INTERNATIONAL STANDARD

ISO 6363-2

Third edition
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Wrought aluminium and aluminium alloys — Cold-drawn rods/bars, tubes and wires —

Part 2: Mechanical properties

Aluminium et alliages d'aluminium corroyés — Barres, tubes et fils étirés à froid —

Partie 2: Caractéristiques mécaniques

Reference number
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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 79, *Light metals and their alloys*, Subcommittee SC 6, *Wrought aluminium and aluminium alloys*.

This third edition cancels and replaces the second edition (ISO 6363-2:2012), which has been technically revised. The main changes are as follows:

— in Clause 5, ISO 6362-7 and ISO 2107 have been added as references for the alloys and tempers listed in this document;

— in Clause 5, alloys 2033 and 6026 have been added in Table 1;

— errors have been corrected and expressions modified throughout.

A list of all parts in the ISO 6363 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.

Wrought aluminium and aluminium alloys — Cold-drawn rods/bars, tubes and wires —

Part 2: Mechanical properties

1 Scope

This document specifies the mechanical properties of wrought aluminium and aluminium alloy rods/bars, tubes and wires for general engineering applications (except aeronautical rivets).

It is applicable to products which are extruded and then cold drawn.

It does not apply to:

— products which are rolled and then cold drawn, including seam-welded tubes;

— forging stock, wire for drawing stock;

— drawn wires for aeronautical application, electrical or welding purposes.

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 6363-1, *Wrought aluminium and aluminium alloys — Cold-drawn rods/bars, tubes and wires — Part 1: Technical conditions for inspection and delivery*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ASTM B557M, *Standard Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6363-1 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/

4 Tensile testing

The selection of the specimens and tensile testing shall be in accordance with ISO 6892-1 or ASTM B557M.

5 Mechanical properties

Values for mechanical properties of aluminium and aluminium alloys are given in Tables 1 and 2.

For elongation, two different gauge lengths are used. The choice of the gauge length for elongation measurements (A or A_{50mm}) is at the discretion of the producer, unless otherwise agreed.

NOTE A is the percentage elongation on a gauge length of 5,65 $\sqrt{S_o}$. A_{50mm} is the percentage elongation on a gauge length of 50 mm.

Alloys mentioned in this document are listed in ISO 6362-7.

Temper designations used in this document are in accordance with ISO 2107. Test results shall be rounded in accordance with the rules given in Annex A.

A list of tempers used in Tables 1 and 2 is given in Annex B.

Table 1 — Mechanical properties of rods/bars and wires

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
1050	O	D or $S \leq 3$	60	100	—	—	—	—
		$3 < D$ or $S \leq 100$	60	100	20	—	—	25
	H14	D or $S \leq 10$	95	—	—	—	—	—
	H18	D or $S \leq 10$	125	—	—	—	—	—
1050A	O	D or $S \leq 30$	60	—	20	—	25	—
	H14	D or $S \leq 30$	100	—	70	—	6	5
	H16	$D \leq 15$ or $S \leq 5$	120	160	105	—	4	3
	H18	D or $S \leq 10$	130	—	110	—	3	—
1070	O	D or $S \leq 3$	55	95	—	—	—	—
		$3 < D$ or $S \leq 100$	55	95	15	—	—	25
	H14	D or $S \leq 10$	85	—	—	—	—	—
	H18	D or $S \leq 10$	120	—	—	—	—	—
1080A	O	$D \leq 20$	—	80	—	—	—	—
	H14	$D \leq 18$	90	—	—	—	—	—
	H18	$D \leq 10$	120	—	—	—	—	—
1098	O	$D \leq 20$	—	70	—	—	—	—
	H14	$D \leq 18$	85	—	—	—	—	—
	H18	$D \leq 10$	115	—	—	—	—	—
1100	O	D or $S \leq 3$	75	110	—	—	—	—
		$3 < D$ or $S \leq 100$	75	110	20	—	22	25
	H14	D or $S \leq 30$	110	—	80[b]	—	5	—
	H18	D or $S \leq 10$	150	—	130[b]	—	3	—
1200	O	D or $S \leq 3$	75	110	—	—	—	—
		$3 < D$ or $S \leq 30$	75	110	30	—	20	25
		$30 < D$ or $S \leq 100$	75	110	20	—	—	25
	H14	D or $S \leq 30$	110	—	80	—	5	—
	H16	$D \leq 15$ or $S \leq 5$	135	170	115		3	3

Table 1 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
2007	T3	D or $S \leq 30$	370	—	240	—	7	5
		$30 < D$ or $S \leq 80$	340	—	220	—	6	—
	T351	D or $S \leq 80$	370	—	240	—	5	3
2011	T3[g]	$3 < D$ or $S \leq 38$	310	—	260	—	9	10
		$38 < D$ or $S \leq 50$	295	—	235	—	10	12
		$50 < D$ or $S \leq 80$	280	—	205	—	10	14
	T8[g]	$3 \leq D$ or S ≤ 80	370	—	270	—	8	10
	H13	$D \leq 18$	155	225	—	—	—	—
	H18	$D \leq 10$	240	—	—	—	—	—
2011A	T3	D or $S \leq 40$	320	—	270	—	10	8
		$40 < D$ or $S \leq 50$	300	—	250	—	10	—
		$50 < D$ or $S \leq 80$	280	—	210	—	10	—
	T8	D or $S \leq 80$	370	—	270	—	8	6
2014	O	$3 \leq D$ or S ≤ 100	—	245	—	—	—	12
	T3	D or $S \leq 80$	380	—	290	—	8	6
	T351	D or $S \leq 80$	380	—	290	—	6	4
	T4 T42[c] T451	$3 \leq D$ or S ≤ 100	380	—	220	—	10	16
	T6 T62[d] T651	$3 \leq D$ or S ≤ 100	450	—	380	—	7	8
2014A	O H111	D or $S \leq 80$	—	240	—	125	12	10
	H13[e]	$D \leq 18$	210	280	—	—	—	—
	H18	$D \leq 10$	295	—	—	—	—	—
	T3	D or $S \leq 80$	380	—	290	—	8	6
	T351	D or $S \leq 80$	380	—	290	—	6	4
	T4 T451	D or $S \leq 100$	380	—	220	—	10	10
	T6	D or $S \leq 50$	440	—	360	—	7	8
	T651	D or $S \leq 100$	450	—	380	—	7	8
2017	O	D or $S \leq 3$	—	245	—	—	—	—
		$3 < D$ or S ≤ 100	—	245	—	—	—	16
	H13	$3 \leq D$ or S ≤ 10	205	275	—	—	—	—
	T4	D or $S \leq 3$	380	—	—	—	—	—
	T42[c]	$3 < D$ or S ≤ 100	380	—	225	—	—	12

Table 1 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
2017A	O H111	D or $S \leq 80$	—	240	—	125	12	10
	H13[e]	$D \leq 18$	210	300	—	—	—	—
	H18	$D \leq 10$	315	—	—	—	—	—
	T3[g]	D or $S \leq 80$	400	—	250	—	10	8
	T351[g]	D or $S \leq 80$	400	—	250	—	8	6
	T4	D or $S \leq 50$	380	—	220	—	10	—
	T451	$50 < D$ or $S \leq 100$	390	—	235	—	10	—
2117	H13[e]	D or $S \leq 18$	170	240	—	—	—	—
	H15	$3 < D$ or $S \leq 10$	195	245	—	—	—	—
	H18	$D \leq 18$	260	—	—	—	—	—
	T4	$3 < D$ or $S \leq 10$	265	—	125	—	—	18
2024	O[f]	D or $S \leq 3$	—	245	—	—	—	—
	H111	$3 < D$ or $S \leq 100$	—	245	—	—	—	16
	H13[e]	$D \leq 18$	230	300	—	—	—	—
	H18	$D \leq 10$	320	—	—	—	—	—
	T3	D or $S \leq 10$	425	—	310	—	10	8
		$10 < D$ or $S \leq 80$	425	—	290	—	9	7
	T351	$12,5 < D$ or $S \leq 100$	425	—	310	—	9	—
	T4	D or $S \leq 3$	425	—	—	—	—	—
	T451	$3 < D$ or $S \leq 12$	425	—	310	—	10	10
		$12 < D$ or $S \leq 100$	425	—	290	—	9	10
	T42[c]	D or $S \leq 3$	430	—	—	—	—	—
		$3 < D$ or $S \leq 100$	430	—	275	—	—	10
	T6	D or $S \leq 80$	425	—	315	—	5	4
	T651	D or $S \leq 80$	425	—	315	—	4	3
	T62[d]	D or $S \leq 3$	410	—	—	—	—	—
		$3 < D$ or $S \leq 100$	410	—	315	—	—	5
	T8	D or $S \leq 80$	455	—	400	—	4	3
	T851	D or $S \leq 80$	455	—	400	—	3	2
2030	T3	D or $S \leq 50$	370	—	250	—	7	—
		$50 < D$ or $S \leq 100$	340	—	210	—	7	—
	T351	D or $S \leq 80$	370	—	240	—	5	3
2033	T3	D or $S \leq 30$	370	—	240	—	7	—
		$30 < D$ or $S \leq 80$	340	—	220	—	7	—
	T351	D or $S \leq 80$	370	—	240	—	5	—
	T8	D or $S \leq 80$	370	—	270	—	8	—
2219	T851	$10 < D$ or $S \leq 50$	400	—	275	—	3	—
		$50 < D$ or $S \leq 100$	395	—	270	—	3	—

Table 1 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
3003	O	D or $S \leq 3$	95	125	—	—	—	—
		$3 < D$ or $S \leq 100$	95	125	35	—	22	25
	H12	D or $S \leq 10$	115	—	80[b]	—	7[b]	—
	H14	D or $S \leq 10$	135	—	110[b]	—	6[b]	—
	H16	$D \leq 15$ or $S \leq 5$	160	—	130[b]	—	3[b]	—
	H18	D or $S \leq 10$	180	—	145[b]	—	2[b]	—
3103	O	D or $S \leq 50$	95	—	35	—	22	19
	H14	D or $S \leq 30$	130	—	90	—	6	4
	H16	$D \leq 15$ or $S \leq 5$	160	195	130	—	4	3
	H18	D or $S \leq 10$	160	—	130	—	4	3
5005	O H111	$D \leq 80$ or $S \leq 60$	100	145	40	—	18	16
	H14	$D \leq 40$ or $S \leq 10$	140	—	110	—	6	4
	H18	$D \leq 15$ or $S \leq 2$	185	—	155	—	4	2
5005A	O H111	$D \leq 80$ or $S \leq 60$	100	145	40	—	18	16
	H14	$D \leq 40$ or $S \leq 10$	140	—	110	—	6	4
	H18	$D \leq 15$ or $S \leq 2$	185	—	155	—	4	2
5019	O H111	$D \leq 80$ or $S \leq 60$	250	320	110	—	16	14
	H12 H22 H32	$D \leq 40$ or $S \leq 25$	270	350	180	—	8	7
	H14 H24 H34	$D \leq 25$ or $S \leq 10$	300	—	210	—	4	3
5041	O	D or $S \leq 25$	225	—	—	—	—	20
5050	O	D or $S \leq 10$	125	180	—	—	25	22
	H32	D or $S \leq 10$	150	—	—	—	—	—
	H34	D or $S \leq 10$	170	—	—	—	—	—
	H36	D or $S \leq 10$	185	—	—	—	—	—
	H38	D or $S \leq 10$	200	—	—	—	—	—
5051A	O	$D \leq 20$	—	195	—	—	—	—
	H12	$D \leq 18$	170	220	—	—	—	—
	H14	$D \leq 18$	195	245	—	—	—	—
	H18	$D \leq 10$	245	—	—	—	—	—

Table 1 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
5052	O	D or $S \leq 3$	170	220	—	—	—	—
	H111	$3 < D$ or $S \leq 100$	170	220	65	—	22	25
	H32	$3 < D$ or $S \leq 10$	215	255	—	—	—	—
	H14	D or $S \leq 3$	235	—	—	—	—	—
		$3 < D$ or $S \leq 30$	235	—	180	—	5	—
	H34	D or $S \leq 3$	235	—	—	—	—	—
		$3 < D$ or $S \leq 30$	235	—	180	—	6[b]	—
	H16 H26 H36	D or $S \leq 15$	250	290	200	—	3	3
	H18	D or $S \leq 10$	270	—	220	—	2	—
	H38	D or $S \leq 10$	270	—	220[b]	—	2[b]	—
5056	O	D or $S \leq 3$	—	315	—	—	—	—
		$3 < D$ or $S \leq 100$	250	320	110	—	16	20
	H12 H32	D or $S \leq 10$	300	—	—	—	—	—
	H34	D or $S \leq 10$	345	—	—	—	—	—
	H38	D or $S \leq 10$	380	—	—	—	—	—
5083	O	D or $S \leq 3$	275	355	—	—	—	—
		$3 < D$ or $S \leq 100$	275	355	110	—	14	14
	H111	D or $S \leq 50$	270	—	140	—	12	—
	H12	D or $S \leq 30$	300	—	200	—	4	—
5086	O	D or $S \leq 50$	240	—	95	—	16	—
	H12	D or $S \leq 25$	270	—	190	—	4	—
	H32	D or $S \leq 25$	270	—	190	—	5	—
5154	O	D or $S \leq 10$	205	285	75	—	20	16
	H32	D or $S \leq 10$	250	—	—	—	—	—
	H34	D or $S \leq 10$	270	—	—	—	—	—
	H36	D or $S \leq 10$	290	—	—	—	—	—
	H38	D or $S \leq 10$	310	—	—	—	—	—
5251	O H111	$D \leq 80$ or $S \leq 60$	150	200	60	—	17	15
	H14 H24 H34	$D \leq 30$ or $S \leq 5$	200	240	160	—	5	4
	H18 H28 H38	$D \leq 20$ or $S \leq 3$	240	—	200	—	2	2

Table 1 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
5754	O	D or $S \leq 50$	180	—	80	—	16	—
	H14	D or $S \leq 30$	250	—	180	—	4	—
	H34	D or $S \leq 30$	250	—	180	—	5	—
	H18	D or $S \leq 10$	280	—	240	—	2	—
	H38	D or $S \leq 10$	280	—	240	—	3	—
6012	T4[g]	D or $S \leq 80$	200	—	100	—	10	8
	T6[g]	D or $S \leq 80$	310	—	260	—	8	6
6026	T6	D or $S \leq 80$	370	—	300	—	8	—
	T8	D or $S \leq 80$	345	—	315	—	4	—
	T9	D or $S \leq 80$	360	—	330	—	4	—
6056	H13[d]	$D \leq 18$	160	240	—	—	—	—
	H18	$D \leq 10$	240	—	—	—	—	—
	T39[i]	$D < 6$	400	—	—	—	—	—
	T39[i]	$D \geq 6$	360	—	—	—	—	—
	T4	$D \leq 20$	300	380	—	—	—	—
	T6	$D \leq 20$	400	—	—	—	—	—
	T89[i]	$D < 6$	420	—	—	—	—	—
6060	T39[g,i]	$D \geq 6$	220	—	—	—	—	—
	T39[i]	$D < 6$	270	—	—	—	—	—
	T4[g]	D or $S \leq 80$	130	—	65	—	15	13
	T6[g]	D or $S \leq 80$	215	—	160	—	12	10
	T89[g,i]	$D < 6$	260	—	—	—	—	—
6061	O[f]	D or $S \leq 3$	145	—	—	—	—	—
		$3 < D$ or $S \leq 100$	145	—	—	—	—	18
	H13[h]	$3 \leq D$ or $S \leq 10$	155	205	—	—	—	—
	H18	$D \leq 10$	210	—	—	—	—	—
	T39[g]	$D < 6$	310	—	—	—	—	—
		$6 \leq D$	260	—	—	—	—	—
	T4	D or $S \leq 3$	205	—	—	—	—	—
		$3 < D$ or $S \leq 100$	205	—	110	—	16	18
	T42[c]	D or $S \leq 3$	205	—	—	—	—	—
		$3 < D$ or $S \leq 100$	205	—	95	—	—	18
	T6	D or $S \leq 3$	290	—	—	—	—	—
	T62[d]	$3 < D$ or $S \leq 100$	290	—	240	—	9	10
	T89[g,i]	$D < 6$	300	—	—	—	—	—
6063	T39[i]	$D \geq 6$	230	—	—	—	—	—
	T39[g,i]	$D < 6$	280	—	—	—	—	—
	T4[g]	D or $S \leq 80$	150	—	75	—	15	13
	T6[g]	D or $S \leq 80$	220	—	190	—	10	8
	T66[g]	D or $S \leq 80$	230	—	195	—	10	8
	T89[g,i]	$D < 6$	270	—	—	—	—	—

Table 1 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
6063A	O H111	D or $S \leq 80$	—	140	—	—	15	13
	T4[g]	D or $S \leq 80$	150	—	90	—	16	14
	T6[g]	D or $S \leq 80$	230	—	190	—	9	7
6065	T6[g]	$D \leq 120$ or $S \leq 85$	290	—	240	—	10	8
	T8[g]	$D \leq 120$ or $S \leq 85$	345	—	315	—	4	3
	T9[g]	$D \leq 120$ or $S \leq 85$	360	—	330	—	4	3
6082	O	D or $S \leq 80$	—	160	—	110	15	—
	H13[h]	$D \leq 18$	165	225	—	—	—	—
	H18	$D \leq 10$	220	—	—	—	—	—
	T39[g,i]	$D < 6$	360	—	—	—	—	—
	T39[i]	$6 \leq D$	310	—	—	—	—	—
	T4	D or $S \leq 80$	205	—	110	—	14	—
	T6	D or $S \leq 80$	310	—	255	—	10	—
	T8[g]	D or $S \leq 80$	310	—	260	—	8	—
	T89[g,i]	$D < 6$	340	—	—	—	—	—
6181	T4	D or $S \leq 50$	200	—	100	—	15	—
	T6	D or $S \leq 50$	280	—	240	—	8	—
6262	T6	D or $S \leq 100$	290	—	240	—	8	7
	T8[g]	D or $S \leq 50$	345	—	315	—	4	3
	T9	D or $S \leq 50$	360	—	330	—	4	5
		$50 < D$ or $S \leq 80$	345	—	315	—	4	—
6262A	T6[g]	$D \leq 120$ or $S \leq 85$	290	—	240	—	10	8
	T8[g]	$D \leq 120$ or $S \leq 85$	345	—	315	—	4	3
	T9[g]	$D \leq 120$ or $S \leq 85$	360	—	330	—	4	3
7020	T5 T6	D or $S \leq 50$	350	—	280	—	10	—
7022	T6[g]	D or $S \leq 80$	460	—	380	—	8	6
7049A	T6	$D \leq 80$	590	—	500	—	7	—
7075	O[f]	$3 \leq D$ or $S \leq 100$	—	275	—	—	—	10
	H13[h]	$D \leq 18$	230	310	—	—	—	—
	H18	$D \leq 10$	285	—	—	—	—	—
	T6 T62[d] T651	$3 \leq D$ or $S \leq 100$	520	—	460	—	6	7
	T73[j]	D or $S \leq 100$	470	—	385	—	9	7

Table 1 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
[a] D (mm) = diameter for round bar. S (mm) = width across flats for square and hexagonal bar, thickness for rectangular bar.								
[b] Guaranteed values agreed upon between the supplier and the purchaser where requested by the purchaser.								
[c] The mechanical properties of temper grade T42 shall be applied only where the material of temper grade O has been naturally age-hardened after solution treatment by the purchaser. If the material is cold or hot worked prior to solution treatment by the purchaser, its mechanical properties may be lower than the specified values.								
[d] The mechanical properties of temper grade T62 shall be applied only where the material of temper grade O has been artificially age-hardened after solution treatment by the purchaser. If the material is cold or hot worked prior to solution treatment by the purchaser, its mechanical properties may be lower than the specified values.								
[e] Mechanical properties shall be tested in T4 temper (alloys 2017A, 2117 and 2024) or T6 temper (alloy 2014A). Testing may also be carried out in T42 temper or T62 temper instead of T4 or T6, respectively. In this case, the mechanical property limits are those given for the corresponding T4 and T6 tempers.								
[f] The material of temper grade O shall be a basis for materials of temper grades T42 or T62. Where requested by the purchaser, the capability to achieve T42 or T62 properties after appropriate heat treatment is demonstrated.								
[g] Applicable to those after extrusion followed by controlled cooling at a rate rapid enough to hold constituents in solution.								
[h] Mechanical properties shall be tested in T6 temper. Testing may also be carried out in T62 temper instead of T6. In this case, the mechanical property limits are those given for the corresponding T6 tempers.								
[i] For these tempers, the mechanical properties are very dependent on the amount of cold work and, for T89 temper, on the ageing conditions. It is recommended that these characteristics be agreed between the supplier and the purchaser. Consequently, typical values of $R_{p0,2}$ and elongation are not given.								
[j] For materials of thickness 20 mm or above, see ISO6363-1, with respect to stress corrosion cracking resistance.								

Table 2 — Mechanical properties of tubes

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
1050	O	$0,4 \le t \le 12$	60	100	—	—	—	—
	H14	$0,4 \le t \le 12$	95	—	—	—	—	—
	H16	$0,4 \le t \le 12$	110	—	—	—	—	—
	H18	$0,4 \le t \le 12$	125	—	—	—	—	—
1050A	O	$0,5 \le t \le 10$	60	95	20	—	25	22
	H14	$0,5 \le t \le 6$	100	—	70	—	6	3
	H16	$t \le 5$	120	160	105	—	4	3
	H18	$0,5 \le t \le 3$	130	—	110		3	2
1070	O	$0,4 \le t \le 12$	55	95	—	—	—	—
	H14	$0,4 \le t \le 12$	85	—	—	—	—	—
	H16	$0,4 \le t \le 12$	95	—	—	—	—	—
	H18	$0,4 \le t \le 12$	120	—	—	—	—	—
1100 1200	O	$0,4 \le t \le 12$	75	110	—	—	—	—
	H14	$0,4 \le t \le 12$	110	—	—	—	—	—
	H16	$0,4 \le t \le 12$	135	—	—	—	—	—
	H18	$0,4 \le t \le 12$	155	—	—	—	—	—

Table 2 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
2007	T3	$t \leq 20$	370	—	250	—	7	5
	T3510 T3511	$t \leq 20$	370	—	240	—	5	3
2011	T3[e]	$0,5 \leq t \leq 6$	310	—	260	—	10	8
		$6 < t \leq 20$	290	—	240	—	8	9
	T8[e]	$0,5 \leq t \leq 20$	370	—	275	—	8	8
2011A	T3	$t < 5$	310	—	260	—	10	8
		$5 \leq t \leq 20$	290	—	240	—	8	6
	T8	$t \leq 20$	370	—	275	—	8	6
2014 2014A	T3	$0,5 \leq t \leq 10$	380	—	250	—	8	10
	T3510 T3511	$t \leq 20$	380	—	290	—	6	4
	T4	$0,5 \leq t \leq 6$	370	—	205	—	10	9
		$6 < t \leq 10$	370	—	205	—	10	10
	T4510 T4511	$t \leq 20$	380	—	240	—	10	8
	T6	$0,5 \leq t \leq 6$	450	—	370	—	6	5
		$6 < t \leq 10$	450	—	370	—	7	7
	T6510 T6511	$t \leq 20$	450	—	380	—	6	4
2017	O[b]	$0,6 \leq t \leq 12$	—	245	—	125	—	17
	T3[e]	$0,6 \leq t \leq 12$	375	—	215	—	—	13
	T42[c]	$0,6 \leq t \leq 12$	345	—	195	—	—	13
2017A	O H111	$t \leq 20$	—	240	—	125	12	10
	T3[e]	$t \leq 20$	400	—	250	—	10	8
	T3510[e] T3511[e]	$t \leq 20$	400	—	250	—	8	6
2024	O[b]	$0,6 \leq t \leq 12$	—	215	—	100	—	—
	T3	$0,6 \leq t \leq 1,2$	440	—	295	—	—	12
		$1,2 < t \leq 6,5$	440	—	295	—	—	14
		$6,5 < t \leq 12$	440	—	295	—	—	16
	T42[c]	$0,6 \leq t \leq 1,2$	440	—	275	—	—	12
		$1,2 < t \leq 6,5$	440	—	275	—	—	14
		$6,5 < t \leq 12$	440	—	275	—	—	16
2030	T3	$1 \leq t \leq 6$	370	—	250	—	10	—
		$6 < t \leq 20$	360	—	230	—	8	—

Table 2 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
3003 3103 3203	O	$0,4 \le t \le 1,2$	95	125	35	—	—	30
		$1,2 < t \le 6,5$	95	125	35	—	—	35
		$6,5 < t \le 12$	95	125	35	—	—	—
	H11	$t \le 17$	105	140	55	—	20	16
	H12	$t \le 15$	115	150	75	—	14	12
	H13	$t \le 12$	125	160	95	—	11	8
	H14	$0,4 \le t \le 0,6$	135	—	120	—	—	3
		$0,6 < t \le 1,2$	135	—	120	—	—	5
		$1,2 < t \le 6,5$	135	—	120	—	—	8
	H15	$t \le 7$	145	180	120	—	5	4
	H16	$t \le 5$	160	195	130	—	4	3
	H17	$t \le 4$	170	205	140	—	3	2
	H18	$0,4 \le t \le 0,6$	185	—	165	—	—	2
		$0,6 < t \le 1,2$	185	—	165	—	—	3
		$1,2 < t \le 6,5$	185	—	165	—	—	5
3021	O	$0,4 \le t \le 12$	75	—	—	—	—	—
	H14	$0,4 \le t \le 12$	110	—	—	—	—	—
	H16	$0,4 \le t \le 12$	135	—	—	—	—	—
	H18	$0,4 \le t \le 12$	155	—	—	—	—	—
5005	O	$0,5 \le t \le 10$	100	—	40	—	20	18
	H12	$0,5 \le t \le 5$	115	—	80	—	7	4
	H14	$0,5 \le t \le 5$	140	—	90	—	6	3
	H18	$0,5 \le t \le 1,5$	185	—	155	—	4	2
5005A	O H111	$t \le 20$	100	145	40	—	18	16
	H14	$t \le 5$	140	—	110	—	6	4
	H18	$t \le 3$	185	—	155	—	4	2
5019	O H111	$t \le 20$	250	320	110	—	16	14
	H12 H22 H32	$t \le 10$	270	350	180	—	8	7
	H14 H24 H34	$t \le 5$	300	380	220	—	4	3
	H16 H26 H36	$t \le 3$	320	—	260	—	2	2

Table 2 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
5049	O H111	$t \leq 20$	180	250	80	—	17	15
	H11	$t \leq 17$	195	260	100	—	13	12
	H12	$t \leq 15$	210	270	120	—	10	9
	H13	$t \leq 12$	225	280	140	—	7	6
	H14	$t \leq 10$	240	290	160	—	4	3
	H15	$t \leq 7$	250	300	180	—	3	2
	H16	$t \leq 5$	260	310	200	—	3	2
	H17	$t \leq 4$	270	320	220	—	2	1
	H18	$t \leq 3$	280	—	240	—	2	1
5050	O	$0,5 \leq t \leq 10$	125	165	40	—	19	17
	H32	$0,5 \leq t \leq 10$	150	—	110	—	—	—
	H34	$0,5 \leq t \leq 5$	170	—	140	—	5	3
	H36	$0,5 \leq t \leq 5$	185	—	150	—	—	—
	H38	$0,5 \leq t \leq 1,5$	200	—	165	—	3	2
5052	O	$0,6 \leq t \leq 12$	175	245	70	—	—	—
	H14 H34	$0,6 \leq t \leq 12$	235	—	175	—	—	—
	H18 H38	$0,6 \leq t \leq 6$	275	—	215	—	—	—
5056	O	$0,6 \leq t \leq 12$	—	315	100	—	—	—
	H12 H32	$0,6 \leq t \leq 12$	305	—	—	—	—	—
5083	O	$0,6 \leq t \leq 12$	275	355	110	—	—	14
	H22[d] H32	$0,6 \leq t \leq 12$	315	—	235	—	—	5
5086	O	$0,5 \leq t \leq 10$	240	—	95	—	16	14
	H12	$0,5 \leq t \leq 5$	270	—	190	—	4	3
	H14	$0,5 \leq t \leq 3$	305	—	230	—	3	2
	H32	$0,5 \leq t \leq 5$	270	—	190	—	5	4
	H33	$0,5 \leq t \leq 3$	300	—	230	—	3	2
5154	O	$0,6 \leq t \leq 12$	205	285	75	—	—	—
5154A	O H111	$t \leq 20$	200	260	85	—	16	14
	H14 H24 H34	$t \leq 10$	260	320	200	—	5	4
	H18 H28 H38	$t \leq 5$	310	—	240	—	3	2

Table 2 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
5251	O	$0,5 \le t \le 10$	150	200	60	—	17	15
	H12	$0,5 \le t \le 5$	180	—	110	—	5	4
	H14	$0,5 \le t \le 5$	200	—	160	—	4	3
	H16	$0,5 \le t \le 1,5$	220	—	180	—	3	2
	H18	$0,5 \le t \le 1,5$	235	—	200	—	2	2
5754	O	$0,5 \le t \le 10$	180	—	80	—	17	15
	H12	$0,5 \le t \le 5$	215	—	140	—	5	4
	H14	$0,5 \le t \le 5$	250	—	180	—	4	3
	H34	$0,5 \le t \le 5$	250	—	180	—	5	4
6012	T4[e]	$t \le 20$	200	—	100	—	10	8
	T6[e]	$t \le 20$	310	—	260	—	8	6
6060	T4	$0,5 \le t \le 10$	130	—	65	—	15	—
	T5 T6	$0,5 \le t \le 10$	215	—	160	—	12	—
	T8[e]	$0,5 \le t \le 10$	215	—	160	—	10	—
6061	O[b]	$0,6 \le t \le 12$	—	145	—	100	—	15
	T4	$0,6 \le t \le 1,2$	205	—	110	—	—	16
		$1,2 < t \le 6,5$	205	—	110	—	—	18
		$6,5 < t \le 12$	205	—	110	—	—	20
	T42[c]	$0,6 \le t \le 1,2$	205	—	95	—	—	16
		$1,2 < t \le 6,5$	205	—	95	—	—	18
		$6,5 < t \le 12$	205	—	95	—	—	20
	T6 T62[f]	$0,6 \le t \le 1,2$	295	—	245	—	10	10
		$1,2 < t \le 6,5$	295	—	245	—	12	12
		$6,5 < t \le 12$	295	—	245	—	14	14
6063	O	$0,6 \le t \le 12$	—	125	—	—	—	—
	T4[e]	$t \le 5$	150	—	75	—	12	10
		$5 < t \le 20$	150	—	75	—	15	13
	T6	$0,6 \le t \le 1,2$	225	—	195	—	—	12
		$1,2 < t \le 6,5$	225	—	195	—	—	14
		$6,5 < t \le 12$	225	—	195	—	—	16
	T66[e]	$t \le 20$	230	—	195	—	10	8
	T83[e]	$0,6 \le t \le 12$	225	—	205	—	—	5
	T832[e]	$t \le 5$	275	—	240	—	5	5
6063A	O H111	$t \le 20$	—	140	—	—	15	13
	T4[e]	$t \le 20$	150	—	90	—	16	14
	T6[e]	$t \le 20$	230	—	190	—	9	7

Table 2 *(continued)*

Alloy	Temper	Dimensions[a]	Tensile strength R_m MPa		0,2 % proof stress $R_{p0,2}$ MPa		Elongation min.	
			min.	max.	min.	max.	A %	A_{50mm} %
6082	O	$0,5 \le t \le 10$	—	160	—	110	—	—
	T4	$0,5 \le t \le 10$	205	—	110	—	14	12
	T6	$0,5 \le t \le 5$	310	—	255	—	8	7
	T8[e]	$0,5 \le t \le 5$	310	—	240	—	9	8
		$5 < t \le 10$	310	—	260	—	8	8
6262	T6	$1 \le t \le 6$	290	—	240	—	8	7
		$6 < t \le 10$	290	—	240	—	8	8
	T9[e]	$1 \le t \le 10$	330	—	305	—	3	3
7020	T6[e]	$t \le 20$	350	—	280	—	10	8
7022	T6[e]	$t \le 20$	460	—	380	—	8	6
7049A	T6	$t \le 5$	590	—	530	—	6	4
	T6510 T6511	$5 < t \le 20$	590	—	530	—	7	5
7075	O[b]	$0,6 \le t \le 1,2$	—	275	—	145	—	10
		$1,2 < t \le 12$	—	275	—	145	—	12
	T6	$0,6 \le t \le 6,5$	530	—	460	—	—	8
	T62[f]	$6,5 < t \le 12$	530	—	460	—	—	9
	T6510 T6511	$t \le 20$	540	—	485	—	5	4
	T73[g]	$t \le 20$	455	—	385	—	10	8
	T73510[g] T73511[g]	$t \le 20$	455	—	385	—	8	6

[a] t (mm) = wall thickness.

[b] The material of temper grade O shall be a basis for materials of temper grades T42 or T62. Where requested by the purchaser, the capability to achieve T42 or T62 properties after appropriate heat treatment is demonstrated.

[c] The mechanical properties of temper grade T42 shall be applied only where the material of temper grade O has been naturally age-hardened after solution treatment by the purchaser. If the material is cold or hot worked prior to solution treatment by the purchaser, its mechanical properties may be lower than the specified values.

[d] For temper grade H22, proof stress shall not apply.

[e] Applicable for those after extrusion followed by controlled cooling at a rate rapid enough to hold constituents in solution.

[f] The mechanical property values of temper grade T62 shall be applied where the purchaser carries out solution heat treatment and subsequent artificial age-hardening treatment for temper grade O. However, where a certain cold working or hot working has been conducted by the purchaser prior to solution heat treatment, the values of mechanical properties may occasionally be lower than the specified limits.

[g] For materials of thickness 20 mm or above, see ISO 6363-1, with respect to stress corrosion cracking resistance.

Annex A
(normative)

Rules for rounding

A.1 Rounding of results obtained by inspection and testing

A.1.1 Mechanical and chemical properties

The results of mechanical and chemical tests shall be rounded using either the rules specified in the International Standard specifying the method of test or, if the value obtained contains a larger number of significant figures than the guaranteed value, the generally accepted rules for rounding.

A.1.2 Dimensional characteristics

The results of determinations of dimensions (length, width, thickness, rounding, etc.) and shape (squaring, cambering, straightness, flatness, kinking, circularity, etc.) are not rounded. These shall conform to the specification in the relevant International Standard, taking into account permissible tolerances also given in that International Standard.

A.2 Rounding of determination of conformity

In recording test results, the number representing the result of a test to determine a given property or to determine chemical composition should be expressed to the same number of decimal places as the corresponding number in the relevant International Standard.

The following rules should be used for rounding.

a) Where the figure immediately after the last figure to be retained is less than 5, the last figure to be retained remains unchanged.

b) Where the figure immediately after the last figure to be retained is greater than 5, or equal to 5 and followed by at least one figure other than zero, the last figure to be retained remains unchanged if even and is increased by one if odd.

c) Where the figure immediately after the last figure to be retained is equal to 5 and followed by zeros only, the last figure to be retained remains unchanged if even and is increased by one if odd.