PUBLICLY AVAILABLE SPECIFICATION

ISO/PAS 22101-2

First edition
2022-06

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

Part 2: Pipes

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

Partie 2: Tubes

Reference number
ISO/PAS 22101-2:2022(E)

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

Published in Switzerland

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.

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

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

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

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

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 3, *Polyethylene reinforced with short glass fibres (PE-sGF) piping systems 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 pipes 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 International 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 2: Pipes

1 Scope

This document is applicable to short glass fibre reinforced polyethylene (PE-sGF) pipes manufactured by the spiral cross winding method, which are used below ground for the conveyance of liquid fluids for the following industrial and agricultural uses:

— 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);

In conjunction with the other parts of the ISO 22101 series, this document applies to PE-sGF pipes, fittings and their joints with each other, with other PE-sGF components, and to components from other materials intended for use under the following conditions:

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

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

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

Other application areas differing from those listed in the scope can be permitted if the requirements of this document and/or relevant national requirements are taken into account. Drinking water applications are outside the scope of this document.

This document is applicable to pipes with an inside diameter of 200 mm to 1 000 mm with integrated socket and spigot fusion joint.

Components conforming to any of the documents listed in the Bibliography or to national standards, as applicable, can be used with components conforming to this document, provided that they conform to the requirements for joint dimensions and to the relevant requirements of this document.

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*

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

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

ISO 1167-1, *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 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 11922-1, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

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:—[2)], *Polyethylene reinforced with short glass fibres (PE-sGF) piping systems for industrial applications — Part 1: General*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/PAS 22101-1 and the following 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
out-of-roundness
difference between the maximum and the minimum inside diameters in the same cross-section of a pipe or spigot

3.2
electrofusion socket end
glass fibre reinforced polyethylene (PE-sGF) pipe socket 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

3.3
spigot end
glass fibre reinforced polyethylene (PE-sGF) pipe end where the outside diameter of the spigot length is equal to the socket inside diameter, d_{im}, of the corresponding pipe

2) Under preparation. Under preparation. Stage at the time of publication: ISO/PAS PRF 22101-1:2022

3.4
tolerance
permissible variation of the specified value of a quantity expressed as the difference between the permissible maximum and permissible minimum values

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in ISO/PAS 22101-1 apply.

5 Material

The material from which the pipe is made shall be in accordance with ISO/PAS 22101-1.

6 General characteristics

6.1 Appearance

When viewed without magnification the internal surfaces of pipes, sockets and spigots shall be smooth, clean and free from scoring, cavities and other surface defects to an extent that would prevent conformity of the pipe to this document. When applicable, the pipe ends shall be cut cleanly and square to the axis of the pipe.

6.2 Colour

The pipes shall be black.

7 Geometrical characteristics

7.1 Measurements

The dimensions of the pipe, of the socket length of the pipe for welding, and of the integrated spigot length shall be measured in accordance with ISO 3126, where applicable. In case of dispute, the measurements of dimensions shall be made not less than 24 h after manufacture, after being conditioned for at least 4 h at (23 ± 2) °C.

7.2 Mean inside diameter and out-of-roundness (ovality)

The nominal inside diameter, d_{in}, the mean inside diameters, d_{im}, and the out-of-roundness (ovality) shall be in accordance with Table 1.

Table 1 — Mean inside diameter and out-of-roundness (ovality)

Dimensions in millimetres

Nominal size	Nominal inside diameter	Mean inside diameter		Maximum out-of-roundness (ovality)[b]
DN/ID	d_{in}	$d_{im,min}$	$d_{im,max}$[a]	
200	200	200	208	8
300	300	300	308	10
400	400	400	408	14
500	500	500	508	17
600	600	600	610	21
700	700	700	711	24
800	800	800	813	28
900	900	900	915	31
1 000	1 000	1 000	1 017	35

[a] Tolerances for grass-filled layer are calculated based on the following formula, rounding calculated values down to the nearest 1 mm: $d_{im,max}=d_{in}+(d_{in} \cdot 0{,}017)$, but $\geqq d_{in}+8$ mm.

[b] Out of roundness (ovality) is calculated in accordance with ISO 11922-1.

7.3 Wall thicknesses and their tolerances

Table 2 provides maximum allowable pressure (PS) values for pipes with and without integral socket. Pipes with integral sockets are derated to account for the socket strength. Minimum wall thicknesses shall be in accordance with Table 2. Values shown in Table 2 do not include a non-glass-filled layer of outer and inner polyethylene, minimum 1,5 mm each, for protecting against UV and chemical degradation (see also Annex C).

Alternatively, other diameters and pressures may be used; the corresponding wall thickness is then calculated according to the national requirements.

The PS values in Table 2 are based on the value C = 1,60, where C is the design coefficient. Higher design coefficients may be agreed upon between the manufacturer and the purchaser. See Annex A.

Table 2 — Pressure rating and wall thickness

Dimensions in millimetres

	Pipe series							
	SIDR 9 S_i 5		SIDR 11 S_i 6		SIDR 14 S_i 7,5		SIDR 21 S_i 10	
	Nominal pressure, PS in bar[d]							
Pipes without socket	PS 25		PS 20		PS 16		PS 11	
Pipe with socket	PS 16		PS 13		PS 10		PS 8	
Nominal size	Wall thicknesses[a,b,c]							
DN/ID	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
200	22,6	27,9	18,5	23,4	14,5	19,1	10,7	14,9
300	33,9	40,4	27,7	33,6	21,8	27,1	16,1	20,8
400	45,0	52,6	36,8	43,6	28,9	34,9	21,3	26,5
500	56,1	64,8	45,9	53,6	36,1	42,8	26,6	32,3
600	67,8	77,7	55,5	64,1	43,6	51,0	32,1	38,4
700	78,9	89,9	64,5	74,1	50,7	58,9	37,4	44,2
800	90,0	102,1	73,6	84,1	57,9	66,7	42,6	50,0
900	101,1	114,3	82,7	94,1	65,0	74,6	47,9	55,8
1 000	112,8	127,2	92,3	104,6	72,5	82,9	53,4	61,9

[a] Minimum wall thicknesses are calculated based on SIDR values that are derived from Renard Series R20 according to ISO 3, where possible.

[b] Tolerances in accordance with grade V of ISO 11922-1.

[c] See Annex A for actual calculated values.

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

Table 2 *(continued)*

Dimensions in millimetres

	Pipe series							
	SIDR 24 S_i 11,5		SIDR 32 S_i 15,5		SIDR 38 S_i 19,5		SIDR 46 S_i 23,5	
	Nominal pressure, PS in bar[d]							
Pipes without socket	PS 10		PS 8		PS 6		PS 5	
Pipe with socket	PS 7		PS 5		PS 4		PS 3	
Nominal size	**Wall thicknesses**[a,b,c]							
DN/ID	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
200	9,2	13,3	6,8	10,5	5,3	9,0	4,4	8,0
300	13,9	18,4	10,2	14,3	8,0	11,9	6,6	10,4
400	18,4	23,4	13,5	18,0	10,7	14,8	8,8	12,8
500	23,0	28,4	16,8	21,6	13,3	17,7	11,0	15,2
600	27,7	33,6	20,3	25,5	16,1	20,8	13,3	17,7
700	32,3	38,6	23,7	29,1	18,7	23,7	15,4	20,1
800	36,8	43,6	27,0	32,8	21,3	26,5	17,6	22,5
900	41,4	48,6	30,3	36,5	23,9	29,4	19,8	24,9
1,000	46,1	53,9	33,8	40,3	26,7	32,5	22,1	27,4

[a] Minimum wall thicknesses are calculated based on SIDR values that are derived from Renard Series R20 according to ISO 3, where possible.

[b] Tolerances in accordance with grade V of ISO 11922-1.

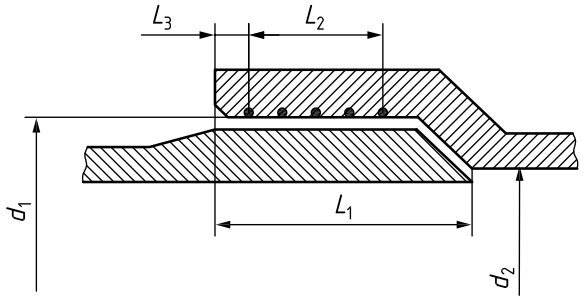
[c] See Annex A for actual calculated values.

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

7.4 Dimensions of integrated electrofusion socket

7.4.1 Diameters and lengths of electrofusion sockets

When measured in accordance with 7.1, the diameters and lengths of electrofusion sockets (see Figure 1) shall conform to Table 3 and Table 4.



Key

d_1 is the 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 from that face:

d_2 is the bore, which is the minimum diameter of the flow channel through the socket end:

L_1 is the spigot length corresponding to the socket length

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

L_3 is the distance ≥ 20 mm between the mouth of the socket end and the start of the fusion zone as declared by the manufacturer to be the nominal unheated entrance length of the socket end

Figure 1 — Dimensions of electrofusion socket and spigot ends

Table 3 — Dimensions of electrofusion socket ends

Dimensions in millimetres

Nominal diameter of the pipe d_n	DN/ID		Socket length	Fusion zone
	$d_{2,min}$	$d_{2,max}$	$L_{1,min}$	$L_{2,min}$
200	200	205	147	28
300	300	308	152	38
400	400	408	157	47
500	500	508	162	56
600	600	610	168	65
700	700	711	172	73
800	800	813	177	82
900	900	915	183	90
1 000	1 000	1 017	188	98

Table 4 — Dimensions of electrofusion socket ends

Dimensions in millimetres

Nominal diameter of the pipe d_n	SIDR of the electrofusion socket [a]						
	9	11	14	19	30	38	46
	Socket inside diameter d_1						
200	254	246	239	239	239	239	239
300	379	366	364	364	364	364	364
400	501	485	465	465	465	465	465
500	623	603	575	575	575	575	575
600	752	727	703	680	676	676	676
700	874	845	817	791	788	788	788
800	996	963	932	901	892	892	892
900	1 118	1 081	1 046	1 012	994	994	994
1 000	1 247	1 206	1 166	1 128	1 107	1 107	1 107

[a] For joint connecting reason with other piping system, SIDR shall be provided.

The manufacturer shall declare minimum and maximum values of d_1 and determine their suitability for joint assembly and fitness for purpose of the system.

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

7.4.2 Wall thicknesses

In order to prevent stress concentrations, any changes in wall thickness of the electrofusion socket ends shall be gradual.

The wall thickness of the electrofusion socket ends at any point, e, shall be greater than or equal to e_{min} of the corresponding pipe.

7.4.3 Out-of-roundness of the bore of an electrofusion socket end (at any point)

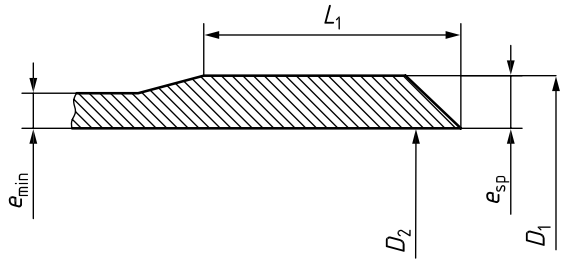
When a electrofusion socket ends leaves the site of the manufacturer, the out-of-roundness of the bore of a electrofusion socket ends at any point shall not exceed 0,015 d_n.

7.5 Dimensions of integrated spigot end

When measured in accordance with 7.1, the spigot dimensions shall conform to the requirements given in Table 5 (see Figure 2). The wall thickness of the spigot end, e_{sp}, shall be at least equal to the minimum wall thickness of the pipe.

The spigot end is subjected to machining to ensure the outer diameter of Table 5; that process allows to maintain at the least a non-glass fibre filled layer of 1,5 mm PE without glass fibre exposing (see also Annex C).

The manufacturer shall declare minimum and maximum values of D_1 and determine their suitability for joint assembly and fitness for purpose of the system.



Key

D_1 mean outside diameter of spigot end
D_2 DN/ID of the pipe
L_1 design penetration depth of the male end of a spigot end corresponding to the socket length
e_{min} wall thickness of pipe
e_{sp} spigot end wall thickness

Figure 2 — Dimensions of spigot end

Table 5 — Dimensions of spigot for electrofusion

Dimensions in millimetres

	SIDR of the electrofusion spigot [a]						
	9	*11*	*14*	*19*	*30*	*38*	*46*
Nominal diameter of the pipe d_n	**Spigot outside diameter** D_1						
200	255	247	239	239	239	239	239
300	380	367	364	364	364	364	364
400	501	485	465	465	465	465	465
500	622	602	575	575	575	575	575
600	751	726	702	679	676	676	676
700	872	843	815	789	788	788	788
800	994	961	930	899	892	892	892
900	1 116	1 079	1 044	1 010	994	994	994
1 000	1 245	1 204	1 164	1 126	1 107	1 107	1 107

[a] For reasons of joint connecting with other piping system, SIDR shall be provided.

8 Mechanical characteristics

8.1 Conditioning

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 6.

8.2 Requirements

When tested in accordance with the test methods as specified in Table 6 and Table 7, using the indicated parameters, all the pipes (including those with electrofusion ends) shall have mechanical characteristics conforming to the requirements given in Table 6 and Table 7.

Table 6 — Mechanical characteristics of pipes

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 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 [c]	
		Test temperature	20 °C	
		Test period	100 h	
		Circumferential (hoop) stress for PE-sGF 200	36 MPa [d]	
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 1167-2	ISO 1167-2
		Number of test pieces [b]	3	
		Type of test	Water-in-water [c]	
		Test temperature	80 °C	
		Test period	165 h [e]	
		Circumferential (hoop) stress for PE-sGF 200	12 MPa [d]	
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 1167-2	ISO 1167-2
		Number of test pieces [b]	3	
		Type of test	Water-in-water [c]	
		Test temperature	80 °C	
		Test period	1 000 h	
		Circumferential(hoop) stress for PE-sGF 200	10 MPa [d]	
Tensile strength in circumferential direction [f g]	≥ 40 MPa	Shape of type	Type 1	ISO 527-1
		Tensile speed	50 mm/min	
		Number of test pieces	5	
Tensile strength in longitudinal direction [f]	≥ 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 the 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] 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.

[d] Test pressure shall be determined based on the measured dimensions of the test piece according to ISO 1167-1:2006, 7.2.

[e] If the pipe fails before 165 h, a 1 000 h test shall be performed (see 1 000 h requirement in Table 6).

[f] Thickness may be reduced by machining.

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

Table 7 — Mechanical characteristics of pipes with integrated electrofusion socket ends[j]

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 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	
		Circumferential (hoop) stress for PE-sGF 200	24 MPa [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 1167-2	ISO 1167-2
		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 [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 1167-2	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 [i]	
Tensile strength in circumferential direction [c, d, e]	≥ 40 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 the 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 Table 7).

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

[h] The test sample can be mechanically reduced in wall thickness for testing large diameter electrofusion socket ends by keeping a minimum of 15 mm wall thickness for each component.

[i] 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 electrofusion socket end to be tested.

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

Table 7 *(continued)*

Characteristics	Requirements	Test parameters		Test method
		Parameters	Value	
Tensile strength in longitudinal direction [c]	≥ 24 MPa	Shape of type	Type 1	ISO 527-1
		Tensile speed	50 mm/min	
		Number of test pieces	5	
Decohesive resistance	Length of initiation rupture ≤ L2/3 in brittle failure [g]	Test temperature	23 °C	ISO 13954
		Number of test pieces [h]	Shall conform to ISO 13954 and ISO 13955	ISO 13955

[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 the 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 Table 7).

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

[h] The test sample can be mechanically reduced in wall thickness for testing large diameter electrofusion socket ends by keeping a minimum of 15 mm wall thickness for each component.

[i] 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 electrofusion socket end to be tested.

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

8.3 Additional characteristics

Additional characteristics, such as ring stiffness and the bending modulus, delamination of each layer shall be determined using Annex B.

9 Physical characteristics

9.1 Conditioning

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 8.

9.2 Requirements

When tested in accordance with the test methods as specified in Table 8, using the indicated parameters, the physical characteristics of the pipe shall be in accordance with the requirements given in Table 8.

Table 8 — Physical characteristics

Characteristics	Requirements	Test parameters		Test method
All pipes				
Longitudinal reversion	≤ 3 %	Number of test pieces	3	ISO 2505
		Length of test piece	200 mm	
		Test temperature	110 °C	
		Test period	See ISO 2505	
OIT [b]	≥ 20 min	Test temperature	210 °C [c]	ISO 11357-6
		Number of test pieces [a]	3	
		Test atmosphere	Oxygen	
Melt mass-flow rate[d] (MFR)	After processing maximum deviation of ±20 % of the value measured on the batch used for manufacturing	Loading mass	5 kg	ISO 1133-1
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces [a]	Shall conform to ISO 1133-1	

[a] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in the table.

[b] All pipes produced according to this document have co-extruded, non-glass filled skin layers, made of the same PE compound as that used to produce the PE-sGF compound, intended to give a PE surface. 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.

[d] MFR deviation is calculated on PE used to manufacture PE layers as well as glass filled PE thickness.

10 Chemical characteristics

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.

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

11 Marking

11.1 General

11.1.1 All pipes shall be permanently and legibly marked in such a way that the marking does not initiate cracks or other types of failure and that normal storage, weathering, handling, installation and use shall not affect the legibility of the marking.

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

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

11.2 Minimum required marking of pipes

The minimum required marking shall conform to Table 9, with the frequency of marking being not less than once per pipe.

Table 9 — Minimum required marking

Aspects	Marking or symbol
Document number	ISO/PAS 22101-2
Manufacturer's identification	Name or symbol
Dimensions ($d_{im} \times e_n$)	e.g. 500 × .....
SIDR	e.g. 17
Material and designation	e.g. PE-sGF 200
Nominal pressure	e.g. PS 16,0
Intended use	e.g. IS [a]
Production period (date or code)	e.g. 0 207 [b]

[a] IS means Industrial Application.

[b] In clear figures or in code providing traceability to the production period within the year and month and if the manufacturer is producing at different sites, the production site.

11.3 Electrofusion system recognition

Electrofusion socket ends should have a system, either numerical, electromechanical or self-regulatory as described in ISO 13950, for recognizing the fusion parameters and facilitating the fusion process. Where bar codes are used for the numerical recognition, the bar-code label shall be stuck to the electrofusion socket ends or provide from the manufacturer and shall be protected against deterioration.

12 Packaging

The socket and spigot shall be packaged to protect jointing surfaces 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)

Relationship between PS, MRS, S_i and SIDR

A.1 Introduction

The relationship between maximum allowable pressure, PS, design stress, σ_s, and the series S_i/SIDR is given by the Formula (A.1):

$$\rho_{a,max} = \frac{20\sigma_s}{R_{SID} + 1} \quad \text{(A.1)}$$

where

$\rho_{a,max}$ is the maximum allowable pressure (PS);

σ_s is the design stress;

R_{SID} is the standard inside dimension ration (SIDR).

Examples of the relationship between PS, MRS, S_i, and SIDR based on Formula (A.2) are given in Table A.1, where C =1,60.

$$\sigma_s = \frac{F_{r,min}}{C} \quad \text{(A.2)}$$

where

$F_{r,min}$ is the minimum required strength (MRS)

The maximum allowable pressures (PS) given in Table B.1 are based on the use of a design coefficient of C =1,60. However, if a higher value for C is required, the PS values shall be recalculated using the Formulae (A.1) and (A.2) and based on the calculated design stress, σ_s, for each material class. A higher value for C can also be obtained by choosing a higher PS class.

Table A.1 — Examples of the relationship between PS, MRS, S_i and SIDR at 20 °C (C =1,60)

SIDR	S_i	PS of pipes without socket bar [a] PE-sGF 200
46	23,5	5
38	19,5	6
32	15,5	8
24	11,5	10
21	10	11
14	7,5	16

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

The PS values in Table A.1 are based on the value C=1,60. Higher design coefficients may be agreed upon between the manufacturer and the purchaser.

Table A.1 *(continued)*

SIDR	S_i	PS of pipes without socket bar [a] PE-sGF 200
11	6	20
9	5	25

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

The PS values in Table A.1 are based on the value C=1,60. Higher design coefficients may be agreed upon between the manufacturer and the purchaser.