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Resistance welding equipment — Water-cooled secondary connection cables

Matériel de soudage par résistance — Câbles secondaires refroidis par eau

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Foreword

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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).

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This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 6, *Resistance welding and allied mechanical joining,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces ISO 8205-1:2002, ISO 8205-2:2002 and ISO 8205-3:2012.

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.

Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

Resistance welding equipment — Water-cooled secondary connection cables

1 Scope

This document gives specifications for single- and double-conductor secondary connection cables used for resistance welding and allied processes. These specifications include requirements for electrical, mechanical and cooling characteristics of the cables and their test procedures.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
double-conductor connection cable
cable comprising two conductors providing an electrical link between the secondary terminals of a welding transformer and the welding set (manual or robotized guns) and designed so as to have as low an electrical reactance as possible

3.2
single-conductor connection cable
cable comprising one conductor providing an electrical link between the secondary terminals of a welding transformer and the welding set (manual or robotized guns)

4 Classification

4.1 Form of the end lugs

Double-conductor water-cooled connection cables are classified into two types, A-1 and A-2, in accordance with the form of the end lugs (see 5.1.3).

Single-conductor water-cooled connection cables are classified into three types, C-1, C-2 and D, in accordance with the form of the end lugs (see 5.2.3).

4.2 Resistance and reactance

Double-conductor, water cooled connection cables are classified into two types, A-1 and A-2, with power factor $\cos\varphi \geq 0{,}95$ as shown in Figure 1.

5   Dimensions

5.1   Double conductor connection cables

5.1.1   Cross-sectional area

The effective cross-sectional area of copper per conductor shall be one of the following:

— 100 mm^2

— 150 mm^2

— 160 mm^2

— 200 mm^2

— 250 mm^2

— 315 mm^2

5.1.2   Length

The length, L, of the cable shall be one of the following (non-preferred values are given in parentheses). The length shall have a tolerance $^{+1}_{0}$ %:

— 1 000 mm

— 1 200 mm

— 1 250 mm – (1 500 mm)

— 1 600 mm – (1 800 mm)

— 2 000 mm – (2 240 mm)

— 2 400 mm

— 2 500 mm – (2 800 mm)

— 3 000 mm

— 3 150 mm

— 3 500 mm – (3 550 mm)

— 4 000 mm

5.1.3   End lugs

The end lugs shall have the dimensions given in Figure 1 and Table 1.

Dimensions in millimetres

a) Type A-1

b) Type A-2

Key
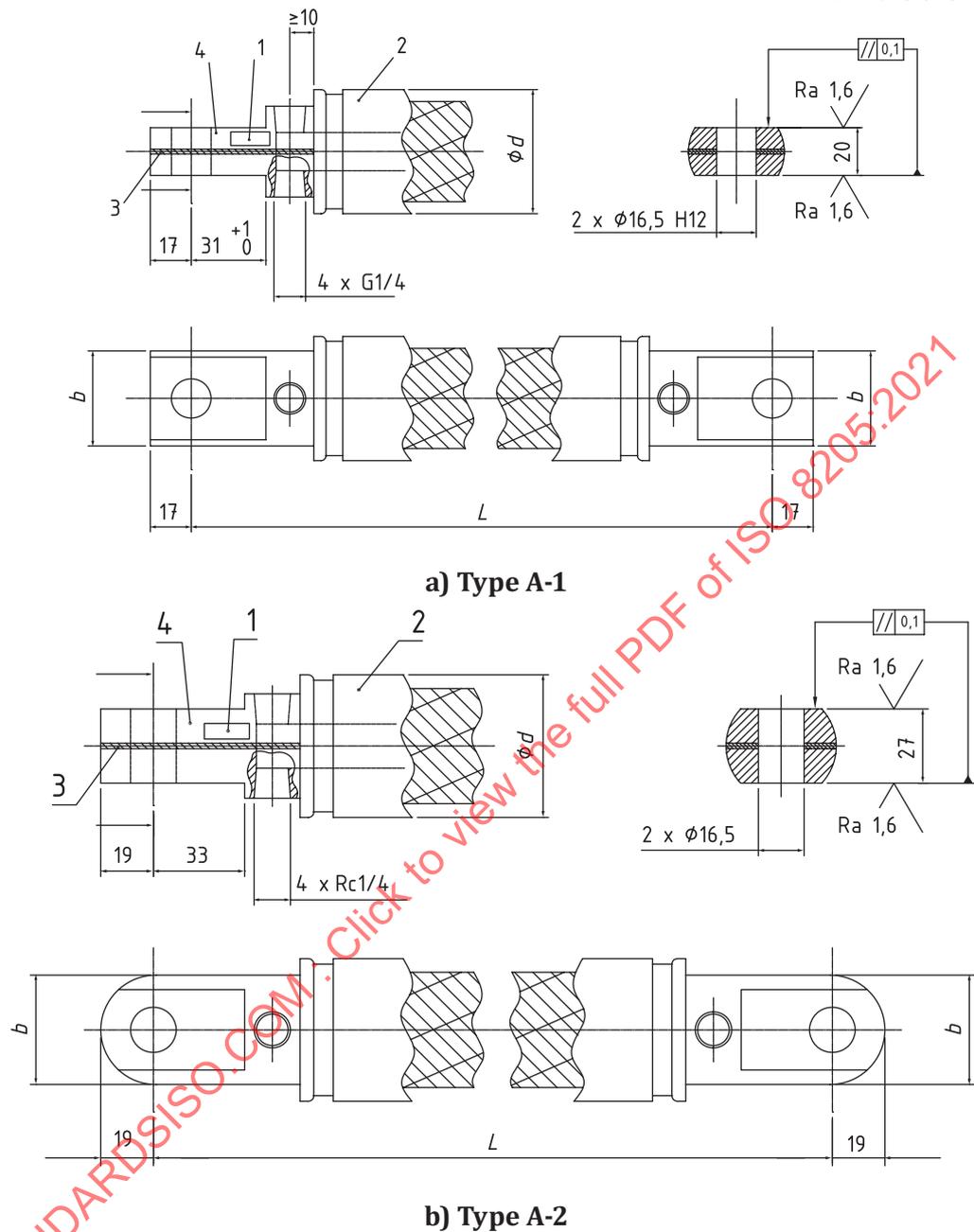
1 marking
2 insulating covering
3 insulation
4 polarity mark on both ends

NOTE   Surface roughness values in micrometres.

Figure 1 — End lug

Table 1 — Dimensions (double conductor connection cables)

Cross-sectional area	b mm		d_{max} mm	
mm^2	Type A-1	Type A-2	Type A-1	Type A-2
100	—	35 to 41	—	46
150	35 to 38	35 to 41	56	52
160	35 to 38	—	56	—
200	42 to 45	35 to 41	63	54
250	45 to 48	—	63	—
315	45 to 48	—	63	—

5.2 Single conductor connection cables

5.2.1 Cross-sectional area

The effective cross-sectional area of copper per conductor shall be one of the following:

— 150 mm^2

— 160 mm^2

— 180 mm^2

— 200 mm^2

— 250 mm^2

— 315 mm^2

5.2.2 Length

The length, L, of the cable shall be one of the following (non-preferred values are given in parentheses). The length shall have a tolerance $_{0}^{+1}$ %:

— 500 mm

— 630 mm

— 800 mm

— 1 000 mm

— 1 250 mm – (1 500 mm)

— 1 600 mm – (1 800 mm)

— 2 000 mm – (2 240 mm)

— 2 500 mm – (2 800 mm)

— 3 150 mm – (3 550 mm)

— 4 000 mm

5.2.3   End lugs

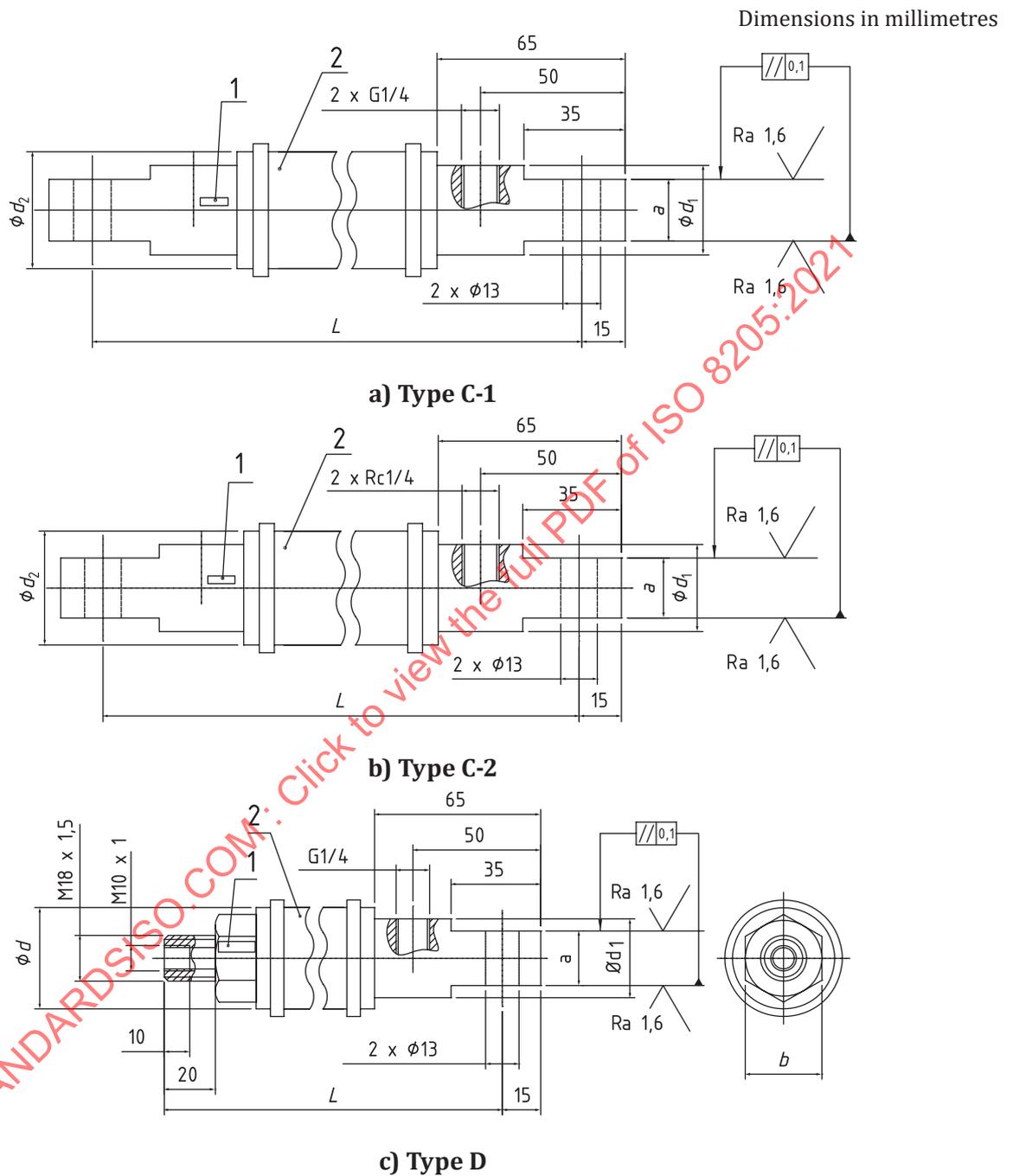The end lugs shall have the dimensions given in Figure 2 and Table 2.

Dimensions in millimetres

a) Type C-1

b) Type C-2

c) Type D

Key

1   marking

2   insulating covering

NOTE   surface roughness values in micrometres

Figure 2 — End lug

Table 2 — Dimensions (single conductor connection cables)

Cross-sectional area	a	b	d_1	d_2
mm^2	mm	mm	mm	mm
150	15	27	25	35
160	15	27	25	35
180	15	27	25	35
200	15	27	25	35
250	18	30	28	40
315	18	32	32	42

6 Marking

Conductor connection cables which comply with the requirements of this document shall be marked indelibly on the end lug of one terminal, with the designation stipulated in this clause, but excluding the description block and the reference to this document.

EXAMPLE 1   Type A double-conductor connection cable having a cross-sectional area of 2 × 200 mm^2 and a length of 2 500 mm is designated as follows:

A – 2 × 200 – 2 500

EXAMPLE 2   Type E single-conductor connection cable having a cross-sectional area of 200 mm^2 and a length of 2 500 mm is designated as follows:

C– 200 – 2 500

The cable shall be clearly marked with the manufacturer's/supplier's name or trademark.

7 Designation

The designation for connection cables that comply with the requirements of this document shall comprise the following information in the order given:

a)   the description block (i.e. "double-conductor connection cable" or "single-conductor connection cable");

b)   a reference to this document (i.e. ISO 8205:2021);

c)   the type of connection cable (i.e. A-1, A-2, C-1, C-2 or D);

d)   the cross-sectional area of the cable, expressed in mm^2;

e)   the length, expressed in mm.

EXAMPLE 1   Type A-1 double-conductor connection cable having a cross-sectional area of 2 × 200 mm^2 and a length of 2 500 mm is designated as follows:

ISO 8205 – A-1 – 2 × 200 – 2 500

EXAMPLE 2   Type C-1 single-conductor connection cable having a cross-sectional area of 200 mm^2 and a length of 2 500 mm is designated as follows:

ISO 8205 – C-1 – 200 – 2 500

8 Materials

The choice of the materials is at the discretion of the manufacturer. The cable shall be free of silicone.

The insulating covering and the insulation between the two end lugs of double-conductor connection cable shall be undamaged. In addition, these shall not contain any components which give off toxic gases on burning and shall withstand a maximum temperature of 100 °C without damage.

9 Electrical characteristics

9.1 General

The electrical characteristics are given as theoretical values as a function of cross-sectional areas and lengths.

The values are only given to calculate the permissible welding current and the voltage drop in the cable, and they are not acceptance figures.

9.2 Permanent current

The values for the permanent current I_{2p} are given in Table 3 and Table 4. The secondary current, I_X, at a given duty factor X may be calculated from Formula (1)[1]:

$$I_X = I_{2p} \sqrt{\frac{100}{X}}$$ (1)

It shall be taken into consideration that the values shall be reduced if parasitic heating occurs or other influences require it.

Table 3 — Permanent current, I_{2p} (double conductor connection cables) in A

Length	Double conductor connection cables, cross-sectional area					
mm	mm²					
	2 × 100	2 × 150	2 × 160	2 × 200	2 × 250	2 × 315
1 000	6 200	7 500	8 000	9 000	10 000	11 200
1 250	5 700	6 700	7 100	8 000	9 000	10 000
(1 500)	5 300	6 300	6 500	7 300	8 200	9 200
1 600	5 100	6 000	6 300	7 100	8 000	9 000
(1 800)	4 800	5 600	6 000	6 700	7 500	8 500
2 000	4 600	5 300	5 600	6 300	7 100	8 000
(2 240)	4 300	5 000	5 300	6 000	6 700	7 500
2 500	4 000	4 750	5 000	5 600	6 300	7 100
(2 800)	3 800	4 500	4 750	5 300	6 000	6 700
3 150	3 600	4 250	4 500	5 000	5 600	6 300
(3 550)	3 300	4 000	4 250	4 750	5 300	6 000
4 000	3 000	3 750	4 000	4 500	5 000	5 600
NOTE 1 Non-preferred values are given in parentheses.						
NOTE 2 The values have been calculated with a water flow of 7 l/min, with an inlet temperature of 30 °C and an outlet temperature of 70 °C.						

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1)   See ISO 669.

Table 4 — Permanent current, I_{2p} (single conductor connection cables) in A

Length mm	Double conductor connection cables, cross-sectional area mm²					
	(150)	**160**	**(180)**	**200**	**250**	**315**
500	13 200	14 000	15 000	16 000	18 000	20 000
630	12 500	12 500	14 000	14 000	16 000	18 000
800	11 200	11 200	12 000	12 500	14 000	16 000
1 000	9 500	10 000	10 600	11 200	12 500	14 000
1 250	8 500	9 000	9 500	10 000	11 200	12 500
(1 500)	8 000	8 500	9 000	9 700	10 800	11 900
1 600	7 500	8 000	8 500	9 000	10 000	11 200
(1 800)	7 100	7 500	8 000	8 500	9 500	10 600
2 000	6 700	7 100	7 500	8 000	9 000	10 000
(2 240)	6 300	6 700	7 100	7 500	8 500	9 500
2 500	6 000	6 300	6 700	7 100	8 000	9 000
(2 800)	5 600	6 000	6 300	6 700	7 600	8 500
3 150	5 300	5 600	6 000	6 300	7 100	8 000
(3 550)	5 000	5 300	5 600	6 000	6 700	7 500
4 000	4 750	5 000	5 300	5 600	6 300	7 100
NOTE 1 Non-preferred values are given in parentheses.						
NOTE 2 The values have been calculated with a water flow of 7 l/min, with an inlet temperature of 30 °C and an outlet temperature of 70 °C.						

9.3   Resistance

Resistance values for each conductor are given in Table 5 and Table 6.

It shall be taken into consideration that, in practice, the values are higher depending on manufacturer and material.

Table 5 — Resistance, R_{30}, in one conductor (double conductor connection cables) in µΩ

Length mm	Double conductor connection cables, cross-sectional area mm²					
	2 × 100	**2 × 150**	**2 × 160**	**2 × 200**	**2 × 250**	**2 × 315**
1 000	160	140	125	100	80	63
1 250	200	170	160	125	100	80
(1 500)	245	200	190	150	118	95
1 600	265	224	200	160	125	100
(1 800)	300	250	224	180	140	112
2 000	330	265	250	200	160	125
(2 240)	370	300	280	224	180	140
2 500	410	335	315	250	200	160
(2 800)	460	375	355	280	224	180
3 150	520	425	400	315	250	200
(3 550)	580	475	450	355	280	224
NOTE 1 Non-preferred values are given in parentheses.						
NOTE 2 The values have been calculated with $\rho = 0{,}018\,5$ Ω·mm²/m + 10 % and are rounded to the next preferred numbers.						

Table 5 (continued)

Length	Double conductor connection cables, cross-sectional area					
mm	mm²					
	2 × 100	2 × 150	2 × 160	2 × 200	2 × 250	2 × 315
4 000	650	530	500	400	315	250
NOTE 1 Non-preferred values are given in parentheses.						
NOTE 2 The values have been calculated with ρ = 0,018 5 Ω·mm²/m + 10 % and are rounded to the next preferred numbers.						

Table 6 — Resistance, R_{30}, in one conductor (single conductor connection cables) in μΩ

Length	Single conductor connection cables, cross-sectional area					
mm	mm²					
	(150)	160	(180)	200	250	315
500	67	63	56	50	40	32
630	85	80	71	63	50	40
800	106	100	90	80	63	50
1 000	140	125	112	100	80	63
1 250	170	160	140	125	100	80
(1 500)	200	190	170	150	125	95
1 600	212	200	180	160	125	100
(1 800)	250	224	200	180	140	112
2 000	280	250	224	200	160	125
(2 240)	300	280	250	224	180	140
2 500	335	315	280	250	200	160
(2 800)	375	355	315	280	224	180
3 150	425	400	355	315	250	200
(3 550)	475	450	400	355	280	224
4 000	530	500	450	400	315	250
NOTE 1 Non-preferred values are given in parentheses.						
NOTE 2 The values have been calculated with ρ = 0,018 5 Ω·mm²/m + 10 % and are rounded to the next preferred numbers.						

10 Electrical requirement

10.1 Type test

10.1.1 Measurement of insulation resistance

Measure the insulation resistance of a new dry cable following application of a D.C. voltage of 48 V for 1 min.

10.1.2 Determination of the impedance of the cable (only for cables in accordance with double conductor connection cables)

Determine the impedance of the cable at 30 °C by:

— application of an alternating voltage, U, to its terminals (as sinusoidal as possible);

— using a calibrated toroid, measuring the intensity, I, of the current circulating in the cable.

The impedance, Z, is then given by Formula (2):

$$Z = \frac{U}{I} \tag{2}$$

where

    U is the alternating voltage: frequency 50 Hz or 60 Hz, r.m.s.;

    I is the intensity of the current circulating in the cable.

10.1.3 Determination of the resistance of the cable

Determine the resistance of the cable at 30 °C and with no water in the cable, by applying to its terminals a D.C. voltage, U_d, and measuring the intensity, I_d, of the current circulating in the cable. The resistance, R, is then given by Formula (3):

$$R = \frac{U_d}{I_d} \tag{3}$$

10.1.4 Calculation of power factor (only for cables in accordance with double conductor connection cables)

The value of power factor for the cable can then be calculated by using the values obtained in 10.1.2 and 10.1.3 by Formula (4):

$$\cos \varphi = \frac{R}{Z} \tag{4}$$

10.2 Routine test (only for cables in accordance with double conductor connection cables)

The insulation resistance shall not be less than 3 MΩ.

Insulation resistance test carry out this test without water in the cooling circuit. Measure the insulation resistance between the go and return cables by an insulation resistance tester of 48 V D.C. or more.
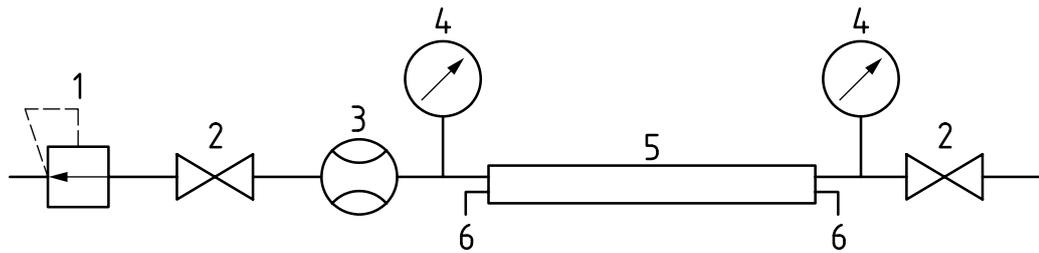
11 Mechanical requirement

11.1 General

All the tests are type tests.

Figure 3 gives an example of the water supply to the cable for the tests requiring this.

When the tests are carried out, there shall be no trace of water at the various connections.

Key

1 pressure reducing valve
2 valve
3 flow meter
4 pressure gauge
5 cable
6 seal

Figure 3 — Example of water supply to the cable

11.2 Leak tightness and pressure resistance of the water circuit

Supply the water circuit, sealed downstream of the cable (e.g. by closing the valve on the right-hand side of Figure 1), under a pressure of 0,75 MPa (7,5 bar), e.g. by adjusting pressure-reducing valve 1, for 6 min.

11.3 Water flow

Carry out this test successively:

— with the cable laid flat out straight on a horizontal surface [see Figure 4 a)];

— with the cable placed on a horizontal surface but bent with a radius of curvature of 300 mm [see Figure 4 b)];

— with the water circulating in the cable, e.g. by opening both valves (see Figure 3, item 2) adjust the pressure less to 0,07 MPa (0,7 bar) for an upstream pressure greater than or equal to 0,1 MPa (1 bar).

Measure the water flow using a suitable flow transducer (see Figure 3, item 3).

11.4 Verification of flexibility at ends

11.4.1 General

Carry out this test on a low-reactance cable with a cross-sectional area of 200 mm^2 and length of 2 500 mm, considered to be representative of cables of the same design with a cross-sectional area or length as specified in double conductor connection cables and single connection cables.

11.4.2 Fixing of the cable

Fix the cable by one of its end lugs to a device fitted with horizontal and vertical graduated rules for measuring the coordinates of a point, in such a way that its other end hangs free (see Figure 5).

Carry out the test for each of the two ends of the cable.

11.4.3 Measurements to be taken

Using the two graduated rules, measure the ordinate y at each of the points A, B and C with x (equal to 0 mm, 150 mm and 300 mm, respectively). The origin A of the coordinates is the point of intersection of

the axis of the fixing hole in the end lug with its median piano; points B and C are located on the axis of the cable (see Figure 5).

11.4.4 Interpretation of results

Determine the arc of the circle passing through the three points A, B and C by geometrical construction. The radius of the arc shall be regarded as the radius of curvature -(see Figure 5).

NOTE   If the ordinate of point C is greater than 0,30 m, the radius of curvature is regarded as being less than 0,30 m provided that the ordinate of point B is different from 0.

11.5 Torsion

11.5.1 General

Carry out this test on low-reactance cable with a cross-sectional area of 200 mm^2 and length of 1 250 mm, regarded as being representative of cables of the same design having a cross-sectional area and length as specified in double conductor connection cables.

11.5.2 Test rig

Suspend the cable vertically, with the end lug by which it is suspended, immobilized as regards rotational and translational motion. Apply a force of 500 N ± 50 N to the lower lug of the cable by means of a rotating fork coupling and a pressure cylinder. Fill the cable with water at a pressure of 0,15 MPa (1,5 bar) (see Figure 6).
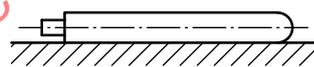
11.5.3 Measurement to be taken

Measure the torque required to effect 180° rotation in each direction of the lower lug.
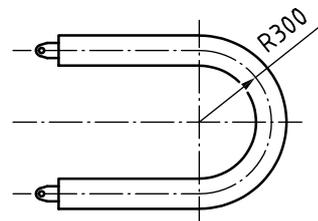
Dimensions in millimetres

a) Straight cable

R300

b) Curved cable

Figure 4 — Verification of water

Dimensions in millimetres

1)   2)

a) Test device   **b) Determination of radius of curvature**

Figure 5 — Measurement of radius of curvature

Key

1   cable
2   elastic proving device
3   cylinder – tensile load,500 N

Figure 6 — Rig for torsion test

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