BS EN 12516-4:2014

BSI Standards Publication

Industrial valves — Shell design strength

Part 4: Calculation method for valve shells manufactured in metallic materials other than steel

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National foreword

This British Standard is the UK implementation of EN 12516-4:2014. It supersedes BS EN 12516-4:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PSE/18/1, Industrial valves, steam traps, actuators and safety devices against excessive pressure - Valves - Basic standards.

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Foreword

This document (EN 12516-4:2014) has been prepared by Technical Committee CEN/TC 69 “Industrial valves”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2015 and conflicting national standards shall be withdrawn at the latest by April 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12516-4:2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 97/23/EC.

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

EN 12516, *Industrial valves — Shell design strength*, consists of four parts:

— *Part 1: Tabulation method for steel valve shells*;

— *Part 2: Calculation method for steel valve shells*;

— *Part 3: Experimental method*;

— *Part 4: Calculation method for valve shells manufactured in metallic materials other than steel* (the present document).

The main changes compared to the previous edition are:

a) normative references have been updated;

b) Clause 4 has been revised;

c) additional ductile iron materials were added to Table 2;

d) Subclause 5.2.2 has been revised;

e) Safety factors in Table 17 have been corrected to be in line with other practicable standards;

f) Annex ZA has been revised.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the calculation method for valve shells manufactured in metallic materials other than steel. The loadings to be accounted for are in accordance with EN 12516-2.

Design methods are in accordance with EN 12516-2, design by formulae according to the relevant clauses.

2 Normative references

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

EN 485-2:2013, *Aluminium and aluminium alloys — Sheet, strip and plate — Part 2: Mechanical properties*

EN 586-2:1994, *Aluminium and aluminium alloys — Forgings — Part 2: Mechanical properties and additional property requirements*

EN 754-2:2013, *Aluminium and aluminium alloys — Cold drawn rod/bar and tube — Part 2: Mechanical properties*

EN 755-2:2013, *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles — Part 2: Mechanical properties*

EN 1092-2, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 2: Cast iron flanges*

EN 1092-3, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 3: Copper alloy flanges*

EN 1092-4, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 4: Aluminium alloy flanges*

EN 1561:2011, *Founding — Grey cast irons*

EN 1562:2012, *Founding — Malleable cast irons*

EN 1563:2011, *Founding — Spheroidal graphite cast irons*

EN 1653:1997, *Copper and copper alloys — Plate, sheet and circles for boilers, pressure vessels and hot water storage units*

EN 1759-3, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, Class designated — Part 3: Copper alloy flanges*

EN 1982:2008, *Copper and copper alloys — Ingots and castings*

EN 12163:2011, *Copper and copper alloys — Rod for general purposes*

EN 12420:2014, *Copper and copper alloys — Forgings*

EN 12449:2012, *Copper and copper alloys — Seamless, round tubes for general purposes*

EN 12516-2:2014, *Industrial valves — Shell design strength — Part 2: Calculation method for steel valve shells*

CEN/TS 13388:2013, *Copper and copper alloys — Compendium of compositions and products*

EN 13445-8:2009, *Unfired pressure vessels — Part 8: Additional requirements for pressure vessels of aluminium and aluminium alloys*

ISO 7005-3, *Metallic flanges — Part 3: Copper alloy and composite flanges*

3 Symbols and units

Table 1 — Symbols and units

Symbol	Characteristic	Unit
f	nominal design stress	MPa
$f_{d/t}$	nominal design stress for design conditions at temperature t °C	MPa
$f_{d/20}$	nominal design stress for design conditions at 20 °C	MPa
R_m	minimum tensile strength	MPa
$R_{m/20}$	Tensile strength at 20 °C	MPa
$R_{m/t}$	tensile strength at temperature t °C	MPa
$R_{p0,1}$	minimum 0,1 %-proof strength	MPa
$R_{p0,2}$	minimum 0,2 %-proof strength	MPa
$R_{p0,2/t}$	0,2 % — proof strength at temperature t °C	MPa
$R_{p1,0/t}$	1,0 % — proof strength at temperature t °C	MPa

4 Interrelation of thickness definitions

For interrelation of thickness definitions refer to EN 12516-2:2014, Clause 4.

5 Requirements

5.1 General

The calculation method for a valve shell in materials other than steel shall be in accordance with EN 12516-2. The choice of materials and their parameters shall be taken from the following clauses of this European Standard.

5.2 Materials — Cast iron

5.2.1 Allowable grades

Materials shall be in accordance with Table 2.

Table 2 — Allowable cast iron material types and grades

Cast iron material type	EN-standard	Designation	
		Symbol	Number
Grey cast iron	EN 1561	EN-GJL-200[a] EN-GJL-250	5.1300 5.1301
Malleable cast iron	EN 1562	EN-GJMB-300-6 EN-GJMB-350-10	5.4100 5.4101
Spheroidal graphite cast iron	EN 1563	EN-GJS-350-22-LT EN-GJS-350-22-RT EN-GJS-400-18-LT EN-GJS-400-18-RT EN-GJS-400-18 EN-GJS-400-15 EN-GJS-500-7 EN-GJS-600-3 EN-GJS-700-2	5.3100 5.3101 5.3103 5.3104 5.3105 5.3106 5.3200 5.3201 5.3300

[a] Grade EN-GJL-200 shall not be used for valves with flanged connections PN 25 or above.

Material properties shall be taken from the standards listed in Table 2.

5.2.2 Strength values

Tensile strength values for grey cast iron shall be taken from EN 1561.

For the tensile strength value of malleable iron grade EN-GJMB-300-6, to be used in the calculation, 300 MPa shall be taken.

The strength values for malleable cast iron grade EN-GJMB-350-10 shall be in accordance with Table 3.

Table 3 — Malleable cast iron — Strength values

Material designation	Strength characteristics $R_{p0,2/t}$ at calculation temperature in °C						
	20	100	150	200	250	300	350
	MPa						
EN-GJMB-350-10	200	190	180	160	150	140	120

The strength values for spheroidal graphite cast iron grades shall be in accordance with Table 4, 5 or 6.

Table 4 — Spheroidal graphite cast iron — Strength values for wall thickness up to 30 mm

Material designation	Strength characteristics $R_{p0,2/t}$ at calculation temperature in °C						
	20	100	150	200	250	300	350
	MPa						
EN-GJS-350-22 LT	220	210	200	180	170	150	140
EN-GJS-350-22 RT	220	210	200	180	170	150	140
EN-GJS-400-18 LT	240	230	220	200	190	170	150
EN-GJS-400-18 RT	250	240	230	210	200	180	160
EN-GJS-400-18	250	240	230	210	200	180	160
EN-GJS-400-15	250	240	230	210	200	180	160
EN-GJS-500-7	320	300	290	270	250	230	200
EN-GJS-600-3	370	350	340	320	300	270	220
EN-GJS-700-2	420	400	390	370	350	320	280

Table 5 — Spheroidal graphite cast iron — Strength values for wall thickness > 30 mm up to 60 mm

Material designation	Strength characteristics $R_{p0,2/t}$ at calculation temperature in °C						
	20	100	150	200	250	300	350
	MPa						
EN-GJS-350-22 LT	210	200	190	170	160	145	130
EN-GJS-350-22 RT	220	210	200	180	170	150	140
EN-GJS-400-18 LT	230	220	210	190	180	165	145
EN-GJS-400-18 RT	250	240	230	210	200	180	160
EN-GJS-400-18	250	240	230	210	200	180	160
EN-GJS-400-15	250	240	230	210	200	180	160
EN-GJS-500-7	300	275	265	245	225	205	180
EN-GJS-600-3	360	325	315	300	280	255	205
EN-GJS-700-2	400	370	360	345	325	300	265

Table 6 — Spheroidal graphite cast iron — Strength values for wall thickness > 60 mm up to 200 mm

Material designation	Strength characteristics $R_{p0,2/t}$ at calculation temperature in °C						
	20	100	150	200	250	300	350
	MPa						
EN-GJS-350-22 LT	200	190	180	160	150	140	120
EN-GJS-350-22 RT	200	190	180	160	150	140	120
EN-GJS-400-18 LT	220	210	200	200	170	160	140
EN-GJS-400-18 RT	240	220	210	210	180	170	150
EN-GJS-400-18	240	220	210	210	180	170	150
EN-GJS-400-15	240	220	210	210	180	170	150
EN-GJS-500-7	290	250	240	220	200	180	160
EN-GJS-600-3	340	300	290	280	260	240	190
EN-GJS-700-2	380	340	330	320	300	280	250

5.2.3 Pressure/temperature ratings for cast iron

5.2.3.1 The pressure/temperature ratings shall comply with EN 1092-2.

5.2.3.2 The use of valves at temperatures lower than those given in the tables for pressure/temperature ratings of EN 1092-2 is permitted, provided that their shells and bonnets are manufactured in spheroidal graphite cast iron of grades EN-GJS-350-22-LT or EN-GJS-400-18-LT, see Table 7. For temperatures below the lowest temperature given in the tables of ratings, the maximum allowable pressure shall not be higher than the pressure associated to the lowest temperature in the tables. The lowest calculation temperature shall not be less than the temperature specified for Charpy impact testing in accordance with EN 1563.

Table 7 — Allowable material grades for low temperature (LT) design conditions

Symbol	Number	Temperature limits
EN-GJS-350-22-LT	5.3100	- 40 °C to 350 °C
EN-GJS-400-18-LT	5.3103	- 20 °C to 350 °C

5.2.4 Welding

Repair welding on spheroidal and malleable cast iron may be carried out at the foundry only if it is approved by the customer.

Production or repair welding shall not be carried out on parts manufactured from grey cast iron.

5.3 Materials — Wrought copper alloys

5.3.1 General

Materials shall be in accordance with Table 8.

Table 8 — Allowable material grades

Material symbol	Material number	Material composition in accordance with	Temperature limits[a]
	EN		
SF-Cu	CW024A	EN 1653	– 269 °C to 250 °C
CuZn40	CW509L	CEN/TS 13388	– 196 °C to 250 °C
CuZn39Pb0,5	CW610N	EN 1653	– 196 °C to 250 °C
CuZn20Al2	CW702R	EN 1653	– 10 °C [c] to 250 °C[b]
CuZn28Sn1	CW706R	CEN/TS 13388	– 269 °C to 250 °C[b]
CuZn32Pb2AsFeSi[c]	CW709R	EN 12163	– 10 °C to 200 °C
CuZn38Sn1	CW717R	EN 1653	– 10 °C [c] to 250 °C
CuZn38SnAl	CW715R	EN 1653	– 196 °C to 250 °C
CuNi10Fe1Mn	CW352H	EN 1653	– 269 °C to 300 °C
CuNi30Mn1Fe	CW354H	EN 1653	– 269 °C to 350 °C
CuAl10Ni5Fe4	CW307G	EN 1653	– 10 °C [c] to 250 °C
CuNi30Fe2Mn2	CW353H	CEN/TS 13388	– 269 °C to 250 °C
CuSn6[c]	CW452K	EN 12449	– 10 °C to 200 °C
CuZn36Pb2As[c]	CW602N	EN 12420	– 10 °C to 200 °C
CuZn39Pb3[c]	CW614N	EN 12420	– 10 °C to 200 °C
CuZn40Pb2[c]	CW617N	EN 12420	– 10 °C to 200 °C
CuSn5Pb5Zn5-C[c]	CC491K	EN 1982	– 10 °C to 260 °C [d]
CuSn7Pb3Zn2-C[c]	CC492K	EN 1982	– 10 °C to 260 °C
CuSn7Pb7Zn4-C[c]	CC493K	EN 1982	– 10 °C to 260 °C [d]
CuSn6Zn4Pb2-C[c]	CC498K	EN 1982	– 10 °C to 260 °C
CuAl10Fe2-C[c]	CC331G	EN 1982	– 10 °C to 260 °C
CuAl10Ni5Fe5-C[c]	CC333G	EN 1982	– 10 °C to 350 °C
CuZn33Pb2Si-C[c]	CC751S	EN 1982	– 10 °C to 200 °C
CuZn39Pb1Al-C[c]	CC754S	EN 1982	– 10 °C to 200 °C
CuAl8Fe3	CW303G	EN 12420	– 10 °C to 260 °C
CuAl10Fe3Mn2	CW306G	EN 12420	– 10 °C to 260 °C

[a] The lowest temperature limits given apply to non-welded parts. For welded parts, the lowest service temperatures are defined by the manufacturer.

[b] CuZn20Al2 F30, F33 and CuZn28Sn1 F32 only applicable up to 150 °C.

[c] Materials should be preferred.

[d] Material may be used down to – 196 °C if ductility and toughness of the material have been verified by additional Charpy impact testing.

5.3.2 Strength values

Strength values shall be in accordance with Table 9, Table 10, Table 11 and Table 12.

Table 9 — Strength values for plates

Material code	Material condition	Thickness mm	Type of test value	Minimum value at temperature °C						
				50	100	150	200	250	300	350
				MPa						
SF-Cu	F20	> 15 to ≤ 120	$R_{p1,0/t}$ $R_{m/20}$	60 200	55 200	55 175	150	125		
	F25	> 15 to ≤ 40	$R_{p0,2/t}$	180	170	160	150			
CuZn40 and CuZn39Pb0,5	F34	> 15 to ≤ 40 > 40 to ≤ 80 > 80 to ≤ 120	$R_{p1,0/t}$	140 120 110	137 115 104	137 115 104	132 110 100			
	F40	> 15 to ≤ 40 > 40 to ≤ 80	$R_{p0,2/t}$	200 180	190 170	180 160				
CuZn20Al2 (CuZn20Al)	F30	> 15 to ≤ 40	$R_{p1,0/t}$	100	86	86				
	F39	> 15 to ≤ 40	$R_{p0,2/t}$	240	230	225				
CuZn38Sn1 (CuZn39Sn)	F34	> 15 to ≤ 40 > 40 to ≤ 80 > 80 to ≤ 120	$R_{p1,0/t}$	175 170 160	172 153 153	168 148 148				
	F40	> 15 to ≤ 40 > 40 to ≤ 80	$R_{p0,2/t}$	200 180	190 170	180 160				
CuZn38SnAl	F39	> 15 to ≤ 160	$R_{p1,0/t}$	180	175	172	170			
	F43	> 15 to ≤ 40 > 40 to ≤ 80 > 80 to ≤ 120	$R_{p0,2/t}$	200 190 180	185 175 165	185 175 165	175 165 155			
CuNi10Fe1Mn (CuNi10Fe)	F30	> 15 to ≤ 60 > 60 to ≤ 120	$R_{p1,0/t}$	145 125	138 118	133 114	128 109	123 104	118 99	
	F32	> 15 to ≤ 60	$R_{p0,2/t}$	200	190	185	175	170	165	
	F35	> 15 to ≤ 60	$R_{p0,2/t}$	250	235	225	220	210	205	
CuNi30Mn1Fe (CuNi30Fe)	F35	> 15 to ≤ 60 > 60 to ≤ 120	$R_{p1,0/t}$	175 140	163 130	158 126	153 123	148 120	143 117	138 112
	F41	> 15 to ≤ 60	$R_{p0,2/t}$	300	275	265	260	255	245	240
CuAl10Ni5Fe4 (CuAl10Ni)	F63	> 15 to ≤ 80	$R_{p0,2/t}$	270	265	260	260	250		

NOTE The pressure/temperature ratings comply with EN 1092-3, EN 1759-3 or ISO 7005-3.

Table 10 — Strength values for sheets and strips

Material code	Material condition	Thickness mm	Type of test value	Minimum value at temperature °C						
				50	100	150	200	250	300	350
				MPa						
SF-Cu	F20	> 15 to ≤ 120	$R_{p1,0/t}$ $R_{m/20}$	60 200	55 200	55 175	150	125		
	F25	> 15 to ≤ 40	$R_{p0,2/t}$	180	170	160	150			
CuZn40 and CuZn39Pb0,5	F34	> 15 to ≤ 40 > 40 to ≤ 80 > 80 to ≤ 120	$R_{p1,0/t}$	140 120 110	137 115 104	137 115 104	132 110 100			
	F40	> 15 to ≤ 40 > 40 to ≤ 80	$R_{p0,2/t}$	200 180	190 170	180 160				
CuZn20Al2 (CuZn20Al)	F30	> 15 to ≤ 40	$R_{p1,0/t}$	100	86	86				
	F39	> 15 to ≤ 40	$R_{p0,2/t}$	240	230	225				
CuZn38Sn1 (CuZn39Sn)	F34	> 15 to ≤ 40 > 40 to ≤ 80 > 80 to ≤ 120	$R_{p1,0/t}$	175 170 160	172 153 153	168 148 148				
	F40	> 15 to ≤ 40 > 40 to ≤ 80	$R_{p0,2/t}$	200 180	190 170	180 160				
CuZn38SnAl	F39	> 15 to ≤ 160	$R_{p1,0/t}$	180	175	172	170			
	F43	> 15 to ≤ 40 > 40 to ≤ 80 > 80 to ≤ 120	$R_{p0,2/t}$	200 190 180	185 175 165	185 175 165	175 165 155			
CuNi10Fe1Mn (CuNi10Fe)	F30	> 15 to ≤ 60 > 60 to ≤ 120	$R_{p1,0/t}$	145 125	138 118	133 114	128 109	123 104	118 99	
	F32	> 15 to ≤ 60	$R_{p0,2/t}$	200	190	185	175	170	165	
	F35	> 15 to ≤ 60	$R_{p0,2/t}$	250	235	225	220	210	205	
CuNi30Mn1Fe (CuNi30Fe)	F35	> 15 to ≤ 60 > 60 to ≤ 120	$R_{p1,0/t}$	175 140	163 130	158 126	153 123	148 120	143 117	138 112
	F41	> 15 to ≤ 60	$R_{p0,2/t}$	300	275	265	260	255	245	240
CuAl10Ni5Fe4 (CuAl10Ni)	F63	> 15 to ≤ 80	$R_{p0,2/t}$	270	265	260	260	250		

Table 11 — Strength values for seamless tubes

Material code	Material condition	Type of test value	Minimum value at temperature °C						
			50	100	150	200	250	300	350
			MPa						
SF-Cu	F20	$R_{p1,0/t}$	60	55	55				
		$R_{m/20}$	200	200	175	150	125		
	F22	$R_{p1,0/t}$	65	58	58				
		$R_{m/20}$	220	220	195	170	145		
	F25	$R_{p0,2/t}$	150	135	130	125	120		
CuZn20Al2	F34	$R_{p1,0/t}$	130	125	125	120			
	F39	$R_{p1,0/t}$	160	148	143	138			
CuZn28Sn1	F32	$R_{p1,0/t}$	105	103	100				
	F36	$R_{p1,0/t}$	150	144	140	135			
CuNi10Fe1Mn	F29	$R_{p1,0/t}$	115	108	105	102	98	93	
CuNi30Mn1Fe	F37	$R_{p1,0/t}$	140	130	126	123	120	117	112
CuNi30Fe2Mn2	F42	$R_{p0,2/t}$	145	140	135	125	120		

Table 12 — Strength values for bars and rods

Material code	Material condition	Type of test value	Minimum value at temperature °C						
			50	100	150	200	250	300	350
			MPa						
SF-Cu	F20	$R_{p1,0/t}$	60	55	55				
		$R_{m/20}$	200	200	175	150	125		
	F22	$R_{p1,0/t}$	65	58	58				
		$R_{m/20}$	220	220	195	170	145		
	F25	$R_{p0,2/t}$	150	135	130	125	120		
CuZn20Al2	F34	$R_{p1,0/t}$	130	125	125	120			
	F39	$R_{p1,0/t}$	160	148	143	138			
CuZn28Sn1	F32	$R_{p1,0/t}$	105	103	100				
	F36	$R_{p1,0/t}$	150	144	140	135			
CuNi10Fe1Mn	F29	$R_{p1,0/t}$	115	108	105	102	98	93	
CuNi30Mn1Fe	F37	$R_{p1,0/t}$	140	130	126	123	120	117	112
CuNi30Fe2Mn2	F42	$R_{p0,2/t}$	145	140	135	125	120		

5.3.3 Pressure/temperature ratings for wrought copper alloy

The pressure/temperature ratings shall comply with EN 1092-3, EN 1759-3, ISO 7005-3.

5.4 Materials — Wrought aluminium alloys

5.4.1 General

Materials and related requirements shall be in accordance with EN 13445-8:2009, Clause 5.

Materials and requirements for valves made from aluminium castings shall be agreed by the parties concerned. Other materials not defined in EN 13445-8:2009 may be used by agreement of the parties concerned if they meet the requirements of EN 13445-8:2009, 5.2 and 5.5 and a particular material appraisal is produced (see EN 764-4).

5.4.2 Strength values

5.4.2.1 General

Design strength values given in italics are time-dependent. For strength values see Table 13 to 16.

5.4.2.2 Extruded rod/bar, tube and profile

Mechanical properties shall comply with EN 755-2.

Table 13 — Extruded rod/bar, tube and profile

EN AW number	Temper	$R_{p,20°C}$ MPa	Value of f for design temperature[a] MPa							
			20°C	50°C	75°C	100°C	125°C	150°C	175°C	200°C
EN AW-1050A	O/H111	20	20,0	19,3	18,7	*16,7*	*13,3*	*10,0*	*8,0*	*6,3*
EN AW-1070A	H112	23	25,6	24,5	23,5	21,5	20,4	19,4	—	—
EN AW-3003	O/H111	35	23,3	23,3	22,0	21,3	20,7	19,3	*17,3*	*15,3*
EN AW-3103	O/H111	35	23,3	23,3	22,0	21,3	20,7	19,3	*17,3*	*15,3*
EN AW-5005	O/H111	40	26,7	26,7	25,9	25,1	*34,3*	*26,7*	*19,8*	*16,0*
EN AW-5005A	O/H111	40	26,7	26,7	26,0	25,3	*32,0*	*24,7*	*18,0*	*14,7*
	H112	40	26,7	26,7	26,0	25,3	*32,0*	*24,7*	*18,0*	*14,7*
EN AW-5052	O/H111	70	46,7	46,7	45,9	44,5	*36,8*	*29,1*	*21,5*	*14,4*
EN AW-5154A	O/H111	85	56,7	56,7	55,3	54,0	*46,7*	*29,3*	*18,7*	*12,0*
EN AW-5251	O/H111	60	40,0	40,0	39,3	38,0	*32,6*	*27,3*	*18,0*	*12,7*
EN AW-5454	O/H111	85	56,7	56,7	55,3	54,0	*45,3*	*31,3*	*21,3*	*15,3*
EN AW-5754	O/H111	80	53,3	53,3	52,0	50,7	*40,7*	*26,0*	*15,3*	*10,7*
EN AW-5083	O/H111	110	73,3	73,3	71,6	71,6	*42,8*	*25,2*	*14,1*	*8,8*
EN AW-5086	O/H111	95	63,3	63,3	62,1	62,1	*45,6*	*27,2*	*16,5*	*10,8*

[a] Italic numerical values are creep-range values.

5.4.2.3 Cold drawn rod/bar and tube

Mechanical properties shall comply with EN 754-2.

Table 14 — Cold drawn rod/bar and tube

EN AW number	Temper	$R_{p,20°C}$ MPa	Value of f for design temperature[a] MPa							
			20°C	50°C	75°C	100°C	125°C	150°C	175°C	200°C
EN AW-3003	O/H111	35	23,3	23,3	22,0	21,3	20,7	19,3	*17,3*	*15,3*
EN AW-3103	O/H111	35	23,3	23,3	22,0	21,3	20,7	19,3	*17,3*	*15,3*
EN AW-5005	O/H111	40	26,7	26,7	25,9	25,1	*23,3*	*21,5*	*19,8*	*16,0*
EN AW-5005A	O/H111	40	26,7	26,7	26,0	25,3	*22,8*	*20,4*	*18,0*	*14,7*
EN AW-5049	O/H111	80	53,3	53,3	52,0	50,7	*44,0*	*30,7*	*22,0*	*16,0*
EN AW-5052	O/H111	65	43,3	43,3	42,7	41,3	*34,2*	*27,1*	*20,0*	*13,3*
EN AW-5154A	O/H111	85	56,7	56,7	55,3	54,0	*46,7*	*29,3*	*18,7*	*12,0*
EN AW-5754	O/H111	80	53,3	53,3	52,0	50,7	*40,7*	*26,0*	*15,3*	*10,7*
EN AW-5083	O/H111	110	73,3	73,3	71,6	71,6	*42,8*	*25,2*	*14,1*	*8,8*
EN AW-5086	O/H111	95	63,3	63,3	62,1	62,1	*45,6*	*27,2*	*16,5*	*10,8*

[a] Italic numerical values are creep-range values.

5.4.2.4 Forgings

Mechanical properties shall comply with EN 586-2.

Table 15 — Forgings

EN AW number	Test direction	Temper	$R_{p,20°C}$ MPa	Value of f for design temperature[a] MPa							
				20° C	50° C	75° C	100° C	125° C	150° C	175° C	200° C
EN AW-5754		H112	80	53,3	53,3	52,2	50,7	*23,2*	*14,9*	*8,8*	*6,1*
EN AW-5083	L (12%)	H112	120	80,0	80,0	80,0	76,2	*46,7*	*27,5*	*15,4*	*9,6*
	T (10%)	H112	110	73,3	73,3	73,3	69,8	*42,8*	*25,2*	*14,1*	*8,8*

[a] Italic numerical values are creep-range values.

5.4.2.5 Plate

Mechanical properties shall comply with EN 485-2.

Table 16 — Plate

EN AW number	Temper	Wall thickness mm	$R_{p,20°C}$ MPa	Value of f for design temperature[a] MPa							
				20°C	50°C	75°C	100°C	125°C	150°C	175°C	200°C
EN AW-1050A	O/H111		20	20,0	19,3	18,7	16,7	13,3	10,0	8,0	6,3
	H112	6 ≤ t ≤ 12,5	30	20,0	19,3	18,7	16,7	13,3	10,0	*8,0*	*6,4*
		12,5 < t ≤ 80	25	16,7	16,1	15,6	13,9	11,1	8,3	*6,7*	*5,3*
EN AW-1070A	O/H111		15	16,7	16,0	15,3	14,0	13,3	12,7	—	—
	H112	6 ≤ t ≤ 12,5	20	22,2	21,3	20,4	18,7	17,8	16,9	—	—
EN AW-1080A	O/H111		15	14,7	14,0	13,3	12,7	12,0	11,3	—	—
EN AW-3003	O/H111	t ≤ 50	35	23,3	23,3	22,0	21,3	20,7	19,3	*17,3*	*15,3*
	H112	6 ≤ t < 12,5	70	46,7	46,7	44,7	42,0	*34,7*	*26,0*	*19,3*	*15,3*
		12,5 ≤ t < 80	40	26,7	26,7	25,5	24,0	*19,8*	*14,9*	*11,0*	*8,8*
EN AW-3103	O/H111		35	23,3	23,3	22,0	21,3	20,7	19,3	*19,3*	*15,3*
	H112	6 ≤ t < 12,5	70	45,8	45,8	44,7	42,0	*34,7*	*26,0*	*19,3*	*15,3*
		12,5 ≤ t < 80	40	26,7	26,7	25,5	24,0	*19,8*	*14,9*	*11,0*	*8,8*
EN AW-3105	O/H111		40	26,7	26,7	25,3	24,0	*30,0*	*23,3*	*17,3*	*14,0*
EN AW-5005	O/H111		35	23,3	23,3	22,7	22,0	*20,4*	*18,8*	*17,3*	*14,0*
EN AW-5005A	O/H111		35	23,3	23,3	22,8	22,2	*20,0*	*17,9*	*15,8*	*12,8*

EN AW number	Temper	Wall thickness mm	$R_{p,20°C}$ MPa	Value of f for design temperature[a] MPa							
				20°C	50°C	75°C	100°C	125°C	150°C	175°C	200°C
EN AW-5050	O/H111		45	30,0	30,0	29,3	28,7	*25,8*	*22,9*	*20,0*	*14,7*
	H112		55	36,7	36,7	36,0	34,7	*29,8*	*24,9*	*20,0*	*14,7*
EN AW-5049	O/H111		80	53,3	53,3	52,0	50,7	*44,0*	*30,7*	*22,0*	*16,0*
	H112	6 < t ≤ 12,5	100	66,7	66,7	65,2	63,3	*31,4*	*21,9*	*15,7*	*11,4*
		12,5 < t ≤ 25	90	60,0	60,0	58,7	57,0	*28,3*	*19,7*	*14,1*	*10,3*
		25 < t ≤ 80	80	53,3	53,3	52,2	50,7	*25,1*	*17,5*	*12,6*	*9,1*
EN AW-5052	O/H111	0,2 < t ≤ 80	65	43,3	43,3	42,7	41,3	*34,2*	*27,1*	*20,0*	*13,3*
	H112	6 < t ≤ 12,5	80	53,3	53,3	52,4	50,9	*31,5*	*30,1*	*14,5*	*9,7*
		12,5 < t ≤ 80	70	46,7	46,7	45,8	44,5	*27,6*	*26,3*	*12,7*	*8,5*
EN AW-5154A	O/H111		85	56,7	56,7	55,3	54,0	*46,7*	*29,3*	*18,7*	*12,0*
	H112	6 < t ≤ 12,5	125	83,3	83,3	81,3	79,3	*46,7*	*29,3*	*18,7*	*12,0*
		12,5 < t ≤ 80	90	60,0	60,0	58,6	57,1	*33,6*	*21,1*	*13,4*	*8,6*
EN AW-5251	O/H111		60	40,0	40,0	39,3	38,0	*32,6*	*27,3*	*18,0*	*12,7*
EN AW-5454	O/H111		85	56,7	56,7	55,3	54,0	*45,3*	*31,3*	*21,3*	*15,3*
	H112	40 < t ≤ 120	90	60,0	60,0	58,6	57,1	*32,6*	*22,6*	*15,4*	*11,0*
EN AW-5754	O/H111		80	53,3	53,3	52,0	50,7	*40,7*	*26,0*	*15,3*	*10,7*
	H112	6 < t ≤ 12,5	100	66,7	66,7	65,2	63,3	*29,0*	*18,6*	*11,0*	*7,6*
		12,5 < t ≤ 25	90	60,0	60,0	58,7	57,0	*26,1*	*16,7*	*9,9*	*6,9*
		25 < t ≤ 80	80	53,3	53,3	52,2	50,7	*23,2*	*14,9*	*8,8*	*6,1*

EN AW number	Temper	Wall thickness mm	$R_{p,20°C}$ MPa	Value of f for design temperature[a] MPa							
				20°C	50°C	75°C	100°C	125°C	150°C	175°C	200°C
EN AW-5083	O/H111	t ≤ 50 [b]	125	83,3	83,3	83,3	79,3	*48,7*	*28,7*	*16,0*	*10,0*
		50 < t ≤ 80	115	76,7	76,7	76,7	73,0	*44,8*	*26,4*	*14,7*	*9,2*
		80 < t ≤ 120	110	73,3	73,3	73,3	69,8	*42,8*	*25,2*	*14,1*	*8,8*
		120 < t ≤ 200	105	70,0	70,0	70,0	66,6	*40,9*	*24,1*	*13,4*	*8,4*
		200 < t ≤ 250	95	63,3	63,3	63,3	60,3	*37,0*	*21,8*	*12,2*	*7,6*
		250 < t ≤ 300	90	60,0	60,0	60,0	57,1	*35,0*	*20,6*	*11,5*	*7,2*
	H112	6 < t ≤ 40	125	83,3	83,3	83,3	79,3	*48,7*	*28,7*	*16,0*	*10,0*
		40 < t ≤ 80	115	76,7	76,7	76,7	73,0	*44,8*	*26,4*	*14,7*	*9,2*
		80 < t ≤ 120	110	73,3	73,3	73,3	69,8	*42,8*	*25,2*	*14,1*	*8,8*
EN AW-5086	O/H111		100	66,7	66,7	66,7	63,3	*48,0*	*28,7*	*17,3*	*11,3*
	H112	40 < t ≤ 80	100	66,7	66,7	66,7	63,5	*38,4*	*22,9*	*13,9*	*9,1*

a Italic numerical values are creep-range values.

b Yield strength at room temperature of 125 MPa shall be guaranteed and verified by the plate manufacturer.

5.4.3 Pressure/temperature ratings for wrought aluminium alloys

The pressure/temperature ratings shall comply with EN 1092-4.

5.5 Allowable stresses

5.5.1 Aluminium and aluminium alloys - wrought materials

Nominal design stress $f_{d/t}$ for design conditions at calculation temperature t shall be in accordance with EN 13445-8:2009, Table 6.3-1.

5.5.2 Materials other than aluminium

Allowable stresses shall be in accordance with Table 17.

Table 17 — Nominal design stresses for design conditions f in MPa (allowable stresses)

Material	Nominal design stress $f_{d/t}$ for design conditions at calculation temperature
EN-GJL-200 EN-GJL-250	$f_{d/20} = R_{m/20} / 9$
EN-GJMB-300-6 EN-GJMB-350-10	$f_{d/20} = R_{m/20} / 7$ $f_{d/t} = R_{p0,2/t} / 4,0$
EN-GJS-350-22-LT EN-GJS-350-22-RT EN-GJS-400-18-LT EN-GJS-400-18-RT EN-GJS-400-18	$f_{d/t} = R_{p0,2/t} / 2,4$
EN-GJS-400-15	$f_{d/t} = R_{p0,2/t} / 3,5$
EN-GJS-450-10 EN-GJS-500-7	$f_{d/t} = R_{p0,2/t} / 4,0$
EN-GJS-600-3 EN-GJS-700-2	$f_{d/t} = R_{p0,2/t} / 5,0$
Copper and copper alloys including rolled and cast copper-tin alloys	f_d = *min* ($R_{p0,2/t}$ / 1,5 ; $R_{p1,0/t}$ / 1,5 ; $R_{p1,0\ creep\ strain\ limit/t}$ / 1,0) for SF-Cu (seamless and welded components): $f_d = R_{p0,2/t}/3,5$ for SF-Cu (soldered/brazed components): $f_d = R_{p\ 0,2/t}/4,0$
Aluminium and aluminium alloys — wrought materials	$f = R_{p0,2/t} / 1,5$

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC (PED)

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC (PED).

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 97/23/EC (PED)

Clause(s)/sub-clause(s) of this EN	Essential Requirements (ERs) of Directive 97/23/EC, Annex I	Qualifying remarks/Notes
5.2.2, 5.3.2, 5.4.2	2.2.2, 2.2.3	Design for adequate strength — calculation method
Clause 4	2.6	Corrosion or other chemical attack
5.3.1, 5.4.1	4.1 a), 4.2 a)	Materials
5.5.1	7.1.2	Permissible membrane stresses

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] EN 545, *Ductile iron pipes, fittings, accessories and their joints for water pipelines — Requirements and test methods*

[2] EN 736-1, *Valves — Terminology — Part 1: Definition of types of valves*

[3] EN 736-2, *Valves — Terminology — Part 2: Definition of components of valves*

[4] EN 736-3, *Valves — Terminology — Part 3: Definition of terms*

[5] EN 764-4, *Pressure equipment — Part 4: Establishment of technical delivery conditions for metallic materials*

[6] EN 1093-3, *Safety of machinery — Evaluation of the emission of airborne hazardous substances — Part 3: Test bench method for the measurement of the emission rate of a given pollutant*

[7] EN 1412, *Copper and copper alloys — European numbering system*

[8] EN 1503-4, *Valves — Materials for bodies, bonnets and covers — Part 4: Copper alloys specified in European Standards*

[9] EN 1559-3, *Founding — Technical conditions of delivery — Part 3: Additional requirements for iron castings*

[10] EN 12164, *Copper and copper alloys — Rod for free machining purposes*

[11] EN 12165, *Copper and copper alloys — Wrought and unwrought forging stock*

[12] EN 12167, *Copper and copper alloys — Profiles and bars for general purposes*

[13] EN 12168, *Copper and copper alloys — Hollow rod for free machining purposes*

[14] EN 12266-1, *Industrial valves — Testing of metallic valves — Part 1: Pressure tests, test procedures and acceptance criteria — Mandatory requirements*

[15] EN 12266-2, *Industrial valves — Testing of metallic valves — Part 2: Tests, test procedures and acceptance criteria — Supplementary requirements*

[16] EN 12516-3, *Valves — Shell design strength — Part 3: Experimental method*

[17] EN 13445-6:2009, *Unfired pressure vessels — Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron*

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