INTERNATIONAL STANDARD

ISO 8458-3

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Steel wire for mechanical springs —

Part 3:
Oil-hardened and tempered wire

Fils en acier pour ressorts mécaniques —
Partie 3: Fils trempés à l'huile et revenus

Reference number
ISO 8458-3:1992(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8458-3 was prepared by Technical Committee ISO/TC 17, *Steel*.

ISO 8458 consists of the following parts, under the general title *Steel wire for mechanical springs*:

— *Part 1: General requirements*

— *Part 2: Cold-drawn carbon steel wire*

— *Part 3: Oil-hardened and tempered wire*

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Steel wire for mechanical springs —

Part 3:
Oil-hardened and tempered wire

1 Scope

1.1 This part of ISO 8458 specifies requirements for oil-hardened and tempered carbon and low alloy steel wire, for the manufacture of mechanical springs for static duty and dynamic duty[1] applications, complying with the general requirements of ISO 8458-1.

1.2 The wire diameter ranges normally available for the steel types and spring applications are shown in table 1.

Table 1 — Wire diameter ranges

Type designation	Steel type	Wire diameter, mm			
		Static duty		Dynamic duty	
		min.	max.	min.	max.
SC	Carbon steel	0,50	15,00	—	—
DC	Carbon steel	—	—	0,50	15,00
DAA	Low-alloy steel	—	—	0,50	15,00
DAB	Low-alloy steel	—	—	0,50	15,00
DAC	Low-alloy steel	—	—	0,50	15,00

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8458. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8458 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8457-2:1989, *Steel wire rod — Part 2: Quality requirements for unalloyed steel wire rods for conversion to wire.*

ISO 8458-1:1989, *Steel wire for mechanical springs — Part 1: General requirements.*

ISO 683-14:1992, *Heat-treatable steels, alloy steels and free-cutting steels — Part 14: Hot-rolled steels for quenched and tempered springs.*

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis.*

3 Surface condition

The surface of the wire as received shall be free from any oxidation products, harmful surface defects or inclusions detrimental to the dynamic performance of mechanical springs produced from the wire.

4 Chemical composition

4.1 The chemical composition of the steel, as given by the cast analysis, shall be in accordance with table 2 for carbon steels and table 4 for low-alloy steels.

NOTE 1 Steel types for carbon steels and low-alloy steels shall be in accordance with those prescribed in ISO 8457-2 and ISO 683-14, respectively.

1) For definitions, see 3.4 and 3.5 of ISO 8458-1:1989.

4.2 The product analysis shall be in accordance with table 3 for carbon steels and table 5 for low-alloy steels.

4.3 The chemical composition shall be determined in accordance with the appropriate International Standards listed in ISO/TR 9769.

5 Tensile strength

The tensile strength of the wire shall be in accordance with table 6 for carbon steels and table 7 for low-alloy steels.

Table 2 — Chemical composition of carbon steels (cast analysis), % (*m*/*m*)

Element	Chemical composition[1]			
	Type SC		Type DC	
	min.	max.	min.	max.
Carbon	0,53	0,88	0,53	0,88
Silicon	0,10	0,35	0,10	0,35
Manganese	0,50	1,20	0,50	1,20
Phosphorus	—	0,040	—	0,030
Sulfur	—	0,040	—	0,030

1) Maximum copper content is negotiable.

Table 3 — Tolerance on product analysis for carbon steels

Element	Maximum limit of specified range % (*m*/*m*)	Tolerances over maximum limit or under minimum limit[1] % (*m*/*m*)
Carbon	Up to and including 0,55	0,03
	Over 0,55	0,04
Silicon	Up to and including 0,35	0,03
Manganese	Up to and including 1,00	0,04
	Over 1,00	0,06
Phosphorus	Up to and including 0,040	0,008
Sulfur	Up to and including 0,040	0,008

1) The deviations apply either above or below the specified limit of the range given for cast analysis, but not both above and below for the same element from different sample products from the same cast. When maxima only are specified, the deviations are positive only.

Table 4 — Chemical composition for low-alloy steels (cast analysis), % (*m/m*)

Element	Chemical composition[1)]					
	Type DAA		Type DAB		Type DAC	
	min.	max.	min.	max.	min.	max.
Carbon	0,47	0,55	0,57	0,75	0,51	0,59
Silicon	0,10	0,40	0,15	0,30	1,20	1,60
Manganese	0,60	1,00	0,50	0,90	0,50	0,80
Phosphorus	—	0,030	—	0,030	—	0,030
Sulfur	—	0,030	—	0,030	—	0,030
Chromium	0,80	1,10	0,35	0,70	0,55	0,85
Vanadium	0,10	0,25	0,10	0,25	—	—

1) Maximum copper content is negotiable.

Table 5 — Tolerance on product analysis for low-alloy steels

Element	Maximum limit of specified range % (*m/m*)	Tolerances over maximum limit or under minimum limit[1)] % (*m/m*)
Carbon	Up to and including 0,55	0,03
	Over 0,55	0,04
Silicon	Up to and including 0,40	0,03
	Over 0,40	0,05
Manganese	Up to and including 1,00	0,04
Phosphorus	Up to and including 0,030	0,005
Sulfur	Up to and including 0,030	0,005
Chromium	Up to and including 1,10	0,05
Vanadium	Up to and including 0,25	0,02

1) The deviations apply either above or below the specified limit of the range given for cast analysis, but not both above and below for the same element from different sample products from the same cast. When maxima only are specified, the deviations are positive only.

Table 6 — Tensile strength requirements for carbon steels

Nominal diameter[1]	Tensile strength, N/mm² [2]		Nominal diameter	Tensile strength, N/mm² [2]	
	Types SC, DC[3]			Types SC, DC	
mm	min.	max.	mm	min.	max.
0,50	1 720	2 100	3,00	1 620	1 770
0,53	1 720	2 100	3,20	1 610	1 760
0,56	1 720	2 100	3,40	1 590	1 740
0,60	1 720	2 100	3,60	1 580	1 730
0,63	1 720	2 100	3,80	1 570	1 720
0,65	1 720	2 100	4,00	1 560	1 710
0,70	1 720	2 100	4,25	1 540	1 690
0,80	1 720	2 080	4,50	1 530	1 680
0,85	1 720	2 060	4,75	1 520	1 670
0,90	1 720	2 050	5,00	1 500	1 650
0,95	1 720	2 040	5,30	1 490	1 640
1,00	1 720	2 030	5,60	1 470	1 620
1,05	1 720	2 020	6,00	1 460	1 610
1,10	1 720	2 010	6,30	1 450	1 600
1,20	1 720	1 990	6,50	1 440	1 590
1,25	1 720	1 980	7,00	1 430	1 580
1,30	1 720	1 970	7,50	1 410	1 560
1,40	1 720	1 950	8,00	1 400	1 550
1,50	1 720	1 940	8,50	1 390	1 540
1,60	1 720	1 920	9,00	1 370	1 520
1,70	1 720	1 910	9,50	1 360	1 510
1,80	1 720	1 890	10,00	1 350	1 500
1,90	1 720	1 880	10,50	1 340	1 490
2,00	1 720	1 870	11,00	1 330	1 480
2,10	1 710	1 860	12,00	1 320	1 470
2,25	1 690	1 840	13,00	1 300	1 450
2,40	1 680	1 830	14,00	1 290	1 440
2,50	1 670	1 820	15,00	1 270	1 420
2,60	1 660	1 810			
2,80	1 640	1 790			

1) For intermediate wire diameters between the two nominal diameters, the specified value of the next larger diameter shall apply.

2) 1 N/mm² = 1 MPa

3) For SC and DC grades in the size range 0,50 mm to 1,50 mm, a restricted tensile strength range of 200 N/mm² within the specified range may be negotiated.

Table 7 — Tensile strength requirements for low-alloy steels

Nominal diameter[1]	Tensile strength, N/mm² [2]					
	Type DAA[3]		Type DAB[3]		Type DAC[3]	
mm	min.	max.	min.	max.	min.	max.
0,50	1 630	2 100	1 680	2 200	2 000	2 300
0,53	1 630	2 100	1 680	2 200	2 000	2 300
0,56	1 630	2 100	1 680	2 200	2 000	2 300
0,60	1 630	2 100	1 680	2 200	2 000	2 300
0,63	1 630	2 100	1 680	2 200	2 000	2 300
0,65	1 630	2 100	1 680	2 200	2 000	2 300
0,70	1 630	2 100	1 680	2 200	2 000	2 300
0,80	1 630	2 100	1 680	2 170	2 000	2 300
0,85	1 630	2 100	1 680	2 150	2 000	2 300
0,90	1 630	2 100	1 680	2 130	2 000	2 300
0,95	1 630	2 090	1 680	2 120	2 000	2 300
1,00	1 630	2 080	1 680	2 110	2 000	2 300
1,05	1 630	2 070	1 680	2 100	2 000	2 290
1,10	1 630	2 050	1 680	2 080	2 000	2 280
1,20	1 630	2 030	1 680	2 060	2 000	2 260
1,25	1 630	2 020	1 680	2 050	2 000	2 250
1,30	1 630	2 010	1 680	2 040	2 000	2 240
1,40	1 630	1 990	1 680	2 030	2 000	2 230
1,50	1 630	1 970	1 680	2 010	2 000	2 210
1,60	1 630	1 950	1 680	2 000	2 000	2 190
1,70	1 630	1 930	1 680	1 980	2 000	2 180
1,80	1 630	1 920	1 680	1 970	2 000	2 170
1,90	1 630	1 900	1 680	1 950	2 000	2 150
2,00	1 630	1 890	1 680	1 940	2 000	2 140
2,10	1 630	1 880	1 680	1 930	1 990	2 130
2,25	1 630	1 860	1 680	1 910	1 970	2 120
2,40	1 630	1 840	1 680	1 900	1 960	2 110
2,50	1 630	1 830	1 680	1 890	1 950	2 100
2,60	1 630	1 820	1 680	1 880	1 930	2 080
2,80	1 630	1 800	1 680	1 850	1 920	2 070
3,00	1 630	1 780	1 680	1 840	1 900	2 050
3,20	1 620	1 760	1 680	1 830	1 890	2 040
3,40	1 600	1 750	1 660	1 810	1 870	2 020
3,60	1 580	1 730	1 650	1 800	1 860	2 010
3,80	1 570	1 720	1 640	1 790	1 850	2 000
4,00	1 560	1 710	1 620	1 770	1 840	1 990
4,25	1 540	1 690	1 610	1 760	1 830	1 980
4,50	1 520	1 670	1 600	1 750	1 810	1 970
4,75	1 510	1 660	1 580	1 730	1 800	1 950
5,00	1 500	1 650	1 570	1 720	1 790	1 940
5,30	1 480	1 630	1 560	1 710	1 780	1 930

Nominal diameter[1]	Tensile strength, N/mm² [2]					
	Type DAA[3]		Type DAB[3]		Type DAC[3]	
mm	min.	max.	min.	max.	min.	max.
5,60	1 460	1 610	1 540	1 690	1 770	1 920
6,00	1 440	1 590	1 520	1 670	1 750	1 900
6,30	1 430	1 580	1 510	1 660	1 740	1 890
6,50	1 420	1 570	1 500	1 650	1 730	1 880
7,00	1 400	1 550	1 490	1 640	1 710	1 860
7,50	1 390	1 540	1 480	1 630	1 700	1 850
8,00	1 380	1 530	1 470	1 620	1 680	1 830
8,50	1 370	1 520	1 470	1 620	1 670	1 820
9,00	1 360	1 510	1 460	1 610	1 660	1 810
9,50	1 350	1 500	1 460	1 610	1 650	1 800
10,00	1 350	1 500	1 450	1 600	1 640	1 790
10,50	1 340	1 490	1 450	1 600	1 630	1 780
11,00	1 330	1 480	1 440	1 590	1 630	1 780
12,00	1 320	1 470	1 430	1 580	1 610	1 760
13,00	1 310	1 460	1 420	1 570	1 590	1 740
14,00	1 300	1 450	1 410	1 560	1 580	1 730
15,00	1 290	1 440	1 410	1 560	1 570	1 720

1) For intermediate wire diameters between the two nominal diameters, the specified value of the next larger diameter shall apply.

2) 1 N/mm² = 1 MPa

3) For DAA grades in the size range 0,50 mm to 2,40 mm, DAB grades in the size range 0,50 mm to 2,50 mm and DAC grades in the size range 0,50 mm to 1,50 mm, a restricted tensile strength range of 200 N/mm² within the specified range may be negotiated.

6 Ductility testing

6.1 General

For ductility testing, the wrapping test shall be applied to wires with nominal diameter 6,00 mm and smaller, and the bend test shall be applied with nominal diameter greater than 6,00 mm. When agreed, these two tests can be replaced by the torsion test or the reduction of area test corresponding to the wire diameter.

6.2 Wrapping test

6.2.1 Wires of diameter up to and including 6 mm shall not fracture nor show evidence of cracking when subjected to the wrapping test.

6.2.2 Wires of diameter up to and including 4,00 mm shall be wound at least four turns around a mandrel of the same diameter as the wire. Wires of diameter greater than 4,00 mm shall be wound at least four turns around a mandrel of diameter equal to twice the wire diameter.

6.3 Bend test

6.3.1 The bend test shall be applied to wires with nominal diameter greater than 6,00 mm.

6.3.2 The wire shall not show any sign of fracture when bent through an angle of 90° around a mandrel of diameter equal to twice the wire diameter.

6.4 Torsion test

6.4.1 The torsion test shall be applied to wires with nominal diameter from 0,70 mm to 6,00 mm.

6.4.2 The wire shall withstand being twisted without failure on a gauge length given in table 8. The number of turns shall be subject to negotiation on the gauge length equivalent to 100 wire diameters.

If the gauge length applied is greater or less than 100 wire diameters, the number of twists shall be adjusted in proportion to the gauge length.

6.5 Reduction of area

The minimum reduction of area shall be in accordance with table 9.

7 Surface quality tests

7.1 Surface quality tests shall be applied to wires intended for use both in dynamic duty springs and in static duty springs, although its application to the latter shall be negotiable.

7.2 The cross-section shall show no completely decarburized layer. The radial depth of total decarburization, as indicated by the combination of partial decarburization and carbon gradient, shall not exceed 1,5 % of the nominal diameter of the wire.

NOTE 2 A zone of partial decarburization is characterized by the presence of variable amounts of ferrite spines at the grain boundaries of the tempered martensite. An area of carbon gradient is defined as one where the tempered martensite etches lighter than that of the core of the wire, but which is free from recognizable ferrite.

7.3 The radial depth of seams or other surface defects shall be not greater than 1 % of the nominal diameter of the wire.

Table 8 — Gauge length

Nominal diameter d mm		**Free length between grips** mm	
From	Up to but excluding	Standard gauge length	Acceptable gauge length
Over 0,70	1,00	$100d$	$200d$
1,00	5,00	$100d$ [1]	—
5,00	6,00 inclusive	$100d$	$50d$ [2]

1) $50d$ may be used by special agreement when the machine will not permit the use of a length equal to $100d$.

2) $30d$ may be used by special agreement when the machine will not permit the use of a length equal to $50d$.

Table 9 — Reduction of area

Nominal diameter mm		**Reduction of area** (percent minimum)
Over	Up to and including	Types SC, DC, DAA, DAB, DAC
1,00	3,00	45
3,00	5,00	40
5,00	8,00	35
8,00	14,00	30
14,00	15,00	—