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# ISO/PAS 22101-3

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# Polyethylene reinforced with short glass fibres (PE-sGF) piping systems for industrial applications —

## Part 3: Fittings

*Systèmes de canalisations en polyéthylène renforcé de fibres de verre courtes (PE-sGF) pour les applications industrielles —*

*Partie 3: Raccords*



Reference number
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# Foreword

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

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

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 3, *Plastics pipes and fittings for industrial applications*.

A list of all parts in the ISO 22101 series can be found on the ISO website.

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

# Introduction

Polyethylene reinforced with short glass fibres (PE-sGF) piping systems are pipe systems which consist of fittings produced by adding short glass fibres into high density polyethylene resins. Their physical and mechanical properties are influenced by short glass fibre orientation.

For the material subject of this document, the mechanical performances are obtained on the basis of standards dedicated to thermoplastics. The geometrical characteristics are defined for this material in line with ISO 3 and ISO 4065.

# Polyethylene reinforced with short glass fibres (PE-sGF) piping systems for industrial applications —

# Part 3: Fittings

## 1 Scope

This document specifies the fittings made from short glass fibre reinforced polyethylene (PE-sGF) manufactured by the spiral cross winding method used below ground for the conveyance of fluids in the following industrial and agricultural contexts:

— chemical plants;

— industrial sewerage engineering;

— power engineering (cooling and general-purpose water supply);

— agricultural production plants;

— water treatment;

— small hydraulic power plants (general-purpose water supply).

This document also specifies the test parameters for the test methods it references.

In conjunction with the other parts of the ISO 22101 series, this document is applicable to PE-sGF fittings, and to joints with components of PE-sGF or other materials, intended to be used under the following conditions:

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

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

NOTE 1 For other operating temperatures, guidance is given in ISO/PAS 22101-1:2022, Annex A.

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

NOTE 2 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.

This document is applicable to fittings of the following types:

— electrofusion socket fittings;

— loose backing flanges and flange adapters;

— fabricated fittings (see Annex A).

1) 1 bar = 0,1 MPa = 105 Pa; 1 MPa = 1 N/mm$^2$.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

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 1167-2, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces*

ISO 2505, *Thermoplastics pipes — Longitudinal reversion — Test method and parameters*

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

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

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

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/PAS 22101-1, *Polyethylene reinforced with short glass fibres (PE-sGF) piping systems for industrial applications — Part 1: General*

ISO/PAS 22101-2, *Polyethylene reinforced with short glass fibres (PE-sGF) piping systems for industrial applications — Part 2: Pipes*

ISO/PAS 22101-5, *Polyethylene reinforced with short glass fibres (PE-sGF) piping systems for industrial applications — Part 5: Fitness for purpose of the system*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

**3.1**
**electrofusion socket fitting**
PE-sGF 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**
**mechanical fitting**
fitting that generally includes a compression part to provide pressure integrity, leak tightness and resistance to end loads for assembling PE-sGF pipe to another PE-sGF pipe or any other element of the piping system

Note 1 to entry: The fitting can allow either a dismountable or permanently assembled joint.

Note 2 to entry: The fitting can be supplied for field assembly or pre-assembled by the manufacturer.

**3.3**
**fabricated fitting**
fitting produced from pipe conforming to ISO/PAS 22101-2 or the spiral cross winding process in accordance with this document, or both

# 4 Material

## 4.1 PE compound

The PE compound from which the fitting is made shall conform to ISO/PAS 22101-1.

## 4.2 PE-sGF compound

The PE-sGF compound from which the fittings are made shall conform to ISO/PAS 22101-1.

## 4.3 Material for non-polyethylene-based parts

### 4.3.1 General

The materials and constituent elements used in making the fitting (including 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-sGF pipe conforming to ISO/PAS 22101-2 with which they are intended to be used:

a) during storage;

b) under the effect of the fluids being conveyed;

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

### 4.3.2 Metal parts

All parts susceptible to corrosion shall be adequately protected, provided this is necessary for durability and function of the system. When dissimilar metallic parts are used which can potentially be in contact with moisture, appropriate actions shall be taken to avoid galvanic corrosion.

# 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 which would prevent conformity of the fitting to this document.

## 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 are not displaced.

The electrofusion fitting body shall be made with PE-sGF. Electrofusion fitting sockets shall have an internal layer in PE. Heating wires shall be placed in the internal PE layer. The outer surface shall have a protective PE layer.

Flange adapters shall be made from PE-sGF.

Loose backing flanges shall be made from metal.

Fabricated fittings shall be designed in accordance with Annex A.

### 5.3 Colour

The colour of the PE-sGF parts of the fitting shall be black.

### 5.4 Electrical characteristics for electrofusion fittings

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

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

NOTE 1 The fitting during the fusion process is part of an electrical system as defined in EN 60335-1,[7] HD 60364-1,[8] and IEC 60449.[6]

The specified electrical resistances of the fitting at 23 °C shall be stated by the manufacturer and its tolerance shall be between nominal resistance (±5 % Ω).

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

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

### 5.5 Appearance of factory-made joints

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

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

## 6 Geometrical characteristics

### 6.1 Measurement of dimensions

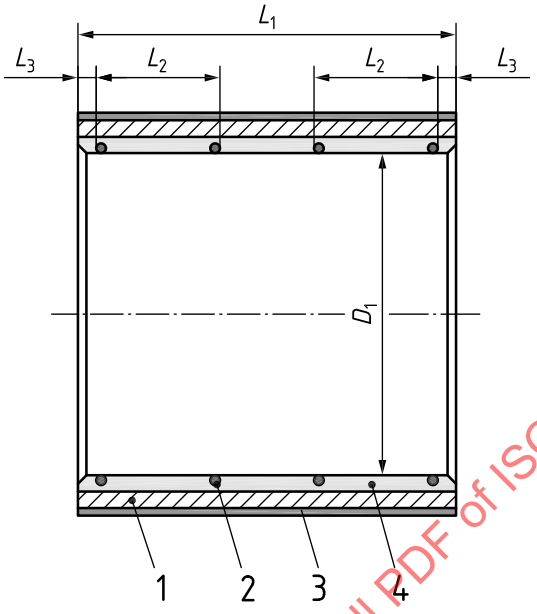
The dimensions of the fittings shall be measured in accordance with ISO 3126. In case of dispute, the measurement of dimensions shall be made not less than 24 h after manufacture and after conditioning for at least 4 h at (23 ± 2) °C.

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

## 6.2 Dimensions of electrofusion socket

### 6.2.1 Diameters and lengths of electrofusion socket fitting

When measured in accordance with 7.1, the diameters and lengths of electrofusion sockets as shown in Figure 1 shall conform to ISO/PAS 22101-2. $L_3$ shall be at least 20 mm. The thickness of the non-glass filled layer of inner polyethylene shall be at least 1,5 mm for electrofusion socket fittings.




**Key**

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

$L_1$ socket depth corresponding to the maximum spigot insertion

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

$L_3$ distance between the mouth of the fitting and the start of the fusion zone

1 glass-filled layer of electrofusion socket fitting

2 electrical oils

3 non-glass-filled layer of electrofusion socket fitting

4 non-glass-filled layer of electrofusion socket fitting

**Figure 1 — Dimensions of electrofusion socket fitting**

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

The connection of two pipes of different materials (e.g. PE to PE-sGF) and thicknesses is allowed by the fitting.

### 6.2.2 Wall thickness of the fitting body

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

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

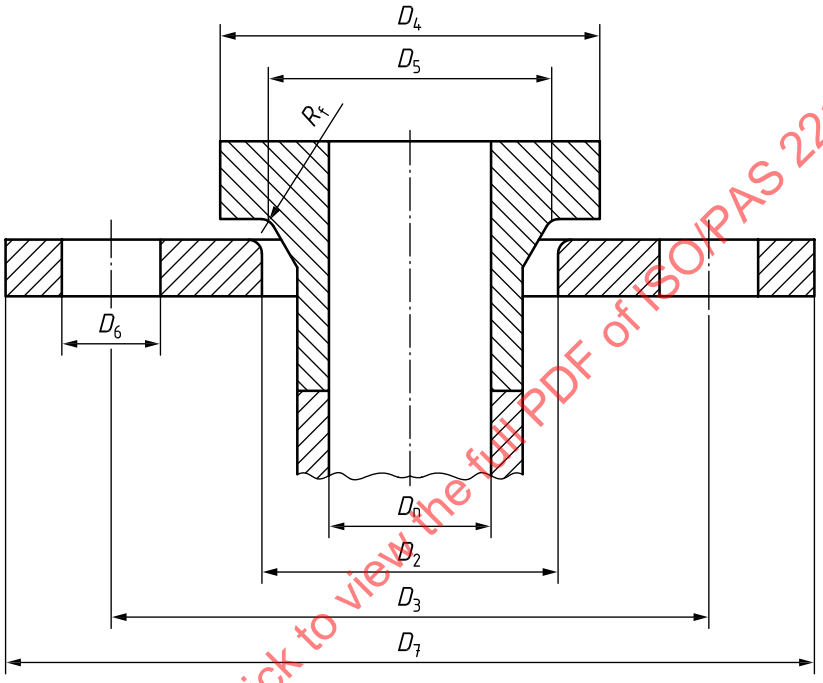
## 6.3 Dimensions of fabricated fittings

When the description and dimensions of fittings of this type are required, Annex A applies.

## 6.4 Dimensions of loose backing flanges and flange adapters

Loose backing flanges shall be designed to the relevant PS, in accordance with Table 2 and Table 3 as appropriate.

Flange adapters shall be designed in order to prevent stress concentration at any changes in cross-section. The thickness of the flange adapter face and loose backing flange shall be dependent on the material used in the manufacture of the adapter and on the nominal pressure, PS, of the piping system for which it is designed. All dimensions shall be measured in accordance with Figure 2.




**Key**

$D_n$ nominal (inside) diameter of connecting pipe
$R_f$ radius of shoulder of flange adapter
$D_2$ inside diameter of loose backing flange
$D_3$ pitch circle diameter
$D_4$ outside diameter of flange adapter head
$D_5$ outside diameter of flange adapter shank
$D_6$ bolt hole diameter
$D_7$ outside diameter of loose backing flange

**Figure 2 — Butt fusion systems**

For butt fusion systems, the dimensions of the flange adapters shall conform to those given in Table 1.

**Table 1 — Flange adapters — Dimensions for butt fusion systems**

Dimensions in millimetres

| Nominal inside diameter of pipe and spigot [a] $d_n$ | Outside diameter of flange adapter head [b] $D_{4min}$ | Outside diameter of flange adapter shank [c] $D_{5min}$ | Radius of shoulder of flange adapter $R_f$ (+0,5/-0,5) |
|---|---|---|---|
| 200 | 231 | 235 | 10 |
| 300 | 335 | 343 | 10 |
| 400 | 440 | 449 | 10 |
| 500 | 589 | 560 | 10 |
| 600 | 797 | 682 | 15 |
| 700 | 905 | 788 | 15 |
| 800 | 1 005 | 894 | 15 |
| 900 | 1 107 | 1 010 | 20 |
| 1 000 | 1 217 | 1 121 | 20 |

[a] The diameter of the spigot shall conform to the relevant product standard.

[b] The actual value of $D_4$ should be as high as possible to ensure fitness for purpose of the assembly.

[c] $D_5$ shall be measured in the middle of the radius, $R_f$.

The dimensions of PS 10 designated loose backing flanges shall conform to those given in Table 2.

**Table 2 — PS 10 designated loose backing flange dimensions for butt fusion systems**

Dimensions in millimetres

| DN/ID | Nominal outside diameter of pipe DN/OD | PS 10 designated loose backing flanges | | | | | |
|---|---|---|---|---|---|---|---|
| | | Outside diameter $D_{7min}$ | Inside diameter $D_2$ | Pitch circle diameter $D_3$ | Bolts | | |
| | | | | | Bolt hole diameter $D_6$ | Number $n$ | Screw thread |
| 200 | 224 | 290 | 228 | 262 | 23 | 12 | M20 |
| 300 | 333 | 400 | 337 | 368 | 25 | 16 | M22 |
| 400 | 441 | 510 | 445 | 475 | 27 | 16 | M24 |
| 500 | 554 | 675 | 558 | 620 | 27 | 20 | M24 |
| 600 | 660 | 905 | 664 | 840 | 33 | 24 | M30 |
| 700 | 768 | 1 020 | 772 | 950 | 33 | 28 | M30 |
| 800 | 876 | 1 120 | 880 | 1 050 | 33 | 28 | M30 |
| 900 | 982 | 1 235 | 986 | 1 160 | 39 | 28 | M36 |
| 1 000 | 1 095 | 1 345 | 1 099 | 1 270 | 39 | 28 | M36 |

The dimensions of PS 16 designated loose backing flanges shall conform to those given in Table 3.

**Table 3 — PS 16 designated loose backing flange dimensions for butt fusion systems**

Dimensions in millimetres

| DN/ID | Nominal outside diameter of pipe | PS 16 designated loose backing flanges | | | | | |
|---|---|---|---|---|---|---|---|
| | | Outside diameter | Inside diameter | Pitch circle diameter | Bolts | | |
| | | | | | Bolt hole diameter | Number | Screw thread |
| | DN/OD | $D_{7\min}$ | $D_2$ | $D_3$ | $D_6$ | $n$ | |
| 200 | 224 | 305 | 228 | 275 | 25 | 12 | M22 |
| 300 | 333 | 430 | 337 | 395 | 27 | 16 | M24 |
| 400 | 441 | 605 | 445 | 540 | 33 | 16 | M30 |
| 500 | 554 | 730 | 558 | 660 | 33 | 20 | M30 |
| 600 | 666 | 845 | 670 | 770 | 39 | 24 | M36 |
| 700 | 776 | 1 085 | 778 | 990 | 42 | 24 | M39 |
| 800 | 884 | 1 185 | 888 | 1 090 | 48 | 24 | M45 |
| 900 | 992 | 1 320 | 994 | 1 210 | 48 | 28 | M45 |
| 1 000 | 1 105 | 1 420 | 1 109 | 1 310 | 56 | 32 | M52 |

# 7 Mechanical characteristics

## 7.1 General

Mechanical fittings shall be tested assembled with pipes conforming to ISO/PAS 22101-2 or ISO 4427-2.

Jointed pipe and fitting test pieces shall be assembled in accordance with the technical instructions of the manufacturer, taking into consideration the extreme conditions of utilization described in ISO/PAS 22101-5. The sample test assemblies shall take into account the manufacturing and assembly tolerances.

## 7.2 Conditioning

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

## 7.3 Requirements

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

a) electrofusion;

b) butt fusion.

**Table 4 — Mechanical characteristics**

| Characteristics | Requirements | Test parameters | | Test method |
|---|---|---|---|---|
| | | Parameters | Value | |
| Hydrostatic strength at 20 °C | No failure during test period of any test pieces | End caps | Type A [a] | ISO 1167-1 |
| | | Conditioning period | As specified in ISO 1167-1 | ISO 1167-2 |
| | | Number of test pieces [b] | 3 | |
| | | Type of test | Water-in-water | |
| | | Test temperature | 20 °C | |
| | | Test period | 100 h | |
| | | Circumferential (hoop) stress for: PE-sGF 200 | 24 MPa | |
| Hydrostatic strength at 80 °C | No failure during test period of any test pieces | End caps | Type A [a] | ISO 1167-1 |
| | | Conditioning period | As specified in ISO 1167-1 | ISO 1167-2 |
| | | Number of test pieces [b] | 3 | |
| | | Type of test | Water-in-water | |
| | | Test temperature | 80 °C | |
| | | Test period | 165 h | |
| | | Circumferential (hoop) stress for: PE-sGF 200 | 9 MPa | |
| Hydrostatic strength at 80 °C | No failure during test period of any test pieces | End caps | Type A [a] | ISO 1167-1 |
| | | Conditioning period | As specified in ISO 1167-1 | ISO 1167-2 |
| | | Number of test pieces [b] | 3 | |
| | | Type of test | Water-in-water | |
| | | Test temperature | 80 °C | |
| | | Test period | 1 000 h | |
| | | Circumferential (hoop) stress for: PE-sGF 200 | 7 MPa | |

[a] Type B end caps may be used for batch release tests for diameters ≥ 500 mm.

[b] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in this table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance on assessment of conformity can be found in CEN/TS 1555-7.[9]

[c] Test sample can be mechanically reduced in wall thickness for testing purpose of large diameter fittings by keeping a minimum 10 mm wall thickness of each component.

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

**Table 4** *(continued)*

| Characteristics | Requirements | Test parameters | | Test method |
|---|---|---|---|---|
| | | Parameters | Value | |
| Short-term internal pressure resistance for electrofusion socket fitting<br>a) Electrofusion | Failure pressure shall be greater than pressure equivalent of 2×MRS calculated for thickest-walled pipe for which fitting has been designed. | End caps<br>Orientation<br>Conditioning time<br>Type of test<br>Circumferential (hoop) stress in joint for:<br>Pressure increase rate<br>Test temperature | Type A<br>Free<br>12 h<br>Water-in-water<br>40 MPa<br>5 bar/min<br>20 °C | Annex B |
| Tensile strength for butt fusion [c]<br>b) Butt fusion | Test to failure:<br>ductile–pass brittle -fail | Test temperature<br>Number of test pieces [b] | 23 °C<br>3 | Annex C |
| Decohesive resistance<br>a) Electrofusion | Length of initiation rupture ≤ $1/3L_2$ in brittle failure [d] | Test temperature | 23 °C | ISO 13954 [c]<br>ISO 13955 |

[a] Type B end caps may be used for batch release tests for diameters ≥ 500 mm.

[b] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in this table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance on assessment of conformity can be found in CEN/TS 1555-7.[9]

[c] Test sample can be mechanically reduced in wall thickness for testing purpose of large diameter fittings by keeping a minimum 10 mm wall thickness of each component.

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

# 8 Physical characteristics

## 8.1 Conditioning

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

## 8.2 Requirements

When tested in accordance with the test methods as specified in Table 5 using the indicated parameters, the fittings shall have physical characteristics conforming to the requirements given in Table 5.

**Table 5 — Physical characteristics**

| Characteristics | Requirements | Test parameters | | Test method |
|---|---|---|---|---|
| | | Parameters | Value | |
| Longitudinal reversion | ≤ 3 % | Shape and number of test pieces<br>Test temperature<br>Time | 3<br>110 °C<br>See ISO 2505 | ISO 2505 |
| Oxidation induction time [b] (OIT) | ≥ 20 min | Test temperature<br>Test environment<br>Specimen weight<br>Number of test pieces [a] | 210 °C [c]<br>Oxygen<br>(15 ± 2) mg<br>3 | ISO 11357-6 |
| Effect on water quality | National regulations apply | | | |

[a] The number of test pieces given indicate 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. Guidance on assessment of conformity can be found in CEN/TS 1555-7.[9]

[b] OIT shall be measured for each glass filled layer and non-glass filled layer.

[c] The test may be carried out at 200 °C or 220 °C, provided that a clear correlation has been established. In case of dispute, the reference temperature shall be 210 °C.

## 9 Chemical resistance of fittings in contact with chemicals

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

NOTE Guidance for the resistance of the PE-sGF pipes to chemicals is given in ISO/TR 10358, considering the PE resistance as a reference. Consult pipe manufacturer for additional information.

## 10 Performance requirements

When fittings conforming to this document are assembled to each other or to components conforming to other parts of the ISO 22101 series, the joints shall be in accordance with ISO/PAS 22101-5.

## 11 Marking

### 11.1 General

All fittings shall be marked according to 11.2.

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

If printing is used, the colour of the printed information shall differ from the basic colour of the product.

The marking shall be such that it is legible without magnification.

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

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

### 11.2 Minimum required marking

The minimum required marking shall be in accordance with Table 6.

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

**Table 6 — Minimum required marking**

| Aspects | Marking or symbol |
|---|---|
| Reference to this document | ISO/PAS 22101-3 |
| Manufacturer's name or trademark or both | Name or symbol |
| Dimensions ($d_{im} \times e_n$) | e.g. 500 × ..... |
| Design application series (i.e. design SIDR) | e.g. 17 |
| Material and designation | e.g. PE-sGF 200 |
| Pressure rating in bar | e.g. PS 12,5 |
| Production period (date or code) | e.g. 0207 [a] |
| [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. | |

### 11.3 Fusion system recognition

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

Where bar codes are used for the numerical recognition, the bar-code label shall be adhered to the fitting or be provided from the manufacturer and shall be protected against deterioration during transportation and storage to the point of installation.

## 12 Packaging

The fitting shall be packaged in bulk or individually protected where necessary in order to prevent deterioration and contamination during transportation and storage to the point of installation.

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

# Annex A
(normative)

# Fabricated fittings

## A.1 General

The fabricated fittings' performance requirements and dimensions shall be in accordance with Tables A.1 and A.2, as applicable.

The pipes used to manufacture these fittings shall be accordance with ISO/PAS 22101-2.

This annex applies only to fabricated fittings obtained by the butt fusion process.

The PS rating of fabricated fittings shall be derived from the PS of the used pipes and the geometry derating factors given in Clause A.3.

The manufacturer shall be responsible for the design and the pressure rating of the fittings. It is the manufacturer's responsibility to demonstrate conformity to the declared minimum required given in Table 6. The minimum testing to demonstrate the performance of the fitting design is given in Table A.1.

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

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

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

**Table A.1 — Performance requirements — Fabricated fittings**

| Characteristics | Requirements | Test parameters | | Test method |
|---|---|---|---|---|
| | | Parameter | Value | |
| Hydrostatic strength at 20 °C | No failure during test period of any test pieces | End caps | Type A or B [a] | ISO 1167-1 |
| | | Conditioning period | As specified in ISO 1167-2 | ISO 1167-2 |
| | | Number of test pieces [b] | 3 | |
| | | Type of test | Water-in-water [f] | |
| | | Test temperature | 20 °C | |
| | | Test period | 100 h [c] | |
| | | Circumferential (hoop) stress for: PE-sGF 200 | 24 MPa [g] × $f$ [i] | |
| Hydrostatic strength at 80 °C | No failure during test period of any test pieces | End caps | Type A or B [a] | ISO 1167-1 |
| | | Conditioning period | As specified in ISO 1167-1 | ISO 1167-2 |

**Table A.1** *(continued)*

| Characteristics | Requirements | Test parameters | | Test method |
|---|---|---|---|---|
| | | **Parameter** | **Value** | |
| | | Number of test pieces [b] | 3 | |
| | | Type of test | Water-in-water [f] | |
| | | Test temperature | 80 °C | |
| | | Test period | 165 h [c] | |
| | | Circumferential (hoop) stress for: PE-sGF 200 | 9 MPa [g]×$f$ [i] | |
| Hydrostatic strength at 80 °C | No failure during test period of any test pieces | End caps | Type A or B [a] | ISO 1167-1<br>ISO 1167-2 |
| | | Conditioning period | As specified in ISO 1167-2 | |
| | | Number of test pieces [b] | 3 | |
| | | Type of test | Water-in-water [f] | |
| | | Test temperature | 80 °C | |
| | | Test period | 1 000 h | |
| | | Circumferential (hoop) stress for: PE-sGF 200 | 7 MPa [g]×$f$ [i] | |
| Tensile strength for fabricated fittings in circumferential direction [d, e] | ≥ 40 MPa | Shape of type | Type 1 | ISO 527-1 |
| | | Tensile speed | 50 mm/min | |
| | | Number of test pieces | 5 | |
| Tensile strength for fabricated fittings in longitudinal direction | ≥ 24 MPa | Shape of type | Type 1 | ISO 527-1 |
| | | Tensile speed | 50 mm/min | |
| | | Number of test pieces | 5 | |

[a] Type B end caps may be used for batch release tests for diameters ≥ 200 mm.

[b] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in this table. The number of test pieces required for the quality control test and the process control test should be listed in the manufacturer's quality plan.

[c] If the pipe fails before 165 h, a 1 000 h test shall be performed (see 1 000 h requirement in Clause A.3).

[d] Thickness may be reduced by machining.

[e] Test specimen may be pressed at 110 °C by compression machine.

[f] For $d_n$ = 1 000 mm, the test can also be performed water-in-air. In case of dispute, water-in-water shall be used.

[g] Test pressure shall be determined based on the measured dimensions of the test piece according to ISO 1167-1:2006, 7.2. This figure is the declared derating factor related to the integrated socket end to be tested.

[h] These requirements are valid for both monolithic pipes with integrated socket ends as well as assembled joints.

[i] $f$ = the derating factor related to the segmented fitting design.

## A.2 Dimensions

The main dimensions of fabricated fittings are reported in Table A.2.

**Table A.2 — Fabricated fitting dimensions**

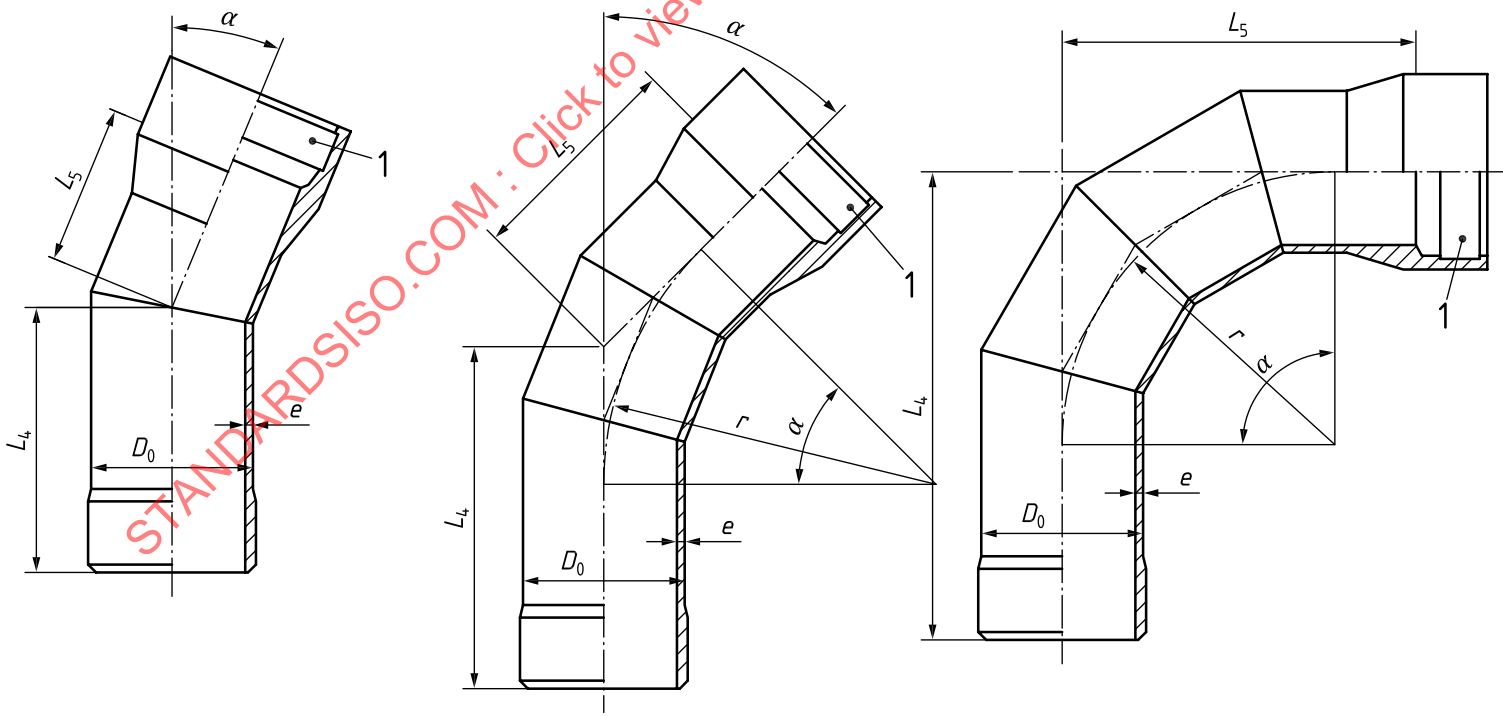
Dimensions in millimetres

| Nominal inside diameter DN/ID | Minimum length of fitting | Nominal branch length | Nominal angle of fitting $\alpha$ |
|---|---|---|---|
| 200 | 200 | Declared by the fitting manufacturer | Declared by the fitting manufacturer<br><br>With a tolerance of ±2°<br>The maximum tolerance for pipe bends shall be ±5° |
| 300 | 300 | | |
| 400 | 300 | | |
| 500 | 400 | | |
| 600 | 400 | | |
| 700 | 400 | | |
| 800 | 500 | | |
| 900 | 500 | | |
| 1 000 | 500 | | |

## A.3 Segmented bends

Examples of typical fabricated bends made out of pipe segments are shown in Figure A.1. The segment design is shown in Figure A.2.

Only indicated dimensions shall be considered. A full set of dimensions shall be provided by the fitting manufacturer in their technical literature.



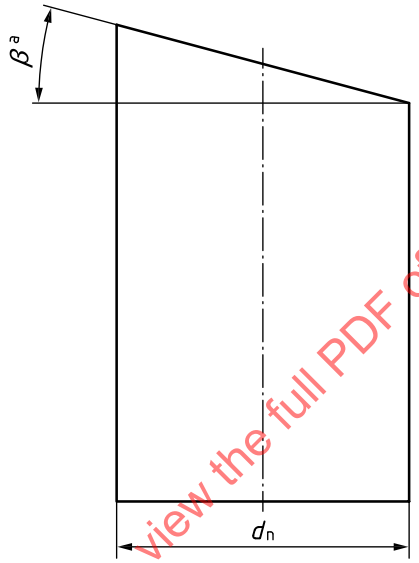

**a) 22,5°** **b) 45°** **c) 90°**

**Key**

$L_4$ nominal length of fitting branch to axis
$L_5$ nominal length of fitting branch to axis
$\alpha$ nominal angle of fitting
1 fusion zone
$e$ wall thickness
$D_0$ outside diameter

**Figure A.1 — Segmented bends**

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




**Key**

$d_n$ nominal inside diameter
$\beta$ cut angle
a The cut angle shall not be greater than 15°.

**Figure A.2 — Segment design**

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

$$\rho_n = f \times \rho_p$$

where

$\rho_n$ is the nominal pressure, PS;

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

$\rho_p$ is the nominal pressure, PS, of the pipe.

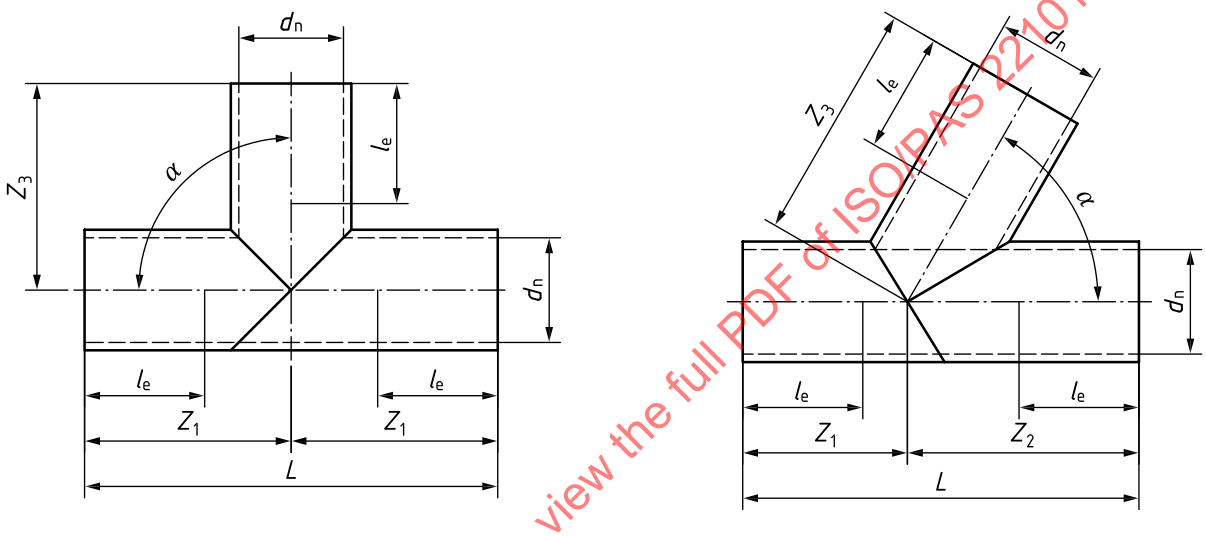
The minimum testing to demonstrate the performance of the segmented bends is given in Table A.3.

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

| Cut angle<br>$\beta$ | Derating factor<br>$f$ |
|---|---|
| ≤ 7,5° | 1,0 |
| 7,5°< $\beta$ ≤ 15° | 0,8 [a] |
| [a] In accordance with Clause A.1, the test results of the manufacturer may demonstrate that a derating factor of 1,0 or another factor is applicable. | |

## A.4 Segmented tees

Fabricated tees made out of pipe segments are not required to accord with the drawings given in Figure A.3. Only indicated dimensions shall be considered. A full set of dimensions shall be provided by the fitting manufacturer in their technical literature.




**a) 90°** **b) 60°**

**Key**

| | |
|---|---|
| $d_n$ | nominal inside diameter |
| $l_e$ | tubular length of fusion end piece |
| $Z_1$, $Z_2$, $Z_3$ | nominal lengths of fitting branch |
| $\alpha$ | nominal angle of fitting (±2°) |
| | $L$ and $\alpha$ shall be in accordance with any relevant national guidance |

**Figure A.3 — Segmented tees**

The tubular length of the fusion end piece 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.

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

$$\rho_s = f_T \times \rho_p$$

where

$\rho_s$ is the nominal pressure of the segmented tee;

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

$\rho_p$ is the nominal pressure, PS, of the pipe.

Practice has shown that these factors are applicable. Results of testing according to Table A.3 will determine the applicable factor $f_T$.

# Annex B
(normative)

# Short-term pressure test method

## B.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.

## B.2 Apparatus

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

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

**B.2.3 Bourdon tube 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. Alternatively, a digital pressure gauge, having an accuracy of not less than 2 % the measured value and with the capability to record the maximum pressure reached.

A gauge shall be located in 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.

## B.3 Test piece

The test piece shall be an assembly of one or more electrofusion fittings connected to PE-sGF 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 in accordance with 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.