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**Plastics piping systems — Polyethylene  
(PE) pipes and fittings for water supply —**

**Part 3:  
Fittings**

*Systèmes de canalisations en plastique — Tubes et raccords en  
polyéthylène (PE) destinés à l'alimentation en eau*

*Partie 3: Raccords*



Reference number  
ISO 4427-3:2007(E)

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## 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 4427-3 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*.

ISO 4427 consists of the following parts, under the general title *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply*:

- *Part 1: General*
- *Part 2: Pipes*
- *Part 3: Fittings*
- *Part 5: Fitness for purpose of the system*

## Introduction

ISO 4427, the system standard, specifies the requirements for a piping system and its components when made from polyethylene (PE). The piping system is intended to be used for water supply intended for human consumption, including the conveyance of raw water prior to treatment and that of water for general purposes.

In respect of potential adverse effects on the quality of water intended for human consumption caused by the products covered by ISO 4427:

- a) ISO 4427 provides no information as to whether the products may be used without restriction;
- b) existing national regulations concerning the use and/or the characteristics of these products are in force.

NOTE Guidance for assessment of conformity can be found in Bibliographical references [8] and [9].



# Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply —

## Part 3: Fittings

### 1 Scope

This part of ISO 4427 specifies the general aspects of fittings made from polyethylene (PE) for piping systems intended for the conveyance of water for human consumption, including raw water prior to treatment and water for general purposes.

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

In conjunction with the other parts of ISO 4427, it is applicable to PE fittings, their joints, to joints with components of PE and to joints with mechanical fittings of other materials, intended to be used under the following conditions:

- a) a maximum operating pressure (MOP) up to and including 25 bar<sup>1</sup>);
- b) an operating temperature of 20 °C as the reference temperature.

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

NOTE 2 ISO 4427 covers a range of maximum operating pressures and gives requirements concerning colours and additives. It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national guidance or regulations and installation practices or codes.

It is applicable to fittings of the following types:

- fusion fittings — electrofusion fittings, butt fusion fittings and socket fusion fittings (see Annex A);
- fabricated fittings (see Annex B);
- mechanical fittings;
- flanged fittings.

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

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1133:2005, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics* <sup>2)</sup>

ISO 1167-1, *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 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

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

ISO 4427-2:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 2: Pipes*

ISO 4427-5, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — 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*

ISO 11357-6, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)* <sup>3)</sup>

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

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2) Under revision.

3) To be published. (Revision of ISO 11357-6:2002)



ISO 14236, *Plastics pipes and fittings — Mechanical-joint compression fittings for use with polyethylene pressure pipes in water supply systems*

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

EN 681-2:2000, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 2: Thermoplastic elastomers*

### 3 Terms, definitions, symbols and abbreviated terms

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

#### 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 produce a fusion 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 part of ISO 4427

#### 3.6

##### **mechanical fitting**

fitting used for assembling a polyethylene (PE) pipe to another PE pipe or any other element of the piping system

NOTE 1 The mechanical fitting can be supplied for field assembly or pre-assembled by the manufacturer and generally includes a compression part to provide pressure integrity, leaktightness and resistance to end loads. A support sleeve inserted into the pipe bore provides a permanent support for the PE pipe to prevent creep in the pipe wall under radial compressive forces.

NOTE 2 The metallic parts of the fitting can be assembled to metallic pipes by using screw threads, compression joints, welded or flanged connections including PE flanges. The fitting can allow either a dismantable or permanently assembled joint. In some cases, the supporting ring can also act as a grip ring.

**3.7 voltage regulation**  
control of energy supplied during the fusion process of an electrofusion fitting by means of the voltage parameter

**3.8 intensity regulation**  
control of energy supplied during the fusion process of an electrofusion fitting by means of the current parameter

## **4 Material**

### **4.1 PE compound**

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

### **4.2 Material for non-polyethylene parts**

#### **4.2.1 General**

The materials and constituent elements used in making the fitting (including elastomers, greases 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) taking account of the service environment and operating conditions.

The requirements for the level of material performance for non-polyethylene parts shall be at least as stringent as that of the PE compound for the piping system.

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

#### **4.2.2 Metal parts**

All parts susceptible to corrosion shall be adequately protected.

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

#### **4.2.3 Elastomers**

Elastomeric materials used for the manufacture of seals shall conform to EN 681-1 or EN 681-2, as applicable.

#### **4.2.4 Other materials**

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

## 5 General characteristics

### 5.1 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 part of ISO 4427.

### 5.2 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.

### 5.3 Colour

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

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

### 5.4 Electrical characteristics for electrofusion fittings

The electrical protection to be provided by the system depends on the voltage and the current strength used and on the characteristics of the electricity power.

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

NOTE 1 This type of fitting is a part of an electrical system as defined in IEC 60335-1, IEC 60364-1 and IEC 60449. Protection against direct contacts with active parts (live conductors) is required for conformity with IEC 60529. This protection is a function of the work site conditions.

NOTE 2 See Annex C for examples of typical electrofusion terminal connectors.

The surface finish of the terminal pins shall allow a minimum contact resistance in order to satisfy the resistance tolerance requirements (nominal value  $\pm 10\%$ ).

### 5.5 Appearance of factory-made joints

The following requirements apply only to joints and fittings made or assembled in the factory.

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.

Any melt exudation shall not cause wire movement in electrofusion fittings leading to short circuiting when jointed in accordance with the manufacturer's instructions. There shall be no excessive creasing of the internal surfaces of the adjoining pipes or spigots.

### 5.6 Effect on water quality

Attention is drawn to the requirements of national regulations (see also the Introduction). See ISO 4427-1:2007, Clause 5.

## 6 Geometrical characteristics

### 6.1 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  $(23 \pm 2) ^\circ\text{C}$ .

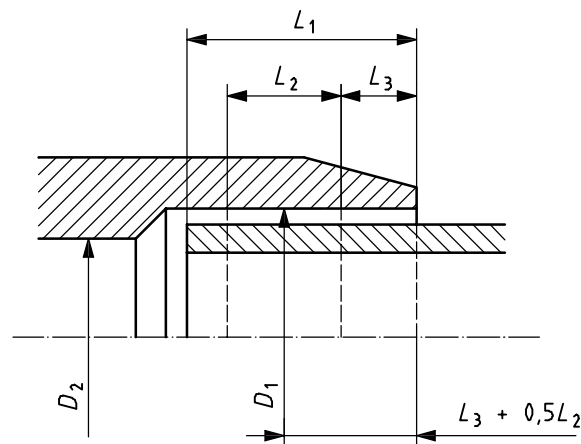
### 6.2 Dimensions of electrofusion sockets

#### 6.2.1 Diameters and lengths of electrofusion sockets

When measured in accordance with 6.1, the diameters and lengths of electrofusion sockets (see Figure 1) shall be in accordance with Table 1.

The mean inside diameter of the fitting in the middle of the fusion zone,  $D_1$ , shown in Figure 1, shall not be less than  $d_n$ . The manufacturer shall declare the actual maximum and minimum values of  $D_1$  and  $L_1$  for determining suitability for clamping and joint assembly.

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



#### Key

$D_1$  mean inside diameter in fusion zone <sup>a</sup>

$D_2$  bore that is minimum diameter of flow channel through body of fitting <sup>b</sup>

$L_1$  depth of penetration of pipe or male end of spigot fitting <sup>c</sup>

$L_2$  heated length within socket <sup>d</sup>

$L_3$  distance between mouth of fitting and start of fusion zone <sup>e</sup>

<sup>a</sup>  $D_1$  is measured in a plane parallel to the plane of the mouth at a distance of  $L_3 + 0,5L_2$ .

<sup>b</sup>  $D_2 \geq (d_n - 2e_{\min})$ .

<sup>c</sup> In the case of a coupling without a stop, it is not greater than half the total length of the fitting.

<sup>d</sup> As declared by the manufacturer to be the nominal length of the fusion zone.

<sup>e</sup> As declared by the manufacturer to be the nominal unheated entrance length of the fitting.  $L_3$  shall be  $\geq 5$  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			Fusion zone $L_{2,min}$
	$L_{1,min}$		$L_{1,max}$	
	Intensity regulation	Voltage regulation		
20	20	25	41	10
25	20	25	41	10
32	20	25	44	10
40	20	25	49	10
50	20	28	55	10
63	23	31	63	11
75	25	35	70	12
90	28	40	79	13
110	32	53	82	15
125	35	58	87	16
140	38	62	92	18
160	42	68	98	20
180	46	74	105	21
200	50	80	112	23
225	55	88	120	26
250	73	95	129	33
280	81	104	139	35
315	89	115	150	39
355	99	127	164	42
400	110	140	179	47
450	122	155	195	51
500	135	170	212	56
560	147	188	235	61
630	161	209	255	67

**6.2.2 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.

- 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 7.5.

**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	$E \geq 1,25e_{min}$

**6.2.3 Out-of-roundness of 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  $0,015d_n$ .

**6.2.4 Spigots**

For fittings that contain spigot outlets (e.g. electrofusion equal tee with spigotted branch), the dimensions of the spigot shall be according to 6.3.

**6.3 Dimensions of spigot fittings**

When measured according to 6.1, the spigot dimensions shall be in accordance with Table 3 (see Figure 2).

**6.4 Dimensions of socket fusion fittings**

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

**6.5 Dimensions of fabricated fittings**

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

Table 3 — Spigot dimensions

Dimensions in millimetres

Nominal outside diameter of spigot $d_n$	Mean outside diameter of fusion end <sup>a</sup>			Electrofusion <sup>e</sup>				Socket fusion	Butt fusion			
	$D_{1,min}$	Grade A $D_{1,max}$	Grade B $D_{1,max}$	Out-of-roundness max.	Min. bore $D_2$	Cut-back length $L_{1,min}$	Tubular length <sup>b</sup> $L_{2,min}$	Tubular length $L_{2,min}$	Out-of-roundness max.	Cut-back length $L_{1,min}$	Tubular length $L_{2,min}$	
											Normal <sup>c</sup>	Special <sup>d</sup>
20	20,0	—	20,3	0,3	13	25	41	11	—	—	—	—
25	25,0	—	25,3	0,4	18	25	41	12,5	—	—	—	—
32	32,0	—	32,3	0,5	25	25	44	14,6	—	—	—	—
40	40,0	—	40,4	0,6	31	25	49	17	—	—	—	—
50	50,0	—	50,4	0,8	39	25	55	20	—	—	—	—
63	63,0	—	63,4	0,9	49	25	63	24	1,5	5	16	5
75	75,0	—	75,5	1,2	59	25	70	25	1,6	6	19	6
90	90,0	—	90,6	1,4	71	28	79	28	1,8	6	22	6
110	110,0	—	110,7	1,7	87	32	82	32	2,2	8	28	8
125	125,0	—	125,8	1,9	99	35	87	35	2,5	8	32	8
140	140,0	—	140,9	2,1	111	38	92	—	2,8	8	35	8
160	160,0	—	161,0	2,4	127	42	98	—	3,2	8	40	8
180	180,0	—	181,1	2,7	143	46	105	—	3,6	8	45	8
200	200,0	—	201,2	3,0	159	50	112	—	4,0	8	50	8
225	225,0	—	226,4	3,4	179	55	120	—	4,5	10	55	10
250	250,0	—	251,5	3,8	199	60	129	—	5,0	10	60	10
280	280,0	282,6	281,7	4,2	223	75	139	—	9,8	10	70	10
315	315,0	317,9	316,9	4,8	251	75	150	—	11,1	10	80	10
355	355,0	358,2	357,2	5,4	283	75	164	—	12,5	10	90	12
400	400,0	403,6	402,4	6,0	319	75	179	—	14,0	10	95	12
450	450,0	454,1	452,7	6,8	359	100	195	—	15,6	15	60	15
500	500,0	504,5	503,0	7,5	399	100	212	—	17,5	20	60	15
560	560,0	565,0	563,4	8,4	447	100	235	—	19,6	20	60	15
630	630,0	635,7	633,8	9,5	503	100	255	—	22,1	20	60	20

<sup>a</sup> Tolerance grades A and B are in accordance with ISO 11922-1:1997.

<sup>b</sup> The values of  $L_2$  (electrofusion) are based on the following equations:

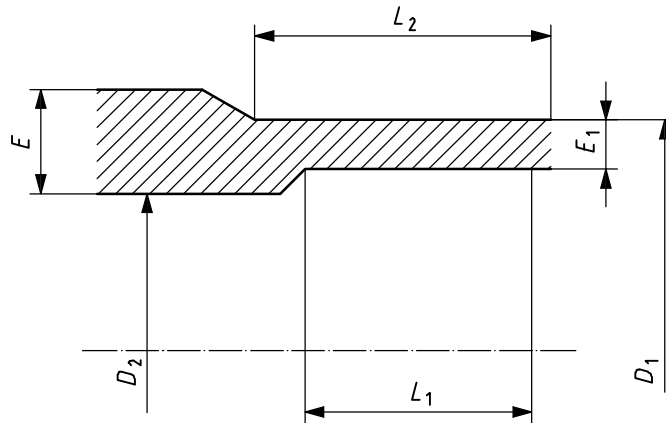
— for  $d_n \leq 90$ ,  $L_2 = 0,6d_n + 25$  mm;

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

<sup>c</sup> Used by preference.

<sup>d</sup> Used for fittings fabricated in the factory.

<sup>e</sup> Spigot fittings designed for electrofusion are also suitable for butt fusion.



**Key**

- $D_1$  mean outside diameter of fusion end piece <sup>a</sup>
- $D_2$  bore comprising minimum diameter of flow channel through body of fitting <sup>b</sup>
- $E$  body wall thickness of fitting <sup>c</sup>
- $E_1$  fusion face wall thickness <sup>d</sup>
- $L_1$  cut-back length of fusion end piece <sup>e</sup>
- $L_2$  tubular length of fusion end piece <sup>f</sup>

- <sup>a</sup>  $D_1$  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.
- <sup>b</sup> The measurement of this diameter does not include the fusion pad (if present).
- <sup>c</sup> It comprises the thickness measured at any point of the wall of the fitting.
- <sup>d</sup> 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 4427-2:2007, Table 2.  $E_1$  for small dimensions is at least 3 mm.
- <sup>e</sup> 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.
- <sup>f</sup> 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.

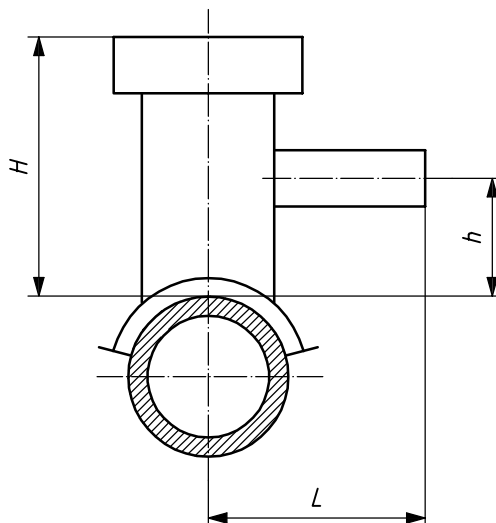
**Figure 2 — Dimensions of spigot fittings**

**6.6 Dimensions of electrofusion saddle fittings**

Outlets from tapping tees and branch saddles shall be spigotted in accordance with 6.3 or with electrofusion sockets in accordance with 6.2. The manufacturer shall declare the overall characteristic dimension of the fitting in the technical file. These dimensions shall include the maximum height of the saddle and the height of the service pipe measured from the top of the main, as shown in Figure 3.

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**Key***H* height of saddle <sup>a</sup>*h* height of service pipe <sup>b</sup>*L* width of tapping tee <sup>c</sup><sup>a</sup> It is the distance from the top of the main to the top of the tapping tee.<sup>b</sup> It is the distance between the top of the main pipe and the axis of the service pipe.<sup>c</sup> It is the distance between the axis of the pipe and the plane of the mouth of the service tee.**Figure 3 — Dimensions of electrofusion saddle fittings****6.7 Dimensions of mechanical fittings**

Mechanical fittings manufactured substantially from PE and intended for part fusion to PE pipe and part mechanical jointing to other pipe components, e.g. adapters, shall conform to the geometrical characteristics of the PE jointing system to be used in at least one joint.

Mechanical fittings not manufactured substantially from PE shall be in accordance with ISO 14236 or other relevant standards, as applicable.

**6.8 Dimensions of loose backing flanges and flange adapters**

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

**7 Mechanical characteristics****7.1 General**

A fitting shall be tested assembled with pipe or as a part of an assembly of more than one fitting fused to pipe conforming to ISO 4427-2.

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

**7.2 Conditioning**

Unless otherwise specified in the applicable test method, the test pieces shall be conditioned at  $(23 \pm 2) ^\circ\text{C}$  prior to testing.

### 7.3 Requirements

The test pieces shall be tested in accordance with Table 4. When tested using the test method and parameters specified therein, the fitting shall have mechanical characteristics conforming to the requirements of Table 4.

Mechanical fittings shall be in accordance with ISO 14236.

**Table 4 — Mechanical characteristics**

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	ISO 1167-1 ISO 1167-3
		Conditioning period	According to ISO 1167-1	
		Number of test pieces <sup>b</sup>	3	
		Type of test	Water-in-water	
		Test temperature	20 °C	
		Test period	100 h	
		Circumferential (hoop) stress for: <sup>c</sup>		
PE 80	10 MPa			
PE 100	12,4 MPa			
Hydrostatic strength at 80 °C	No failure of any test piece during test period	End caps	Type A <sup>a</sup>	ISO 1167-1 ISO 1167-3
		Conditioning period	According to ISO 1167-1	
		Number of test pieces <sup>b</sup>	3	
		Type of test	Water-in-water	
		Test temperature	80 °C	
		Test period	165 h <sup>d</sup>	
		Circumferential (hoop) stress for: <sup>c</sup>		
PE 80	4,5 MPa			
PE 100	5,4 MPa			
Hydrostatic strength at 80 °C	No failure during test period of any test pieces	End caps	Type A	ISO 1167-1 ISO 1167-3
		Conditioning period	According to ISO 1167-1	
		Type of test	Water-in-water	
		Test temperature	80 °C	
		Number of test pieces <sup>b</sup>	3	
		Test period	1 000 h	
		Circumferential (hoop) stress for: <sup>c</sup>		
PE 80	4 MPa			
PE 100	5 MPa			

Table 4 (continued)

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Cohesive resistance for electrofusion socket fittings	Length of initiation rupture $\leq L_2/3$ in brittle failure	Test temperature	23 °C	ISO 13954 or ISO 13955
		Number of test pieces <sup>b</sup>	According to ISO 13954 or ISO 13955	
Cohesive resistance for electrofusion saddle fittings	Length of initiation rupture $\leq L_2/3$ in brittle failure	Test temperature	23 °C	ISO 13955 <sup>e</sup>
		Number of test pieces <sup>b</sup>	According to ISO 13955	
Tensile strength for butt fusion fittings and spigotted fittings	Test to failure: Ductile — Pass Brittle — Fail	Test temperature	23 °C	ISO 13953
		Number of test pieces <sup>b</sup>	According to ISO 13953	
Impact resistance of tapping tees	No failure, no leaks	Test temperature	(0 ± 2) °C	ISO 13957
		Mass of striker	(2 500 ± 20) g	
		Height	(2 000 ± 10) mm	
		Conditioning period	4 h in air	
		Air tightness test	25 mbar, 5 min	
<p><sup>a</sup> Type B end caps may be used for batch release tests for diameters <math>\geq 500</math> mm.</p> <p><sup>b</sup> 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.</p> <p><sup>c</sup> The stress shall be calculated using the nominal dimensions of the pipe used in the test assembly.</p> <p><sup>d</sup> Premature ductile failures are not taken into account. For retest procedure, see 7.4.</p> <p><sup>e</sup> This test method and its requirements may be superseded by an appropriate test standard under development by ISO/TC 138/SC 5.</p>				

#### 7.4 Retest in case of failure at 80 °C

A fracture in a brittle mode in less than 165 h shall constitute a failure; however, if a sample in the 165 h test fails in a ductile mode in less than 165 h, a retest shall be performed at a selected lower stress in order to achieve the minimum required time for the selected stress obtained from the line through the stress/time points in accordance with Table 5.

Table 5 — Test parameters for retest of hydrostatic strength at 80 °C

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	1 000
4	1 000		

### 7.5 Performance requirements

Where 6.2.2 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 $2 \times$ MRS calculated for thickest-walled pipe for which fitting has been designed	End caps	Type A	Annex D
		Orientation	Unimportant	
		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 <sup>2</sup> .				

## 8 Physical characteristics

### 8.1 Conditioning

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

### 8.2 Requirements

The test pieces shall be tested in accordance with Table 7. When tested using the test methods and parameters specified therein, the pipe shall have physical characteristics conforming to the requirements of Table 7.

Mechanical fittings shall be in accordance with ISO 14236.

**Table 7 — Physical characteristics — All fittings**

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Melt mass-flow rate (MFR)	Change of MFR by processing $\pm 20$ % <sup>b</sup>	Load	5 kg	ISO 1133:2005, Condition T
		Test temperature	190 °C	
		Test period	10 min	
		Number of test pieces <sup>a</sup>	According to ISO 1133	
Oxidation induction time	$\geq 20$ min	Test temperature	200 °C <sup>c</sup>	ISO 11357-6
		Number of test pieces <sup>a</sup>	3	
Effect on water quality	National regulations apply			
<sup>a</sup> 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. <sup>b</sup> Value as measured on the fitting relative to the value measured on the compound used. <sup>c</sup> The test may be carried out as an indirect test at 210 °C, provided there is a clear correlation to the results at 200 °C. In case of dispute, the reference temperature shall be 200 °C.				

## 9 Chemical resistance of fittings in contact with chemicals

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

NOTE Guidance for the resistance of polyethylene fittings to chemicals is given in ISO/TR 10358 [1].

## 10 Performance requirements

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

## 11 Marking

### 11.1 General

All fittings shall be permanently and legibly marked in such a way that the marking does 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.

### 11.2 Minimum required marking

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

For fabricated fittings, marking shall be agreed between the manufacturer and purchaser.

**Table 8 — Minimum required marking**

Aspect	Marking
Standard number	ISO 4427 <sup>a</sup>
Manufacturer's identification	Name or code
Manufacturer's informaton	<sup>b</sup>
Nominal diameter and pipe/SDR series	e.g. $d_n$ 110/S 5 or $d_n$ 110/SDR 11
Material and designation	e.g. PE 80
Pressure rating in bar	e.g. PN 12,5 <sup>a</sup>
Tolerance (only for spigot fittings) $d_n \geq 280$ mm	e.g. Grade A <sup>a</sup>
SDR fusion range (only for electrofusion fittings)	e.g. SDR 11–SDR 26 <sup>a</sup>

<sup>a</sup> 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.

<sup>b</sup> 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.

### 11.3 Fusion system recognition

Fusion fittings should have a system, either numerical, electromechanical or self-regulatory, 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.

## 12 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.

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## 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 $d_n$	Mean inside diameter of socket				Out-of-roundness max.	Min. bore $D_3$	Socket reference length $L_{min}$	Heated socket length		Penetration of pipe into socket	
		Mouth		Root					$(L - 2,5)$	$(L)$	$(L - 3,5)$	$(L - 1)$
		$D_{1,min}$	$D_{1,max}$	$D_{2,min}$	$D_{2,max}$				$L_{2,min}$	$L_{2,max}$	$L_{3,min}$	$L_{3,max}$
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 <sup>a</sup>	62,4 <sup>a</sup>	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.

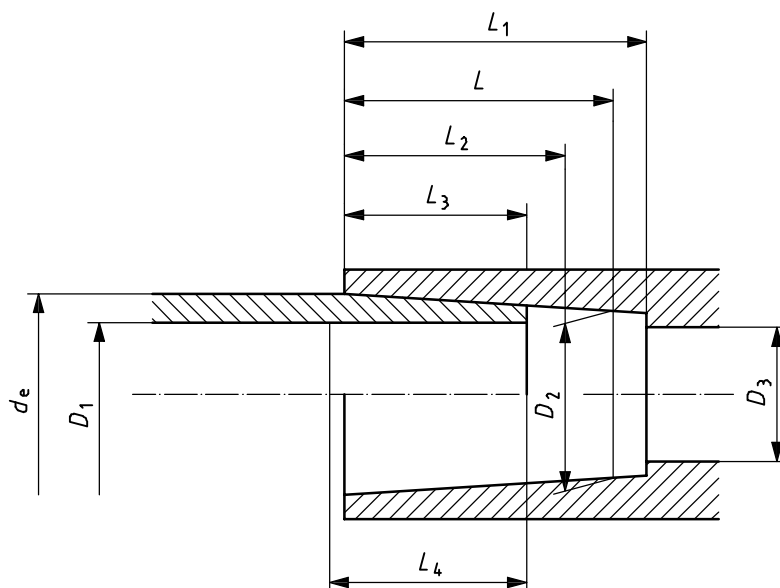
<sup>a</sup> Where rounding clamps are used, the maximum diameter of 62,4 mm may be increased by 0,1 mm to 62,5 mm. Conversely, where a peeling technique is used, the minimum diameter of 62,0 mm may be reduced by 0,1 mm to 61,9 mm.

**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 $d_n$	Mean inside diameter of socket				Out-of-roundness max.	Min. bore $D_3$	Socket ref. length $L_{min}$	Heated socket length		Penetration of pipe into socket	
	$d_{em\ min}$	$d_{em\ max}$		Mouth		Root					$(L - 4)$	$(L)$	$(L - 5)$	$(L - 1)$
				$D_{1,min}$	$D_{1,max}$	$D_{2,min}$	$D_{2,max}$				$L_{2,min}$	$L_{2,max}$	$L_{3,min}$	$L_{3,max}$
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 <sup>a</sup>
- $D_2$  mean inside root diameter <sup>b</sup>
- $D_3$  minimum bore <sup>c</sup>
- $d_e$  outside diameter
- $L$  reference socket length <sup>d</sup>
- $L_1$  actual length of socket from mouth to shoulder (if present)
- $L_2$  heated length of fitting <sup>e</sup>
- $L_3$  insertion depth <sup>f</sup>
- $L_4$  heated length of pipe <sup>g</sup>

- <sup>a</sup> It is the mean diameter of the circle at the intersection of the extension of the socket with the plane of the socket mouth.
- <sup>b</sup> 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.
- <sup>c</sup> It is the minimum diameter of the flow channel through the body of the fitting.
- <sup>d</sup> It is the theoretical minimum socket length used for the purpose of calculation.
- <sup>e</sup> It is the length of penetration of the heated tool into the socket.
- <sup>f</sup> It is the depth of the heated pipe end into the socket.
- <sup>g</sup> 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.

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.

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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 <sup>a</sup>	ISO 1167-1 ISO 1167-3
		Conditioning period	According to ISO 1167-1	
		Number of test pieces <sup>b</sup>	3	
		Type of test	Water-in-water	
		Test temperature	20 °C	
		Test period	100 h	
		Circumferential (hoop) stress for: <sup>c</sup>		
		PE 40	7 MPa × <i>f</i>	
PE 63	8 MPa × <i>f</i>			
PE 80	10 MPa × <i>f</i>			
PE 100	12,4 MPa × <i>f</i>			
Hydrostatic strength at 80 °C	No failure of any test piece during test period	End caps	Type A <sup>a</sup>	ISO 1167-1 ISO 1167-3
		Conditioning period	According to ISO 1167-1	
		Number of test pieces <sup>b</sup>	3	
		Type of test	Water-in-water	
		Test temperature	80 °C	
		Test period	1 000 h	
		Circumferential (hoop) stress for: <sup>c</sup>		
		PE 40	2 MPa × <i>f</i>	
PE 63	3,2 MPa × <i>f</i>			
PE 80	4 MPa × <i>f</i>			
PE 100	5 MPa × <i>f</i>			
Tensile strength for fabricated fittings <sup>d</sup>	Test to failure: Ductile — Pass Brittle — Fail	Test temperature	23 °C	ISO 13953
		Number of test pieces <sup>b</sup>	According to ISO 13953	

*f* declared derating factor related to the fitting to be tested.

<sup>a</sup> Type B end caps may be used for batch release tests for diameters ≥ 500 mm.

<sup>b</sup> 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.

<sup>c</sup> The stress shall be calculated using the nominal dimensions of the pipe used in the test assembly.

<sup>d</sup> Samples are to be taken from joints between longitudinal aligned segments to produce a flat specimen geometry.

## B.2 Dimensions

See Table B.2.

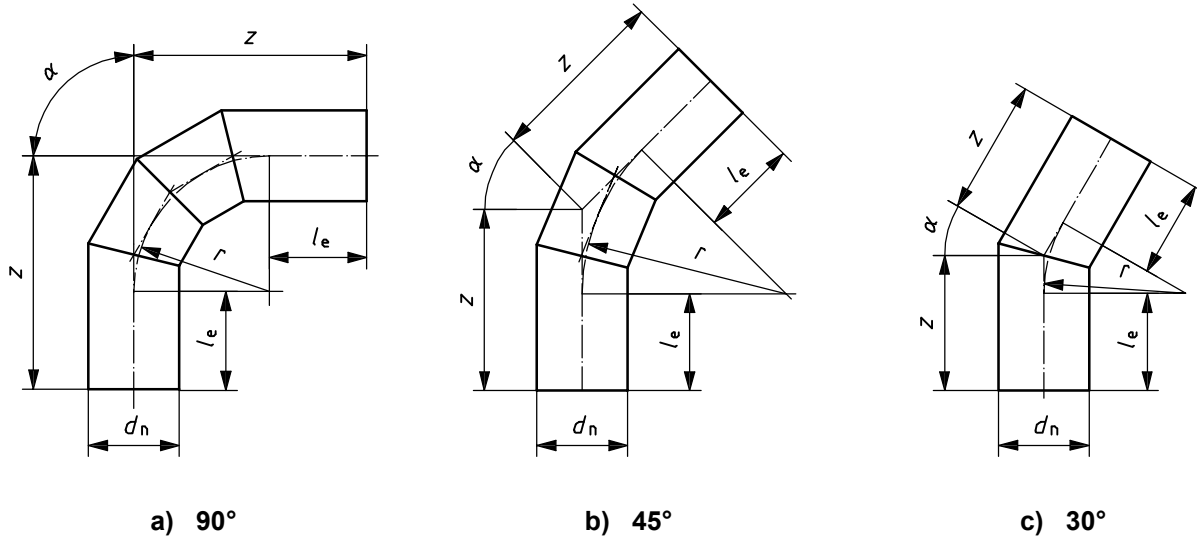
Table B.2 — Fabricated fitting dimensions

Dimensions in millimetres

Nominal outside diameter $d_n$	Minimum tubular length of fitting $l_{e,min}$	Nominal bend radius $r$	Nominal branch length $z$	Nominal angle of fitting $\alpha$
90	150			
110	150			
125	150			
140	150			
160	150			
180	150			
200	150			Declared by the fitting manufacturer
225	150	Declared by the fitting manufacturer		
250	250			
280	250		Declared by the fitting manufacturer	With a tolerance of $\pm 2^\circ$
315	300	e.g. $1,5 \times d$		
355	300	$2 \times d$		
		$2,5 \times d$		
		$3 \times d$		
400	300			The maximum tolerance for pipe bends shall be $\pm 5^\circ$
450	300			
500	350			
560	350			
630	350			
710	350			
800	350			
900	400			

### 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 fitting manufacturer in his technical literature.



$d_n$ ,  $l_e$  and  $r$  and  $\alpha$  shall be in accordance with Table B.2.

#### Key

- $d_n$  nominal outside diameter
- $l_e$  tubular length of fusion end piece <sup>a</sup>
- $r$  nominal bend radius of fitting
- $z$  nominal length of fitting branch to axis
- $\alpha$  nominal angle of fitting

<sup>a</sup> 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:

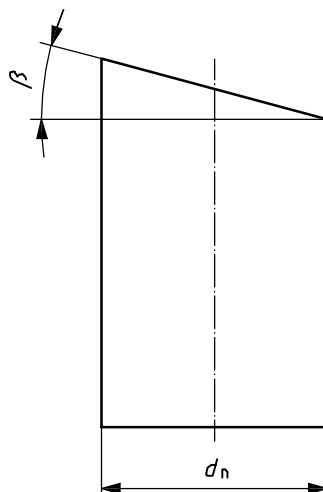
$$PN = f_B \times PN_{\text{pipe}}$$

where

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

$PN_{\text{pipe}}$  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  $f_B$ .



$\beta$  shall not be greater than  $15^\circ$ .

**Key**

$d_n$  nominal outside diameter

$\beta$  cut angle

**Figure B.2 — Segment design**

**Table B.3 — Derating factors for segmented bends**

Cut angle $\beta$	Derating factor $f_B$
$\leq 7,5^\circ$	1,0
$7,5^\circ < \beta \leq 15^\circ$	0,8

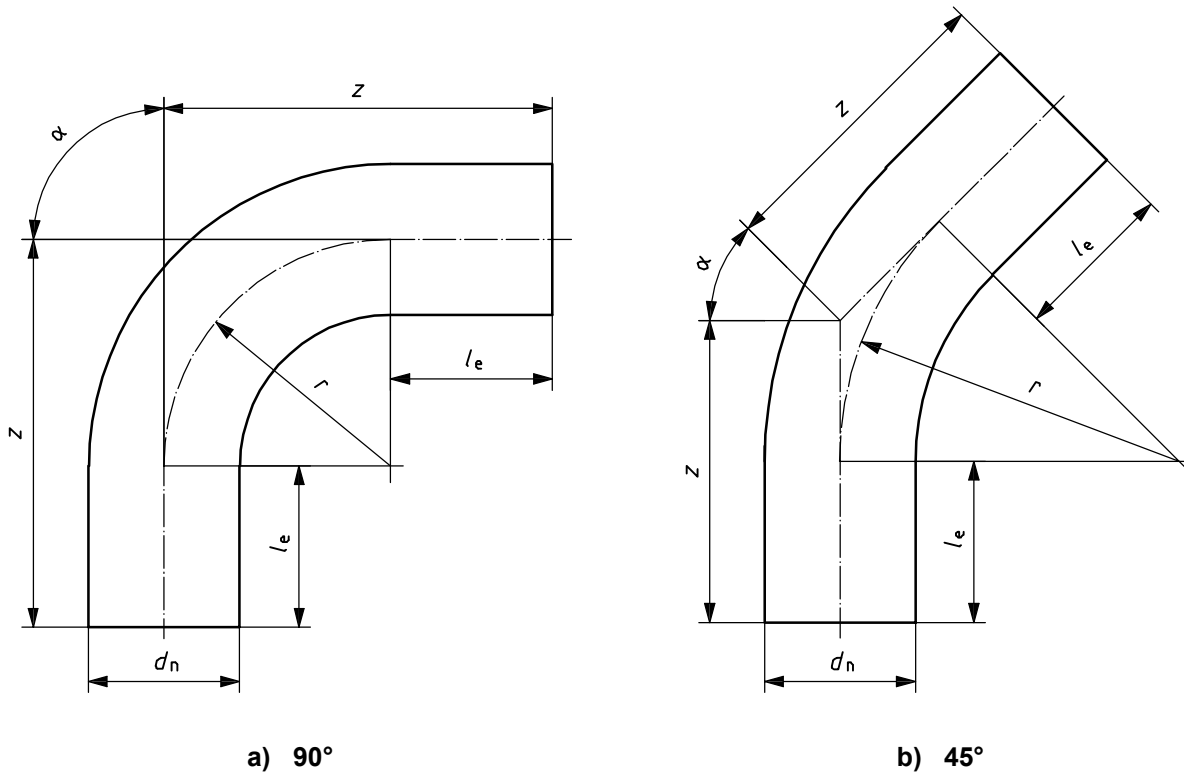
#### B.4 Swept bends

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.



$d_n$ ,  $l_e$  and  $r$  and  $\alpha$  shall be in accordance with Table B.2.

**Key**

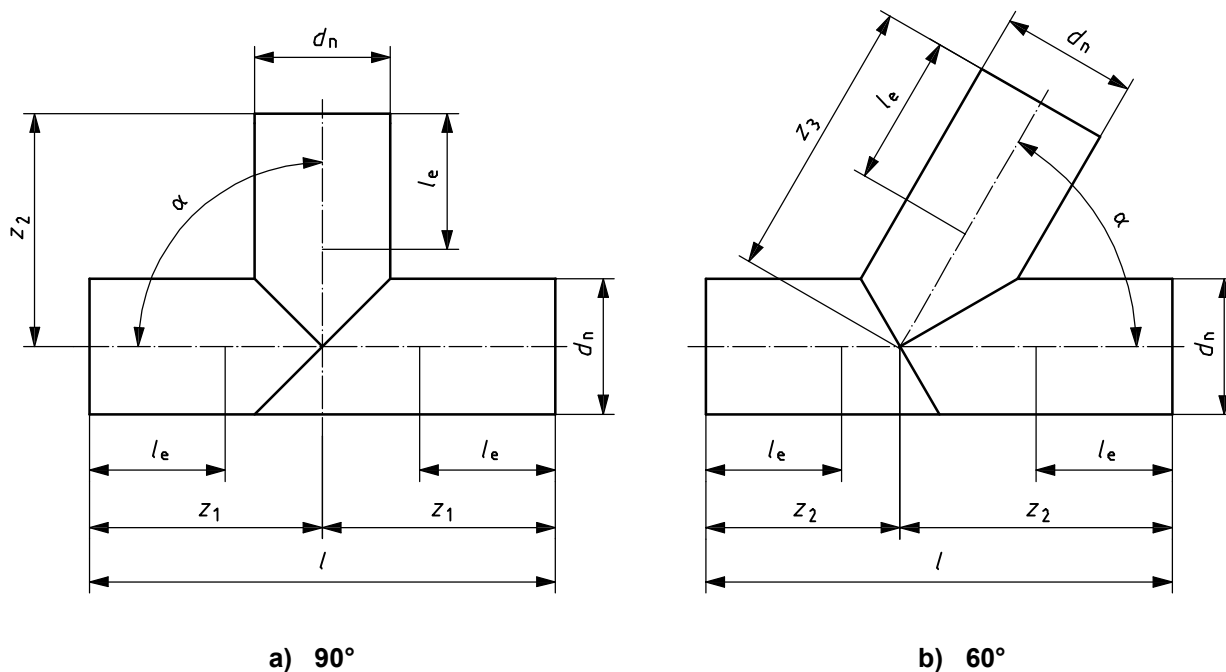
- $d_n$  nominal outside diameter
- $l_e$  tubular length of fusion end piece <sup>a</sup>
- $r$  nominal bend radius of fitting
- $z$  nominal length of fitting branch to axis
- $\alpha$  nominal angle of fitting <sup>b</sup>

<sup>a</sup> 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.  
<sup>b</sup> 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 fitting manufacturer in his technical literature.



$d_n$ ,  $l_e$  and  $r$  and  $\alpha$  shall be in accordance with Table B.2.

**Key**

- $d_n$  nominal outside diameter
- $l_e$  tubular length of fusion end piece <sup>a</sup>
- $z_1, z_2, z_3$  nominal lengths of fitting branch to axis
- $\alpha$  nominal angle of fitting ( $\pm 2^\circ$ )

<sup>a</sup> 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:

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

where

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

$PN_{\text{pipe}}$  is the nominal pressure of the pipe.

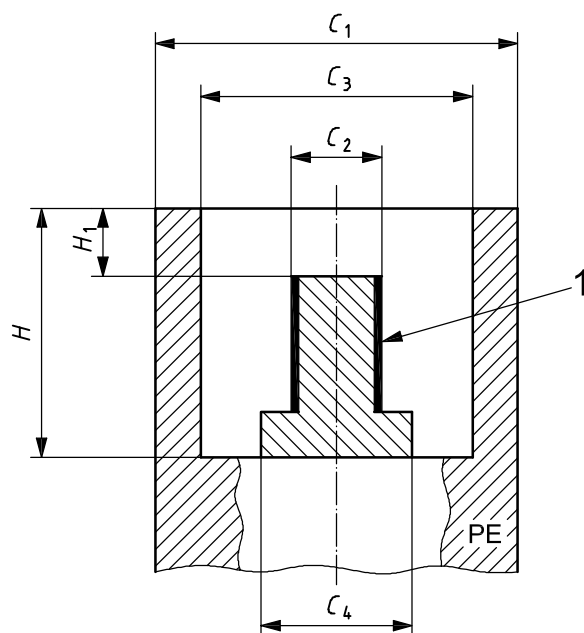
Practice has shown that these factors are applicable. Results of testing according to Table B.1 will determine the applicable factor  $f_T$ .

## 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  $\leq 48$  V (types A and B).

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

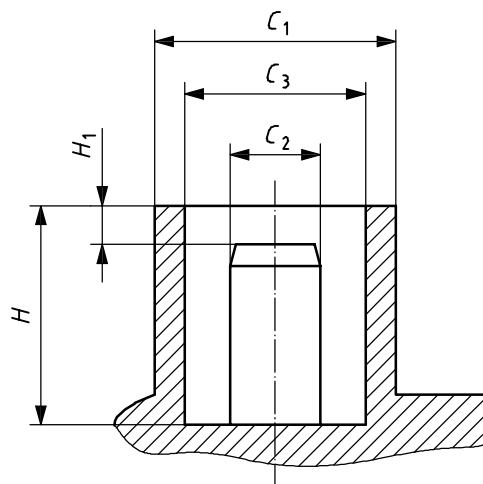


#### Key

- $C_1$  outside diameter of terminal ( $C_1 \geq 11,8$  mm)
- $C_2$  diameter of active part of terminal ( $C_2 = 4$  mm  $\pm$  0,03 mm)
- $C_3$  internal diameter of terminal ( $C_3 = 9,5$  mm  $\pm$  1,0 mm)
- $C_4$  maximum overall diameter of base ( $C_4 \leq 6$  mm)
- $H$  internal depth of terminal ( $H \geq 12$  mm)
- $H_1$  distance between upper and active parts of terminal ( $H_1 = 3,2$  mm  $\pm$  0,5 mm)
- 1 active zone

**Figure C.1 — Typical type A connection**



**Key**

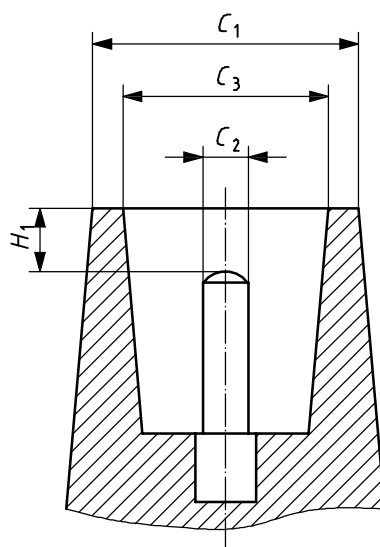
$C_1$  outside diameter of terminal ( $C_1 = 13 \text{ mm} \pm 0,05 \text{ mm}$ )

$C_2$  diameter of active part of terminal ( $C_2 = 4,7 \text{ mm} \pm 0,03 \text{ mm}$ )

$C_3$  internal diameter of terminal ( $C_3 = 10 \text{ mm} \pm 0,50 \text{ mm}$ )

$H$  internal depth of terminal ( $H \geq 15,5 \text{ mm}$ )

$H_1$  distance between upper and active parts of terminal ( $H_1 = 4,5 \text{ mm} \pm 0,5 \text{ mm}$ )

**Figure C.2 — Typical type B connection****Key**

$C_1$  outside diameter of terminal ( $C_1 \geq C_3 + 2 \text{ mm}$ )

$C_2$  diameter of active part of terminal ( $C_2 \geq 2 \text{ mm}$ )

$C_3$  internal diameter of terminal ( $C_3 \geq C_2 + 4 \text{ mm}$ )

$H_1$  distance between upper and active parts of terminal ( $H_1$  securing IP2  $\times$  degree of protection according to IEC 60947-1)

**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  $(20 \pm 2)$  °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  $(5 \pm 1)$  bar/min<sup>4)</sup> 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.

#### 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  $(20 \pm 2)$  °C for at least as long as the period defined in ISO 1167-1 for the appropriate pipe wall thickness.

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4) 1 bar = 0,1 MPa =  $10^5$  Pa; 1 MPa = 1 N/mm<sup>2</sup>.

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

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) reference to this part of ISO 4427 (i.e. "ISO 4427-3");
- 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) details of the fusion-jointing procedure used to assemble the test piece;
- d) pressure at failure;
- e) time to failure;
- f) failure location;
- g) 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 this part of ISO 4427;
- i) 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  $(5 \pm 1,25)$  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 may 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.

#### E.4 Procedure

This shall be in accordance with ISO 13951, but without that International Standard's requirement for the load to be constant. The pulling rate shall be  $5 \text{ mm/min} \pm 25 \%$ , sustained until a test piece elongation of 25 % is reached.

#### E.5 Test report

The test report shall include the following information:

- a) reference to this part of ISO 4427 (i.e. "ISO 4427-3");
- b) all details necessary for complete identification of the pipes and electrofusion fittings used, including manufacturer, type of material and size of fitting and pipe;
- c) details of the fusion-jointing procedure used to assemble the test piece;
- d) test temperature;
- e) leaktightness 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 this part of ISO 4427;
- g) date of test.

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