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Third edition
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Round non-alloy steel wires for general purpose wire ropes, large diameter wire ropes and mine hoisting wire ropes — Specifications

Fils ronds en acier non allié pour câbles à usage général, câbles de grand diamètre et câbles d'extraction minière — Spécifications

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 105, *Steel wire ropes*.

This third edition cancels and replaces the second edition (ISO 2232:1990), which has been technically revised.

The main changes are as follows:

— addition of tensile grades 2 260 N/mm^2 and 2 360 N/mm^2;

— inclusion of wire for mine hoisting ropes previously covered by ISO 6984.

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.

Introduction

This document was developed in response to a worldwide demand for a specification giving minimum requirements for round non-alloy steel wires for general purpose, large diameter and mine hoisting wire ropes.

As in previous editions, this edition of ISO 2232 specifies metric sizes and grades of wire for the more common diameter and grades of wire.

Round non-alloy steel wires for general purpose wire ropes, large diameter wire ropes and mine hoisting wire ropes — Specifications

1 Scope

This document specifies round non-alloy steel wires used in the manufacture of general purpose and large diameter ropes to according to ISO 2408:2017 and mine hoisting wire ropes according to ISO 3154:1988.

It specifies:

— the dimensional tolerances;

— the mechanical characteristics;

— the required conditions for any coatings;

— the conditions of sampling, control and terms of acceptance.

It applies to round, bright, zinc (Zn) or zinc/aluminium (Zn/Al) alloy coated wires of quality A or quality B and of nominal diameters from 0,2 mm to 7,0 mm.

It does not apply to steel wire taken from manufactured ropes.

It does not apply to wire for steel wire ropes for special applications, such as:

— ropes for aircraft controls;

— ropes for aerial ropeways;

— ropes for lifts;

— ropes for prestressed concrete;

— ropes for conveyor belts.

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 1460, *Metallic coatings — Hot dip galvanized coatings on ferrous materials — Gravimetric determination of the mass per unit area*

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

ISO 7800, *Metallic materials — Wire — Simple torsion test*

ISO 7801, *Metallic materials — Wire — Reverse bend test*

ISO 7802, *Metallic materials — Wire — Wrapping test*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1
lot
definite quantity of wire of the same nominal diameter, grade and finish, presented for control and manufactured under conditions which are presumed uniform

3.2
unit
coil of single length of wire of which the mass or length is variable or fixed, or variable or fixed quantity of a single length of wire which is wound on a bobbin with flanges, or variable or fixed quantity of a single length of wire which is wound of a cardboard centre; known as a cheese wound coil

Note 1 to entry: Unit can also be called as unit of product.

3.3
basic sampling unit
m_1
mass, expressed in kilograms, having by convention a value equal to 100d, d being the diameter of the wire expressed in millimetres

3.4
size of lot
N
number given by the formula below

$$N = \frac{m}{10^{-3} \times m_1}$$

where

m is the mass of the *lot* (3.1) in tonnes and m_1 is the *basic sampling unit* (3.3) in kilograms, since, by convention $m_1 = 100d$;

d is the nominal diameter of the wire, it follows that

$$N = \frac{m}{10^{-3} \times 100d} = \frac{10m}{d}$$

3.5
test piece
length of wire sufficient for one test of one characteristic

3.6
test length
length of wire sufficient to provide all the *test pieces* (3.5) needed for one test of all characteristics

3.7
sample
all *test lengths* (3.6) intended to provide information on the *lot* (3.1)

3.8
size of sample
n
number of *test lengths* (3.6)

3.9
defect
non-conformance of the result of a test with the requirement for a characteristic

3.10
defective length
test length (3.6) showing one or more *defects* (3.9)

4 Wire characteristics

4.1 General conditions of manufacture

Wires shall be manufactured from steel according to the requirements of ISO 16120-1.

The finished wires shall not show superficial defects (e.g. defective length) detrimental to their use.

When specified, the wires shall be supplied with a zinc coating or Zn/Al alloy coating, as required, applied by the hot dip or the electrolytic process.

4.2 Diameter

4.2.1 Nominal diameter *d*

The nominal diameter of the wire in millimetres is that by which the wire is designated. It shall be the basis on which the values of all characteristics are determined for acceptance of the wire.

4.2.2 Actual diameter

The actual diameter of the wire is the arithmetic mean of the two measurements carried out in accordance with 7.1. It shall be within the limits of tolerance specified in Table 1.

4.3 Ovality of the wire

The arithmetic difference between the two measurements of the diameter shall not be more than half the tolerance specified in Table 1.

Table 1 — Tolerances on diameter

Dimensions in millimetres

Nominal wire diameter *d* [mm]	Tolerance on diameter	Nominal wire diameter *d* [mm]	Tolerance on diameter
	Bright wires and Zn or Zn/Al alloy coated wires quality B		Zn or Zn/Al alloy coated wires quality A
$0,2 \le d < 0,3$	±0,008	$0,3 \le d < 0,5$	±0,025
$0,3 \le d < 0,5$	±0,01	$0,5 \le d < 1,0$	±0,03
$0,5 \le d < 0,8$	±0,015	$1,0 \le d < 1,7$	±0,04
$0,8 \le d < 1,0$	±0,015	$1,7 \le d < 2,1$	±0,05
$1,0 \le d < 1,8$	±0,02	$2,1 \le d < 2,8$	±0,06
$1,8 \le d < 2,8$	±0,025	$2,8 \le d < 4,0$	±0,07
$2,8 \le d < 5,4$	±0,03	$4,0 \le d < 5,4$	±0,08
$5,4 \le d \le 7,0$	±0,04	$5,4 \le d < 6,75$	±0,09
		$6,75 \le d \le 7,0$	±0,10

4.4 Type

This specification provides details on two types of wire:

— standard duty - wire is specified for general purpose and large diameter ropes;

— high duty- wire is specified for demanding applications such as mine hoisting ropes.

5 Tensile grades

5.1 General

— 1 570 MPa for wires of all classes, quality A and B

— 1 770 MPa for wires of all classes, quality A and B

— 1 960 MPa for wires of all classes, quality A and B

— 2 160 MPa for bright wires and zinc or Zn/Al alloy coated wires, quality B

— 2 260 MPa for bright wires and zinc or Zn/Al alloy coated wires, quality B

— 2 360 MPa for bright wires and zinc or Zn/Al alloy coated wires, quality B

These nominal values are the lower limits of strength. The upper limits are equal to the lower limits plus the tolerances specified in Table 2.

The tensile test shall be performed in accordance with 7.2.

NOTE Other tensile grades can be used by agreement between the manufacturer and the supplier.

Table 2 — Upper limit tolerances for all tensile grades

Nominal wire diameter, *d* [mm]	Tolerance on tensile grade [MPa]
$0,2 \leq d < 0,5$	390
$0,5 \leq d < 1,0$	350
$1,0 \leq d < 1,5$	320
$1,5 \leq d < 2,0$	290
$2,0 \leq d < 3,5$	260
$3,5 \leq d \leq 7,0$	250

5.2 Reverse bend strength

The wire shall withstand, without breaking, the minimum number of reverse bends specified in Table 3 or 4 for the appropriate type, diameter, tensile grade and finish. The radius of curvature of the supports for the various wire diameters is also specified.

The reverse bend strength test shall be in accordance with 7.3.

If the tensile grade of a wire lies between two tensile grades given in Tables 3 and 4, then the number of reverse bends for the next upper tensile grade shall be chosen.

Table 3 — Minimum number of reverse bends for standard duty wire for general purpose and large diameter ropes

Nominal wire diameter	Radius of curvature of supports	Bright and Zn or Zn/Al alloy coated wire quality B						Zn or Zn/Al alloy coated wire quality A		
		Tensile strength grade [MPa]						Tensile strength grade [MPa]		
d [mm]	[mm]	1 570	1 770	1 960	2 160	2 260	2 360	1 570	1 770	1 960
$0,2 \leq d < 0,25$										
$0,25 \leq d < 0,3$										
$0,3 \leq d < 0,4$										
$0,4 \leq d < 0,5$										
$0,5 \leq d < 0,55$	1,75	15	14	13	12	11	10			
$0,55 \leq d < 0,6$		14	13	12	11	10	9			
$0,6 \leq d < 0,65$		12	11	10	9	8	7			
$0,65 \leq d < 0,7$		11	10	9	8	7	6			
$0,7 \leq d < 0,75$	2,5	17	16	15	14	13	12	13	12	11
$0,75 \leq d < 0,8$		16	15	14	13	12	11	12	11	10
$0,8 \leq d < 0,85$		14	13	12	11	10	9	11	10	9
$0,85 \leq d < 0,9$		13	12	11	10	9	8	10	9	8
$0,9 \leq d < 0,95$		12	11	10	9	8	7	9	8	7
$0,95 \leq d < 1,0$		11	10	9	8	7	6	8	7	6
$1,0 \leq d < 1,1$	3,75	18	17	16	14	13	12	15	14	12
$1,1 \leq d < 1,2$		17	16	15	13	12	11	14	13	11
$1,2 \leq d < 1,3$		16	15	14	12	11	10	12	11	9
$1,3 \leq d < 1,4$		14	13	12	10	9	8	10	8	7
$1,4 \leq d < 1,5$		12	11	10	9	8	7	8	7	6
$1,5 \leq d < 1,6$	5	15	14	13	12	11	10	11	10	9

Table 3 *(continued)*

Nominal wire diameter	Radius of curvature of supports	Bright and Zn or Zn/Al alloy coated wire quality B						Zn or Zn/Al alloy coated wire quality A		
		Tensile strength grade [MPa]						Tensile strength grade [MPa]		
d [mm]	[mm]	1 570	1 770	1 960	2 160	2 260	2 360	1 570	1 770	1 960
$1{,}6 \leq d < 1{,}7$		14	13	12	11	10	9	10	9	8
$1{,}7 \leq d < 1{,}8$		12	11	11	10	9	8	9	8	7
$1{,}8 \leq d < 1{,}9$		11	10	10	8	7	6	8	7	6
$1{,}9 \leq d < 2{,}0$		10	9	9	7	6	5	7	6	5
$2{,}0 \leq d < 2{,}1$	7,5	16	15	14	12	11	10	13	12	11
$2{,}1 \leq d < 2{,}2$		15	14	13	11	10	9	12	11	10
$2{,}2 \leq d < 2{,}4$		14	13	12	10	9	8	11	10	9
$2{,}4 \leq d < 2{,}5$		13	12	11	9	8	7	10	9	8
$2{,}5 \leq d < 2{,}6$		12	11	10	8	7	6	9	8	7
$2{,}6 \leq d < 2{,}7$		11	10	9	7	6	5	8	7	6
$2{,}7 \leq d < 2{,}9$		10	9	8	6	5		7	6	5
$2{,}9 \leq d < 3{,}0$		9	8	7	6	5		6	5	4
$3{,}0 \leq d < 3{,}1$	10	14	13	12	10	9		10	9	8
$3{,}1 \leq d < 3{,}2$		13	12	11	9	8		9	8	7
$3{,}2 \leq d < 3{,}3$		12	11	10	8	7		8	7	6
$3{,}3 \leq d < 3{,}4$		11	10	9	7	6		8	7	6
$3{,}4 \leq d < 3{,}5$		10	9	8	6			7	6	5
$3{,}5 \leq d < 3{,}6$		9	8	7	5			6	5	4
$3{,}6 \leq d < 3{,}7$		8	7	6	5			5	4	3
$3{,}7 \leq d < 3{,}8$		7	6	5	4			4	3	3
$3{,}8 \leq d < 3{,}9$		7	6	5	4			4	3	3
$3{,}9 \leq d < 4{,}0$		6	5	4	3			4	3	3
$4{,}0 \leq d < 4{,}2$	15	11	10	9	8			7	6	5
$4{,}2 \leq d < 4{,}4$		10	9	8				6	5	4
$4{,}4 \leq d < 4{,}6$		9	8	7				5	5	
$4{,}6 \leq d < 4{,}8$		8	8	6				5	4	
$4{,}8 \leq d < 5{,}0$		7	7	5				4	4	
$5{,}0 \leq d < 5{,}2$		6	6	4				3	3	
$5{,}2 \leq d < 5{,}4$		5	5					3	3	
$5{,}4 \leq d < 5{,}6$		4	4					2	2	
$5{,}6 \leq d < 5{,}8$		4	4					2	2	
$5{,}8 \leq d < 6{,}0$		3	3					2	2	
$6{,}0 \leq d < 6{,}25$	20	8	6					4	3	
$6{,}25 \leq d < 6{,}5$		6						3		
$6{,}5 \leq d < 6{,}75$		5						2		
$6{,}75 \leq d \leq 7{,}0$		3						2		

Table 4 — Minimum number of reverse bends for high duty wire

Nominal wire diameter	Radius of curvature of supports	Bright and Zn or Zn/Al alloy coated wire quality B						Zn or Zn/Al alloy coated wire quality A		
		Tensile strength grade [MPa]						Tensile strength grade [MPa]		
d [mm]	[mm]	1 570	1 770	1 960	2 160	2 260	2 360	1 570	1 770	1 960
$0,2 \leq d < 0,25$										
$0,25 \leq d < 0,3$										
$0,3 \leq d < 0,4$										
$0,4 \leq d < 0,5$										
$0,5 \leq d < 0,55$	1,75	18	17	16	15	14	13			
$0,55 \leq d < 0,6$		16	15	14	12	12	11			
$0,6 \leq d < 0,65$		13	12	11	10	10	9			
$0,65 \leq d < 0,7$		12	11	11	9	8	8			
$0,7 \leq d < 0,75$	2,5	20	19	18	16	14	13	14	13	12
$0,75 \leq d < 0,8$		18	17	16	14	13	12	13	12	11
$0,8 \leq d < 0,85$		17	16	15	13	11	10	12	11	10
$0,85 \leq d < 0,9$		15	14	13	11	10	9	12	11	10
$0,9 \leq d < 0,95$		14	13	12	10	9	8	11	10	9
$0,95 \leq d < 1,0$		14	13	12	9	8	7	11	10	9
$1,0 \leq d < 1,1$	3,75	19	18	17	15	14	13	16	15	14
$1,1 \leq d < 1,2$		18	17	16	14	13	12	15	14	12
$1,2 \leq d < 1,3$		17	16	15	13	12	11	13	12	10
$1,3 \leq d < 1,4$		15	14	13	11	10	9	11	10	9
$1,4 \leq d < 1,5$		13	12	11	10	9	8	10	9	8
$1,5 \leq d < 1,6$	5	16	15	14	13	12	11	13	12	11
$1,6 \leq d < 1,7$		15	14	13	12	11	10	12	11	10
$1,7 \leq d < 1,8$		14	13	12	11	10	9	11	10	9
$1,8 \leq d < 1,9$		13	12	11	9	8	7	10	9	8
$1,9 \leq d < 2,0$		12	11	10	9	7	6	9	8	7
$2,0 \leq d < 2,1$	7,5	17	16	15	13	12	11	14	13	12
$2,1 \leq d < 2,2$		16	15	14	12	11	10	13	12	11
$2,2 \leq d < 2,4$		15	14	13	11	10	9	12	11	10
$2,4 \leq d < 2,5$		14	13	12	10	9	8	11	10	9
$2,5 \leq d < 2,6$		13	12	11	9	8	7	10	9	8
$2,6 \leq d < 2,8$		12	11	10	8	7	6	9	8	7
$2,8 \leq d < 3,0$		11	10	9	7	6		8	7	6
$3,0 \leq d < 3,2$	10	15	14	13	11	10		11	10	9
$3,2 \leq d < 3,4$		13	12	11	9	9		10	9	8
$3,4 \leq d < 3,6$		12	11	10	9			9	8	7
$3,6 \leq d < 3,8$		10	9	8	7			8	7	6
$3,8 \leq d < 4,0$		8	7	6	5			7	6	5

Table 4 *(continued)*

Nominal wire diameter	Radius of curvature of supports	Bright and Zn or Zn/Al alloy coated wire quality B						Zn or Zn/Al alloy coated wire quality A		
		Tensile strength grade [MPa]						Tensile strength grade [MPa]		
d [mm]	[mm]	1 570	1 770	1 960	2 160	2 260	2 360	1 570	1 770	1 960
4,0 ≤ *d* < 4,2	15	12	11	10	9			9	8	7
4,2 ≤ *d* < 4,4		11	10	9				8	7	6
4,4 ≤ *d* < 4,6		10	9	8				7	7	
4,6 ≤ *d* < 4,8		9	8	7				6	6	
4,8 ≤ *d* < 5,0		8	8	6				5	5	
5,0 ≤ *d* < 5,2		7	7	5				4	4	
5,2 ≤ *d* < 5,4		6	6					4	4	
5,4 ≤ *d* < 5,6		5	5					3	3	
5,6 ≤ *d* < 5,8		5	5					3	3	
5,8 ≤ *d* < 6,0		4	4					3	3	
6,0 ≤ *d* < 6,25	20	9	7					5	4	
6,25 ≤ *d* < 6,5		7						4		
6,5 ≤ *d* < 6,75		6						3		
6,75 ≤ *d* ≤ 7,0		4						3		

5.3 Torsional strength

The wire shall withstand, without breaking, the minimum number of torsions specified in Table 5 or 6 for the appropriate type, diameter, tensile grade and finish.

The test shall be in accordance with 7.4.

If the tensile grade of a wire lies between two tensile grades given in Tables 5 and 6, then the number of torsions for the next upper tensile grade shall be chosen.

Table 5 — Minimum number of torsions for standard duty wire for general purpose and large diameter ropes

Bright and Zn or Zn/Al alloy coated wire quality B							Zn or Zn/Al alloy coated wire quality A			
Nominal wire diameter	Tensile grades [MPa]				Nominal wire diameter	Tensile grades [MPa]		Nominal wire diameter	Tensile grades [MPa]		
d [mm]	1 570	1 770	1 960	2 160	*d* [mm]	2 260	2 360	*d* [mm]	1 570	1 770	1 960
0,2 ≤ *d* < 0,5											
0,5 ≤ *d* < 1,0	30	28	25	23	0,5 ≤ *d* < 1,0	21	19	0,7 ≤ *d* < 1,0	21	19	17
1,0 ≤ *d* < 1,3	29	26	23	21	1,0 ≤ *d* < 1,3	19	17	1,0 ≤ *d* < 1,2	20	18	13
1,3 ≤ *d* < 1,8	28	25	22	20	1,3 ≤ *d* < 1,8	18	16	1,2 ≤ *d* < 1,8	18	15	10
1,8 ≤ *d* < 2,4	27	24	21	19	1,8 ≤ *d* < 2,4	17	15	1,8 ≤ *d* < 2,4	17	14	9
2,4 ≤ *d* < 3,0	26	23	20	18	2,4 ≤ *d* < 3,0	16	14	2,4 ≤ *d* < 3,0	15	12	7
3,0 ≤ *d* < 3,5	25	21	18	16	3,0 ≤ *d* < 3,5	14		3,0 ≤ *d* < 3,5	12	8	5
3,5 ≤ *d* < 3,7	24	20	16	14				3,5 ≤ *d* < 3,7	10	6	5
3,7 ≤ *d* < 3,8	23	19	15	13				3,7 ≤ *d* < 3,8	8	6	5
3,8 ≤ *d* < 4,0	22	18	14	12				3,8 ≤ *d* < 4,0	7	6	4
4,0 ≤ *d* < 4,2	21	17	13	11				4,0 ≤ *d* < 4,2	6	6	4

Table 5 *(continued)*

Bright and Zn or Zn/Al alloy coated wire quality B								Zn or Zn/Al alloy coated wire quality A			
Nominal wire diameter	Tensile grades [MPa]				Nominal wire diameter	Tensile grades [MPa]		Nominal wire diameter	Tensile grades [MPa]		
d [mm]	1 570	1 770	1 960	2 160	*d* [mm]	2 260	2 360	*d* [mm]	1 570	1 770	1 960
$4{,}2 \le d < 4{,}4$	19	15	11					$4{,}2 \le d < 4{,}4$	6	5	4
$4{,}4 \le d < 4{,}6$	18	14	10					$4{,}4 \le d < 4{,}6$	6	5	
$4{,}6 \le d < 4{,}8$	16	12	8					$4{,}6 \le d < 4{,}8$	5	4	
$4{,}8 \le d < 5{,}0$	14	11	7					$4{,}8 \le d < 5{,}4$	4	3	
$5{,}0 \le d < 5{,}2$	14	11	7					$5{,}4 \le d < 5{,}6$	3	2	
$5{,}2 \le d < 5{,}4$	12	10						$5{,}6 \le d < 6{,}25$	2	2	
$5{,}4 \le d < 5{,}6$	10	8						$6{,}25 \le d \le 7{,}0$	2		
$5{,}6 \le d < 6{,}0$	8	6									
$6{,}0 \le d < 6{,}5$	6	5									
$6{,}5 \le d \le 7{,}0$	5	4									

Table 6 — Minimum number of torsions for high duty wire for mine hoisting ropes

Nominal wire diameter	Bright and Zn or Zn/Al alloy coated wire quality B						Zn or Zn/Al alloy coated wire quality A		
	Tensile strength grade [MPa]						Tensile strength grade [MPa]		
d [mm]	1 570	1 770	1 960	2 160	2 260	2 360	1 570	1 770	1 960
$0{,}2 \le d < 0{,}5$									
$0{,}5 \le d < 1{,}0$	35	33	27	25	23	21	23	21	19
$1{,}0 \le d < 1{,}3$	33	31	26	24	22	20	21	19	17
$1{,}3 \le d < 1{,}8$	32	29	25	23	21	18	20	18	16
$1{,}8 \le d < 2{,}4$	30	28	23	21	19	16	19	16	14
$2{,}4 \le d < 3{,}0$	28	25	21	20	18	15	16	13	12
$3{,}0 \le d < 3{,}5$	27	23	20	19	16		13	10	8
$3{,}5 \le d < 3{,}7$	26	22	18	16			13	9	7
$3{,}7 \le d < 4{,}0$	24	20	17	15			12	8	5
$4{,}0 \le d < 4{,}2$	23	19	15	13			10	7	5
$4{,}2 \le d < 4{,}4$	22	18	14	12			8	6	4
$4{,}4 \le d < 4{,}6$	20	16	12				7	6	
$4{,}6 \le d < 4{,}8$	18	14	10				6	5	
$4{,}8 \le d < 5{,}0$	16	13	9				5	4	
$5{,}0 \le d < 5{,}2$	15	12	8				4	3	
$5{,}2 \le d < 5{,}4$	14	11					4	3	
$5{,}4 \le d < 5{,}6$	12	10					3		
$5{,}6 \le d < 6{,}0$	9	7							
$6{,}0 \le d < 6{,}5$	7	6							
$6{,}5 \le d \le 7{,}0$	6	5							

5.4 Zinc or Zn/Al alloy coating

Two qualities of zinc or Zn/Al alloy coatings are recognized:

— quality B, normal coating, for tensile grades 1 570 MPa, 1 770 MPa, 1 960 MPa, 2 160 MPa, 2 260 MPa, and 2 360 MPa for all wire diameters;

— quality A, thick galvanization coating, for tensile grades 1 570 MPa, 1 770 MPa, and 1 960 MPa for all wire diameters.

The zinc coating process is not specified.

The quality of the coating is defined by the minimum mass of zinc, in grams per square meter, as specified in Table 7. The test shall be performed in accordance with 7.5.

NOTE When assessing the amount of coating, it is possible that some loss will occur during the subsequent rope spinning process.

Other alloy coatings are available as agreed by customer and supplier.

The composition of two approved Zn/Al alloys are provided in Table C.1 and coating performance under salt spray testing is provided in Table C.2.

Table 7 — Minimum mass of Zn or Zn/Al alloy for standard duty and high duty wire

Nominal diameter of wire, d [mm]	Minimum mass of Zn or Zn/Al alloy [g/m^2]	
	Quality B	Quality A
$0{,}20 \le d < 0{,}25$	20	
$0{,}25 \le d < 0{,}40$	30	
$0{,}40 \le d < 0{,}50$	40	85
$0{,}50 \le d < 0{,}60$	50	100
$0{,}60 \le d < 0{,}70$	60	115
$0{,}70 \le d < 0{,}80$	60	130
$0{,}80 \le d < 0{,}90$	70	145
$0{,}90 \le d < 1{,}00$	70	155
$1{,}00 \le d < 1{,}20$	80	165
$1{,}20 \le d < 1{,}40$	90	180
$1{,}40 \le d < 1{,}65$	100	195
$1{,}65 \le d < 1{,}85$	100	205
$1{,}85 \le d < 2{,}15$	115	215
$2{,}15 \le d < 2{,}50$	125	230
$2{,}50 \le d < 2{,}80$	125	245
$2{,}80 \le d < 3{,}20$	135	255
$3{,}20 \le d < 3{,}80$	135	265
$3{,}80 \le d < 4{,}40$	135	275
$4{,}40 \le d < 5{,}20$	150	280
$5{,}20 \le d \le 7{,}00$	160	290

6 Sampling

Samples for testing shall be taken in accordance with Table 8, unless other methods of sampling have been agreed between purchaser and supplier.

Test lengths shall be long enough for the tests and check tests to be carried out.

Table 8 — Sampling

Size of lot N	Size of sample n[a]	Number of failures for conformity	Number of failures for nonconformity
$2 \leq N \leq 15$	8	0	1
$16 \leq N \leq 50$	13	0	1
$51 \leq N \leq 90$	20	1	2
$91 \leq N \leq 150$	32	1	2
$151 \leq N \leq 280$	50	2	3
$281 \leq N \leq 500$	80	3	4
[a] If the size of the lot is less than n, a test shall be carried out on each unit.			

7 Tests

7.1 Measurement of actual diameter

The actual diameter shall be determined from two measurements in two perpendicular directions in the same section and on the same diametrical plane.

7.2 Tensile test

The tensile test shall be carried out in accordance with ISO 6892-1. The rate of stressing may be greater than that specified in ISO 6892-1, in view of the number of tests on wire involved in the inspection of the lot. However, it shall not exceed a rate producing an elongation of 25 % of the distance between grips within 1 min. The length of the test piece shall preferably be such that the distance between grips of the testing machine is 100 mm.

In case of dispute, the tensile test shall be performed strictly in accordance with ISO 6892-1, particularly with regard to the rate of stressing.

7.3 Reverse bend test

The test shall be carried out in accordance with ISO 7801, with the radius of curvature of supports specified in Tables 3 and 4.

7.4 Torsion test

The test shall be carried out in accordance with ISO 7800, with the number of torsions specified in Tables 5 and 6.

A length of 100d for the test piece between grips is preferred. If this length cannot be adopted, an alternate length shall be chosen at the wire manufacturer's discretion. In this case, the minimum number of torsions which the wire shall withstand shall be proportional to the number specified in Tables 5 and 6, for a test length of 100d.

7.5 Inspection of zinc or Zn/Al alloy coating

The determination of mass of coating shall be carried out in accordance with Annex A. For wires of quality A and B, an adhesion test shall be carried out in accordance with Annex B.

8 Certificate

8.1 General

According to the purchaser's order, one of the following control documents may be established.

8.2 Certificate of conformity

By this certificate, the manufacturer acknowledges that the conditions as specified in purchaser's order are fulfilled.

8.3 Full works certificate

This certificate shall give the results of tests carried out by the manufacturer in accordance with this document.

8.4 Certificate of acceptance

In particular cases, when requested by the purchaser, tests may be undertaken after manufacture in the presence of the purchaser or his representative. The test results shall be provided in the certificate of acceptance, which is equivalent to a full works certificate.

9 Marking

Each delivery unit shall be marked and identified by a durable label securely fixed to each coil or bobbin clearly indicating at least the following:

a) the name of the manufacturer or supplier;

b) the indications relative to the wire (diameter, surface condition, tensile grade and mass or length per delivery unit);

c) the number of the customer's order;

d) the number of the bobbin or coil.

10 Information to be supplied by the purchaser

The purchaser shall indicate with the order:

a) reference to this document;

b) the nominal diameter of the wire;

c) the surface finish (bright, zinc or Zn/Al alloy coated);

d) the tensile grade of the wire;

e) the type of certificate to be supplied by the manufacturer;

f) the mass or length of the delivery unit.

Annex A
(normative)

Determination of mass of zinc or Zn/Al alloy deposited per unit of surface area

A.1 General

Two methods are recognized: the gravimetric method described in ISO 1460 and the gas volumetric method described in A.2.

The gas volumetric method is the easiest to carry out. In case of dispute, however, the gravimetric method in ISO 1460 shall be used.

A.2 Gas volumetric method

A.2.1 Principle

The coating of a test specimen of wire of given dimensions is dissolved in a hydrochloric acid solution. The mass of coating dissolved is determined by measuring the volume of hydrogen released during dissolution of the coating (gas volumetric method). By relating the mass of zinc or zinc and aluminium determined in this way to the surface area of the test specimen measured after dissolving the coating, the mass of zinc or zinc and aluminium deposited per unit surface area is obtained.

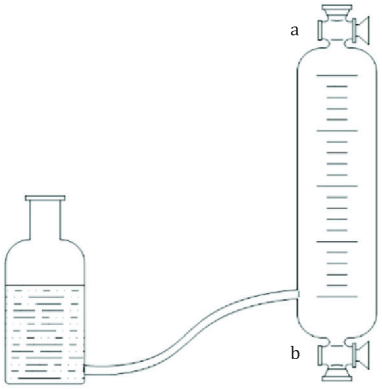
A.2.2 Reagents

A.2.2.1 Hydrochloric acid, solution of suitable concentration.

A.2.2.2 Inhibitor, for example, hexamethylene tetramine, antimony chloride or antimony oxide.

A.2.3 Apparatus

The apparatus used consists of the following elements (see Figure A.1).



a Tap a.
b Tap b.

Figure A.1 — Apparatus for the gas volumetric method

A.2.3.1 Tube, graduated in millilitres at least, with a tap a and b at each end.

A.2.3.2 Flask, with a nozzle near the bottom connected by a rubber tube to a nozzle near the bottom of the graduated tube.

A.2.3.3 Beaker, for holding the test specimen after removal of the coating.

A.2.4 Preparation of test specimens

After carefully straightening the sample of wire, test specimens shall be cut to a length of:

— 300 mm for wires of less than 1 mm in diameter;

— 150 mm for wires of 1 mm to 1,49 mm in diameter;

— 100 mm for wires of 1,5 mm to 3 mm in diameter;

— 50 mm for wires of more than 3 mm in diameter.

NOTE Test specimens more than 100 mm long can be cut into several pieces of approximately equal length prior to insertion into the graduated tube.

A.2.5 Procedure

With tap **b** closed, the graduated tube and part of the flask are filled with hydrochloric acid solution (A.2.2.1) containing a suitable inhibitor (A.2.2.2).

The level of the liquid in the graduated tube (A.2.3.1) is raised to just under tap **a** by raising the acid reservoir flask (A.2.3.2). The level in the tube and flask should be the same.

After introducing the test specimen into the graduated tube, tap **a** is closed and the hydrogen released by the action of the acid on the coating is allowed to accumulate in the upper part of the graduated tube.

When hydrogen is no longer released, the flask is lowered in relation to the graduated tube to bring the levels of the solution in the tube and the flask into the same plane. The position of the meniscus of the liquid in the tube then indicates the volume of the hydrogen released.

The remaining part of the solution contained in the graduated tube is collected in the flask by placing the flask on a table and opening tap **a**.