
Non-alloy steel wire rod for conversion to wire —

Part 4:
Specific requirements for wire rod for special applications

Fil-machine en acier non allié destiné à la fabrication de fils —

Partie 4: Exigences spécifiques au fil-machine pour applications spéciales

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16120-4 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 16120-4:2001), which has been technically revised.

ISO 16120 consists of the following parts, under the general title *Non-alloy steel wire rod for conversion to wire*:

- *Part 1: General requirements*
- *Part 2: Specific requirements for general-purpose wire rod*
- *Part 3: Specific requirements for rimmed and rimmed substitute, low-carbon steel wire rod*
- *Part 4: Specific requirements for wire rod for special applications*

Non-alloy steel wire rod for conversion to wire —

Part 4: Specific requirements for wire rod for special applications

1 Scope

This part of ISO 16120 is applicable to steel wire rod with improved characteristics intended for drawing and/or cold rolling.

2 Normative references

The following referenced documents are indispensable for the application 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 4948-1, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition*

ISO 4948-2, *Steels — Classification — Part 2: Classification of unalloyed and alloy steels according to main quality classes and main property or application characteristics*

ISO/TS 4949, *Steel names based on letter symbols*

ISO 4967, *Steel — Determination of content of nonmetallic inclusions — Micrographic method using standard diagrams*

ISO 16120-1:2011, *Non-alloy steel wire rod for conversion to wire — Part 1: General requirements*

ISO 16120-2:2011, *Non-alloy steel wire rod for conversion to wire — Part 2: Specific requirements for general-purpose wire rod*

ASTM E45, *Standard Test Methods for Determining the Inclusion Content of Steel*

3 Designation

In the designation C##D2, “C” means non-alloy steel (see ISO/TS 4949); ## is the indicative average content of carbon; “D” signifies that it is for wire-drawing; “2” means wire rod for special applications.

If steels are ordered according to the chemical composition, ## means that values are to be inserted by the purchaser according to the steel names as designated in Table 1, first column.

Steels can also be ordered according to tensile strength. The mid-point of the required ultimate tensile strength (UTS) range shall be indicated as a suffix to the grade designation, e.g. C##D2 – 1020, where the required mid-point of the UTS is 1 020 MPa. “##” means “to be left blank” since the carbon content is at the discretion of the supplying mill, and the supplying mill indicates the exact number of ## based on the grade designation until shipment. See Table 1 of ISO 16120-2:2011 for the grade designation.

4 Requirements

4.1 General

For the general requirements, see ISO 16120-1.

4.2 Chemical composition and mechanical properties

For heat analysis, the values shown in Table 1 shall apply. If product analysis is required, the permissible deviations of the product analysis relative to the specified value of the heat analysis are given in Table 2.

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Table 1 — Chemical analysis (heat analysis)^a

Steel grade ^b	Heat analysis										
	C ^c	Si ^{d,j}	Mn ^e	P	S	Cr ^f	Ni ^f	Mo	Cu ^{f,g}	Al ^h	N ⁱ
	%	%	%	max. %	max. %	max. %	max. %	max. %	max. %	max. %	max. %
C3D2	≤0,05	≤0,30	0,30 - 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C5D2	≤0,07	≤0,30	0,30 - 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C8D2	0,06 - 0,10	≤0,30	0,30 - 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C10D2	0,08 - 0,12	≤0,30	0,30 - 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C12D2	0,10 - 0,14	≤0,30	0,30 - 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C15D2	0,13 - 0,17	≤0,30	0,30 - 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C18D2	0,16 - 0,20	≤0,30	0,30 - 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C20D2	0,18 - 0,23	≤0,30	0,30 - 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C26D2	0,24 - 0,29	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C32D2	0,30 - 0,34	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C36D2	0,34 - 0,38	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C38D2	0,36 - 0,40	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C40D2	0,38 - 0,42	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C42D2	0,40 - 0,44	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C46D2	0,44 - 0,48	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C48D2	0,46 - 0,50	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C50D2	0,48 - 0,52	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C52D2	0,50 - 0,54	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C56D2	0,54 - 0,58	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C58D2	0,56 - 0,60	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C60D2	0,58 - 0,62	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C62D2	0,60 - 0,64	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C66D2	0,64 - 0,68	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C68D2	0,66 - 0,70	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C70D2	0,68 - 0,72	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C72D2	0,70 - 0,74	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C76D2	0,74 - 0,78	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C78D2	0,76 - 0,80	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C80D2	0,78 - 0,82	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C82D2	0,80 - 0,84	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C86D2	0,84 - 0,88	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C88D2	0,86 - 0,90	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C92D2	0,90 - 0,94	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C98D2	0,96 - 1,00	0,10 - 0,30	0,50 - 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007

By agreement between the supplier and purchaser, fine-grained steels may be specified. Such agreement may make reference to the requirement being deemed to be fulfilled if certain criteria (involving the use of Al, Nb or V, either singly or in combination) have been metⁱ.

^a Elements not included in this table may not be added intentionally to the steel without the agreement of the purchaser, except those intended for finishing the heat. By agreement at the time of ordering, the grades can contain additions (commonly termed microalloying additions) of Cr and V. The content of Cr is up to 0,30 % and the content of V is 0,05 % to 0,10 %.

^b Non-alloy steel for special applications shall comply with the non-alloy special steel in ISO 4948-2.

^c For steels C32D2 to C98D2 the carbon range may be enlarged by 0,01 %, either by lowering the minimum or by increasing the maximum, by agreement between the supplier and purchaser.

^d For wire rod intended for galvanizing, the required lower limit of silicon content should be specified at the time of ordering.

^e For the manganese content, a different range from the one indicated in the table may be agreed at the time of ordering, with an amplitude of 0,20 %, and with a maximum not exceeding 1,20 % and a minimum not lower than 0,30 %.

^f The sum of the contents Cu + Ni + Cr shall not exceed 0,30 %, except when Cr is intentionally added at the request of the purchaser.

^g Cu + Sn shall be ≤0,15 %. For certain applications, the Cu content may be restricted to 0,12 % max. by agreement and the content of Sn shall not exceed 0,03 %.

^h By agreement between the supplier and purchaser, an Al range may be specified with a lower limit 0,02 % and an upper limit of 0,06 %. The value for silicon can then be fixed at ≤0,10 % on request.

ⁱ If, in accordance with footnote h, the Al content is fixed, the limit value of N shall be agreed at the time of ordering.

^j For the silicon content, a different range from the one indicated in this table may be agreed at the time of ordering.

Table 2 — Permissible deviation in the product analysis in relation to the specified heat analysis^a

Elements	Steel grade	Permissible deviation in product analysis %
C	C3D2 to C20D2	±0,02
	C26D to C82D2	±0,03
	C86D to C98D2	±0,04
Si	All grades	±0,04
Mn	All grades	±0,06
P and S	All grades	+0,005

^a If agreed at the time or ordering, the permissible deviation between product analysis and heat analysis for carbon shall be in relation to the actual heat analysis instead of the specified range.

4.3 Internal soundness and surface quality

The wire rod shall have no internal and surface discontinuities, such as shrink holes, cracks, folds, incrustations, notches, scabs or rolling burrs, which may be detrimental to its subsequent processing.

4.4 Depth of surface discontinuities

The wire rod shall not have any surface discontinuities with depths greater than those shown in Table 3.

These limit values apply for the test chosen in accordance with 9.4.3 and 9.5.3 of ISO 16120-1:2011.

Table 3 applies to round wire rod only. Maximum discontinuity levels for other shapes may be agreed upon.

Table 3 — Limit values for the depth of surface discontinuities of round wire rod

Dimensions in millimetres

Nominal diameter d_N	Maximum permissible depth of surface discontinuities — radial depth ^a	Maximum actual length of surface discontinuities ^{b,c}
$5 \leq d_N \leq 12$	0,15	0,20
$d_N > 12$	0,20	0,25

^a The depth of surface discontinuities is measured from the actual surface of the product in a radial direction.

^b The actual measured length of the discontinuity.

See Annex B, of ISO 16120-1:2011, for an explanation of terms.

^c The test for the maximum actual length of surface discontinuities may be skipped by agreement between the supplier and purchaser.

4.5 Depth of decarburization

The specifications given below concerning the depth of decarburization and the inspection procedure relating to it apply only to grades C42D2 to C98D2.

4.5.1 Complete decarburization

The wire rod shall not display complete decarburization.

4.5.2 Partial decarburization

The wire rod shall not display partial decarburization with an average depth greater than the values given in Table 4.

The individual measurements shall not exceed twice the limit of Table 4.

These limit values are applicable for the test described in 9.5.4 of ISO 16120-1:2011.

At the time of enquiry and order, it shall be agreed whether Class A or Class B of Table 4 is requested, otherwise class A shall apply.

Table 4 — Limit of the depth of partial decarburization

Dimensions in millimetres

Nominal diameter d_N	Limit values ^a	
	A	B
$5 \leq d_N \leq 8$	0,10	0,08
$8 < d_N \leq 30$	$1,2 \% d_N$	$1,0 \% d_N$

^a By agreement at the time of enquiry and order, other limit values may be specified.

4.6 Non-metallic inclusions

If so agreed at the time of enquiry and order, wire rod shall be inspected for non-metallic inclusions. The method for assessment of non-metallic inclusions and the assessment criteria shall be by the "worst field" method, as defined in ISO 4967 (method A), or ASTM E45 (method A), using a severity rating of 0 to 5 (JK charts). The worst field for each individual inclusion type shall be recorded and a mean value calculated. Acceptance limits are shown in Table 5.

Table 5 — Limit values for non-metallic inclusions

Inclusion type ^a	Thin		Thick	
	Worst	Mean	Worst	Mean
A	4	2	3	1,5
B	3	2	2	1,0
C	4	2	3	1,5
D	3	2	2	1,0
DS	—	—	2,5	1,0

^a Inclusion types according to ISO 4967.

4.7 Core segregation

If so agreed at the time of enquiry and order, wire rod of grade C60D2, or grades with a higher carbon content, shall be inspected for core segregation. Not more than 10 % of the samples tested shall be of Class 4; Class 5 is not allowed (see Annex A of ISO 16120-1:2011). However, it is recommended that the evaluation be done as part of a quality system.

4.8 Tensile strength

For grades specified by chemical composition, and if requested by the purchaser at the time of ordering, the supplier shall provide guidance values of tensile strength.

For grades specified by tensile strength, the purchaser shall use the designations described in Clause 3. The ultimate tensile strength of the wire rod shall fall within the limits of permissible variation given in Table 6 for the designated strength level.

Table 6 — Permissible variation for ultimate tensile strength of the wire rod

Steel grades	Permissible variation (MPa) ^a
C3D2 to C20D2	±80
C26D2 to C70D2	±100
C72D2 to C98D2	±120

^a If agreed at the time of ordering, tighter variation limits may be supplied.

4.9 Scale characteristics

The scale characteristics may be agreed between the supplier and purchaser. These may be specified as quantity of scale and/or descalability.

4.10 Mechanical damage

The wire rod shall have no abrasive damage (the consequence of frictional contact between wire rod and wire rod, wire rod and concrete, or wire rod and steel) detrimental to its subsequent processing and end use. Standards of acceptability relating to permissible levels of damage may be agreed between the supplier and purchaser. Illustrative examples of mechanical damage are shown in Annex C of ISO 16120-1:2011.

4.11 Microstructure

If required for direct drawing, for steel grades containing more than 0,40 % carbon and wire rod diameters not exceeding 16,0 mm, the microstructure shall consist of a uniform pearlite, with a maximum resolvable pearlite as shown in Table 7.

For grades without an intentional addition of Cr, the microstructure shall be free of martensite and bainite. For grades with an intentional addition of Cr, isolated martensitic grains are allowed.

The test method for measurement of resolvable pearlite is specified in Annex D of ISO 16120-1:2011.

Table 7 — Limit values for resolvable pearlite (%)

Carbon content C %	Limit value for resolvable pearlite
0,40 < C ≤ 0,70	30
0,70 < C ≤ 0,80	25

Annex A (informative)

Steel designations in accordance with ISO 16120-4 and designation of comparable steel grades in national or regional standards

This part of ISO 16120 will be adopted by CEN without changes. The equivalent European steel numbers are therefore listed in column 2 of Table A.1.

Table A.1

ISO 16120-4		JIS G 3502		YB/T 170.4:2002	
Steel designation	European material No.	Steel designation	n/nr/y ^a	Steel designation	n/nr/y ^a
C3D2	1.1110	—	—	C3D2	y
C5D2	1.1111	—	—	C5D2	y
C8D2	1.1113	—	—	C8D2	y
C10D2	1.1114	—	—	C10D2	y
C12D2	1.1124	—	—	C12D2	y
C15D2	1.1126	—	—	C15D2	y
C18D2	1.1129	—	—	C18D2	y
C20D2	1.1137	—	—	C20D2	y
C26D2	1.1139	—	—	C26D2	y
C32D2	1.1143	—	—	C32D2	y
C36D2	1.1145	—	—	C36D2	y
C38D2	1.1150	—	—	C38D2	y
C40D2	1.1153	—	—	C40D2	y
C42D2	1.1154	—	—	C42D2	y
C46D2	1.1162	—	—	C46D2	y
C48D2	1.1164	—	—	C48D2	y
C50D2	1.1171	—	—	C50D2	y
C52D2	1.1202	—	—	C52D2	y
C56D2	1.1220	—	—	C56D2	y
C58D2	1.1212	—	—	C58D2	y
C60D2	1.1228	—	—	C60D2	y
C62D2	1.1222	SWRS62A	nr	C62D2	y
		SWRS62B			
C66D2	1.1236	—	—	C66D2	y
C68D2	1.1232	SWRS67A	nr	C68D2	y
		SWRS67B			