Aspects ensuring service life- *Quality of Pipe Materials*

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- *System design*
- *Product Design*
- *Standards*
- *Specifications*
- *Manufacturing*
- *Quality management and Control*
- Handling and storage
- *Installation and jointing*
- Pre- commissioning Testing
- Commissioning
- Maintenance and repairs

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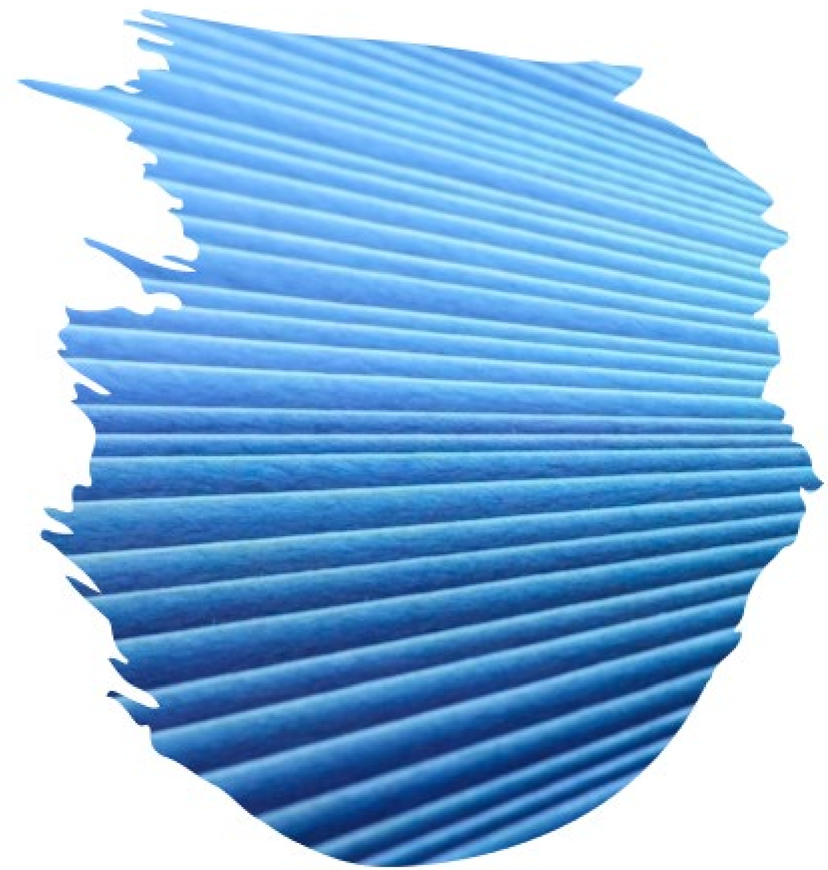
System Design

- Application
- Fatigue
- Time
- Temperature
- Chemical
- Joint/Weld Factors



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What changes Polymer life expectancy

Gene Pool
- Polymer morphology
- Additivities

Environment
- External temperature
- UV irradiation
- Installation conditions

Life Style
- Aggressive media
- Pressure, excessive stress
- Media temperature

Unforeseen
- External damage
- Violence
- Natural disaster

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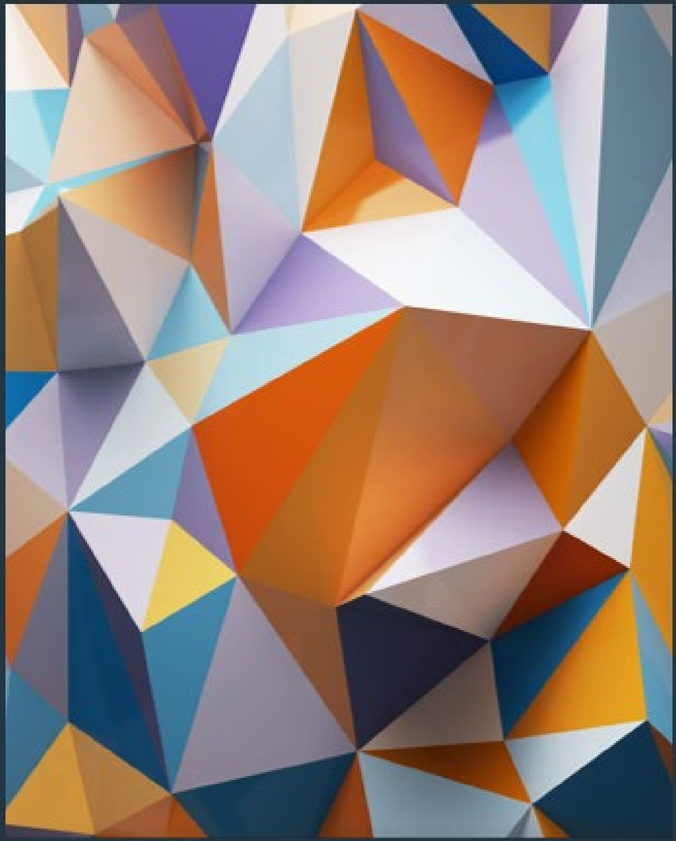
The Lifetime of thermoplastic Pipes is Determined by 3 Ageing Mechanisms

- Mechanical creep
- Slow crack growth – Environmental Stress Cracking
- Thermo-oxidative ageing

The velocity of the ageing mechanisms depends on temperature and loading. There is a „race“ between these mechanisms. Under given conditions the „quickest“ one is leading to failure!



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Annex A
(informative)

List of standards

A list of International Standards for plastics pipes for mechanical fittings is given in Table A.1.

Table A.1 — List of standards

Pipe material	Standard (GAS)	Standard (W, P)	Standard (I)	Standard (IS)
ABS	—	—	—	ISO 15493
PA-U[a]	ISO 16486-2	—	—	—
PB	—	—	—	ISO 15494
PE 32	—	ISO 4427-2:1996	ISO 8779	—
PE 40	—	ISO 4427-2	ISO 8779	—
PE 63	—	ISO 4427-2	—	ISO 15494
PE 80 PE 100	ISO 4437-2	ISO 4427-2	—	ISO 15494
PE-RT[b]	—	—	—	ISO 15494
PE-X	ISO 14531-1	—	—	ISO 15494
PVC-C	—	—	—	ISO 15493
PVC-HI	ISO 6993-1	—	—	—
PVC-O	—	ISO 16422	ISO 16422	—
PVC-U	—	ISO 1452-2	—	ISO 15493
PP[c]	—	—	—	ISO 15494
PVDF	—	—	—	ISO 10931
Multi-layer	ISO 18225[d]	ISO 21004	—	—

[a] PA-U = PA-U 11 160, PA-U 11 180, PA-U 12 160 or PA-U 12 180.

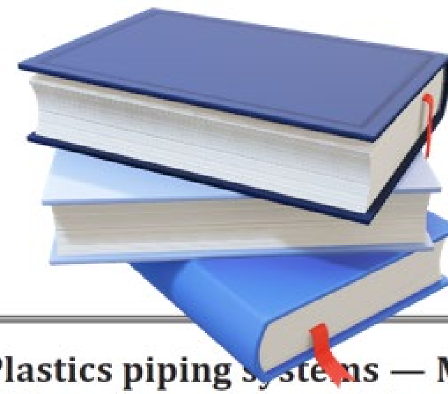
[b] PE-RT = PE-RT type 1 or PE-RT type 2.

[c] PP = PP-H, PP-B, PP-R or PP-RCT.

[d] The corresponding International Standard is a system standard.

INTERNATIONAL STANDARD

ISO 17885



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Plastics piping systems — Mechanical fittings for pressure piping systems — Specifications

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ISO 17885

Content

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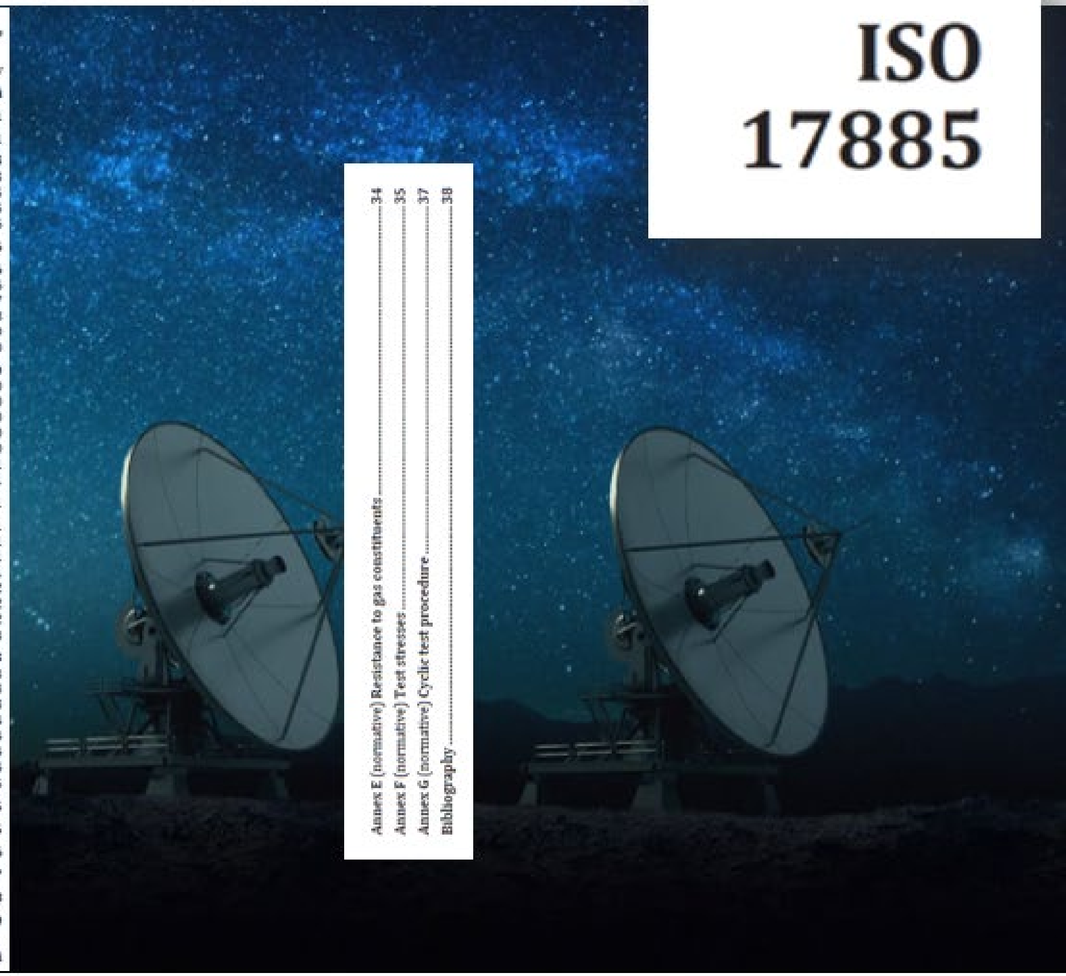

ISO 17885

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3.2.1 Materials

3.2.1.1 Plastics

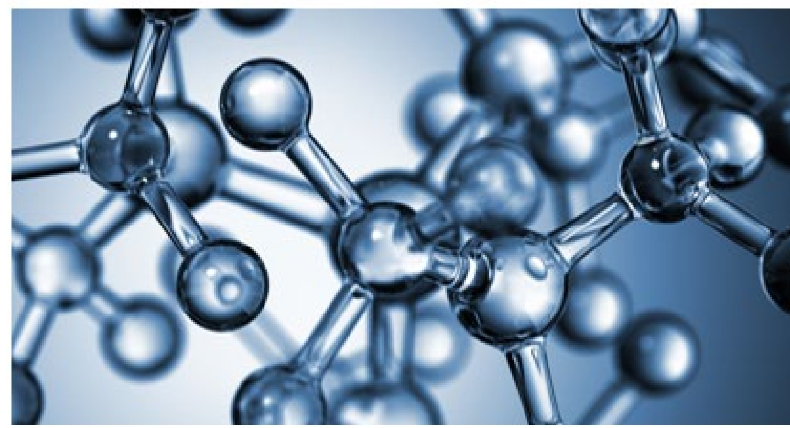
ABS	acrylonitrile-butadiene-styrene
ECTF	ethylene chlorotriflourethylene
EPA-U	unplasticized polyamide
PB	polybutene
PE	polyethylene
PE-RT	polyethylene of raised temperature resistance
PE-X	crosslinked polyethylene
POM	polyoxymethylene, polyformaldehyde
PP-B	polypropylene block-copolymer
PP-H	polypropylene homopolymer
PP-R	polypropylene random-copolymer
PP-	polypropylene random-copolymer with modified crystallinity
RCT	poly(phenylene sulfone)
PPSU	polysulfone
PSU	chlorinated poly(vinyl chloride)
PVC-C	high-impact poly(vinyl
PVC-HI	chloride)
PVC-O	oriented unplasticized poly(vinyl chloride)
PVC-U	unplasticized poly(vinyl chloride)

3.2.1.2 Metals

Al	aluminium
Cu	copper
Cu-	phosphorus deoxidized
DHP	copperoxygen-free copper
Cu-OF	iro
Fe	n
P	lea
b	dtin

3.2.1.3 Other

As	arsenic
C	carbon
GF	glass fibre



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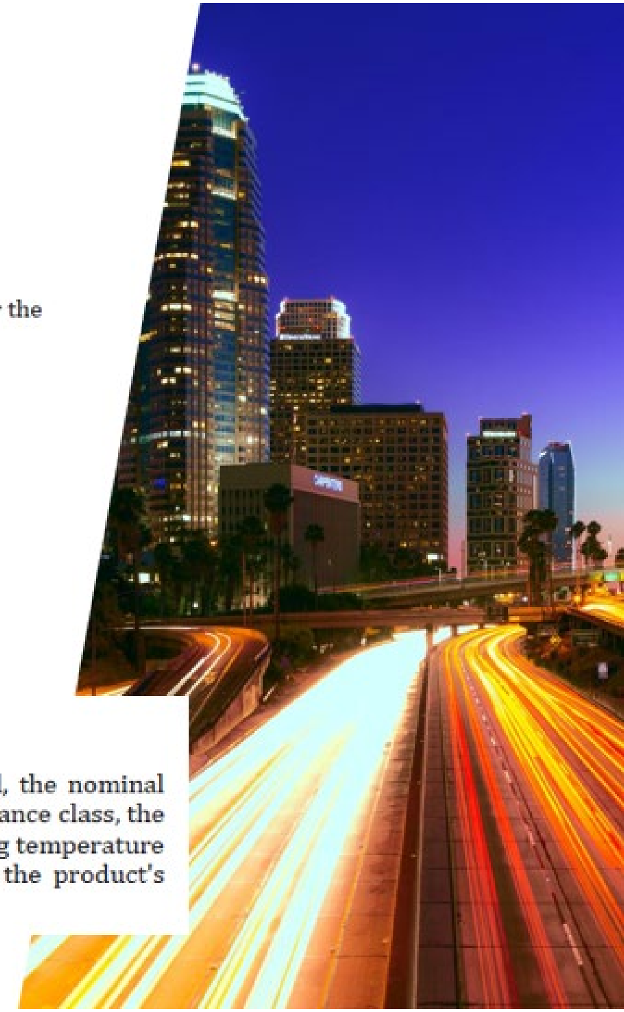
3.2.2 Applications

GAS	supply of gaseous fuels
W	supply of water for human consumption, including raw water prior to treatment and for the supply of water for general purpose
P	supply of underground drainage and sewerage under pressure
I	supply of water for irrigation
I	industrial applications



4 Manufacturers' declaration for the field of application

The manufacturer shall declare, depending on the intended use, the medium supplied, the nominal pressure (PN), the pipe material(s) to be jointed, the use of a stiffener, the end load resistance class, the corrosion resistance, ash content for glass reinforced materials, installation and operating temperature limits, as applicable, of the mechanical fittings. This declaration shall be included in the product's technical file.

5.2 Plastic materials

The compound/formulation used to manufacture any plastic components of the fitting exposed to weathering during storage and handling shall be weathering resistant. For longer use and operation, the component shall be protected.

Pressure-bearing components shall be produced from virgin material, own reprocessable material or a combination of virgin and own reprocessable material. Recycled materials shall not be used. The same applies for glass-reinforced materials with a fibre length up to 3 mm. For glass-reinforced materials with glass fibres longer than 3 mm, only virgin materials shall be used.

Table 1 lists components and fitting body materials in contact with the medium commonly used in practice for GAS, W, P and I. The suitability of the materials with "no experience" or other materials, which are not mentioned in Table 1, shall be demonstrated in agreement between the manufacturer and the end-user.

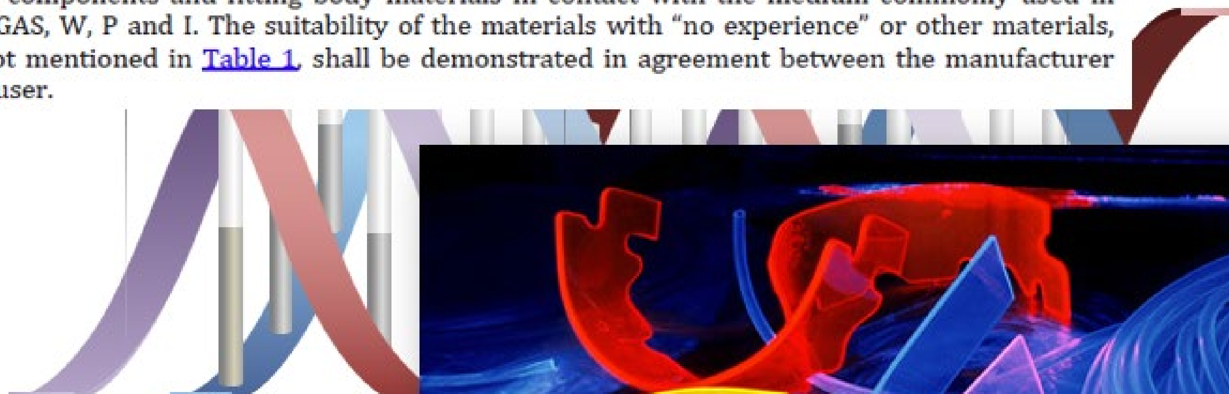


Table 1 *(continued)*

Material	Minimum value of MRS MPa	Suitable for	
		GAS	W, P, I
PVC-O 315	31,5	N.E.	Y
PVC-O 355	35,5	N.E.	Y
PVC-O 400	40,0	N.E.	Y
PVC-O 450	45,0	N.E.	Y
PVC-O 500	50,0	N.E.	Y
PVC-U	25,0	N	Y
PVDF	25,0	N.E.	Y

[a] Copolymer and homopolymer.

Key

Y yes

N no

N.E. no experience with this material

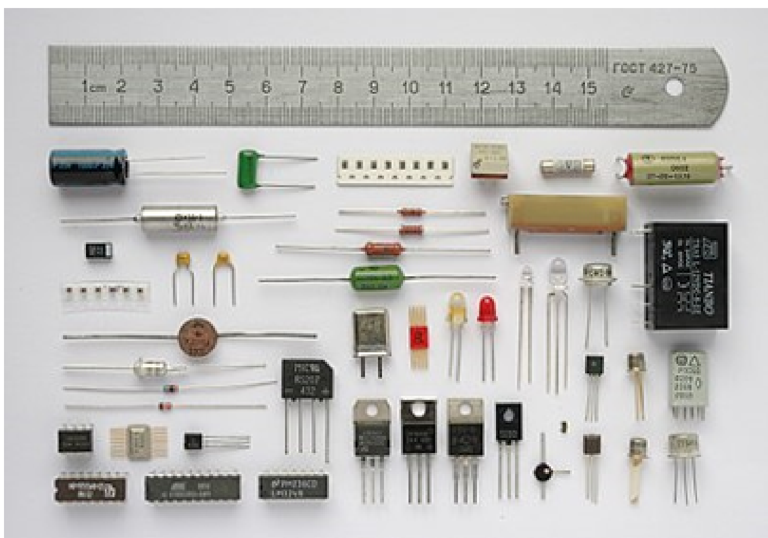


Table 1 — Plastic components and fitting body materials

Material	Minimum value of MRS MPa	Suitable for	
		GAS	W, P, I
ABS	12,5	N.E.	Y
ECTFE	18,4	N.E.	Y
PA-U 11 160	16,0	Y	N
PA-U 11 180	18,0	Y	N
PA-U 12 160	16,0	Y	N
PA-U 12 180	18,0	Y	N
PA-U 12-GF30	20,0	Y	Y
PA-U 12-GF50	20,0	Y	Y
PA-U 12-GF65	20,0	Y	Y
PB	12,5	N.E.	Y
PE 80	8,0	Y	Y
PE 100	10,0	Y	Y
PE-RT Type 1	8,0	N.E.	Y
PE-RT Type 2	8,0	N.E.	Y
PE-X	8,0	Y	Y
POM[a]	10,0	Y	Y
PP-B	8,0	N.E.	Y
PP-H	10,0	N.E.	Y
PP-R	8,0	N.E.	Y
PP-RCT	11,2	N.E.	Y
PPSU	32,0	N.E.	Y
PSU	16,0	N.E.	Y
PVC-C	20,0	N	Y
PVC-HI	14,0	Y	Y

[a] Copolymer and homopolymer.

Key

Y yes

N no

N.E. no experience with this material

5.3 Metals

For fittings made with metal components, these components should be made from one or more of the materials listed in Table 2.

The materials should be corrosion resistant or should be protected against corrosion, according to their intended end-use conditions unless otherwise stated in the manufacturer's declaration (see Clause 4).

Table 2 — Example of commonly used metal fitting materials

Material designation symbol		Relevant standard
Copper	Cu-DHP	EN 12449
	Cu-OF	CEN/TS 13388
Copper alloys	$CuSn_5Zn_5Pb_5$-C	EN 1982
	$CuSn_3Zn_8Pb_5$-C	EN 1982
	$CuSn_7Zn_2Pb_3$-C	EN 1982
	$CuSn_7Zn_4Pb_7$-C	EN 1982
	$CuSn_5Zn_5Pb_3$-C	EN 1982
	$CuSi_4Zn_9MnP$	EN 1982
	$CuZn_{39}Pb_3$	EN 12164, EN 12165
	$CuZn_{40}Pb_2$	EN 12164, EN 12165
	$CuZn_{36}Pb_2As$	EN 12164, EN 12165
	$CuZn_{35}Pb_2Al$-C	EN 1982
	$CuZn_{39}Pb_1Al$-C	EN 1982
	$CuZn_{33}Pb_2$-C	EN 1982
	$CuZn_{15}As$-C	EN 1982
	$CuZn_{21}Si_3P$	EN 1982
Spheroidal graphite cast iron		ISO 1083
Malleable cast iron		ISO 5922:2005[a]
Unalloyed steel	L235 (1.0252)	EN 10224
	L355 (1.0419)	EN 10224
	P235TR1 (1.0254)	EN 10216-1, EN 10217-1
	P235TR2 (1.0255)	EN 10216-1, EN 10217-1
	P355N (1.0562)	EN 10216-3, EN 10217-3
Stainless steel	1.4301	EN 10216-5
	1.4401	EN 10216-5
	1.4404	EN 10216-5
	1.4408	EN 10213
	1.4521	EN 10296-2
	1.4571	EN 10216-5
	1.4581	EN 10213
	1.5710	EN 10216-5

a Excluded material grade ISO 5922/JMB/275-5.

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5.4 Elastomers

The material of elastomeric sealing elements in fittings shall conform to the standards given in Table 3 and Table 4 depending on the application.

For IS and I, the material used for elastomeric sealing elements should be chosen as appropriate.

Table 3 — W and P applications

Type	Application	Standards
WA	Cold potable water	ISO 4633[a]
WC	Cold non-potable water supply, drainage, sewerage and rainwater	ISO 4633[a]
WG	Cold non potable water supply, drainage, sewerage and rainwater pipes with oil resistance	ISO 4633[a]
WT	Waste water and drainage application – Thermoplastic elastomers	ISO 23711[b]
WH	Waste water and drainage application with oil resistance – Thermoplastic elastomers	ISO 23711[b]

NOTE Attention is drawn to the need to comply with national regulations concerning the effects of materials in contact with water for the purpose of drinking water supply.

[a] If an International Standard with the same content exists, e.g. EN 681-1, conformance may alternatively be considered as acceptable.

[b] If an International Standard with the same content exists, e.g. EN 681-2, conformance may alternatively be considered as acceptable.

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Annex C
(normative)

Test stress of materials and fitting bodies

The test stress of materials and fitting bodies are given in Table C.1

Table C.1 — Test stress of materials and fittings bodies

Material	Test temperature	Test duration	$\sigma_{T,F}$	MRS	C_{min}
	°C	h	MPa	MPa	-
ABS	20	1	24,8	12,5	1,6[a]
	70	1 000	3,1	12,5	1,6[a]
ECTFE	20	40	26,0	18,4	1,25
	80	170	8,0	18,4	1,25
PA-U 11 160	20	1 000	19,0	16	1,6[a]
	80	165	10,0	16	1,6[a]
PA-U 11 180	20	1 000	20,0	18	1,6[a]
	80	165	11,5	18	1,6[a]
PA-U 12 160	20	1 000	19,0	16	1,6[a]
	80	165	10,0	16	1,6[a]
PA-U 12 180	20	1 000	20,0	18	1,6[a]
	80	165	11,5	18	1,6[a]
PA-U 12-GF30	20	1	50,0	20	1,6[a]
	60	1 000	20,0	20	1,6[a]
PA-U 12-GF50	20	1	50,0	20	1,6[a]
	60	1 000	20,0	20	1,6[a]
PA-U 12-GF65	20	1	50,0	20	1,6[a]
	60	1 000	20,0	20	1,6[a]
PB	20	1	15,5	12,5	1,25[a]
	95	1 000	6,0	12,5	1,25[a]
PE 80	20	1	11,3	8	1,25[a]
	80	1 000	4,0	8	1,25[a]
PE 100	20	1	13,3	10	1,25[a]
	80	1 000	5,0	10	1,25[a]
PE-RT – Type 1	20	1	9,9	8	1,25[a]
	95	1 000	3,4	8	1,25[a]
PE-RT – Type 2	20	1	10,8	8	1,25[a]
	95	1 000	3,6	8	1,25[a]
PE-X	20	1	11,0	8	1,25[a]
	95	1 000	4,4	8	1,25[a]
POM-C	20	1	31,5	10	1,6
	60	1 000	5,985	10	1,6

[a] Value taken from ISO 12162.

Table C.1 *(continued)*

Material	Test temperature	Test duration	$\sigma_{T,F}$	MRS	C_{min}
	°C	h	MPa	MPa	-
POM-H	20	1	39,69	10	1,6
	60	1 000	9,45	10	1,6
PP-B	20	1	15,75	8	1,25[a]
	95	1 000	2,52	8	1,25[a]
PP-H	20	1	20,79	10	1,6[a]
	95	1 000	3,465	10	1,6[a]
PP-R	20	1	15,75	8	1,25[a]
	95	1 000	3,465	8	1,25[a]
PP-RCT	20	1	15,0	11,2	1,25[a]
	95	1 000	3,8	11,2	1,25[a]
PPSU	20	1	57,1	32	1,4[a]
	95	1 000	21,3	32	1,4[a]
PSU	20	1	66,0	16	1,4
	95	1 000	9,7	16	1,4
PVC-C	20	1	43,0	20	1,6[a]
	60	1 000	16,5	20	1,6[a]
PVC-HI	20	1	30,0	25	1,4[a]
	60	1 000	9,0	25	1,4[a]
PVC-O 315	20	10	40,8	31,5	1,6[a]
	60	1 000	19,2	31,5	1,6[a]
PVC-O 400	20	10	52,0	40,0	1,6[a]
	60	1 000	25,0	40,0	1,6[a]
PVC-O 450	20	10	60,0	45,0	1,4[a]
	60	1 000	29,0	45,0	1,4[a]
PVC-O 500	20	10	65,0	50,0	1,4[a]
	60	1 000	32,0	50,0	1,4[a]
PVC-U	20	1	42,0	25	1,6[a]
	60	1 000	10,0	25	1,6[a]
PVDF	20	1	32,6	25	1,4[a]
	95	1 000	11,5	25	1,4[a]

[a] Value taken from ISO 12162.

9.2.2 Testing of pressure resistance

For plastic materials where an ISO 9080 evaluation has been carried out or where requirements to the long-term pressure resistance exists in a product standard, the test pressure for the fitting body is given in Formula (1):

$$p_{T} = PN \times C_{mi} \times \frac{\sigma_{T,F}}{MRS} \qquad (1$$

where

p_T	is the test pressure of the fitting body (bar);
PN	is the nominal pressure of the fitting (bar);
$\sigma_{T,}$	is the test stress of the fitting material (MPa);
F	is the minimum value of the design coefficient of the fitting material (-).

The test parameters given in Annex C shall be followed, using the test procedure given in ISO 1167-1.

No failure shall occur during the test.

Annex D
(normative)

Physical characteristics of fitting materials

determined in accordance with the test method specified in Table 5, using the parameters ted, the physical characteristics of parts made of fittings materials shall conform to the ements given in Table D.1.

Table D.1 — Physical characteristics of parts made of fitting materials

terial	Characteristic	Requirement	Test parameters		Test method
ABS	Vicat softening temperature (VST/B/50 N)	≥ 90 °C	Conditioning	6 h in air at 80 °C	ISO 306
		and			
		≥ 70 °C	Conditioning	16 h in water at 90 °C	ISO 306
CTFE	Melt mass-flow rate (MFR)	0,8 to 1,3	Temperature Load	275 °C 2,16 kg	ISO 1133-1
	Heat deflection temperature	≥ 90 °C	Load	0,46 MPa	ISO 75-2
11 160 11 180 12 160 12 180	Viscosity number	≥ 180 ml/g	Solvent Concentration	m-Cresol 0,5 %	ISO 307
12-GF30 12-GF50 12-GF65	Viscosity number	≥ 120 ml/g	Solvent Concentration	m-Cresol 0,5 %	ISO 307
2-GF30	Ash content	(30 ± 2) %	Calcination temperature	(850 ± 50) °C[a]	ISO 3451-4
2-GF50	Ash content	(50 ± 2) %	Calcination temperature	(850 ± 50) °C[a]	ISO 3451-4
2-GF65	Ash content	(65 ± 2) %	Calcination temperature	(850 ± 50) °C[a]	ISO 3451-4

at that temperature glass fibres present become molten and thus prevent further calcinations of the polymer, lower perature of calcinations to (600 ± 25) °C and repeat the procedure with a fresh test portion.

t applicable for outerlayer material introduced to facilitate fusion jointing.

tolerance of ±5 % shall apply to manufacturer's nominated value at any point in the body of the fitting.

mples of radial thickness 0.1 mm to be used for measurement of gel content. Samples to be taken at least from the nd inner surfaces of the PE-X fitting and the mid-wall position.

be carried out on feedstock fitting material or on reverted fitting.

e weld-line is likely to become more pronounced, but this should not be taken as a sign of weld-line splitting.

r sprue-gating, the area of the injection point shall be calculated using a radius R = 0,3d, with a maximum value of . For fittings moulded by end-gating techniques (e.g. ring or diaphragm methods) the gating area shall be a cylindrical with a length of L = 0,3d, with a maximum value of 50 mm (see Figure D.1). Any cracks or delamination in the wall fitting within to the injection area, parallel to the axis of the fitting, shall not penetrate in the axial direction more % of the length, L, defined in this footnote.

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Table D.1 *(continued)*

Material	Characteristic	Requirement	Test parameters		Test method
PB	Melt mass-flow rate (MFR)	After processing maximum deviation of ± 30 % of the value measured on the batch used to manufacture the fitting	Temperature Load	190 °C 5 kg or 2,16 kg	ISO 1133-1
PE-X[b]	Degree of crosslinking	Crosslinking process: Peroxide ≥ 70 %[e] Silane ≥ 65 %[e] Electron beam ≥ 60 %[e]	Media Time	Boiling xylene 8 h ± 30 min.	ISO 10147[d]
POM	Melt mass-flow rate (MFR)	≤ 4 g/10 min	Temperature Load	190 °C 2,16 kg	ISO 1133-1
PP-B PP-H PP-R PP-RCT	Melt mass-flow rate (MFR)	After processing maximum deviation of ±30 % of the value measured on the batch used to manufacture the fitting	Temperature Load Alternative condition: Temperature Load	230 °C 2,16 kg 190 °C 5 kg	ISO 1133-1
PPSU	Melt mass-flow rate (MFR)	After processing maximum deviation of ±30 % of the value measured on the batch used to manufacture the fitting	Temperature Load Alternative condition: Temperature Load	365 °C 5 kg 360 °C 10 kg	ISO 1133-1
PSU	Melt mass-flow rate (MFR)	After processing maximum deviation of ±30 % of the value measured on the batch used to manufacture the fitting	Temperature Load Alternative condition: Temperature Load	343 °C 2,16 kg 360 °C 2,16 kg	ISO 1133-1
PVC-C	Vicat softening temperature	≥ 103 °C	Shall conform to ISO 2507-2		ISO 2507-1
PVC-HI PVC-U	Vicat softening temperature	≥ 74 °C	Shall conform to ISO 2507-2		ISO 2507-1

[a] If at that temperature glass fibres present become molten and thus prevent further calcinations of the polymer, lower the temperature of calcinations to (600 ± 25) °C and repeat the procedure with a fresh test portion.

[b] Not applicable for outerlayer material introduced to facilitate fusion jointing.

[c] A tolerance of ±5 % shall apply to manufacturer's nominated value at any point in the body of the fitting.

[d] Samples of radial thickness 0,1 mm to be used for measurement of gel content. Samples to be taken at least from the outer and inner surfaces of the PE-X fitting and the mid-wall position.

[e] To be carried out on feedstock fitting material or on reverted fitting.

[f] The weld-line is likely to become more pronounced, but this should not be taken as a sign of weld-line splitting.

[g] For sprue-gating, the area of the injection point shall be calculated using a radius $R = 0{,}3d_n$ with a maximum value of 50 mm. For fittings moulded by end-gating techniques (e.g. ring or diaphragm methods) the gating area shall be a cylindrical portion with a length of $L = 0{,}3d_n$ with a maximum value of 50 mm (see Figure D.1). Any cracks or delamination in the wall of the fitting within to the injection area, parallel to the axis of the fitting, shall not penetrate in the axial direction more than 20 % of the length, L, defined in this footnote.

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Table D.1 *(continued)*

Material	Characteristic	Requirement	Test parameters		Test method
PVC-O	Vicat softening temperature	≥ 80 °C	Shall conform to ISO 2507-2		ISO 2507-1
PVC-C PVC-O[e] PVC-U	Effects of heating	The fittings shall not show any blisters or signs of weld-line splitting.[f] If injection moulded: No surface damage in the area of any injection point shall penetrate deeper than 30 % of e at that point for $d_n < 75$ mm and 50 % for $d_n > 63$ mm. Outside the area of any injection point or if the fitting is formed no surface damage shall occur.[g]	Test temperature Test period for: $e \leq 3$ $3 < e \leq 10$ $10 < e \leq 20$ $20 < e \leq 30$ $30 < e \leq 40$ $40 < e$ Number of test pieces	(150 ± 2) °C 15 min 30 min 60 min 140 min 220 min 240 min 3	ISO 580:2005, Method A
PVC-HI	Effects of heating	Shall conform to ISO 6993-2 and ISO 6993-3	Test temperature Test period for: $e \leq 3$ $3 < e \leq 10$ $10 < e \leq 20$ $20 < e \leq 30$ $30 < e \leq 40$ $40 < e$ Number of test pieces	(150 ± 2) °C 15 min 30 min 60 min 140 min 220 min 240 min 3	ISO 580:2005, Method A
PVDF	Melt mass-flow rate (MFR)	After processing maximum deviation of ±20 % of the value measured on the batch used to manufacturer the fitting	Temperature Load	230 °C 5 kg	ISO 1133-1
	Vicat softening temperature	≥ 125 °C	Load	1 kg	ISO 306

[a] If at that temperature glass fibres present become molten and thus prevent further calcinations of the polymer, lower the temperature of calcinations to (600 ± 25) °C and repeat the procedure with a fresh test portion.

[b] Not applicable for outerlayer material introduced to facilitate fusion jointing.

[c] A tolerance of ±5 % shall apply to manufacturer's nominated value at any point in the body of the fitting.

[d] Samples of radial thickness 0.1 mm to be used for measurement of gel content. Samples to be taken at least from the outer and inner surfaces of the PE-X fitting and the mid-wall position.

[e] To be carried out on feedstock fitting material or on reverted fitting.

[f] The weld-line is likely to become more pronounced, but this should not be taken as a sign of weld-line splitting.

[g] For sprue-gating, the area of the injection point shall be calculated using a radius $R = 0.3d_n$ with a maximum value of 50 mm. For fittings moulded by end-gating techniques (e.g. ring or diaphragm methods) the gating area shall be a cylindrical portion with a length of $L = 0.3d_n$ with a maximum value of 50 mm (see Figure D.1). Any cracks or delamination in the wall of the fitting within to the injection area, parallel to the axis of the fitting, shall not penetrate in the axial direction more than 20 % of the length, L, defined in this footnote.

Table D.1 *(continued)*

Material	Characteristic	Requirement	Test parameters		Test method
Cu alloys	Dezincification resistance	The maximum depth of dezincification, in any direction, shall be 200 µm	Exposed area	~100 mm²	ISO 6509-1
			Test temperature	(75 ± 5) °C	
			Test duration	24 h	

[a] If at that temperature glass fibres present become molten and thus prevent further calcinations of the polymer, lower the temperature of calcinations to (600 ± 25) °C and repeat the procedure with a fresh test portion.

[b] Not applicable for outerlayer material introduced to facilitate fusion jointing.

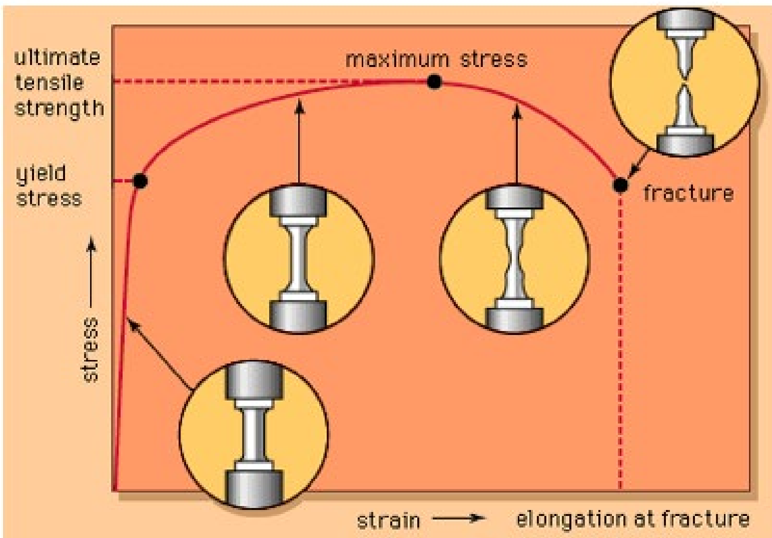
[c] A tolerance of ±5 % shall apply to manufacturer's nominated value at any point in the body of the fitting.

[d] Samples of radial thickness 0,1 mm to be used for measurement of gel content. Samples to be taken at least from the outer and inner surfaces of the PE-X fitting and the mid-wall position.

[e] To be carried out on feedstock fitting material or on reverted fitting.

[f] The weld-line is likely to become more pronounced, but this should not be taken as a sign of weld-line splitting.

[g] For sprue-gating, the area of the injection point shall be calculated using a radius $R = 0{,}3d_n$ with a maximum value of 50 mm. For fittings moulded by end-gating techniques (e.g. ring or diaphragm methods) the gating area shall be a cylindrical portion with a length of $L = 0{,}3d_n$ with a maximum value of 50 mm (see Figure D.1). Any cracks or delamination in the wall of the fitting within to the injection area, parallel to the axis of the fitting, shall not penetrate in the axial direction more than 20 % of the length, L, defined in this footnote.



Annex F
(normative)

Test stresses

The test stresses depending on the pipe materials and intended application are given in Table F.1; see 9.3.3.3 and 9.3.3.4.

Table F.1 — Test stresses depending on pipe materials

Pipe material	Application		Test stress, σ_T MPa
	GAS	W, P, IS, I	
ABS	—	X	12,5[a]
ECTFE	—	X	13,0[b]
PA-U 11 160	X	—	11,5[a]
PA-U 11 180	X	—	13,0[a]
PA-U 12 160	X	—	11,5[a]
PA-U 12 180	X	—	13,0[a]
PB	—	X	7,7[a]
PE32	—	X	2,8[a]
PE40	—	X	3,3[a]
PE63	—	X	4,5[a]
PE80	X	X	5,7[a]
PE100	X	X	6,6[a]
PE-RT – Type 1	—	X	4,9[a]
PE-RT – Type 2	—	X	5,4[a]
PE-X	X	X	5,5[a]
PP-B	—	X	8,0[a]
PP-H	—	X	10,5[a]
PP-R	—	X	8,0[a]
PP-RCT	—	X	7,5[a]

Key

X applicable

— not applicable

[a] These are longitudinal stresses, and their values are therefore half those of the circumferential stresses given as hoop stresses for 1 h at 20 °C.

[b] These are longitudinal stresses, and their values are therefore half those of the circumferential stresses given as hoop stresses for 40 h at 20 °C.

[c] These are longitudinal stresses, and their values are therefore half those of the circumferential stresses given as hoop stresses for 10 h at 20 °C.

[d] Where:

p_T is the calculated pressure and is half of the value of the pressure (bar) at 1 h at 20 °C. This can be calculated by the following:

a) using the formula from ISO 17456:2006, Annex A, if the long-term pressure strength is calculated with Procedure I: "Calculation method" (multilayer P pipes);

b) from reference curve from ISO 17456, if the long-term pressure strength is determined with Procedure II: "Pressure test" (multilayer M and P pipes).

Table F.1 *(continued)*

Pipe material	Application		Test stress, σ_T
	GAS	W, P, IS, I	MPa
PVC-C	—	X	21,5[a]
PVC-HI	X	X	15,0[a]
PVC-O 315	—	X	20,4[c]
PVC-O 355	—	X	23,0[c]
PVC-O 400	—	X	26,0[c]
PVC-O 450	—	X	30,0[c]
PVC-O 500	—	X	32,5[c]
PVC-U	—	X	21,0[a]
PVDF	—	X	16,3[a]
Multi-layer	X	X	$\sigma_T = \frac{p_T \times (d_n - e_n)}{20 \times e_n}$ [d]

Key

X applicable

— not applicable

[a] These are longitudinal stresses, and their values are therefore half those of the circumferential stresses given as hoop stresses for 1 h at 20 °C.

[b] These are longitudinal stresses, and their values are therefore half those of the circumferential stresses given as hoop stresses for 40 h at 20 °C.

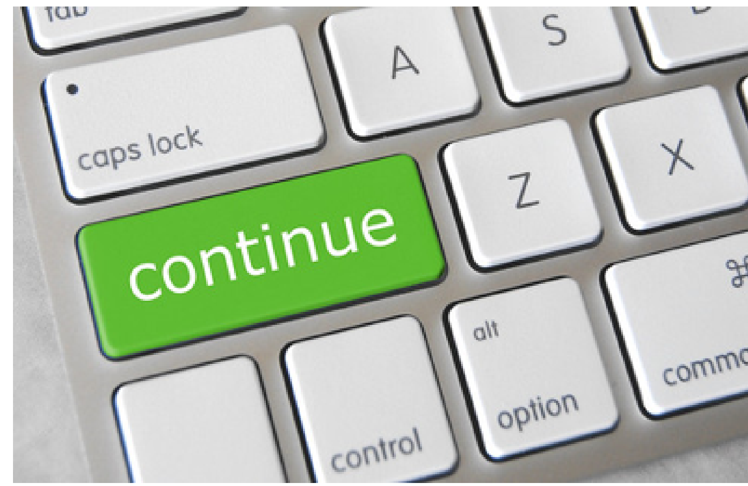
[c] These are longitudinal stresses, and their values are therefore half those of the circumferential stresses given as hoop stresses for 10 h at 20 °C.

[d] Where:

p_T is the calculated pressure and is half of the value of the pressure (bar) at 1 h at 20 °C. This can be calculated by the following:

a) using the formula from ISO 17456:2006, Annex A, if the long-term pressure strength is calculated with Procedure I: "Calculation method" (multilayer P pipes);

b) from reference curve from ISO 17456, if the long-term pressure strength is determined with Procedure II: "Pressure test" (multilayer M and P pipes).



9.3 Fitting assemblies

9.3.1 Preparation of test assemblies

The tests shall be carried out on pipe and fitting assembled in accordance with the manufacturer's instructions. The tests shall include all types of joint design.

The pipe(s) used in the test assemblies shall conform to the corresponding product standard if available.

9.3.2 Test scheme

The fittings and pipes shall not be tested until 24 h after their production. For practical reasons, the manufacturer may wait a shorter time before testing. In case of dispute, a duration of 24 h shall apply.

For initial testing (type testing), all relevant characteristics shown in Table 7 shall be carried out on a representative selection of diameters, pressure classes (PN) and types.

For factory production, control testing should be defined in the manufacturer's quality plan.

NOTE Since there are PE (polyethylene) materials such as PE 63, which are available only in some markets, the testing under general requirements is also applicable and if the products stand in accordance with the requirements, they can be approved for the particular use.

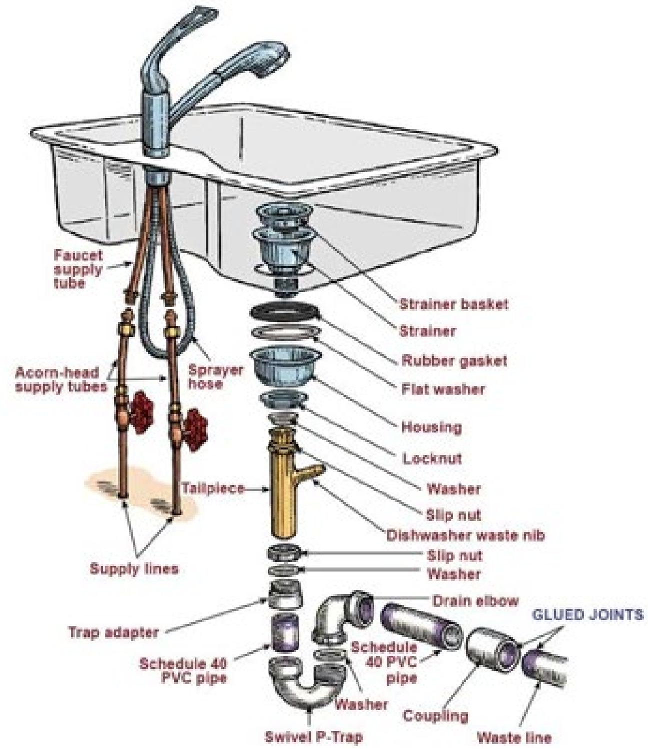


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Table 7 — Test scheme for mechanical fitting assemblies

Characteristics	Requirement	Application		Joint type	Test method
	Subclause	GAS	W, P, I, IS		
Leak tightness under internal pres-sure	9.3.3.1	X[a]	X[b]	All types	ISO 3458
Long-term pressure test for leak tight-ness under internal pressure	9.3.3.2	X[a]	X	All types	ISO 3458 ISO 1167-1 ISO 1167-4
Resistance of plastic pipe/pipe or pipe/fitting assemblies to tensile load-ing at 23 °C	9.3.3.3	X[a]	—	Joints with full-end-load resist-ance[c]	ISO 13951
Resistance to pull out at 23 °C	9.3.3.4	—	X	Joints with end-load resistance[d]	ISO 3501
Resistance to end load at 80 °C	9.3.3.5	X[a]	—	Joints with full-end-load resist-ance[d,e]	ISO 19899
Leak tightness after temperature cycling (outside temperature)	9.3.3.6	X	—	All types	Table 10 ISO 3458
Leak tightness under internal pres-sure when subjected to bending	9.3.3.7	X[a]	X	All types[d,f]	ISO 3503
Leak tightness under negative pres-sure	9.3.3.8	—	X	All types[g]	ISO 3459
Leak tightness with angular deflection and deformation	9.3.3.9	X[a]	X	Joint with non-end-load resist-ance [d,h,i]	ISO 13845 and ISO 13844
Leak tightness and strength while subjected to bending and internal pressure	9.3.3.10	—	X	Joint with end-load resistance [d,j]	ISO 13783

Key

X applicable

— not tested or not applicable

NOTE Full-end-load resistance is the condition in which the joint is stronger than the connecting pipe when exposed to all applied end loads.

[a] For eacht test: if the mechanical fittings are intended to be assembled by the end user, half of the test pieces shall be assembled at the minimum installation temperature as declared by the manufacturer (see Clause 4), the other half at the maximum installation temperature.

[b] If the leak tightness test under internal pressure when subjected to bending (9.3.3.7) is carried out and the requirements have been fulfilled, this test is not necessary.

[c] Only valid for pipes: PE, PE-X, PB, PP-B and PP-R ≤ 250 mm; PA-U ≤ 63 mm; multilayer ≤ 32 mm.

[d] Test of joint design. Normally perfomed on uniaxial fitting (coupling) assemblies.

[e] Only valid for PE pipes ≤ 63 mm.

[f] Only valid for pipes: PA-U, PE, PE-X, PB, PP-B and PP-R ≤ 63 mm; multilayer ≤ 32 mm.

[g] Only valid for pipes ≤ 63 mm.

[h] Only valid for pipes: PVC, PP-H, PVDF and ABS (all dimensions); PE, PE-X, PB, PP-B and PP-R > 63 mm; multilayer > 32 mm.

[i] Only valid for joints with elastomeric-sealing-ring-type sockets.

[j] Only valid for PVC-U and PVC-O pipes.

[k] Only valid for fittings that incorporate an internal cross-section that is smaller than the theoretical minimal internal cross section of the pipe, which is calculated using the minimum outside diameter and the maximum wall thickness of the pipe on which the fitting is to be used.

[l] Only valid for fittings containing brass components.

Annex G
(normative)

Cyclic test procedure

Before being submitted to the cyclic test procedure of Table G.1, the fitting assembly shall be pressurized with the required internal pressure (see 9.3.3.6) **at ambient temperature. After stabilization of the** pressure and verification of the leak tightness of the fitting assembly and the connections of the pressure supply line, the fitting assembly shall be isolated from the pressure source.

Table G.1 gives the cyclic test procedure for leak tightness after temperature cycling (outside temperature: see 9.3.3.6).

After the test, the pressure in the fitting assembly shall be measured. If a decrease in the pressure of >15 % is found, the leak shall be located to verify that it is caused by a fitting and not by the test set-up.

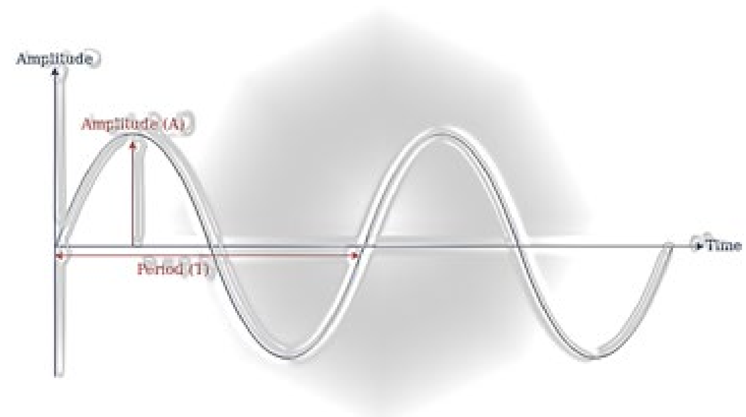
For additional information on the leak tightness of the fitting assembly, the pressure can be recorded during the cyclic test procedure, together with the temperature of the temperature-regulated chamber(s). In case of a decrease in pressure, not related to the temperature variation effects, the position of leak, at which temperature and in which cycle number the leak occurred can be identified.

NOTE Due to the temperature variations in the cyclic test procedure, pressure variations are induced in the fitting assembly.

Alternatively, the air flow may be measured during the cyclic test procedure while keeping the pressure constant. In this case, the leak tightness cannot be evaluated by the pressure inside the fitting assembly after the cyclic test procedure and shall be done by evaluation of the air flow during the test. An air flow ≤10 ml/h is considered leak tight for this test procedure.

Table G.1 — Cyclic test procedure

Test method	Cyclic test procedure
Method A	a) place the fitting assembly in the first chamber at T_{min}[a] ± 2 °C and leave it there for at least 2,5 h; b) transfer the fitting assembly to the second chamber at T_{min}[a] ± 2 °C; the minimum transfer time shall be 0,5 h and the maximum 1 h; c) leave the fitting assembly in the second chamber at T_{max}[a] ± 2 °C for at least 2,5 h; d) transfer the fitting assembly to the first chamber at T_{max}[a] ± 2 °C; the minimum transfer time shall be 0,5 h and the maximum 1 h; e) return to a).
Method B	a) increase the temperature of the chamber to T_{max}[a] ± 2 °C at a minimum rate of 1 °C/min; b) maintain at T_{max}[a] ± 2 °C for at least 2 h; c) reduce the temperature to T_{min}[a] ± 2 °C at a minimum rate of 1 °C/min; d) maintain at T_{min}[a] ± 2 °C for at least 2 h; e) return to a).
[a] T_{max} and T_{min} are installation temperatures as declared by the manufacturer; see Clause 4.	



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Quality Management and Control

- SANS ISO 9001
- Permit Condition Audits
- Guidance standards for assessment
- Appointed Inspection Authorities
- Third Party testing
- Validation testing
- Preapproved manufacturers

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Installation and Jointing

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Installation and Jointing

- Mechanical joints
  - Full range certification on size ranges
  - Classification of mechanical clamps
    - E.g. Type I – Pressure capability without mechanical strength
    - Type II – Pressure capability and mechanical strength equal and or greater than the base pipe

Pre-Commissioning testing

Pre-commissioning testing does not indicate product conformance

Adhere to standard

Questions and Answers

ian@sappma.co.za

admin@sappma.co.za

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