INTERNATIONAL STANDARD

ISO 16120-4

Third edition
2017-05

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

Reference number
ISO 16120-4:2017(E)

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

This third edition cancels and replaces the second edition (ISO 16120-4:2011), which has been technically revised.

The main changes compared to the previous edition are:

— Terms and definitions clause added;

— revisions to the permissible variation for ultimate tensile strength of the wire rod (Table 6 and Table 7);

— cementite network requirement added (5.11.2).

This document is intended to be used in conjunction with ISO 16120-1.

A list of all parts in the ISO 16120 series can be found on the ISO website.

Non-alloy steel wire rod for conversion to wire —

Part 4:
Specific requirements for wire rod for special applications

1 Scope

This document specifies requirements for wire rod for conversion to wire for special applications. It is applicable to non-alloy steel wire rod with improved characteristics intended for drawing and/or cold rolling.

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

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

ISO 16120-1:2017, *Non-alloy steel wire rod for conversion to wire — Part 1: General requirements*

ISO 16120-2:2017, *Non-alloy steel wire rod for conversion to wire — Part 2: Specific requirements for general purpose wire rod*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 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, ## indicates the values to be inserted by the purchaser according to the steel names as designated in Table 1, first column.

The designations of comparable steel grades in national or regional standards are provided in Annex A.

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. The grade designation shall be in accordance with ISO 16120-2:2017, Table 1.

5 Requirements

5.1 General

General requirements are given in ISO 16120-1.

5.2 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.

Table 1 — Chemical analysis (heat analysis)

Steel grade[a]	Heat analysis										
	C[b] %	Si[c,d] %	Mn[e] %	P[f] % max.	S[f] % max.	Cr[g] % max.	Ni[g] % max.	Mo % max.	Cu[g,h] % max.	Al[i] % max.	N[j] % max.
C3D2	≤ 0,05	≤ 0,30	0,30 to 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 to 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C8D2	0,06 to 0,10	≤ 0,30	0,30 to 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C10D2	0,08 to 0,12	≤ 0,30	0,30 to 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C12D2	0,10 to 0,14	≤ 0,30	0,30 to 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C15D2	0,13 to 0,17	≤ 0,30	0,30 to 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C18D2	0,16 to 0,20	≤ 0,30	0,30 to 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C20D2	0,18 to 0,23	≤ 0,30	0,30 to 0,50	0,020	0,025	0,10	0,10	0,05	0,15	0,01	0,007
C26D2	0,24 to 0,29	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C32D2	0,30 to 0,34	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C36D2	0,34 to 0,38	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C38D2	0,36 to 0,40	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C40D2	0,38 to 0,42	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C42D2	0,40 to 0,44	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C46D2	0,44 to 0,48	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C48D2	0,46 to 0,50	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007

Table 1 *(continued)*

Steel grade[a]	Heat analysis										
	C[b] %	Si[c,d] %	Mn[e] %	P[f] % max.	S[f] % max.	Cr[g] % max.	Ni[g] % max.	Mo % max.	Cu[g,h] % max.	Al[i] % max.	N[j] % max.
C50D2	0,48 to 0,52	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C52D2	0,50 to 0,54	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C56D2	0,54 to 0,58	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C58D2	0,56 to 0,60	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C60D2	0,58 to 0,62	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C62D2	0,60 to 0,64	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C66D2	0,64 to 0,68	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C68D2	0,66 to 0,70	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C70D2	0,68 to 0,72	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C72D2	0,70 to 0,74	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C76D2	0,74 to 0,78	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C78D2	0,76 to 0,80	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C80D2	0,78 to 0,82	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C82D2	0,80 to 0,84	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C86D2	0,84 to 0,88	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C88D2	0,86 to 0,90	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007

Table 1 *(continued)*

Steel grade[a]	Heat analysis										
	C[b] %	Si[c,d] %	Mn[e] %	P[f] % max.	S[f] % max.	Cr[g] % max.	Ni[g] % max.	Mo % max.	Cu[g,h] % max.	Al[i] % max.	N[j] % max.
C92D2	0,90 to 0,94	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007
C98D2	0,96 to 1,00	0,10 to 0,30	0,50 to 0,70	0,020	0,025	0,10	0,10	0,03	0,15	0,01	0,007

NOTE 1 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 met.

NOTE 2 Elements not included in Table 1 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 %.

[a] Non-alloy steel for special applications shall comply with the non-alloy special steel in ISO 4948-2.

[b] 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.

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

[d] For the silicon content, a different range from the one indicated in Table 1 may be agreed at the time of ordering.

[e] For the manganese content, a different range from the one indicated in Table 1 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] For certain applications, a lower level of sulfur and phosphorus may be agreed between the supplier and purchaser.

[g] 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.

[h] 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 %.

[i] 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.

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

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

Elements	Steel grade	Permissible deviation in product analysis %
C	C3D2 to C20D2	±0,020
	C26D2 to C82D2	±0,030
	C86D2 to C98D2	±0,040
Si	All grades	±0,040
Mn	All grades	±0,060
P and S	All grades	+0,005
NOTE If agreed at the time of ordering, the permissible deviation between product analysis and heat analysis for carbon can be in relation to the actual heat analysis instead of the specified range.		

5.3 Internal soundness and surface quality

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

5.4 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 ISO 16120-1:2017, 9.4.3 and 9.5.3.

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 ISO 16120-1:2017, Annex B 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.		

5.5 Depth of decarburization

5.5.1 General

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

5.5.2 Complete decarburization

The wire rod shall not display complete decarburization.

5.5.3 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 ISO 16120-1:2017, 9.5.4.

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	Limit values[a]	
d_N	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.

5.6 Non-metallic inclusions

If 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. 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.

5.7 Core segregation

If 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 ISO 16120-1:2017, Annex A). For certain applications, 10 % of the samples of Class 3 may be agreed at the time of enquiry; Class 4 and Class 5 shall not be allowed. However, it is recommended that the evaluation be done as part of a quality system.

5.8 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 4. The ultimate tensile strength of the wire rod shall fall within the limits of permissible variation given in Tables 6 and 7 for the designated strength level.

The ranges in Table 6 are referred to as Option A.

For certain applications, the ranges given in Table 7 (Option B) may be agreed at the time of enquiry and order.

Table 6 — Permissible variation for ultimate tensile strength of the wire rod (MPa), Option A

Steel grade	Batch mean (in relation to the *specified* strength level)	Coil-to-coil and within-coil variation (in relation to the *actual* batch mean)
C4D2 to C20D2	±30	±40
C26D2 to C60D2	±40	±50
C62D2 to C92D2	±50	±60

Table 7 — Permissible variation for ultimate tensile strength of the wire rod (MPa), Option B

Steel grade	Batch mean (in relation to the *specified* strength level)	Coil-to-coil and within-coil variation (in relation to the *actual* batch mean)
C4D2 to C20D2	±60	±40
C26D2 to C60D2	±80	±50
C62D2 to C92D2	±100	±60

5.9 Scale characteristics

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

5.10 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 ISO 16120-1:2017, Annex C.

5.11 Microstructure

5.11.1 Resolvable pearlite

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 8.

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 ISO 16120-1:2017, Annex D.

Table 8 — 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

5.11.2 Cementite network

If agreed at the time of ordering, the test method for the determination of cementite in high-carbon steel wire rod and the classification is specified in ISO 16120-1:2017, Annex E.

Not more than 10 % of the samples shall be of Class D; Class E is not allowed.