Metal parts 4
5.2.3 Elastomers 5
5.2.4 Other materials 5
6 General characteristics 5
6.1 Appearance 5
6.2 Design 5
6.3 Colour 5
6.4 Electrical characteristics for electrofusion fittings 5
6.5 Appearance of factory-made joints 6
6.6 Effect on water quality 6
7 Geometrical characteristics 6
7.1 Measurement of dimensions 6
7.2 Dimensions of electrofusion socket fittings 6
7.2.1 Diameters and lengths of electrofusion sockets 6
7.2.2 Wall thickness 7
7.2.3 Out-of-roundness of the bore of a fitting (at any point) 8
7.2.4 Spigots 8
7.2.5 Other dimensions 8
7.3 Dimensions of electrofusion saddle fittings 8
7.4 Dimensions of spigot end fittings 9
7.4.1 Diameter and length 9
7.4.2 Wall thickness of the fusion end 12
7.4.3 Wall thickness of the fitting body 12
7.4.4 Other dimensions 12
7.5 Dimensions of socket fusion fittings 12
7.6 Dimensions of fabricated fittings 12
7.7 Design and dimensions of mechanical fittings 12
7.7.1 General 12
7.7.2 Mechanical fittings with polyethylene spigot ends 12
7.7.3 Mechanical fittings with polyethylene electrofusion sockets 12
7.7.4 Threads 13
7.8 Dimensions of loose backing flanges and flange adapters 13
8 Mechanical characteristics 13
8.1 General 13
8.2 Conditioning 13
8.3 Requirements 13
8.4 Retest conditions 15
8.5 Performance requirements 16
9 Physical characteristics 16
9.1 Conditioning 16
9.2 Requirements 16

10 **Chemical resistance of fittings in contact with chemicals** 17
11 **Performance requirements** 17
12 **Marking** 17
12.1 General 17
12.2 Minimum required marking 17
12.3 Fusion system recognition 18
13 **Packaging** 18
Annex A (normative) **Socket fusion fittings** 19
Annex B (normative) **Fabricated fittings** 21
Annex C (informative) **Examples of typical terminal connections for electrofusion fittings** 28
Annex D (normative) **Short-term pressure test method** 31
Annex E (normative) **Tensile test for fitting/pipe assemblies** 33
Bibliography 35

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 4427-3:2007), which has been technically revised.

The main changes compared to the previous edition are:

— Update of the normative references;

— Technical consistency with ISO 4437-3 (see Reference [1] in the Bibliography).

A list of all parts in the ISO 4427 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 4427 series of standards are a set of system standards that specify the requirements for a piping system and its components when made from polyethylene (PE). The piping system is intended to be used in buried or above ground applications, for the conveyance of water for human consumption, raw water prior to treatment, drainage and sewerage under pressure, vacuum sewer systems, and water for other purposes.

In respect of potential adverse effects on the quality of water intended for human consumption caused by the products covered by the ISO 4427 series, it does not provide information on the restriction on the use of products.

NOTE Guidance for assessment of conformity can be found in Reference [2] in the Bibliography.

Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) —

Part 3: Fittings

1 Scope

This document specifies the fittings made from polyethylene (PE) for buried or above ground applications, intended for the conveyance of water for human consumption, raw water prior to treatment, drainage and sewerage under pressure, vacuum sewer systems, and water for other purposes.

NOTE 1 The intended uses include sea outfalls, laid in water and connection between pipes suspended below bridges.

This document also specifies the test parameters for the test methods referred to in this document.

In conjunction with the other parts of the ISO 4427 series, this document is applicable to PE fittings, to joints with components of PE or other materials, intended to be used under the following conditions:

a) a maximum allowable operating pressure (PFA) up to and including 25 bar[1)];

b) an operating temperature of 20 °C as the reference temperature.

NOTE 2 For other operating temperatures, guidance is given in ISO 4427-1:2019, Annex A.

This document covers a range of maximum allowable operating pressures and gives requirements concerning colours.

NOTE 3 It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and installation practices or codes.

This document is applicable to fittings of the following types:

1. fusion fittings;
   a. electrofusion fittings;
   b. spigot end fittings (for butt fusion using heated tools and electrofusion socket fusion);
   c. socket fusion fittings (see Annex A);
2. mechanical fittings;
   a. compression fittings;
   b. flanged fittings;
3. fabricated fittings (see Annex B).

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

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*

ISO 1167-3, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 3: Preparation of components*

ISO 1167-4, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 4: Preparation of assemblies*

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

ISO 4427-1, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 1: General*

ISO 4427-2, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 2: Pipes*

ISO 4427-5, *Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) — Part 5: Fitness for purpose of the system*

ISO 4433-1, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 1: Immersion test method*

ISO 4433-2, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 2: Polyolefin pipes*

ISO 9624, *Thermoplastics pipes for fluids under pressure — Mating dimensions of flange adapters and loose backing flanges Thermoplastics pipes for fluids under pressure — Mating dimensions of flange adapters and loose backing flanges*

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

ISO 12176-1, *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 1: Butt fusion*

ISO 13951, *Plastics piping systems — Test method for the resistance of plastic pipe/pipe or pipe/fitting assemblies to tensile loading*

ISO 13953, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

ISO 13954, *Plastics pipes and fittings — Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*

ISO 13955, *Plastics pipes and fittings — Crushing decohesion test for polyethylene (PE) electrofusion assemblies*

ISO 13956, *Plastics pipes and fittings — Decohesion test of polyethylene (PE) saddle fusion joints — Evaluation of ductility of fusion joint interface by tear test*

ISO 13957, *Plastics pipes and fittings — Polyethylene (PE) tapping tees — Test method for impact resistance*

ISO 17885, *Plastics piping systems — Mechanical fittings for pressure piping systems — Specifications*

EN 681-1:1996, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 1: Vulcanized rubber*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4427-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
electrofusion socket fitting
polyethylene (PE) fitting which contains one or more integral heating elements that are capable of transforming electrical energy into heat to realize a fusion joint with a spigot end or pipe

3.2
electrofusion saddle fitting
polyethylene (PE) fitting which contains one or more integral heating elements that are capable of transforming electrical energy into heat to realize a fusion joint onto a pipe

3.2.1
tapping tee
electrofusion saddle fitting (top-loading or wraparound) which contains an integral cutter used for cutting through the wall of the main pipe, which remains in the body of the tapping tee after installation

3.2.2
branch saddle
electrofusion saddle fitting (top-loading or wraparound) which requires an ancillary cutting tool for drilling the hole in the adjoining main pipe

3.3
spigot end fitting
polyethylene (PE) fitting where the outside diameter of the spigot length is equal to the nominal outside diameter, d_n, of the corresponding pipe

3.4
socket fusion fitting
polyethylene (PE) fitting where the socket mouth is designed to be fusion-jointed with a spigot end or a pipe using heated tools

3.5
fabricated fitting
fitting produced from pipe conforming to ISO 4427-2 and/or from injection-moulded fittings in accordance with this document

3.6
mechanical fitting
fitting, that generally includes a compression part to provide pressure integrity, leaktightness and resistance to end loads, for assembling polyethylene (PE) pipe to another PE pipe or any other element of the piping system

Note 1 to entry: The fitting can create a radial compressive force (compression fitting) or an axial compressive force (flange connection).

Note 2 to entry: A pipe-supporting sleeve providing a permanent support for a polyethylene (PE) pipe to prevent creep in the pipe wall under radial compressive forces, can be applicable. In some cases, the supporting sleeve contributes to end load resistance.

Note 3 to entry: The fitting can allow either a dismountable or permanently assembled joint.

Note 4 to entry: The mechanical fitting can be supplied for field assembly or pre-assembled by the manufacturer.

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in ISO 4427-1 apply.

5 Material

5.1 PE compound

The PE compound from which the fittings are made shall be in accordance with ISO 4427-1.

The stress bearing PE parts of injection moulded fittings shall only be made from virgin material.

Non-stress bearing PE parts shall be made from virgin material or own reprocessed material from a compound with the same MRS or a mixture of both materials.

NOTE Since PE 40 is not commonly used for pressure applications, it is the intention of ISO/TC 138/SC 2 to withdraw all references to this compound at the next revision of the ISO 4427 series (all parts).

5.2 Material for non-polyethylene parts

5.2.1 General

The materials and constituent elements used in making the fitting (including elastomers and any metal parts) shall be as resistant to the external and internal environments as the other elements of the piping system and shall have a life expectancy under the following conditions at least equal to that of the PE pipe conforming to ISO 4427-2 with which they are intended to be used:

a) during storage;

b) under the effect of the fluids being conveyed;

c) with respect to the service environment and operating conditions.

Other materials used in fittings and in contact with the PE pipe (e.g. greases) shall not adversely affect the pipe performance or initiate stress cracking.

5.2.2 Metal parts

All parts susceptible to corrosion shall be adequately protected, provided this is necessary for durability and function of the system.

When dissimilar metallic parts are used which may be in contact with moisture, appropriate actions shall be taken to avoid galvanic corrosion.

5.2.3 Elastomers

Elastomeric materials used for the manufacture of seals shall conform to EN 681-1.

5.2.4 Other materials

Greases or lubricants shall not exude on to the fusion areas and shall not affect the long-term performance of the pipes and fittings nor have any adverse effect on the quality of the water.

6 General characteristics

6.1 Appearance

When viewed without magnification, the internal and external surfaces of the fitting shall be smooth, clean and free from scoring, cavities and other surface defects such as would prevent conformity of the fitting to this document.

6.2 Design

The design of the fitting shall be such that, when assembling the fitting onto the pipe or other components in accordance with the manufacturer's recommendations, the electrical coils and/or seals are not displaced.

6.3 Colour

The PE part of fitting shall be either black or blue. For fabricated fittings, the colour characteristics of pipes shall be in accordance with ISO 4427-2.

The blue colour is intended for the conveyance of water for human consumption only.

For above-ground installations, all components other than black should be protected from direct UV light.

6.4 Electrical characteristics for electrofusion fittings

The electrical protection that shall be provided by the fusion process depends on the voltage and the current used and on the characteristics of the electricity power source.

For voltages greater than 25 V, direct human contact with energized parts shall not be possible when the fitting is in the fusion cycle during assembly in accordance with the instructions of the manufacturers of the fittings and of the assembly equipment, as applicable.

NOTE 1 The fitting during the fusion process is part of an electrical system as defined in EN 60335-1, HD 60364-1, and IEC 60449 (References [3], [4] and [5] in the Bibliography).

The tolerance on the electrical resistance of the fitting at 23 °C shall be stated by the manufacturer. The resistance shall be between nominal resistance (−10 %) and nominal resistance (+10 %) + 0,1 Ω.

NOTE 2 0,1 Ω is the assumed value of the contact resistance.

The surface finish of the terminal pins shall allow a minimum contact resistance in order to satisfy the resistance tolerance requirements.

NOTE 3 See Annex C for the examples of typical electrofusion terminal connections.

6.5 Appearance of factory-made joints

The internal and external surfaces of the pipe and fitting after fusion jointing, examined visually without magnification, shall be free from melt exudation outside the confines of the fitting apart from that which may be declared acceptable by the fitting manufacturer or used as a fusion marker.

There shall be no wire movement leading to short circuiting when the electrofusion fittings are jointed in accordance with the manufacturer's instructions. There shall be no excessive creasing of the internal surfaces of the adjoining pipes or spigots.

6.6 Effect on water quality

For fittings to be used in contact with water intended for human consumption, see ISO 4427-1.

7 Geometrical characteristics

7.1 Measurement of dimensions

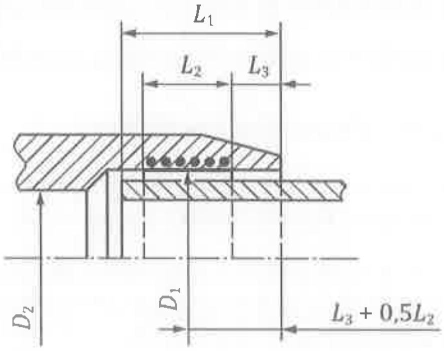
The dimensions of the fittings shall be measured in accordance with ISO 3126. In case of dispute, the measurement of dimensions shall be made not less than 24 h after manufacture and after conditioning for at least 4 h at (23 ± 2) °C.

Indirect measurement at the stage of production is allowed at shorter time periods, provided that evidence is shown of correlation.

7.2 Dimensions of electrofusion socket fittings

7.2.1 Diameters and lengths of electrofusion sockets

When measured in accordance with 7.1, the diameters and lengths of electrofusion sockets (see Figure 1) shall be in accordance with Table 1.



Key

D_1 "mean inside diameter in the fusion zone" measured in a plane parallel to the plane of the mouth at a distance of $L_3 + 0,5L_2$

D_2 bore, which is the minimum diameter of the flow channel through the body of the fitting where $D_2 \geq (d_n - 2e_{min})$

L_1 "design penetration depth" of the pipe or male end of a spigot fitting (in case of a coupling without stop, it is not greater than half the total length of the fitting)

L_2 heated length within a socket as declared by the manufacturer to be the nominal length of the fusion zone

L_3 distance between the mouth of the fitting and the start of the fusion zone as declared by the manufacturer to be the nominal unheated entrance length of the fitting where L_3 shall be ≥ 5 mm

Figure 1 — Dimensions of electrofusion sockets

Table 1 — Electrofusion socket dimensions

Dimensions in millimetres

Nominal diameter of the fitting d_n	Depth of penetration $L_{1,min}$	Depth of penetration $L_{1,max}$	Fusion zone $L_{2,min}$
20	25	41	10
25	25	41	10
32	25	44	10
40	25	49	10
50	28	55	10
63	31	63	11
75	35	70	12
90	40	79	13
110	53	82	15
125	58	87	16
140	62	92	18
160	68	98	20
180	74	105	21
200	80	112	23
225	88	120	26
250	95	129	33
280	104	139	35
315	115	150	39
355	127	164	42
400	140	179	47
450	155	195	51
500	170	212	56
560	188	235	61
630	209	255	67
710	220	280	74
800	230	300	82

The mean inside diameter of the fitting in the middle of the fusion zone (see D_1 in Figure 1) shall be not less than d_n.

The manufacturer shall declare the actual minimum and maximum values of D_1 and determine their suitability for joint assembly and check the fitness for purpose of the fitting by testing in accordance with ISO 4427-5.

In the case of a fitting having sockets of differing nominal diameters, each one shall conform to the requirements for the nominal diameter of the corresponding component.

7.2.2 Wall thickness

In order to prevent stress concentrations, any changes in wall thickness of the fitting body shall be gradual.

a) The wall thickness of the body of the fitting at any point, E, shall be greater than or equal to e_{min} for the corresponding pipe at any part of the fitting located at a distance beyond a maximum of $2L_1/3$ from all entrance faces if the fitting and the corresponding pipe are made from a polyethylene having the same MRS.

If the fitting is produced from a polyethylene having an MRS that is different from that of the corresponding pipe, the relationship between the wall thickness of the fitting, E, and the pipe, e_{min}, shall be in accordance with Table 2.

Table 2 — Relationship between pipe and fitting wall thickness

Material		Relationship between fitting wall thickness, E, and pipe wall thickness, e_{min}
Pipe	Fitting	
PE 80	PE 100	$E \geq 0{,}8e_{min}$
PE 100	PE 80	$E \geq 1{,}25e_{min}$

b) In the case of a wall thickness design different from that according to a), fittings and associated fusion joints shall additionally meet the performance requirements given in 8.5.

7.2.3 Out-of-roundness of the bore of a fitting (at any point)

When a fitting leaves the site of the manufacturer, the out-of-roundness of the bore of a fitting at any point shall not exceed $0{,}015d_n$.

7.2.4 Spigots

For fittings that contain spigot outlets (e.g. electrofusion equal tee with spigotted branch), the dimensions of the spigot shall be according to 7.4.

NOTE For technical and design reasons, the shape of the minimum bore cross-section area can be different from the one of spigot fittings as given in 7.4.

7.2.5 Other dimensions

The dimensional characteristics appropriate to each manufacturer, such as the overall dimensions or mounting dimensions, shall be specified in a technical file.

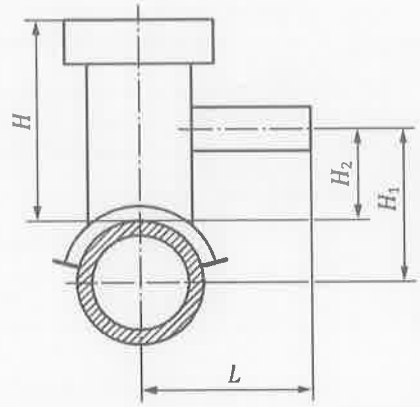
In the case of a coupling without an internal stop or with a removable centre register, the geometry of the fitting shall allow the penetration of the pipe through the fitting.

7.3 Dimensions of electrofusion saddle fittings

Outlets from tapping tees and branch saddles shall have spigots in accordance with 7.4 or electrofusion sockets in accordance with 7.2.

The manufacturer shall specify the overall dimensions of the fitting in the technical file. These dimensions shall include the maximum height of the saddle, H, and for tapping tees the height of the service pipe, H_1 or H_2 (see Figure 2).

NOTE For technical and design reasons, the minimum bore diameter D_2 can be different from the one of spigot fittings as given in 7.4.



Key

H height of the saddle, which comprises the distance from the top of the main pipe to the top of the tapping tee or saddle

H_1 height of service pipe, which comprises the distance from the axis of the main pipe to the axis of the service pipe

H_2 height of service pipe, which comprises the distance from the top of the main pipe to the axis of the service pipe

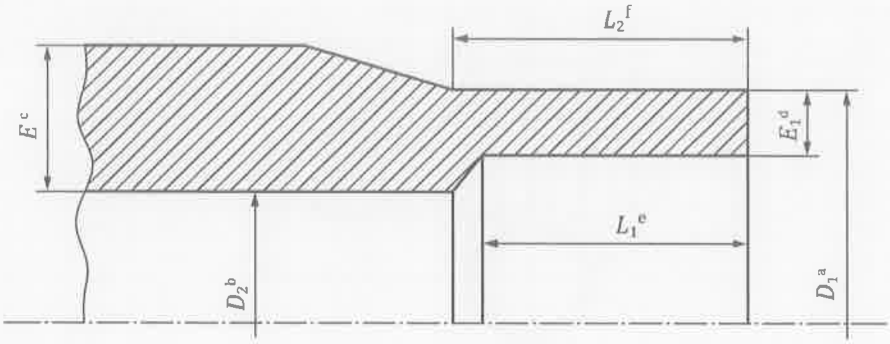
L width of the tapping tee, which comprises the distance between the axis of the pipe and the plane of the mouth of the service tee

Figure 2 — Dimensions of electrofusion saddle fittings

7.4 Dimensions of spigot end fittings

7.4.1 Diameter and length

When measured according to 7.1, the dimensions of spigot end fittings (see Figure 3) shall conform to the values given in Table 3.



Key

D_1 mean outside diameter of fusion end piece

D_2 bore comprising minimum diameter of flow channel through body of fitting

E body wall thickness of fitting

E_1 fusion face wall thickness

L_1 cut-back length of fusion end piece

L_2 tubular length of fusion end piece

a D_1 is measured in any plane parallel to the plane of the entrance face at a distance not greater than L_2 (tubular length) from the plane of the entrance face.

b The measurement of this diameter does not include the fusion bead, if any.

c It comprises the thickness measured at any point of the wall of the fitting.

d It is measured at any point at a maximum distance of L_1 (cut back length) from the entrance face and shall be equal to the pipe wall thickness and tolerance to which it is intended to be butt fused, as specified in ISO 4427-2:2019, Table 2. E_1 for small dimensions is at least 3 mm.

e It comprises the initial depth of the spigot end necessary for butt fusion or reweld and may be obtained by joining a length of pipe to the spigot end of the fitting provided the wall thickness of the pipe is equal to E_1 for its entire length.

f It comprises the initial length of the fusion end piece and shall allow the following (in any combination): the use of clamps required in the case of butt fusion; assembly with an electrofusion fitting; assembly with a socket fusion fitting; the use of a mechanical scraper.

Figure 3 — Dimensions of spigot fittings

Table 3 — Spigot dimensions

Dimensions in millimetres

Nominal outside diameter of spigot	Mean outside diameter of fusion end[a]		Min. bore[b]	Electrofusion[c]			Socket fusion	Butt fusion			
				Out-of-roundness	Cut-back length	Tubular length[d]	Tubular length	Out-of-roundness	Cut-back length	Tubular length	
d_n	D_1		D_2		L_1	L_2	L_2		L_1	L_2	
	min	Max.	min	Max.	min	min	min	Max.	min	Normal[e]	Special[f]
20	20,0	20,3	13	0,3	25	41	11	—	—	—	—
25	25,0	25,3	18	0,4	25	41	12,5	—	—	—	—
32	32,0	32,3	25	0,5	25	44	14,6	—	—	—	—
40	40,0	40,4	31	0,6	25	49	17	—	—	—	—
50	50,0	50,4	39	0,8	25	55	20	—	—	—	—
63	63,0	63,4	49	0,9	25	63	24	1,5	5	16	5
75	75,0	75,5	59	1,2	25	70	25	1,6	6	19	6
90	90,0	90,6	71	1,4	28	79	28	1,8	6	22	6
110	110,0	110,7	87	1,7	32	82	32	2,2	8	28	8
125	125,0	125,8	99	1,9	35	87	35	2,5	8	32	8
140	140,0	140,9	111	2,1	38	92	—	2,8	8	35	8
160	160,0	161,0	127	2,4	42	98	—	3,2	8	40	8
180	180,0	181,1	143	2,7	46	105	—	3,6	8	45	8
200	200,0	201,2	159	3,0	50	112	—	4,0	8	50	8
225	225,0	226,4	179	3,4	55	120	—	4,5	10	55	10
250	250,0	251,5	199	3,8	60	129	—	5,0	10	60	10
280	280,0	281,7	223	4,2	75	139	—	9,8	10	70	10
315	315,0	316,9	251	4,8	75	150	—	11,1	10	80	10
355	355,0	357,2	283	5,4	75	164	—	12,5	10	90	12
400	400,0	402,4	319	6,0	75	179	—	14,0	10	95	12
450	450,0	452,7	359	6,8	100	195	—	15,6	15	60	15
500	500,0	503,0	399	7,5	100	212	—	17,5	20	60	15
560	560,0	563,4	447	8,4	100	235	—	19,6	20	60	15
630	630,0	633,8	503	9,5	100	255	—	22,1	20	60	20
710	710,0	714,9	567	10,6	125	280	—	24,8	20	60	20
800	800,0	805,0	639	12,0	125	300	—	28,0	20	60	20

[a] Tolerance are in accordance with ISO 11922-1:2018 , grade B (see Reference [6] in the Bibliography).

[b] The requirement on D_2 are only applicable for SDR 11 or higher.

[c] Spigot fittings designed for electrofusion are also suitable for butt fusion.

[d] The values of L_2 (electrofusion) are based on the following equations:

— for $d_n \leq 90$, $L_2 = 0{,}6d_n + 25$ mm;

— for $d_n \geq 110$ to $d_n \leq 710$, $L_2 = d_n/3 + 45$ mm.

[e] Used by preference.

[f] Used for fittings fabricated in the factory.

7.4.2 Wall thickness of the fusion end

The wall thickness of the fusion end, E_1, shall be at least equal to the minimum wall thickness of the pipe, with a minimum value of 3 mm.

A thickness reduction, for example a chamfered edge, is permitted. between the plane of the entrance face and a plane parallel to it, located at a distance not greater than (0,01 d_e + 1 mm).

The permissible tolerance of the wall thickness, E_1, at any point shall conform to the tolerance given in ISO 4427-2:2019, Table 2 for the same wall thicknesses.

7.4.3 Wall thickness of the fitting body

The wall thickness, E, of the fitting body measured at any point, shall be at least equal to the nominal wall thickness, e_n, of the pipe.

Any changes in wall thickness inside the body of the fitting shall be gradual in order to prevent stress concentrations.

7.4.4 Other dimensions

The dimensional characteristics appropriate to each manufacturer, such as overall dimensions or clamping requirements, shall be stated in a technical file.

7.5 Dimensions of socket fusion fittings

Where the description and dimensions of fittings of this type is required, Annex A applies.

7.6 Dimensions of fabricated fittings

Where the description and dimensions of fittings of this type is required, Annex B applies.

7.7 Design and dimensions of mechanical fittings

7.7.1 General

Mechanical fittings shall conform to ISO 17885.

Mechanical fittings shall allow installation with pipes according to ISO 4427-2.

If mechanical fittings are intended for jointing with spigot ends of fittings, spigot length (L_2) and cut back length (L_1) should be considered (see Table 3).

The fittings shall be designed and manufactured in such a way that they can be used buried or above ground. Pre-assembled mechanical fittings shall not be capable of being dismantled.

The fittings shall be designed to avoid twisting of the PE pipe during assembly.

The fittings shall not be assembled by thread cutting the PE pipe.

7.7.2 Mechanical fittings with polyethylene spigot ends

Polyethylene spigot ends shall conform to 7.4.

7.7.3 Mechanical fittings with polyethylene electrofusion sockets

Electrofusion sockets shall conform to 7.2.

7.7.4 Threads

Threads on metal ends shall conform to ISO 7-1 or ISO 228-1, as applicable.

7.8 Dimensions of loose backing flanges and flange adapters

Dimensions of loose backing flanges and flange adapters shall be in accordance with ISO 9624.

8 Mechanical characteristics

8.1 General

Fittings shall be tested assembled with pipes conforming to ISO 4427-2 and/or fittings conforming to this document.

Jointed pipe and fitting test pieces shall be assembled in accordance with the technical instructions of the manufacturer, taking into account the manufacturing and assembly tolerances and the extreme conditions of utilization described in ISO 4427-5.

8.2 Conditioning

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

8.3 Requirements

When tested in accordance with the test methods as specified in Table 4 using the indicated parameters, the fittings shall have mechanical characteristics conforming to the requirements given in Table 4, as applicable to the following types of fitting:

— (A) electrofusion socket fitting and socket fusion fitting;

— (B) electrofusion saddle fitting;

— (C) spigot end fitting.

For mechanical fittings, the requirements of ISO 17885 shall apply.

Table 4 — Mechanical characteristics

<table>
<tr><th rowspan="2">Characteristic</th><th rowspan="2">Requirements</th><th colspan="3">Test parameters</th><th rowspan="2">Test method</th></tr>
<tr><th colspan="2">Parameter</th><th>Value</th></tr>
<tr><td rowspan="9">Hydrostatic strength
(20 °C, 100 h)</td><td rowspan="9">No failure during test period of any test piece</td><td colspan="2">End caps</td><td>Type A of ISO 1167-1:2006</td><td rowspan="9">ISO 1167-1:2006 and ISO 1167-4</td></tr>
<tr><td colspan="2">Orientation</td><td>Free</td></tr>
<tr><td colspan="2">Conditioning time</td><td>Shall conform to ISO 1167-1:2006</td></tr>
<tr><td colspan="2">Number of test pieces[a]</td><td>3</td></tr>
<tr><td colspan="2">Type of test[b]</td><td>Water-in-water</td></tr>
<tr><td rowspan="2">Circumferential (hoop) stress in pipe[c] for:</td><td>PE 80</td><td>10,0 MPa</td></tr>
<tr><td>PE 100</td><td>12,0 MPa</td></tr>
<tr><td colspan="2">Test period</td><td>100 h</td></tr>
<tr><td colspan="2">Test temperature</td><td>20 °C</td></tr>
<tr><td rowspan="9">Hydrostatic strength
(80 °C, 165 h)</td><td rowspan="9">No failure during test period of any test piece[d]</td><td colspan="2">End caps</td><td>Type A of ISO 1167-1:2006</td><td rowspan="9">ISO 1167-1:2006 and ISO 1167-4</td></tr>
<tr><td colspan="2">Orientation</td><td>Free</td></tr>
<tr><td colspan="2">Conditioning time</td><td>Shall conform to ISO 1167-1:2006</td></tr>
<tr><td colspan="2">Number of test pieces[a]</td><td>3</td></tr>
<tr><td colspan="2">Type of test[b]</td><td>Water-in-water</td></tr>
<tr><td rowspan="2">Circumferential (hoop) stress in pipe[c] for:</td><td>PE 80</td><td>4,5 MPa</td></tr>
<tr><td>PE 100</td><td>5,4 MPa</td></tr>
<tr><td colspan="2">Test period</td><td>165 h</td></tr>
<tr><td colspan="2">Test temperature</td><td>80 °C</td></tr>
</table>

NOTE Each assembly shall be prepared from components (pipes and fittings) of the same pressure class.

[a] The number of test pieces given indicates the number required to establish a value for the characteristic described in Table 4. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance on assessment of conformity can be found in CEN/TS 12201-7. (See Reference [2] in the Bibliography).

[b] Alternatively, for d_n > 450 mm, the test can also be performed in air. In case of dispute, water-in-water test shall be used. For fitting type (B) d_n > 450 mm, alternative testing is allowed (e.g. pressurization through saddle outlet).

[c] The test pressure shall be calculated using the design standard dimension ratio (SDR) of the fitting.

[d] Only brittle failures shall be taken into account. If a ductile failure occurs before 165 h, the test can be repeated according to 8.4.

[e] Longest length of brittle failure in any of the test samples.

[f] Test sample can be mechanically reduced in wall thickness for testing purpose of large diameter fittings by keeping a minimum of 15 mm wall thickness of each component.

[g] Alternatively, for fittings type (B) d_n > 450 mm, this characteristic can be checked by the strip-bend test according to ISO 21751. (See Reference [7] in the Bibliography)

[h] Applicable to d_n 90 mm and above.

Table 4 *(continued)*

Characteristic	Requirements	Test parameters			Test method
		Parameter		Value	
Hydrostatic strength (80 °C, 1 000 h)	No failure during test period of any test piece	End caps		Type A of ISO 1167-1:2006	ISO 1167-1:2006 and ISO 1167-4
		Orientation		Free	
		Conditioning time		Shall conform to ISO 1167-1:2006	
		Number of test pieces[a]		3	
		Type of test[b]		Water-in-water	
		Circumferential (hoop) stress in pipe[c] for:	PE 80	4,0 MPa	
			PE 100	5,0 MPa	
		Test period		1 000 h	
		Test temperature		80 °C	
Decohesive resistance (A)	Length of initiation rupture ≤ $L_2/3$ in brittle failure[e]	Test temperature Number of test pieces[a,f]		23 °C Shall conform to ISO 13954 and ISO 13955	ISO 13954 ISO 13955
Evaluation of ductility of fusion joint interface (B)[g]	Surface of rupture Ld ≤ 50 % and Ad ≤ 25 %, brittle failure	Test temperature Number of test pieces[a,f]		23 °C Shall conform to ISO 13956	ISO 13956
Tensile strength for butt fusion (C)[h]	Test to failure: ductile – pass brittle – fail	Test temperature Number of test pieces[a,f]		23°C Shall conform to ISO 13953	ISO 13953
Impact resistance (B: Tapping tees only)	No failure, no leakage	Test temperature Falling height Mass of the striker Number of test pieces[a]		0 °C 2 m 2,5 kg 1	ISO 13957

NOTE Each assembly shall be prepared from components (pipes and fittings) of the same pressure class.

[a] The number of test pieces given indicates the number required to establish a value for the characteristic described in Table 4. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance on assessment of conformity can be found in CEN/TS 12201-7. (See Reference [2] in the Bibliography).

[b] Alternatively, for d_n > 450 mm, the test can also be performed in air. In case of dispute, water-in-water test shall be used. For fitting type (B) d_n > 450 mm, alternative testing is allowed (e.g. pressurization through saddle outlet).

[c] The test pressure shall be calculated using the design standard dimension ratio (SDR) of the fitting.

[d] Only brittle failures shall be taken into account. If a ductile failure occurs before 165 h, the test can be repeated according to 8.4.

[e] Longest length of brittle failure in any of the test samples.

[f] Test sample can be mechanically reduced in wall thickness for testing purpose of large diameter fittings by keeping a minimum of 15 mm wall thickness of each component.

[g] Alternatively, for fittings type (B) d_n > 450 mm, this characteristic can be checked by the strip-bend test according to ISO 21751. (See Reference [7] in the Bibliography)

[h] Applicable to d_n 90 mm and above.

8.4 Retest conditions

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 in accordance with Table 5.

Table 5 — Circumferential (hoop) stress at 80 °C and associated minimum test period

PE 80		PE 100	
Stress MPa	**Minimum test period** h	**Stress** MPa	**Minimum test period** h
4,5	165	5,4	165
4,4	233	5,3	256
4,3	331	5,2	399
4,2	474	5,1	629
4,1	685	5,0	1 000
4,0	1 000	—	—

8.5 Performance requirements

Where 7.2.2 b) applies, electrofusion socket fittings shall, additionally, be in accordance with Table 6.

Table 6 — Performance requirements

Characteristic	Requirement	Test parameters		Test method
		Parameter	**Value**	
Short-term internal pressure resistance	Failure pressure shall be greater than pressure equivalent of 2 × MRS calculated for thickest-walled pipe for which fitting has been designed	End caps	Type A of ISO 1167-1:2006	Annex D
		Orientation	free	
		Conditioning time	12 h	
		Type of test	Water-in-water	
		Minimum pressure:		
		PE 80 pipe, SDR 11	32 bar	
		PE 100 pipe, SDR 11	40 bar	
		Pressure increase rate	5 bar/min	
		Test temperature	20 °C	
Resistance to tensile load	Minimum elongation shall be 25 % before pipe yields	Test temperature	23 °C	Annex E
1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.				

9 Physical characteristics

9.1 Conditioning

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

9.2 Requirements

When tested in accordance with the test methods as specified in Table 7 using the indicated parameters, the fittings shall have physical characteristics conforming to the requirements given in Table 7.

For mechanical fittings, the requirements of ISO 17885 shall apply.

Table 7 — Physical characteristics

Characteristic	Requirements	Test parameters		Test method
		Parameter	Value	
Oxidation induction time (Thermal stability)	≥20 min	Test temperature	200 °C[b]	ISO 11357-6
		Number of test pieces[a]	3	
		Test environment	Oxygen	
Melt mass-flow rate (MFR)	After processing maximum deviation of ±20 % of the value measured on the batch used to manufacture the fitting	Loading mass	5 kg	ISO 1133-1
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces[a]	Shall conform to ISO 1133-1	

[a] The number of test pieces given indicates the number required to establish a value for the characteristic described in Table 7. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance on assessment of conformity can be found in CEN/TS 12201-7 (Reference [2] in the Bibliography).

[b] Test can be carried out at 210 °C or 220 °C provided that there is a clear correlation to the results at 200 °C; in case of dispute, the reference temperature shall be 200 °C.

10 Chemical resistance of fittings in contact with chemicals

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

NOTE Guidance for the resistance of polyethylene products to chemicals is given in ISO/TR 10358 (Reference [8] in the Bibliography). This guidance only addresses chemical resistance of products not submitted to any stress, and can need to be completed to additional testing.

11 Performance requirements

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

12 Marking

12.1 General

All fittings shall be marked according to 12.2.

The marking on the product shall be permanent, legible and shall not initiate cracks or other types of failure.

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.

NOTE The manufacturer is not responsible for marking that is illegible owing to actions caused during installation and use such as painting, scratching, covering of components or using detergents, etc. on the components unless agreed or specified by the manufacturer.

There shall be no marking over the minimum spigot length of the fitting.

12.2 Minimum required marking

The minimum required marking shall be in accordance with Table 8.

For fabricated fittings, marking shall at least mention manufacturer's identification (by name or code) on the product or on a label. Further elements may be agreed between the manufacturer and purchaser.

Table 8 — Minimum required marking

Aspect	Marking
Reference to this document	ISO 4427-3[a]
Manufacturer's identification	Name or code
Manufacturer's information	b
Nominal diameter of pipe, d_n	e.g. 110
Material and designation	e.g. PE 100
Nominal pressure	e.g. PN 16a
Design application series	e.g. SDR 11 or S5
Applicable SDR fusion range of pipe (only for electrofusion fittings)	e.g. SDR 11–SDR 26[a]

[a] This information may be printed on a label, with one label attached to the fitting or to the individual bag. The label shall be of sufficient quality as to be intact and legible at the time of installation.

[b] 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.

12.3 Fusion system recognition

Fusion fittings should have a system, either numerical, electromechanical or self-regulatory as described in ISO 13950, for recognizing the fusion parameters and facilitating the fusion process.

Where bar codes are used for the numerical recognition, the bar-code label shall be stuck to the fitting and shall be protected against deterioration.

NOTE ISO 12176-5 (Reference [9] in the Bibliography), defines a 2D code which will also enable the recognition of the fusion parameters.

13 Packaging

The fitting shall be packaged in bulk or individually protected where necessary in order to prevent deterioration and contamination.

The packaging shall have at least one label with the manufacturer's name, type and dimensions of the part, number of units and any special storage conditions.

Annex A
(normative)

Socket fusion fittings

As applicable, the dimensions of socket fusion fittings shall be in accordance with Tables A.1 and A.2. The diameter at the root shall not be greater than the diameter at the mouth. See Figure A.1.

Table A.1 — Socket dimensions — Nominal sizes 16 to 63 inclusive

Dimensions in millimetres

Nom. size DN/OD	Nom. inside diam. of socket	Mean inside diameter of socket				Out-of-roundness	Min. bore	Socket reference length	Heated socket length		Penetration of pipe into socket	
		Mouth		Root					$(L-2,5)$	(L)	$(L-3,5)$	$(L-1)$
	d_n	$D_{1,min}$	$D_{1,max}$	$D_{2,min}$	$D_{2,max}$	max.	D_3	L_{min}	$L_{2,min}$	$L_{2,max}$	$L_{3,min}$	$L_{3,max}$
16	16	15,2	15,5	15,1	15,4	0,4	9	13,3	10,8	13,3	9,8	12,3
20	20	19,2	19,5	19,0	19,3	0,4	13	14,5	12,0	14,5	11,0	13,5
25	25	24,1	24,5	23,9	24,3	0,4	18	16,0	13,5	16,0	12,5	15,0
32	32	31,1	31,5	30,9	31,3	0,5	25	18,1	15,6	18,1	14,6	17,1
40	40	39,0	39,4	38,8	39,2	0,5	31	20,5	18,0	20,5	17,0	19,5
50	50	48,9	49,4	48,7	49,2	0,6	39	23,5	21,0	23,5	20,0	22,5
63	63	62,0[a]	62,4[a]	61,6	62,1	0,6	49	27,4	24,9	27,4	23,9	26,4

Maximum $L_2 = L$ mm; minimum L_2 calculated from $(L - 2,5)$ mm.

Maximum $L_3 = (L - 1)$ mm; minimum $L_3 = (L - 3,5)$ mm.

[a] Where rerounding clamps are used, the maximum diameter of 62,4 mm may be increased by 0,1 mm to 62,5 mm. Conversely, where a peeling technique is used, the minimum diameter of 62,0 mm may be reduced by 0,1 mm to 61,9 mm.

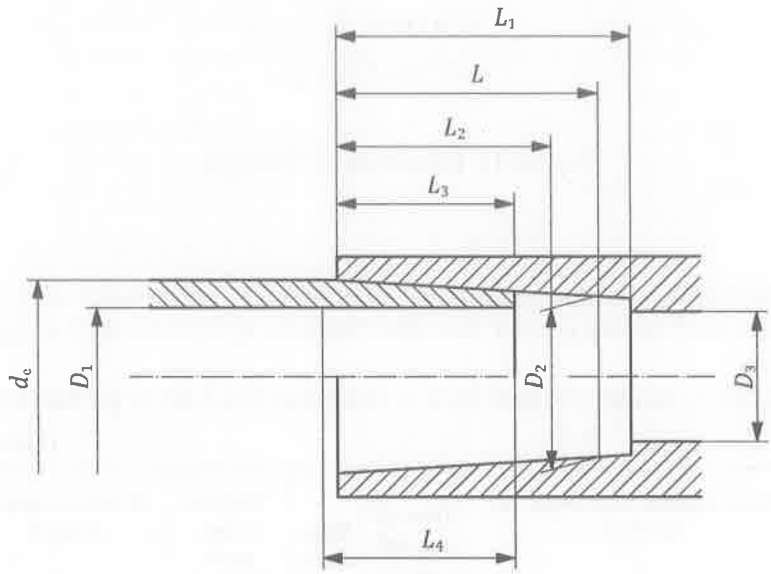
Table A.2 — Socket dimensions — Nominal sizes 75 to 125 inclusive

Dimensions in millimetres

Nom. size DN/OD	Mean outside diameter of pipe		Nom. inside diam. of socket	Mean inside diameter of socket				Out-of-roundness	Min. bore	Socket ref. length	Heated socket length		Penetration of pipe into socket	
				Mouth		Root					$(L-4)$	(L)	$(L-5)$	$(L-1)$
	$d_{em\,min}$	$d_{em\,max}$	d_n	$D_{1,min}$	$D_{1,max}$	$D_{2,min}$	$D_{2,max}$	max.	D_3	L_{min}	$L_{2,min}$	$L_{2,max}$	$L_{3,min}$	$L_{3,max}$
75	75,0	75,5	75	74,3	74,8	73,0	73,5	0,7	59	30	26	30	25	29
90	90,0	90,6	90	89,3	89,9	87,9	88,5	1,0	71	33	29	33	28	32
110	110,0	110,6	110	109,4	110,0	107,7	108,3	1,0	87	37	33	37	32	36
125	125,0	125,6	125	124,4	125,0	122,6	123,2	1,0	99	40	36	40	35	39

Maximum $L_2 = L$ mm; minimum L_2 calculated from $(L - 4)$ mm.

Maximum $L_3 = (L - 1)$ mm; minimum $L_3 = (L - 5)$ mm.



Key

D_1 mean inside diameter of socket[a]

D_2 mean inside root diameter[b]

D_3 minimum bore[c]

d_e outside diameter

L reference socket length[d]

L_1 actual length of socket from mouth to shoulder (if present)

L_2 heated length of fitting[e]

L_3 insertion depth[f]

L_4 heated length of pipe[g]

a It is the mean diameter of the circle at the intersection of the extension of the socket with the plane of the socket mouth.

b It is the mean diameter of the circle in a plane parallel to the plane of the mouth and separated from it by distance L, which is the reference length of the socket.

c It is the minimum diameter of the flow channel through the body of the fitting.

d It is the theoretical minimum socket length used for the purpose of calculation.

e It is the length of penetration of the heated tool into the socket.

f It is the depth of the heated pipe end into the socket.

g It is the depth of penetration of the pipe end into the heated tool.

Figure A.1 — Socket and pipe dimensions

Annex B
(normative)

Fabricated fittings

B.1 General

The fabricated fittings shall be in accordance with Tables B.1 and B.2, as applicable.

For dimensions above and including DN630, the requirements on hydrostatic strength at 20°C and 80°C in Table B.1 may be assessed by indirect testing. The indirect test method used and the correlation or safe relationship of the indirect testing to the specification of Table B.1 shall be documented in the manufacturer's quality plan. The indirect test method shall be agreed between the manufacturer and the end user.

The pipes used for manufacturing these fittings shall be in accordance with ISO 4427-2 and the butt fusion machine shall be in accordance with ISO 12176-1.

This annex applies only to fabricated fittings obtained by the butt fusion process. If other fusion techniques are used (e.g. extrusion welding), additional derating factors will have to be taken into account.

The PN rating of fabricated fittings shall be derived from the PN of the used pipes and the geometry derating factors given in B.3 and B.5.

The manufacturer shall be responsible for the design and the pressure rating of the fittings. It is his responsibility to demonstrate conformity to the declared PN. The pressure rating as well as the applicable derating factor, f, shall be recorded in the manufacturer's technical file. The minimum testing to demonstrate the performance of the fitting design is given in Table B.1.

In some cases, fabricated fittings are made out of injection moulded fittings or pipes of the next lower SDR series where the wall thickness is internally machined back to the next higher SDR. For such fittings, the derating factors may differ from those given in this annex.

Special requirements concerning the appearance of fabricated fittings, e.g. bead removal, shall be agreed between the manufacturer and purchaser.

At least the pressure rating PN of the fitting shall be marked on the fitting, on a label or the packaging.

Table B.1 — Performance requirements — Fabricated fittings

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Hydrostatic strength at 20 °C	No failure of any test piece during test period	End caps	Type A[a]	ISO 1167-1 ISO 1167-3
		Conditioning period	According to ISO 1167-1	
		Number of test pieces[b]	3	
		Type of test[c]	Water-in-water	
		Test temperature	20 °C	
		Test period	100 h	
		Circumferential (hoop) stress for[d]:		
		PE 40	7 MPa × f	
		PE 80	10 MPa × f	
		PE 100	12 MPa × f	
Hydrostatic strength at 80 °C	No failure of any test piece during test period	End caps	Type A[a]	ISO 1167-1 ISO 1167-3
		Conditioning period	According to ISO 1167-1	
		Number of test pieces[b]	3	
		Type of test	Water-in-water[c]	
		Test temperature	80 °C	
		Test period	1 000 h	
		Circumferential (hoop) stress for[d]:		
		PE 40	2 MPa × f	
		PE 80	4 MPa × f	
		PE 100	5 MPa × f	
Tensile strength for fabricated fittings[e]	Test to failure: Ductile — Pass Brittle — Fail	Test temperature	23 °C	ISO 13953
		Number of test pieces[b]	According to ISO 13953	

NOTE f is the declared derating factor related to the fitting to be tested.

[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] Alternatively, for d_n > 450 mm, the test can also be performed in air. In case of dispute, water-in-water test shall be used.

[d] The stress shall be calculated using the nominal dimensions of the pipe used in the test assembly.

[e] Samples are to be taken from joints between longitudinal aligned segments to produce a flat specimen geometry.

B.2 Dimensions

See Table B.2.

Larger nominal outside diameters are permitted and dimensions shall be agreed between the manufacturer and the end-user.

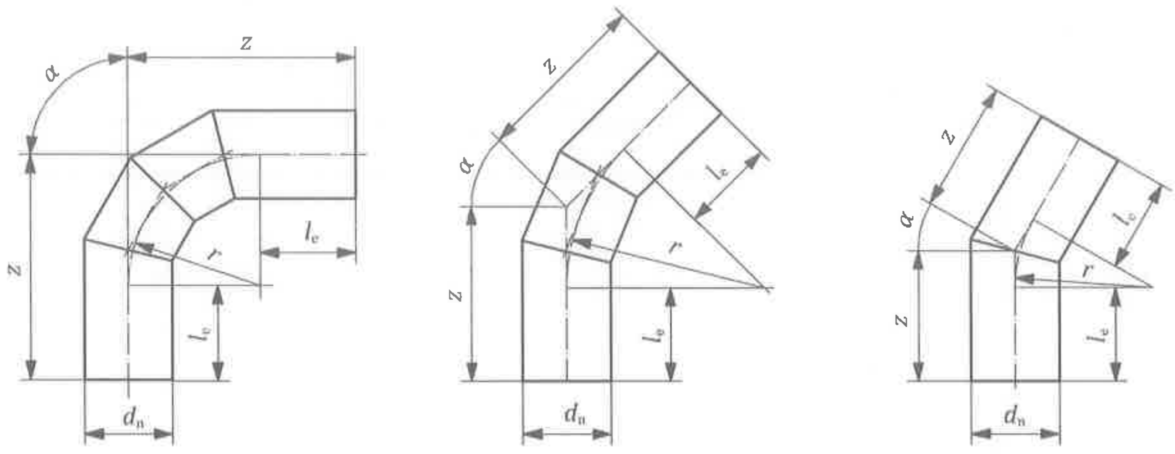
Table B.2 — Fabricated fitting dimensions

Dimensions in millimetres

Nominal outside diameter d_n	Minimum tubular length of fitting l_e	Nominal bend radius r	Nominal branch length z	Nominal angle of fitting α
90	150	Declared by the fitting manufacturer e.g. 1,5 × d 2 × d 2,5 × d 3 × d	Declared by the fitting manufacturer	Declared by the fitting manufacturer With a tolerance of ±2° The maximum tolerance for pipe bends shall be ±5°
110	150			
125	150			
140	150			
160	150			
180	150			
200	150			
225	150			
250	250			
280	250			
315	300			
355	300			
400	300			
450	300			
500	350			
560	350			
630	350			
710	350			
800	350			
900	400			
1 000	400			
1 200	400			
1 400	550			
1 600	550			

B.3 Segmented bends

Examples of typical fabricated bends made out of pipe segments are shown in Figures B.1 and B.2. Only indicated dimensions shall be considered. A full set of dimensions shall be provided by the technical documentation of the fitting manufacturer.



a) 90° b) 45° c) 30°

Key

d_n, l_e and r and α shall be in accordance with Table B.2

d_n nominal outside diameter

l_e tubular length of fusion end piece[a]

r nominal bend radius of fitting

z nominal length of fitting branch to axis

α nominal angle of fitting

[a] The length shall allow the following (in any combination): the use of clamps required in the case of butt fusion; assembly with an electrofusion fitting; assembly with a socket fusion fitting; the use of a mechanical scraper.

Figure B.1 — Segmented bends

For bends fabricated out of pipe segments, the following derating rules for the calculation of the PN shall apply:

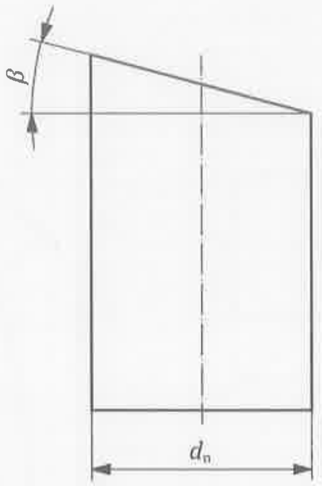
$$PN = f_B \times PN_{pipe}$$

where

f_B is the derating factor related to the bend segment design (see Table B.3);

PN_{pipe} is the nominal pressure of the pipe.

Practice has shown that these factors are applicable. Results of testing according to Table B.1 will determine the applicable factor f_B.



Key

β cut angle (shall not be greater than 15°)

d_n nominal outside diameter

Figure B.2 — Segment design

Table B.3 — Derating factors for segmented bends

Cut angle β	Derating factor f_B
≤7,5°	1,0
7,5° < β ≤ 15°	0,8[a]

[a] In accordance with B.1, the test results of the manufacturer may demonstrate that a derating factor of 1,0 or another factor is applicable

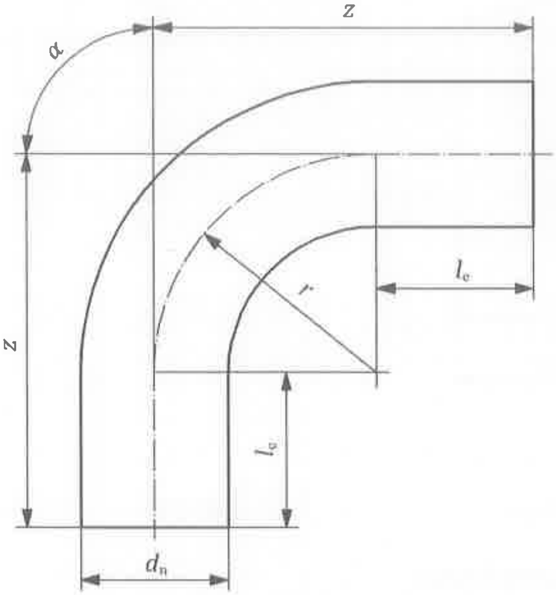
B.4 Swept bends

Fabricated pipe bends are not required to accord with the drawings given in Figure B.3. Only indicated dimensions shall be considered. A full set of dimensions shall be provided by the fitting manufacturer in his technical literature.

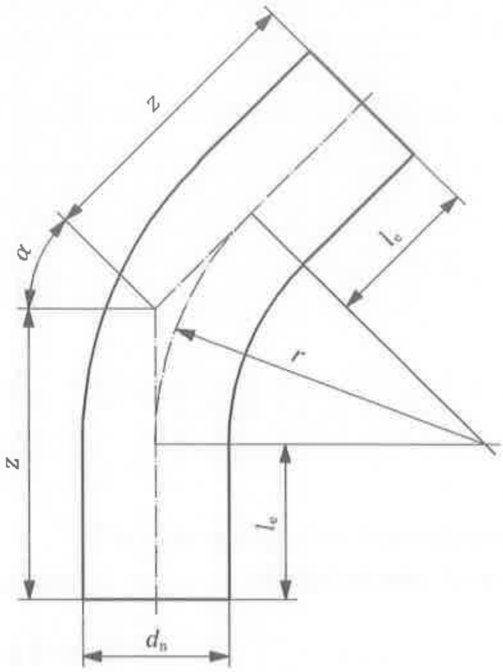
The minimum wall thickness of the pipe bend after bending shall be in accordance with ISO 4427-2.

Destructive techniques may be used to demonstrate consistency of the manufacturing process.

For bends fabricated out of pipes, usually no derating factor applies. Results of testing according to Table B.1 shall demonstrate this.



a) 90°



b) 45°

Key

d_n, l_e	and r and α shall be in accordance with Table B.2
d_n	nominal outside diameter
l_e	tubular length of fusion end piece[a]
r	nominal bend radius of fitting
z	nominal length of fitting branch to axis
α	nominal angle of fitting[b]

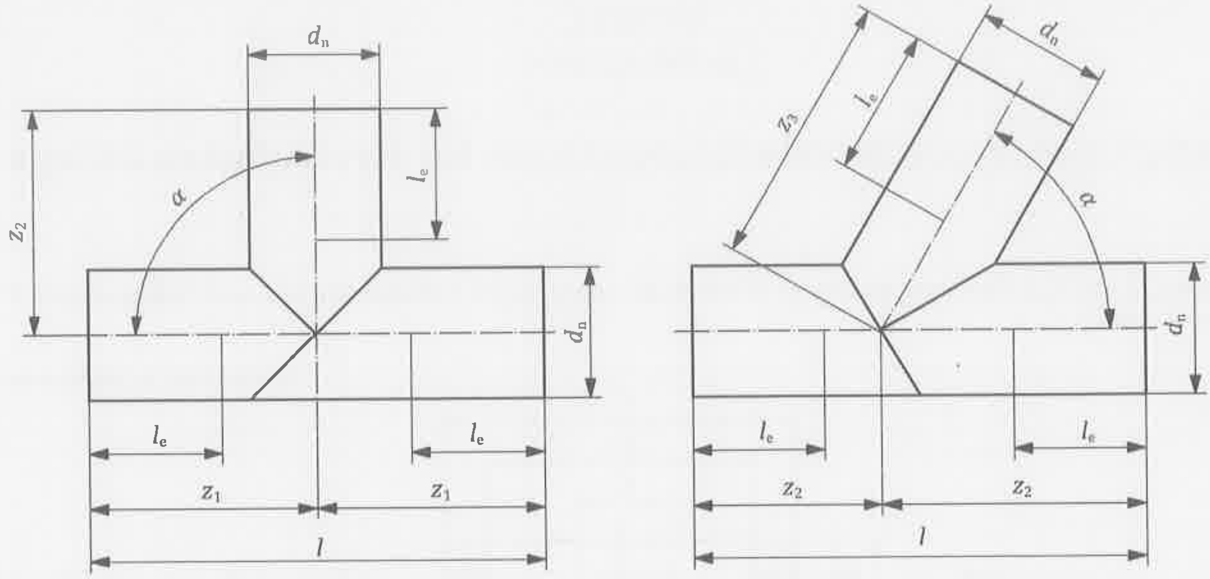
a The length shall allow the following (in any combination): the use of clamps required in the case of butt fusion; assembly with an electrofusion fitting; assembly with a socket fusion fitting; the use of a mechanical scraper.

b Special measures may be taken to keep the pipe-bend angle in place during storage and handling of the fitting.

Figure B.3 — Swept bends

B.5 Segmented tees

Fabricated tees made out of pipe segments are not required to accord with the drawings given in Figure B.4. Only indicated dimensions shall be considered. A full set of dimensions shall be provided by the technical documentation of the fitting manufacturer.



a) 90°

b) 60°

Key

d_n, l_e	and r and α shall be in accordance with Table B.2
d_n	nominal outside diameter
l_e	tubular length of fusion end piece[a]
z_1, z_2, z_3	nominal lengths of fitting branch to axis
α	nominal angle of fitting (±2°)
a	The length shall allow the following (in any combination): the use of clamps required in the case of butt fusion; assembly with an electrofusion fitting; assembly with a socket fusion fitting; the use of a mechanical scraper.

Figure B.4 — Segmented tees

For tees fabricated out of pipe segments, the following derating rules for the calculation of the PN shall apply:

$$PN = f_T \times PN_{pipe}$$

where

f_T is the derating factor for these tees, having a value of 0,5;

PN_{pipe} is the nominal pressure of the pipe.

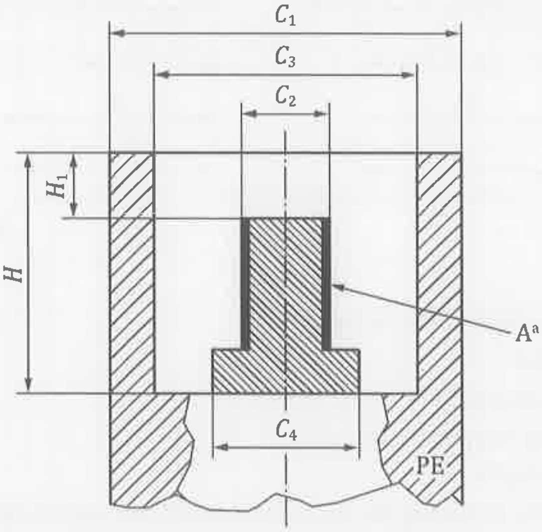
Practice has shown that these factors are applicable. Results of testing according to Table B.1 will determine the applicable factor f_T.

Annex C
(informative)

Examples of typical terminal connections for electrofusion fittings

Figures C.1 and C.2 illustrate examples of terminal connections suitable for use with voltages ≤48 V (types A and B).

Dimensions in millimetres



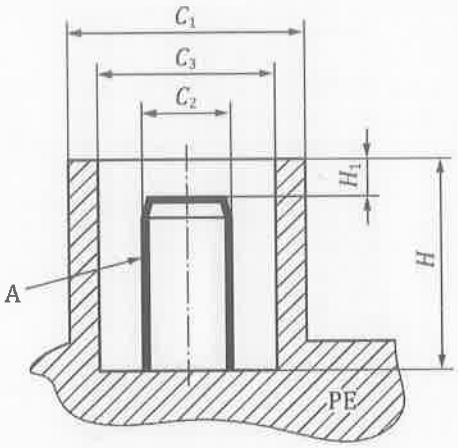
Key

A	active part	
C_1	outside diameter of the terminal shroud	$C_1 \geq 11,8$
C_2	diameter of the active part of the terminal	$C_2 = 4,00 \pm 0,1$
C_3	internal diameter of the terminal shroud	$C_3 = 9,5 \pm 1,0$
C_4	maximum overall diameter of the base of the active part	$C_4 \leq 6,0$
H	internal depth of the terminal	$H \geq 12,0$
H_1	distance between the upper part of the terminal shroud and the active part	$H_1 = 3,2 \pm 0,5$

[a] The height of the active part, H_2, is such that $7 \leq H_2 \leq H - H_1$.

Figure C.1 — Typical type A connection

Dimensions in millimetres



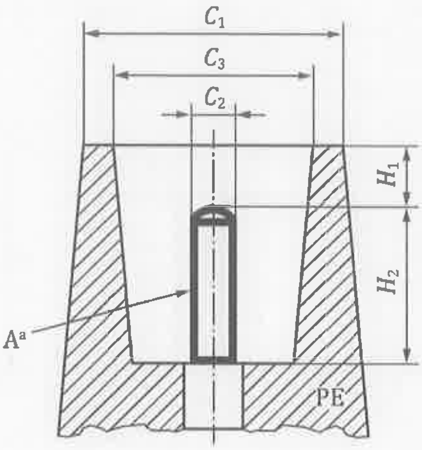
Key

A	active part	
C_1	outside diameter of the terminal shroud	$C_1 = 13{,}00 \pm 0{,}5$
C_2	diameter of the active part of the terminal	$C_2 = 4{,}70 \pm 0{,}1$
C_3	internal diameter of the terminal shroud	$C_3 = 10{,}0 - 0{,}1/+0{,}5$
H	internal depth of the terminal shroud	$H \geq 15{,}5$
H_1	distance between the upper part of the terminal shroud and the active part	$H_1 = 4{,}5 \pm 0{,}5$

Figure C.2 — Typical type B connection

Figure C.3 illustrates an example of a typical electrofusion terminal connection suitable for use with voltages up to 250 V (type C).

Dimensions in millimetres



Key

A	active part	
C_1	outside diameter of the terminal shroud	$C_1 \geq C_3 + 2{,}0$
C_2	diameter of the active part of the terminal	$C_2 \geq 2{,}0 \pm 0{,}1$
C_3	internal diameter of the terminal shroud	$C_3 \geq C_2 + 4{,}0$
H_1	distance between the upper part of the terminal shroud and the active part	H_1: sufficient to ensure a degree of protection of IP 2 X as defined in IEC 60529
a	The height of the active part, H2, is such that 7,0 ≤ H2.	(See Reference [10] in the Bibliography)

Figure C.3 — Typical type C connection

Annex D
(normative)

Short-term pressure test method

D.1 Principle

A test piece, consisting of an electrofusion fitting assembled with one or more PE pipes having reduced free length sufficient to suppress pipe failure and create preferential failure in the fitting or in the connecting pipe-to-fitting joint, is placed in a controlled-temperature environment and subjected to an essentially continually increasing internal hydraulic pressure until failure occurs. The method is designed to establish the short-term failure pressure of the fitting/pipe assembly.

D.2 Apparatus

D.2.1 Constant-temperature water bath, in accordance with ISO 1167-1, capable of being maintained at (20 ± 2) °C.

D.2.2 Pressure test equipment, in accordance with ISO 1167-1, capable of applying a continuously increasing internal hydraulic pressure at a rate of (5 ± 1) bar/min[2] until the test piece fails.

D.2.3 Pressure gauge, having an accuracy of not less than 1 % of full-scale deflection and with a hand which indicates the maximum pressure reached.

A gauge shall be used that will indicate the failure pressure at approximately mid-scale. The gauge should preferably be equipped with a surge protection device.

The gauge shall be located in a position within the pressure system such that it will indicate the internal pressure of the test piece without being affected by pressure transients within the pressure supply lines, etc.

D.3 Test piece

The test piece shall be an assembly of one or more electrofusion fittings connected to PE pipes, with a minimum free pipe length between fittings of any type not exceeding d_n.

The pipes used shall be the thickest-walled pipe for which the fitting has been designed.

The test piece shall be closed with type A end caps in accordance with ISO 1167-1:2006.

D.4 Procedure

Attach the end caps to the test piece and fill it with water at ambient temperature.

Connect the test piece to the pressure source, ensuring that no air is trapped in the test assembly.

Immerse the test piece in the constant-temperature bath and condition it at (20 ± 2) °C for at least as long as the period defined in ISO 1167-1 for the appropriate pipe wall thickness.

Increase the pressure uniformly at a rate of (5 ± 1) bar/min until failure of the test piece occurs.

---

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

Record the pressure at failure.

After testing, inspect the test piece and record the location and mode of failure.

D.5 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 4427-3:2019;

b) all details necessary for complete identification of the pipes and socket fusion fittings used, including manufacturer, type of material and size of fitting and pipe;

c) the details of the fusion-jointing procedure used to assemble the test piece;

d) the pressure at failure;

e) the time to failure;

f) the failure location;

g) the mode of failure, e.g. ductile in fitting, brittle along fusion interface;

h) any factor that could have affected the results, such as an incident or operating detail not specified in Annex D;

i) the date of test.

Annex E
(normative)

Tensile test for fitting/pipe assemblies

E.1 Principle

A test piece consisting of an electrofusion fitting and two connecting PE pipes is subjected to an increasing tensile load at a constant pulling rate until ductile pipe failure occurs. The test is conducted at a constant temperature and is intended to simulate the creation of longitudinal tensile loading along a pipeline as a consequence of external mechanical interference. Rupture of the fitting or the connecting fusion joints is not an acceptable failure mode.

E.2 Apparatus

This shall be in accordance with ISO 13951, with the additional requirement that the tensile-testing machine shall be capable of accommodating a test piece elongation of 25 % and of sustaining a constant test speed of (5 ± 1,25) mm/min.

E.3 Test piece

The test piece shall be in accordance with ISO 13951.

In cases where $d_n \geq 180$ mm and where the conduct of tensile tests on fitting/pipe assemblies is beyond the limits of the available test equipment, the testing of joint segments can be appropriate. Testing of segment test pieces shall not be undertaken, however, unless a correlation with testing of complete pipe/joint assemblies has been established.

NOTE When testing segmented test pieces, leak tightness is not checked.

E.4 Procedure

This shall be in accordance with ISO 13951, but without the requirement for the load to be constant. The pulling rate shall be 5 mm/min ± 25 %, sustained until a test piece elongation of 25 % is reached.

E.5 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 4427-3:2019;

b) all details necessary for complete identification of the pipes and electrofusion fittings used, including the manufacturer, type of material, and size of fitting and pipe;

c) the details of the fusion-jointing procedure used to assemble the test piece;

d) the test temperature;

e) the leak tightness and integrity of the fitting and fusion joint after 25 % elongation of the test piece;

f) any factor that could have affected the results, such as an incident or operating detail not specified in Annex E;

g) the date of test.

Bibliography

[1] ISO 4437-3, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 3: Fittings*

[2] CEN/TS 12201-7, *Plastics piping systems for water supply — Polyethylene (PE) — Part 7: Guidance for the assessment of conformity*

[3] EN 60335-1, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1:2001, modified)*

[4] HD 60364-1, *Low-voltage electrical installations — Part 1: Fundamental principles, assessment of general characteristics, definitions (IEC 60364-1:2005, modified)*

[5] IEC 60449, *Voltage bands for electrical installations of buildings*

[6] ISO 11922-1:2018, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

[7] ISO 21751, *Plastics pipes and fittings — Decohesion test of electrofusion assemblies — Strip-bend test*

[8] ISO/TR 10358, *Plastics pipes and fittings — Combined chemical-resistance classification table*

[9] ISO 12176-5:—[3], *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 5: Two-dimensional data coding of components and data exchange format for PE piping systems*

[10] IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

[11] ISO 13950, *Plastics pipes and fittings — Automatic recognition systems for electrofusion joints*

3) Under preparation. (Stage at the time of publication ISO/DIS 12176-5)

ICS 23.040.45; 91.140.60; 93.025

Price based on 35 pages