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
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this part of ISO 8458 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8458-3 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

This second edition cancels and replaces the first edition (ISO 8458-3:1992), which has been technically revised.

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

— *Part 1: General requirements*

— *Part 2: Patented cold-drawn non-alloy steel wire*

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

This corrected version of ISO 8458-3 has been necessitated by the omission of paragraph 6 above.

Steel wire for mechanical springs —

Part 3:
Oil-hardened and tempered wire

1 Scope

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 applications, complying with the general requirements of ISO 8458-1.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 8458. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 8458 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 4967:1998, *Steel — Determination of content of non-metallic inclusions — Micrographic method using standard diagrams*

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

3 Classification and designation

The various spring wire grades and the relevant diameters are shown in Table 1.

Table 1 — Spring wire grades and diameter ranges

Tensile strength	Static	Medium fatigue	High fatigue
Low tensile strength	FDC	TDC	VDC
Medium tensile strength	FDCrV(A.B)	TDCrV(A.B)	VDCrV(A.B)
High tensile strength	FDSiCr	TDSiCr	VDSiCr
Diameter range (mm)	0,50 to 17,00	0,50 to 10,00	0,50 to 10,00

FD grade is intended for static applications, required for normal springs.

TD grade is intended for medium fatigue levels.

VD grade is intended for use under severe dynamic duty such as for valve springs.

4 Dimensional tolerances

The permissible dimensional tolerances on wire in coils and cut lengths shall be in accordance with those specified in ISO 8458-1.

When the required tolerance level is different from those mentioned above, it shall be agreed at the time of ordering.

5 Requirements

5.1 Chemical composition

The steel is characterized by the heat analysis, which shall be in accordance with the values listed in Table 2. The permissible deviation of the product analysis from the heat analysis shall be in accordance with Table 3.

Table 2 — Chemical composition, mass fraction

Values in percent

Grade	C	Si	Mn	P max.	S max.	Cr	V	Cu max.
FDC	0,60 to 0,75	0,10 to 0,35	0,50 to 1,20	0,030	0,030	—	—	0,20
TDC	0,60 to 0,75	0,10 to 0,35	0,50 to 1,20	0,020	0,025	—	—	0,12
VDC	0,60 to 0,75	0,15 to 0,30	0,50 to 1,00	0,020	0,025	—	—	0,12
FDCrV-A	0,47 to 0,55	0,10 to 0,40	0,60 to 1,20	0,030	0,030	0,80 to 1,10	0,15 to 0,25	0,20
TDCrV-A				0,025	0,025			0,12
VDCrV-A				0,025	0,025			0,12
FDCrV-B	0,62 to 0,72	0,15 to 0,30	0,50 to 0,90	0,030	0,030	0,40 to 0,60	0,15 to 0,25	0,20
TDCrV-B				0,025	0,025			0,12
VDCrV-B				0,025	0,025			0,12
FDSiCr	0,50 to 0,60	1,20 to 1,60	0,50 to 0,90	0,030	0,030	0,50 to 0,80	—	0,20
TDSiCr				0,025	0,025			0,12
VDSiCr				0,025	0,025			0,12

Table 3 — Permissible deviation of the product analysis from the limiting values for the heat analysis

Chemical element	Wire grade	Permissible deviation, % by mass
C	All	± 0,03
Si	SiCr	± 0,05
	other grades	± 0,03
Mn	All	± 0,04
P	All	+ 0,005
S	All	+ 0,005
Cu	All	+ 0,02
Cr	All	± 0,05
V	All	± 0,02

5.2 Surface quality

5.2.1 The surface of the wire shall be smooth. The permissible maximum depth of surface discontinuities measured on samples as defined in ISO 8458-1 shall be in accordance with Table 4.

Table 4 — Permissible maximum depth of surface discontinuities

Dimensions in millimetres

Wire diameter, d	VD	TD		FD
		Class 1	Class 2 [a]	
$2{,}00 \leqslant d \leqslant 6{,}00$	$0{,}005d$	$0{,}008d$	$0{,}013d$	$0{,}01d$ [b]
$6{,}00 < d \leqslant 10{,}00$	$0{,}007d$	$0{,}01d$	$0{,}013d$	$0{,}014d$

[a] Only for SiCr grades.

[b] For SiCr grades, 1,4 %.

5.2.2 Eddy current inline testing shall be performed for VD grades and is optional for TD grades. The method of testing and the evaluation of test results shall be agreed upon between the parties. Eddy current testing is normally applied for sizes 2,50 mm to 6,00 mm.

5.2.3 The cross-section of wire of VD and TD shall be free from complete decarburization. The permissible maximum average depths of partial decarburized layer are shown in Table 5.

Table 5 — Permissible maximum average depth of surface decarburization

Dimensions in millimetres

Wire grade	Diameter, d	
	$d \leqslant 4{,}00$	$d > 4{,}00$
VD	0,04	$0{,}01d$
TD	0,05	$0{,}013d$
FD	$0{,}015d$	

5.3 Non-metallic inclusions

The VD grades shall be checked for maximum size of inclusion in accordance with ISO 4967. The permissible level of inclusions shall be agreed upon between the parties at the inquiry and order.

5.4 Mechanical properties

For tensile strength and reduction in area after rupture, the wire grades shall satisfy the values listed in Table 6 and Table 7. Reduction of area shall be measured only for sizes 1,00 mm and above. The range of tensile strength values within a coil/reel shall not exceed 50 N/mm^2 for the grades VD, 60 N/mm^2 for the grades TD and 70 N/mm^2 for the grades FD.

5.5 Technological properties

5.5.1 Wrapping test

5.5.1.1 The wrapping test may be applied to wires with nominal diameter less than 3,00 mm.

5.5.1.2 The wire shall not show any sign of fracture when closely coiled for at least four turns around a mandrel of diameter equal to that of the wire.

Table 6 — Mechanical properties for oil-hardened and tempered spring steel wire of static duty

Diameter range	Tensile strength, N/mm^2				Reduction in area
mm	FDC [a,b]	FDCrV-A [c]	FDCrV-B [d,e]	FDSiCr [f,g]	min. %
$d \leqslant 0{,}50$	1 800 to 2 100	1 800 to 2 100	1 900 to 2 200	2 000 to 2 250	—
$0{,}50 < d \leqslant 0{,}80$	1 800 to 2 100	1 800 to 2 100	1 900 to 2 200	2 000 to 2 250	—
$0{,}80 < d \leqslant 1{,}00$	1 800 to 2 060	1 780 to 2 080	1 860 to 2 160	2 000 to 2 250	—
$1{,}00 < d \leqslant 1{,}30$	1 800 to 2 010	1 750 to 2 010	1 850 to 2 100	2 000 to 2 250	45
$1{,}30 < d \leqslant 1{,}40$	1 750 to 1 950	1 750 to 1 990	1 840 to 2 070	2 000 to 2 250	45
$1{,}40 < d \leqslant 1{,}60$	1 740 to 1 890	1 710 to 1 950	1 820 to 2 030	2 000 to 2 250	45
$1{,}60 < d \leqslant 2{,}00$	1 720 to 1 890	1 710 to 1 890	1 790 to 1 970	2 000 to 2 250	45
$2{,}00 < d \leqslant 2{,}50$	1 670 to 1 820	1 670 to 1 830	1 750 to 1 900	1 970 to 2 140	45
$2{,}50 < d \leqslant 2{,}70$	1 640 to 1 790	1 660 to 1 820	1 720 to 1 870	1 950 to 2 120	45
$2{,}70 < d \leqslant 3{,}00$	1 620 to 1 770	1 630 to 1 780	1 700 to 1 850	1 930 to 2 100	45
$3{,}00 < d \leqslant 3{,}20$	1 600 to 1 750	1 610 to 1 760	1 680 to 1 830	1 910 to 2 080	40
$3{,}20 < d \leqslant 3{,}50$	1 580 to 1 730	1 600 to 1 750	1 660 to 1 810	1 900 to 2 060	40
$3{,}50 < d \leqslant 4{,}00$	1 550 to 1 700	1 560 to 1 710	1 620 to 1 770	1 870 to 2 030	40
$4{,}00 < d \leqslant 4{,}20$	1 540 to 1 690	1 540 to 1 690	1 610 to 1 760	1 860 to 2 020	40
$4{,}20 < d \leqslant 4{,}50$	1 520 to 1 670	1 520 to 1 670	1 590 to 1 740	1 850 to 2 000	40
$4{,}50 < d \leqslant 4{,}70$	1 510 to 1 660	1 510 to 1 660	1 580 to 1 730	1 840 to 1 990	40
$4{,}70 < d \leqslant 5{,}00$	1 500 to 1 650	1 500 to 1 650	1 560 to 1 710	1 830 to 1 980	40
$5{,}00 < d \leqslant 5{,}60$	1 470 to 1 620	1 460 to 1 610	1 540 to 1 690	1 800 to 1 950	35
$5{,}60 < d \leqslant 6{,}00$	1 460 to 1 610	1 440 to 1 590	1 520 to 1 670	1 780 to 1 930	35
$6{,}00 < d \leqslant 6{,}50$	1 440 to 1 590	1 420 to 1 570	1 510 to 1 660	1 760 to 1 910	35
$6{,}50 < d \leqslant 7{,}00$	1 430 to 1 580	1 400 to 1 550	1 500 to 1 650	1 740 to 1 890	35
$7{,}00 < d \leqslant 8{,}00$	1 400 to 1 550	1 380 to 1 530	1 480 to 1 630	1 710 to 1 860	35
$8{,}00 < d \leqslant 8{,}50$	1 380 to 1 530	1 370 to 1 520	1 470 to 1 620	1 700 to 1 850	30
$8{,}50 < d \leqslant 10{,}00$	1 360 to 1 510	1 350 to 1 500	1 450 to 1 600	1 660 to 1 810	30
$10{,}00 < d \leqslant 12{,}00$	1 320 to 1 470	1 320 to 1 470	1 430 to 1 580	1 620 to 1 770	30
$12{,}00 < d \leqslant 14{,}00$	1 280 to 1 430	1 300 to 1 450	1 420 to 1 570	1 580 to 1 730	30
$14{,}00 < d \leqslant 15{,}00$	1 270 to 1 420	1 290 to 1 440	1 410 to 1 560	1 570 to 1 720	—
$15{,}00 < d \leqslant 17{,}00$	1 250 to 1 400	1 270 to 1 420	1 400 to 1 550	1 550 to 1 700	—

1 N/mm^2 = 1 MPa.

a For diameters $\leqslant$ 2,00 mm, a tensile strength range of 1 720 to 1 920 N/mm^2 may be agreed.

b A lower limit value of 1 900 N/mm^2 may be agreed for diameter $\leqslant$ 1,00 mm.

c For diameters $\leqslant$ 3,00 mm, a tensile strength range of 1 620 to 1 820 N/mm^2 may be agreed.

d For diameters $\leqslant$ 3,00 mm, a tensile strength range of 1 660 to 1 860 N/mm^2 may be agreed.

e A lower limit value of 2 000 N/mm^2 may be agreed for diameter $\leqslant$ 1,00 mm.

f A lower limit value of 2060 N/mm^2 may be agreed for diameter $\leqslant$ 2,00 mm.

g For diameter above 2 mm, the lower limit for tensile strength may be reduced by 30 N/mm^2 if agreed upon.

Table 7 — Mechanical properties for oil-hardened and tempered spring steel wire of dynamic duty [a]

Diameter range mm	Tensile strength, N/mm²				Reduction in area min. %
	TDC VDC	TDCrV-A VDCrV-A [b]	TDCrV-B VDCrV-B [c]	TDSiCr VDSiCr	
$d \leqslant 0{,}50$	1 700 to 2 000	1 750 to 1 950	1 910 to 2 060	1 960 to 2 230	—
$0{,}50 < d \leqslant 0{,}80$	1 700 to 2 000	1 750 to 1 950	1 910 to 2 060	1 960 to 2 230	—
$0{,}80 < d \leqslant 1{,}00$	1 700 to 1 950	1 750 to 1 950	1 910 to 2 060	1 960 to 2 230	—
$1{,}00 < d \leqslant 1{,}30$	1 700 to 1 850	1 700 to 1 900	1 860 to 2 010	1 960 to 2 230	45
$1{,}30 < d \leqslant 1{,}40$	1 700 to 1 850	1 670 to 1 860	1 820 to 1 970	1 960 to 2 230	45
$1{,}40 < d \leqslant 1{,}60$	1 700 to 1 850	1 670 to 1 860	1 820 to 1 970	1 960 to 2 210	45
$1{,}60 < d \leqslant 2{,}00$	1 650 to 1 800	1 620 to 1 800	1 770 to 1 920	1 960 to 2 160	45
$2{,}00 < d \leqslant 2{,}50$	1 600 to 1 750	1 620 to 1 770	1 720 to 1 860	1 900 to 2 060	45
$2{,}50 < d \leqslant 2{,}70$	1 600 to 1 750	1 620 to 1 770	1 660 to 1 810	1 860 to 2 010	45
$2{,}70 < d \leqslant 3{,}00$	1 600 to 1 750	1 620 to 1 770	1 660 to 1 810	1 860 to 2 010	45
$3{,}00 < d \leqslant 3{,}20$	1 570 to 1 720	1 570 to 1 720	1 620 to 1 770	1 860 to 2 010	45
$3{,}20 < d \leqslant 3{,}50$	1 550 to 1 700	1 570 to 1 720	1 620 to 1 770	1 860 to 2 010	45
$3{,}50 < d \leqslant 4{,}00$	1 500 to 1 650	1 520 to 1 670	1 570 to 1 720	1 810 to 1 960	45
$4{,}00 < d \leqslant 4{,}20$	1 500 to 1 650	1 520 to 1 670	1 520 to 1 670	1 810 to 1 960	45
$4{,}20 < d \leqslant 4{,}50$	1 500 to 1 650	1 520 to 1 670	1 520 to 1 670	1 810 to 1 960	45
$4{,}50 < d \leqslant 4{,}70$	1 490 to 1 640	1 470 to 1 620	1 520 to 1 670	1 760 to 1 910	45
$4{,}70 < d \leqslant 5{,}00$	1 490 to 1 640	1 470 to 1 620	1 520 to 1 670	1 760 to 1 910	45
$5{,}00 < d \leqslant 5{,}60$	1 470 to 1 620	1 470 to 1 620	1 470 to 1 620	1 760 to 1 910	40
$5{,}60 < d \leqslant 6{,}00$	1 470 to 1 620	1 470 to 1 620	1 470 to 1 620	1 710 to 1 860	40
$6{,}00 < d \leqslant 6{,}50$	1 420 to 1 570	1 420 to 1 570	1 420 to 1 570	1 710 to 1 860	40
$6{,}50 < d \leqslant 7{,}00$	1 420 to 1 570	1 420 to 1 570	1 420 to 1 570	1 660 to 1 810	40
$7{,}00 < d \leqslant 8{,}00$	1 370 to 1 520	1 370 to 1 520	1 370 to 1 520	1 660 to 1 810	40
$8{,}00 < d \leqslant 9{,}00$	1 340 to 1 490	1 370 to 1 520	1 340 to 1 490	1 620 to 1 770	35
$9{,}00 < d \leqslant 10{,}00$	1 340 to 1 490	1 370 to 1 520	1 340 to 1 490	1 620 to 1 770	35

1 N/mm² = 1 MPa.

[a] A restricted tensile strength range may be specified as follows:

Grade	150 N/mm²	100 N/mm²
VDC,TDC	$d \leqslant 1{,}00$ mm	$d > 1{,}00$ mm
VDCrV-A,TDCrV-A	$d \leqslant 3{,}00$ mm	$d > 3{,}00$ mm
VDCrV-B,TDCrV-B	$d \leqslant 3{,}00$ mm	$d > 3{,}00$ mm
VDSiCr , TDSiCr	$d \leqslant 2{,}00$ mm	$d > 2{,}00$ mm

[b] A lower value of 1 620 N/mm² may be specified for diameter ⩽ 1,60 mm.

[c] A lower value of 1 660 N/mm² may be specified for diameter ⩽ 2,50 mm.