INTERNATIONAL STANDARD

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Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing —

Part 3: **Fittings**

Systèmes de canalisations en matières plastiques pour la distribution de combustibles gazeux — Systèmes de canalisations en polyamide non plastifié (PA-U) avec assemblages par soudage et assemblages mécaniques —

Partie 3: Raccords

Reference number
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Contents

Page

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 16486-3 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

This first edition of ISO 16486-3 cancels and replaces the first edition of ISO 22621-3:2007 which has been technically revised.

ISO 16486 consists of the following parts, under the general title *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

— *Part 5: Fitness for purpose of the system*

— *Part 6: Code of practice for design, handling and installation*

Introduction

Thin wall thickness unplasticized polyamide (PA-U) pipes and solvent cement joints are used typically for low pressures, while thicker wall thickness pipes and butt fusion, electrofusion or mechanical joints are typically used for high pressures.

For technical and safety reasons, it is not possible to mix the components of the two types of piping system (thin wall thickness pipes cannot be jointed by butt fusion or mechanical joints and vice versa). In particular, solvent cement joints must not be used for jointing for high pressure piping systems.

So for the time being, the standardization programme dealing with unplasticized polyamide (PA-U) piping systems for the supply of gaseous fuels is split into two series of International Standards, with one series (ISO 17467) covering piping systems the components of which are connected by solvent cement jointing and the other (ISO 16486) the components of which are connected by fusion jointing and/or mechanical jointing. When more experience will be gained from the field, it might be reasonable to merge the ISO 17467 series and the ISO 16486 series in one single series applicable to PA-U piping systems.

A similar series (ISO 17135) for fusion and mechanically jointed plasticized polyamide (PA-P) piping systems is in preparation.

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Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing —

Part 3: Fittings

1 Scope

This part of ISO 16486 specifies the physical and mechanical properties of fittings made from unplasticized polyamide (PA-U) in accordance with ISO 16486-1, intended to be buried and used for the supply of gaseous fuels.

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

ISO 16486 is applicable to PA-U piping systems the components of which are connected by fusion jointing and/or mechanical jointing.

In addition, it lays down dimensional characteristics and requirements for the marking of fittings.

In conjunction with the other parts of ISO 16486, it is applicable to PA-U fittings, their joints, to joints with components of PA-U and to joints with mechanical fittings of other materials, and to the following fitting types:

— fusion fittings — electrofusion fittings and butt fusion fittings;

— transition fittings.

2 Normative references

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

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 307, *Plastics — Polyamides — Determination of viscosity number*

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 1167-4, *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 4433-1, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 1: Immersion test method*

ISO 11922-1:1997, *Thermoplastic pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

ISO 13951:2001, *Plastics piping systems — Test method for the resistance of polyolefin pipe/pipe or pipe/fitting assemblies to tensile loading*

ISO 13953:2001, *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 13955:1997, *Plastics pipes and fittings — Crushing decohesion test for polyethylene (PE) electrofusion assemblies*

ISO 13956:2010, *Plastics pipes and fittings — Decohesion test of polyethylene (PE) saddle fusion joints — Evaluation of ductility of fusion joint interface by tear test*

ISO 13957:1997, *Plastics pipes and fittings — Polyethylene (PE) tapping tees — Test method for impact resistance*

ISO 16486-1:2012, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 1: General*

ISO 16486-2, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 2: Pipes*

ISO 16486-5, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 5: Fitness for purpose of the system*

EN 682, *Elastomeric seals — Materials requirements for seals used in pipes and fittings carrying gas and hydrocarbon fluids*

IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in ISO 16486-1 and the following apply.

3.1
electrofusion socket fitting
polyamide (PA-U) fitting which contains one or more integral heating elements that are capable of transforming electrical energy into heat to realise a fusion joint with a spigot end and/or a pipe

3.2
electrofusion saddle fitting
unplasticized polyamide (PA-U) fitting which contains one or more integral heating elements that are capable of transforming electrical energy into heat to realize fusion onto a pipe

3.3
tapping tee
electrofusion saddle fitting (top loading or wraparound) which contains an integral cutter, used to cut through the wall of the main pipe, and holds the coupon inside the cutter

NOTE The cutter remains in the body of the saddle after installation.

3.4
branch saddle
electrofusion saddle fitting (top loading or wraparound), which requires an ancillary cutting tool for drilling the hole in the main pipe

3.5
spigot end fitting
unplasticized polyamide (PA-U) fitting where the outside diameter of the spigot length is equal to the nominal outside diameter, d_n, of the corresponding pipe

3.6
mechanical fitting
fitting for assembling an unplasticized polyamide (PA-U) pipe to another PA-U 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, leak-tightness and resistance to end loads. A support sleeve inserted into the pipe bore provides a permanent support for the PA-U pipe to prevent creep in the pipe wall under radial compressive forces.

NOTE 2 The metallic parts of the fitting may be assembled to metallic pipes by screw threads, compression joints, welded or flanged connections. The fitting can allow for either a dismountable or permanently assembled joint. In some cases, the supporting ring may 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

4 Material

4.1 PA-U compound

The fittings shall be made from virgin material.

The compound from which the fittings are made shall be in accordance with ISO 16486-1.

4.2 Material for non-unplasticized polyamide parts

4.2.1 General

The materials and constituent elements used in making the fitting shall be resistant to the external and internal environments in which they are intended to be used

a) during storage,

b) under the effect of the fluids being conveyed, and

c) taking account of the service environment and operating conditions.

Fittings materials, including elastomers, greases and lubricants in contact with the PA-U pipe, shall not adversely affect 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.

Metals and materials produced by corrosion shall not affect the long-term performance of the pipe/fitting.

4.2.3 Elastomers

Elastomeric materials used for the manufacture of seals shall be in accordance with EN 682.

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 pipe/fitting.

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 16486.

5.2 Design

The design of the fitting shall be such that, when assembling the fitting onto the pipe, spigot ends or other components, the electrical coils and/or seals and other functional parts (e.g. grippers) are not displaced.

5.3 Colour

The fitting shall be either black or yellow.

5.4 Electrical characteristics for electrofusion fittings

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

For voltages greater than 25 V, direct human contact with the energized 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 the assembly equipment, as applicable.

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

NOTE See Annex A 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 ± 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.

The interface of the butt fusion joints shall be perpendicular to the pipe and/or spigot end axis.

5.6 Fusion compatibility

Components made from PA-U 11 shall be heat fusion jointed only to components made from PA-U 11.

Components made from PA-U 12 shall be heat fusion jointed only to components made from PA-U 12.

Components made from PA-U are not fusion compatible with components made from other polymers.

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 ± 2) °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.

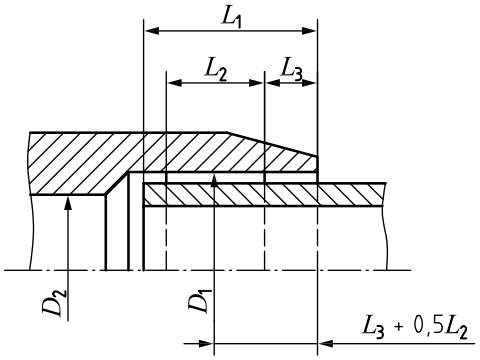
6.2.2 Wall thickness

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 $2L1/3$ from all entrance faces if the fitting and the corresponding pipe are made from an unplasticized polyamide having the same MRS.

b) If the fitting is produced from an unplasticized polyamide 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.

c) 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 Table 3.



Key

D_1 mean inside diameter in fusion zone[a]

D_2 bore that is minimum diameter of flow channel through body of fitting[b]

L_1 depth of penetration of pipe or male end of spigot fitting[c]

L_2 heated length within socket[d]

L_3 distance between mouth of fitting and start of fusion zone[e]

a D_1 is measured in a plane parallel to the plane of the mouth at a distance of $L_3 + 0{,}5L_2$.

b $D_2 \geq (d_n - 2e_{min})$.

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

d As declared by the manufacturer to be the nominal length of the fusion zone.

e 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

Intensity regulation	Voltage regulation		Fusion zone
d_n	$L_{1,min}$	$L_{1,max}$	$L_{2,min}$
20	25	41	10
25	25	41	10
32	25	44	10
40	25	49	12
50	28	55	15
63	31	63	19
75	35	70	22
90	40	79	26
110	53	82	32
125	58	87	36
140	62	92	40
160	68	98	46
180	74	105	52
200	80	112	57
225	88	120	64
250	95	129	71

Table 2 — Relationship between pipe and fitting wall thickness

Material[a]		Relationship between fitting wall thickness, E, and pipe wall thickness, e_{min}
Pipe	Fitting	
PA-U 180	PA-U 160	$E \geq 1{,}12 e_{min}$
PA-U 160	PA-U 180	$E \geq 0{,}9 e_{min}$

[a] For material classification and designation, see ISO 16486-1:2012, 5.4.

Table 3 — Performance requirements

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Short-term internal pressure resistance	Failure pressure shall be greater than pressure equivalent of 2,00 × MRS calculated for thickest-walled pipe for which the fitting has been designed.	End caps	Type A	Annex B
		Orientation	Free	
		Conditioning period	16 h	
		Type of test	Water-in-water	
		Test temperature	20 °C	
		Pressure increase rate	5 bar/min	
		Minimum pressure:		
		PA-U 11 160 and PA-U 12 160[a]	64 bar[b]	
		PA-U 11 180 and PA-U 12 180[a]	72 bar[b]	
Resistance to tensile load	Fitting shall not yield before pipe or until 25 % elongation is reached.	Test temperature	23 °C	Annex C

[a] For material classification and designation, see ISO 16486-1:2012, 5.4.

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

6.3 Dimensions of spigot end fittings

When measured in accordance with 6.1, the spigot end dimensions shall conform to the requirements given in Table 4 (see Figure 2).

The wall thickness of the fusion end, E_1, shall be at least equal to the minimum wall thickness of the pipe, except 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), where a thickness reduction, for example, a chamfered edge, is permissible.

Table 4 — Spigot end dimensions

Dimensions in millimetres

Nominal outside diameter of spigot	Mean outside diameter of fusion end[a]		Electrofusion socket fittings				Butt fusion fittings			
		Grade B	Out-of-round-ness	Min. bore	Cut-back length	Tubular length[b]	Out-of-round-ness	Cut-back length	Tubular length $L_{2,min}$	
d_n	$D_{1,min}$	$D_{1,max}$	max.	D_2	$L_{1,min}$	$L_{2,min}$	max.	$L_{1,min}$	Normal[c]	Special[d]
20	20,0	20,3	0,3	13	25	41	—	—	—	—
25	25,0	25,3	0,4	18	25	41	—	—	—	—
32	32,0	32,3	0,5	25	25	44	—	—	—	—
40	40,0	40,4	0,6	31	25	49	—	—	—	—
50	50,0	50,4	0,8	39	25	55	—	—	—	—
63	63,0	63,4	0,9	49	25	63	1,5	5	16	5

Table 4 *(continued)*

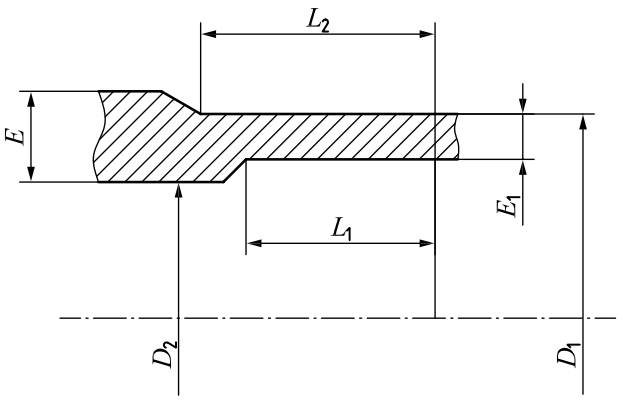
75	75,0	75,5	1,2	59	25	70	1,6	6	19	6
90	90,0	90,6	1,4	71	28	79	1,8	6	22	6
110	110,0	110,6	1,7	87	32	82	2,2	8	28	8
125	125,0	125,8	1,9	99	35	87	2,5	8	32	8
140	140,0	140,9	2,1	111	38	92	2,8	8	35	8
160	160,0	161,0	2,4	127	42	98	3,2	8	40	8
180	180,0	181,1	2,7	143	46	105	3,6	8	45	8
200	200,0	201,2	3,0	159	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

[a] Tolerance grade B is in accordance with ISO 11922-1:1997.

[b] For electrofusion socket fittings, the values of L_2 are as given for L_{max} in Table 1.

[c] Used by preference.

[d] Used for fittings fabricated in the factory.



Key

D_1 mean outside diameter of fusion end piece[a]

D_2 bore comprising minimum diameter of flow channel through body of fitting[b]

E body wall thickness of fitting[c]

E_1 fusion face wall thickness[d]

L_1 cut-back length of fusion end piece[e]

L_2 tubular length of fusion end piece[f]

[a] D_1 is measured in any plane parallel to the plane of the entrance face at a distance $L_2/2$

[b] The measurement of this diameter does not include the fusion pad (if present).

[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.

[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.

Figure 2 — Dimensions of spigot end fittings

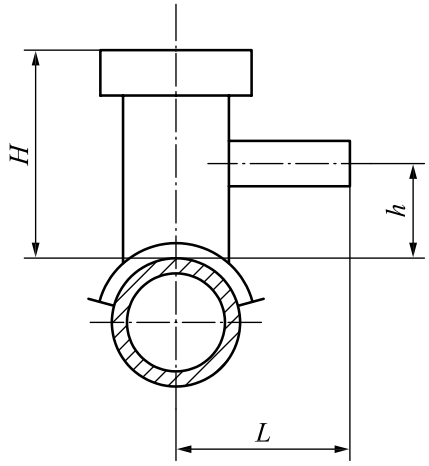
6.4 Dimensions of tapping tees

Outlets from tapping tees shall have spigots conforming to 6.3 or an electrofusion socket conforming to 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.

6.5 Dimensions of transition fittings to other materials

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



Key

H height of saddle[a]

h height of service pipe[b]

L width of tapping tee[c]

a It is the distance from the top of the main to the top of the tapping tee.

b It is the distance between the top of the main pipe and the axis of the service pipe.

c It is the distance between the axis of the pipe and the plane of the mouth of the service tee.

Figure 3 — Dimensions of tapping tees

7 Mechanical characteristics

7.1 General

The fitting shall be tested assembled with pipe or as a part of an assembly of one or more fitting(s) jointed to pipe conforming to ISO 16486-2.

Each assembly shall be prepared from components (pipes and fittings) the wall thicknesses of which shall be in accordance with 6.2.2.

7.2 Conditioning

Unless otherwise specified in the applicable test method, the test pieces shall be conditioned for at least 16 h at 23 °C and 50 % relative humidity in accordance with ISO 291 before testing in accordance with Table 5.

7.3 Requirements

The test pieces shall be tested in accordance with Table 5. When tested using the test method and parameters specified therein, the fitting/pipe assemblies shall have mechanical characteristics conforming to the requirements of Table 5.

Table 5 — Mechanical characteristics

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Hydrostatic strength at 20 °C for 1 000 h	No failure of any test piece during test period	End caps	Type A	ISO 1167-1 ISO 1167-4
		Orientation	Free	
		Conditioning period	6 h	
		Type of test	Water-in-water	
		Test temperature	20 °C	
		Test period	1 000 h	
		Circumferential (hoop) stress for:		
		PA-U 11 160 and PA-U 12 160[a]	19,0 MPa	
		PA-U 11 180 and PA-U 12 180[a]	20,0 MPa	
Hydrostatic strength at 80 °C for 165 h	No failure of any test piece during test period	End caps	Type A	ISO 1167-1 ISO 1167-4
		Orientation	Free	
		Conditioning period	6 h	
		Type of test	Water-in-water	
		Test temperature	80 °C	
		Test period	165 h	
		Circumferential (hoop) stress for:		
		PA-U 11 160 and PA-U 12 160[a]	10,0 MPa	
		PA-U 11 180 and PA-U 12 180[a]	11,5 MPa	
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
Evaluation of ductility of fusion joint interface for electrofusion saddle fittings	Surface of rupture $L_d \leq 50$ % ≤ 25 %, brittle failure	Test temperature	23 °C	ISO 13956
Tensile strength for — butt fusion fittings — spigot end fittings	Test to failure: Ductile — Pass Brittle — Fail	Test temperature	23 °C	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:		
		in air	4 h	
		in liquid	2 h	

[a] For material classification and designation, see ISO 16486-1:2012, 5.4.

8 Physical characteristics

8.1 Conditioning

Unless otherwise specified in the applicable test method, the test pieces shall be conditioned for at least 16 h at 23 °C and 50 % relative humidity in accordance with ISO 291 before testing in accordance with Table 6.

8.2 Requirement

The test pieces shall be tested in accordance with Table 6. When tested using the test method and parameters specified therein, the fittings shall have physical characteristics conforming to the requirements of Table 6.

Table 6 — Physical characteristics

Characteristic	Requirement	Test parameters		Test method
Viscosity number	≥ 180 ml/g	Solvent	m-Cresol	ISO 307

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 method of classification specified in ISO 4433-1 shall be used.

10 Performance requirements

When fittings conforming to this standard are assembled to each other or to components conforming to other parts of ISO 16486, the joints shall conform to the requirements given in ISO 16486-5.

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 to or specified by the manufacturer.

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

11.2 Minimum required marking of fittings

The minimum required marking shall be in accordance with Table 7.

Table 7 — Minimum required marking on fitting

Aspect	Marking
Manufacturer's identification	Name or code
Manufacturer's information	[a]
Nominal diameter/SDR	e.g. 110/SDR 11
Material and designation	e.g. PA-U 11 160[b]

[a] 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.

[b] For material classification and designation see ISO 16486-1:2012, 5.4.

11.3 Additional information required on fitting or label

The additional information as specified in Table 8 shall be either marked on the fitting or printed on a label attached to the fitting or to its individual bag. The label shall be of sufficient quality to be intact and legible at the time of installation.

Table 8 — Additional information required on the fitting or label

Aspect	Marking
Reference to this part of ISO 16486	ISO 16486-3
SDR fusion range	e.g. SDR 11–SDR 17
Internal fluid	Gas

11.4 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

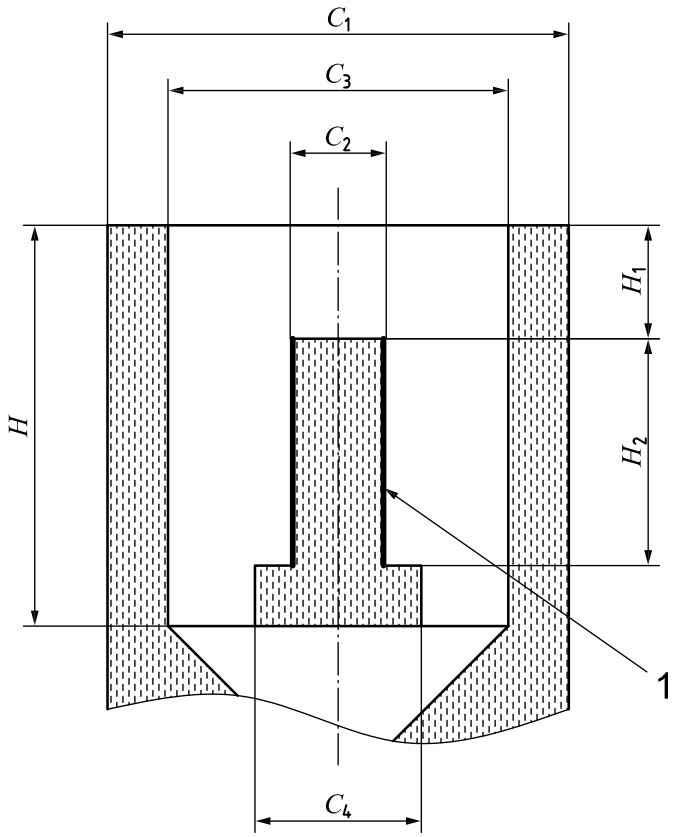
The fitting shall be packaged in bulk or individually protected where necessary in order to prevent deterioration and contamination.

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.

Annex A
(informative)

Examples of typical terminal connections for electrofusion fittings

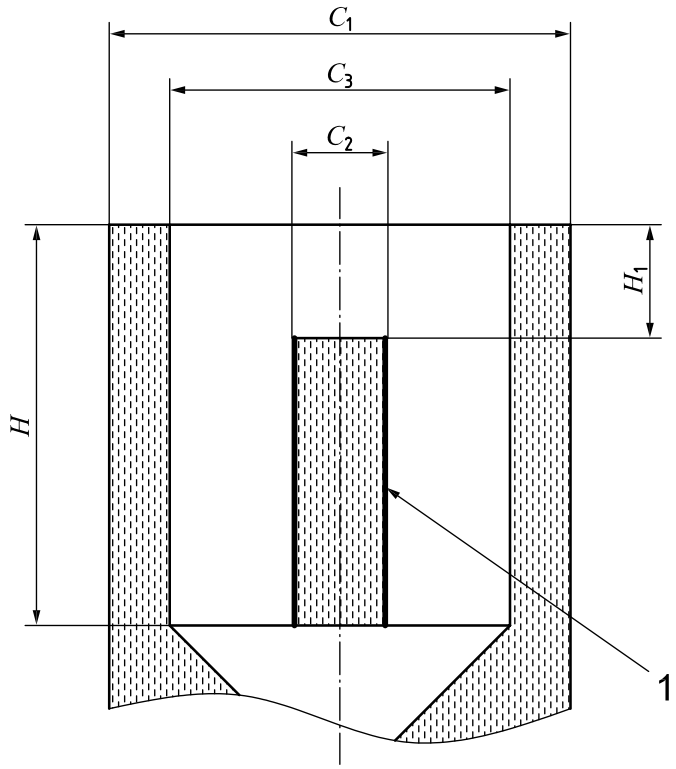
Figures A.1 and A.2 illustrate examples of terminal connections suitable for use with voltages ≤ 48 V (types A and B).



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 ± 0,03 mm)
C_3 internal diameter of terminal ($C_3 = 9{,}5$ mm ± 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 ± 0,5 mm)
1 active zone

Figure A.1 — Typical type A connection



Key

C_1 outside diameter of terminal (C_1 = 13 mm ± 0,05 mm)

C_2 diameter of active part of terminal (C_2 = 4,7 mm ± 0,03 mm)

C_3 internal diameter of terminal (C_3 = 10 mm ± 0,50 mm)

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

H_1 distance between upper and active parts of terminal (H_1 = 4,5 mm ± 0,5 mm)

1 active zone

Figure A.2 — Typical type B connection

Annex B
(normative)

Short-term pressure test method

B.1 Principle

A test piece, consisting of an electrofusion fitting assembled with one or more PA-U pipes with 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 of the test piece occurs. The method is designed to establish the short-term failure pressure of the fitting/joint assembly.

B.2 Apparatus

B.2.1 Tank, conforming to the requirements of ISO 1167-1, capable of being maintained at (20 ± 2) °C.

B.2.2 Pressurizing equipment, conforming to the requirements of ISO 1167-1, capable of applying a continuously increasing internal hydraulic pressure at a rate of (5 ± 1) bar/min until the test piece fails.

B.2.3 Pressure gauge, with an accuracy of not less than 1 % of full-scale deflection and with a hand indicating 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 where it will indicate the internal pressure of the test piece without being affected by pressure transients within the pressure supply lines, etc.

B.3 Test piece

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

The pipe 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 as defined in ISO 1167-1.

B.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.

Record the pressure at failure.

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

B.5 Test report

The test report shall include the following information:

a) reference to this part of ISO 16486 (i.e. “ISO 16486-3”);

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 annex;

i) date of test.

Annex C
(normative)

Tensile test fitting/pipe assemblies

C.1 Principle

A test piece consisting of an electrofusion fitting and two connecting PA-U 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.

C.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 sustaining a constant test speed of 5 mm/min ± 25 %.

C.3 Test piece

As specified in 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.

C.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 mm/min ± 25 %, sustained until a test piece elongation of 25 % is reached.

C.5 Test report

The test report shall include the following information:

a) reference to this part of ISO 16486 (i.e. "ISO 16486-3");

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) 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 any incident or operating detail not specified in this annex;

g) date of test.

Bibliography

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[4] ISO 17467 (all parts), *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems jointed by solvent cement*

[5] ISO 17135 (all parts), *Plastics piping systems for the supply of gaseous fuels — Plasticized polyamide (PA-P) piping systems with fusion jointing and mechanical jointing*

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