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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Locked coil wire ropes for mine hoisting — Technical delivery requirements

Câbles d'extraction clos utilisés dans les mines — Conditions techniques de réception

Reference number
ISO 5614 : 1988 (E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 5614 was prepared by Technical Committee ISO/TC 82, *Mining*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Locked coil wire ropes for mine hoisting — Technical delivery requirements

1 Scope and field of application

This International Standard specifies those properties of locked coil wire ropes for mine hoisting and of their component parts which form a basis for acceptance.

The characteristics of the wire to be used for the manufacture of these ropes are not covered by this International Standard.

2 References

ISO 2232, *Drawn wire for general purpose non-alloy steel wire ropes — Specifications.* [1)]

ISO 2532, *Steel wire ropes — Vocabulary.*

ISO 3156, *Stranded wire ropes for mine hoisting — Impregnating compounds, lubricants and service dressings — Characteristics and tests.*

ISO 6892, *Metallic materials — Tensile testing.*

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

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

3 Components of the rope

3.1 Wires

Locked coil wire ropes for hoisting purposes may be made from a combination of round and shaped wires. These shall be either bright or galvanized.

The requirements for wires after manufacture are given in clause 4.

3.2 Lubricants

The impregnating compounds and lubricants used during the manufacture of these ropes shall comply with the requirements laid down in ISO 3156.

3.3 Construction

The rope shall consist of an outer layer of shaped wire. The inner layers shall have shaped, or a combination of shaped and round, or round wires.

3.4 Wire tensile grades

The ropemaker may employ any combination of round and shaped wire tensile grades given in 4.2.2.1 and 4.3.2.1 to produce the required rope-breaking load, provided that all the round wires and all the shaped wires in any one layer of the rope are each of one tensile grade.

4 Requirements

4.1 Requirements for the completed rope

4.1.1 Rope diameter

4.1.1.1 Nominal rope diameter

The nominal diameter shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

4.1.1.2 Actual rope diameter

The actual rope diameter measured on newly completed rope in the unloaded state shall not vary from the agreed nominal rope diameter by more than ± 2 %, subject to a maximum of ± 0,75 mm for ropes above 38 mm diameter. Closer tolerances on rope diameter for particular purposes may be agreed between the manufacturer or supplier and the purchaser.

The actual rope diameter shall be measured by the method laid down in 5.1.1.

1) Cross-reference to annex A in ISO 2232 applies to the first edition published in 1973.

4.1.2 Rope length

4.1.2.1 Nominal length

The nominal rope length shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered. Any test pieces shall be included in the ordered length.

4.1.2.2 Actual rope length

The actual rope length measured on newly completed rope in the unloaded state shall be subject to the following tolerances on the ordered length :

up to and including 500 m : $^{+\ 4}_{\ 0}$ %

over 500 m : $^{+\ 20}_{\ 0}$ m for each 1 000 m or part thereof.

The actual rope length shall be determined by the method agreed according to 5.1.2.

4.1.3 Nominal rope mass per metre

The nominal rope mass per metre and the tolerances shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

4.1.4 Breaking loads

4.1.4.1 General

Two methods of assessment are recognized. Compliance with one or the other shall be agreed between the manufacturer or supplier and the purchaser. The definitions of breaking loads shall be those given in ISO 2532.

4.1.4.2 Method A

In this method, the terms used are "nominal breaking load" and "measured breaking load".

a) Nominal breaking load

The nominal breaking load shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

b) Measured breaking load

The measured breaking load shall be not more than 5 % below the nominal breaking load. It shall be determined by a tensile test to destruction carried out in the manner specified in 5.1.4.1 on a sample of the rope.

4.1.4.3 Method B

In this method, the terms used are "nominal aggregate breaking load" and "measured aggregate breaking load".

a) Nominal aggregate breaking load

The nominal aggregate breaking load shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.[1)]

b) Measured aggregate breaking load

The measured aggregate breaking load shall not be less than the nominal aggregate breaking load. It shall be determined by the method laid down in 5.1.4.2.

4.2 Requirements for round wires from rope

4.2.1 Wire diameter

4.2.1.1 Nominal diameters

The intervals separating successive nominal diameters for bright and galvanized wires are given in table 1. The diameter of galvanized wires shall be measured over the galvanized coating.

Table 1

Dimensions in millimetres

Nominal diameter d	Intervals
$d \leqslant 2$	0,05
$d > 2$	0,1

If, for technical reasons, the nominal diameters of the wires differ from these values, the nominal diameters of the wires shall be indicated by the manufacturer or supplier in the confirmation of the order to the rope purchaser and in the full works certificate (see 7.3).

1) The minimum breaking load may also be agreed between the manufacturer or supplier and the purchaser; in this case, the minimum breaking load is calculated from the nominal aggregate breaking load and an agreed spinning loss factor.

4.2.1.2 Tolerances

For bright and galvanized wires, the tolerances on the diameter shall be as given in table 2.

Table 2

Dimensions and tolerances in millimetres

Nominal diameter of wire d	Tolerances on bright and normal galvanized wire
$1 \leqslant d < 1,6$	± 0,02
$1,6 \leqslant d < 2,4$	± 0,03
$2,4 \leqslant d \leqslant 3,5$	± 0,03

Galvanized wires may, owing to local irregularities, exceed the tolerances laid down in table 2 over a short length provided that the use of the wires is not affected.

4.2.2 Tensile strength

4.2.2.1 Nominal tensile strength

The nominal tensile strength values (tensile grades) for wires shall be as given in table 3. They shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

Table 3

Nominal tensile strength (Tensile grade) N/mm²
1 570
1 770
1 960

These nominal values are the lower limits for tensile strengths.

The upper limits are equal to the lower limits plus the tolerances given in 4.2.2.2.

If other tensile grades are necessary, these and the relevant technical requirements shall be agreed between the manufacturer or supplier and the purchaser.

4.2.2.2 Tolerances

The tensile grades specified in 4.2.2.1 may be exceeded, depending on the wire diameter, by the values given in table 4 provided that the difference in tensile strength for wires tested does not exceed 240 N/mm² for wires larger than 1,25 mm diameter. In the case of wires less than or equal to 1,25 mm diameter, the differences in tensile strength shall not exceed 290 N/mm².

Table 4

Nominal diameter of wire d	Tolerances for nominal tensile strength
mm	N/mm²
$1 \leqslant d < 1,5$	320
$1,5 \leqslant d < 2$	290
$d \geqslant 2$	260

4.2.3 Number of reverse bends

The minimum numbers of reverse bends shall be in accordance with table 5.

Table 5

Nominal diameter of wire d	Radius of curvature of the supports (i.e. radius of bending cylinder)	Minimum number of reverse bends for bright and normal galvanized wire		
		Nominal tensile strength, N/mm²		
mm	mm	1 570	1 770	1 960
$1,1 \leqslant d < 1,2$	3,75	12	11	11
$1,2 \leqslant d < 1,3$		11	10	9
$1,3 \leqslant d < 1,4$		9	8	8
$1,4 \leqslant d < 1,5$		8	8	7
$1,5 \leqslant d < 1,6$	5	12	11	10
$1,6 \leqslant d < 1,7$		11	10	9
$1,7 \leqslant d < 1,8$		9	8	7
$1,8 \leqslant d < 1,9$		8	7	7
$1,9 \leqslant d < 2$		7	7	6
$2 \leqslant d < 2,1$	7,5	13	12	11
$2,1 \leqslant d < 2,2$		13	11	10
$2,2 \leqslant d < 2,3$		12	10	10
$2,3 \leqslant d < 2,4$		11	10	9
$2,4 \leqslant d < 2,5$		10	9	8
$2,5 \leqslant d < 2,6$		10	8	7
$2,6 \leqslant d < 2,7$		9	7	7
$2,7 \leqslant d < 2,8$		8	7	7
$2,8 \leqslant d < 2,9$		6	6	5
$2,9 \leqslant d < 3$		6	6	4
$3 \leqslant d < 3,1$	10	10	9	8
$3,1 \leqslant d < 3,2$		9	8	7
$3,2 \leqslant d < 3,3$		9	8	7
$3,3 \leqslant d < 3,4$		8	7	6
$3,4 \leqslant d \leqslant 3,5$		7	6	5

4.2.4 Number of torsions

The minimum number of torsions shall be in accordance with the values specified in table 6.

Table 6

Test length	Nominal diameter of wire d	Minimum number of torsions for bright and normal galvanized wire		
		Nominal tensile strength, N/mm²		
mm	mm	1 570	1 770	1 960
$100 \times d$	$1 \leqslant d < 1,3$	30	28	23
	$1,3 \leqslant d < 1,8$	29	27	22
	$1,8 \leqslant d < 2,3$	27	25	21
	$2,3 \leqslant d < 3$	25	22	19
	$3 \leqslant d < 3,4$	23	21	18
	$3,4 \leqslant d \leqslant 3,5$	22	19	16

4.2.5 Zinc coating

Only one grade of galvanizing is recognized : this is normal quality galvanizing which shall show a minimum surface density of zinc of 65 g/m^2.

4.3 Requirements for shaped wires from rope

4.3.1 Wire dimension and tolerances

The type of profile, the nominal dimensions and the tolerances shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

It is recognized that different manufacturers employ different profiles and tolerances. There is no intention in this International Standard to limit the degree of choice.

The typical half-locked and full-locked wire sections shown in figure 1 are only examples to illustrate the types of section.

Two types of half-locked wires are recognized :

B (broad section) — $a : w \leqslant 1{,}5$

N (narrow section) — $a : w > 1{,}5$

where

a is the height;

w is the minimum waist.

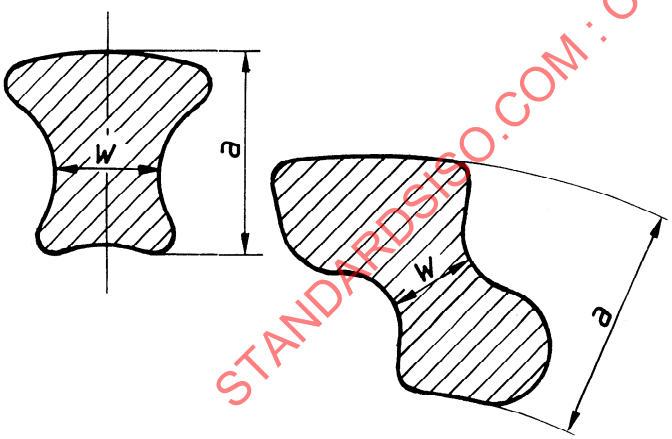

Figure 1

4.3.2 Tensile strength

4.3.2.1 Nominal tensile strength

The nominal tensile strength values (tensile grades) for shaped wires shall be as given in table 7. They shall be agreed between the manufacturer or supplier and the purchaser when the rope is ordered.

Table 7

Nominal tensile strength (Tensile grade) N/mm^2
1 180
1 270
1 370
1 470
1 570

If, in exceptional cases, other nominal tensile grades are necessary, these and the relevant technical requirements shall be agreed between the manufacturer or supplier and the purchaser.

4.3.2.2 Tolerances

The tensile grades specified in 4.3.2.1 are the lower limits for tensile strengths. The upper limits are equal to the lower limits plus 250 N/mm^2.

4.3.3 Number of reverse bends

The minimum number of reverse bends shall be in accordance with table 8.

Table 8

Nominal height of wire a	Radius of curvature of the supports (i.e. radius of bending cylinder)	Minimum number of reverse bends for bright and normal galvanized wire			
		Nominal tensile strength, N/mm^2			
mm	mm	1 180 to 1 470		1 570	
Full-lock wire					
$1{,}27 \leqslant a < 1{,}52$	5	15		14	
$1{,}52 \leqslant a < 1{,}78$		13		12	
$1{,}78 \leqslant a < 2{,}03$		12		11	
$2{,}03 \leqslant a < 2{,}29$		11		10	
$2{,}29 \leqslant a < 2{,}54$		9		9	
$2{,}54 \leqslant a < 2{,}79$		7		6	
$2{,}79 \leqslant a < 3{,}05$	7,5	13		12	
$3{,}05 \leqslant a < 3{,}3$		12		10	
$3{,}3 \leqslant a < 3{,}56$		9		7	
$3{,}56 \leqslant a < 3{,}81$		7		6	
$3{,}81 \leqslant a < 4{,}06$	10	8		7	
$4{,}06 \leqslant a < 4{,}32$		7		6	
$4{,}32 \leqslant a \leqslant 4{,}57$		6		6	
Half-lock wire					
		N[1]	B[1]	N[1]	B[1]
$1{,}27 \leqslant a < 1{,}52$	5	13	11	12	10
$1{,}52 \leqslant a < 1{,}78$		12	9	10	9
$1{,}78 \leqslant a < 2{,}03$		10	9	9	8
$2{,}03 \leqslant a < 2{,}29$		8	6	7	6
$2{,}29 \leqslant a < 2{,}54$		7	6	6	5
$2{,}54 \leqslant a < 2{,}79$	7,5	9	6	8	6
$2{,}79 \leqslant a < 3{,}05$		9	6	7	6
$3{,}05 \leqslant a < 3{,}3$		8	6	7	5

1) N = narrow section, B = broad section (see 4.3.1).

4.3.4 Number of torsions

The minimum number of torsions shall be in accordance with the values specified in table 9.

Table 9

Test length	Nominal height of wire a		Minimum number of torsions for bright and normal galvanized wire	
			Nominal tensile strength, N/mm²	
mm	mm		1 180 to 1 470	1 570
100 × a	Full-lock wire	a <3,55	21	19
		a ⩾3,55	19	18
	Half-lock wire	a <2,75	20	18
		a ⩾2,75	18	17

4.3.5 Zinc coating

The galvanized coating on shaped wires shall be assessed by the mass of zinc deposited per unit area of surface, expressed in grams per square metre.

The minimum surface density of zinc shall be 45 g/m² for normal galvanized wire.

5 Testing

5.1 Tests on the completed rope

5.1.1 Determination of rope diameter

The actual diameter of the rope shall be measured with a suitable measuring instrument to an accuracy of ± 0,1 mm.

Measurements shall be taken, at a sufficient distance from the rope end, on a straight portion of the rope under no-load condition.

The measurements shall be taken at two points spaced at least 1 m apart; at each point two diameters at right angles shall be measured. The average of these four measurements shall be taken as being the actual diameter. It shall be within the tolerances specified by reference to the nominal diameter. The maximum variation between any of the four measurements shall not exceed 2 % of the nominal rope diameter, subject to the limitations of 4.1.1.2.

In case of dispute, the diameter may be measured under a load not exceeding 5 % of the nominal breaking load of the rope.

5.1.2 Determination of rope length

The method of measuring the rope length shall be agreed between the manufacturer or supplier and the purchaser.

The rope length shall be measured by a measuring instrument with an accuracy of at least ± 2,5 %.

5.1.3 Determination of rope mass

The mass of the rope, including reels and packing material, shall be determined in kilograms.

The mass of reels, slings and packing shall be subtracted from this value to give the total rope mass. The total rope mass shall be divided by the measured rope length.

Alternatively, the actual rope mass can also be determined by weighing the rope sample, then calculating the kilograms per metre and multiplying the resulting value by the actual measured length of the rope.

The actual rope mass, in kilograms per metre, shall be within the tolerances specified for the nominal rope mass in 4.1.3.

5.1.4 Determination of breaking loads

5.1.4.1 Measured breaking load

5.1.4.1.1 General

If acceptance method A is agreed (see 4.1.4.2), the measured (actual) breaking load of the rope shall be determined as indicated in 5.1.4.1.2 to 5.1.4.1.7.

5.1.4.1.2 Test length

The length of the test piece is made up of the clear test length and an adequate allowance for gripping.

The clear test length shall be equal to at least 30 times the rope diameter, but not less than 1,5 m.

5.1.4.1.3 Test piece

The test piece shall be representative of the rope as a whole and free from any defect. The test piece, before being cut from the rope, shall be served or clamped securely so as to prevent any slackening of the wires within the test length. The rope from which the test piece is taken shall be secured in the same way. Test pieces showing slack wires or other defects shall not be tested.

For testing the rope to destruction, the test piece shall normally be fitted with conical sockets. Care shall be taken to ensure that the casting material penetrates well into the untwisted ends of the test piece. Other methods of fixing the rope ends may be agreed between the manufacturer or supplier and the purchaser.

5.1.4.1.4 Testing machine

A testing machine of suitable capacity and of an accuracy of ± 1 % that is certified periodically by an officially recognized testing authority shall be used.

The sample shall be gripped in such a way that all wires in the rope take part in the acceptance of the load.

The tests shall be carried out at a testing station agreed by the manufacturer or supplier and the purchaser.

5.1.4.1.5 Performance of test

Not more than 80 % of the nominal breaking load may be applied quickly. Thereafter, the load shall be applied slowly and steadily, at a rate not exceeding 10 N/(mm^2·s), until the maximum load is attained.

5.1.4.1.6 Place of fracture

Tests in which fracture occurs less than two rope diameters away from the grips may be discounted at the option of the manufacturer or supplier.

5.1.4.1.7 Recording of elongation

This shall be the subject of special agreement between the manufacturer or supplier and the purchaser. If required, the elongation shall be measured over a test length of at least 500 mm. Elongation readings shall be taken commencing at a load equal to 10 % of the nominal breaking load and thereafter at increments of 20, 30, 50 and 60 % of the nominal breaking load unless continuous recording is available.

In the case where incremental readings are taken, the permanent elongation shall be determined after each measurement by reducing the test load to 10 % of the minimum breaking load and recording the elongation.

The elongation shall be measured to an accuracy of 0,1 mm.

5.1.4.2 Measured aggregate breaking load

If acceptance method B is agreed (see 4.1.4.3), the measured (actual) aggregate breaking load of the rope shall be found by adding together the breaking loads of all the individual wires from the rope, after they have been tested as specified in 5.2.3.

5.2 Test on wires from the rope

5.2.1 Extent of tests

5.2.1.1 Using acceptance method A (see 4.1.4.2)

The number of wires of each nominal diameter taken for test from the rope shall be agreed between the manufacturer or supplier and the purchaser.

In order to obtain test pieces, a suitable length shall be cut from the rope and the wires unlaid. Wires of each type and size shall be thoroughly mixed and the appropriate number of wires selected at random.

5.2.1.2 Using acceptance method B (see 4.1.4.3)

All tests, with the exception of the test for the galvanized coating, shall be performed on all the steel wires in the rope.

In order to obtain test pieces, a suitable length shall be cut from the rope and the wires unlaid.

The galvanized coating tests shall be carried out on 10 % of all the round wires.

The samples shall be taken at random.

5.2.2 Measurement of diameter of round wires and dimensions of shaped wires

The actual diameter of the steel wire shall be taken as the mean value of two measurements made in mutually perpendicular planes at the same point on the wire. The actual diameter established in this way shall be within the permitted tolerances for the nominal diameter as given in 4.2.1.

The actual dimensions of the shaped wires shall be determined; observance of the agreed tolerances shall be verified.

5.2.3 Wire tensile test

The tensile test shall be performed in accordance with the requirements of ISO 6892, but with the following modifications :

a) the gauge length L_o of the test piece between the grips shall be at least 50 mm;

b) it will not normally be necessary to straighten the wires if only the tensile strength is to be tested.

When tested in this manner, the wires shall comply with the values given in 4.2.2 and 4.3.2.

The tensile strength of shaped wire shall be calculated from the breaking load and "equivalent round section" (the round wire diameter of equal sectional area to that of the shaped wire). The latter shall be shown on the test certificate by the manufacturer for the nominal sizes of shaped wire.

5.2.4 Reverse bend test

The reverse bend test shall be performed in accordance with the requirements of ISO 7801, but with the following modifications :

a) the reverse bend test shall be continued until fracture of the wire occurs;

b) the ratio of the wire diameter (in the case of round wires) to the radius of the bending cylinder specified in table 5 applies;

c) the height, a, of the wire (in the case of shaped wires) is the dimension which governs the choice of the radius of the bending cylinder;

d) the ratio of the nominal height, a (in the case of shaped wires), to the radius of the bending cylinder specified in table 8 applies.

When tested in this manner, the wires shall comply with the values given in in 4.2.3 and 4.3.3.

When testing shaped wires, the wires shall be bent with the waist facing the mandrel and the direction of bending as shown in figure 2.

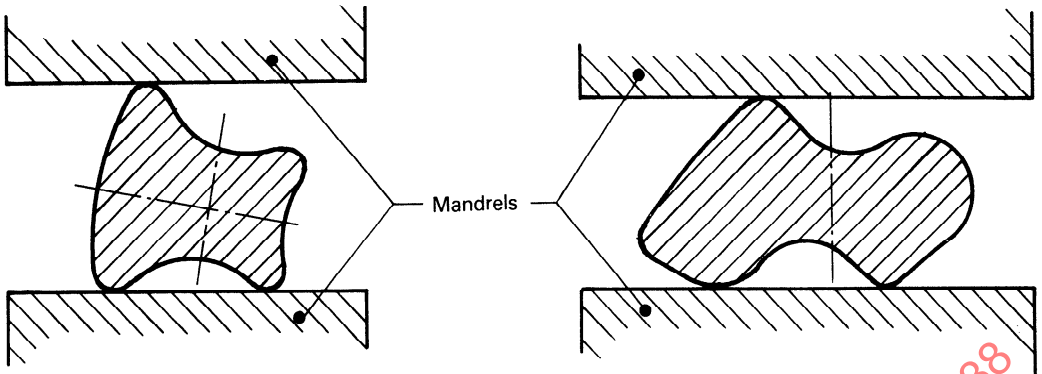

Figure 2

5.2.5 Torsion test

The torsion test shall be performed in accordance with the requirements of ISO 7800, but with the following modifications :

a) the torsion test shall be continued until fracture of the wire occurs;

b) the characteristic dimension (in the case of shaped wires) shall be the height of the wire (see 4.3.1) and NOT the diagonal;

c) the length between the vices (in the case of shaped wires) shall be 100 × a (the nominal height of the wire).

When tested in this manner, the wires shall comply with the values given in 4.2.4 and 4.3.4.

5.2.6 Tests on galvanized coating

The tests on the galvanizing of the wires shall be performed in accordance with ISO 2232, annex A. The coating shall comply with the values given in 4.2.5 and 4.3.5.

For shaped wires, the dimensions nominated by the manufacturer shall be used for the calculation of coating.

5.2.7 Compliance with requirements

5.2.7.1 Using acceptance method A (see 4.1.4.2)

Wires from the rope comply with this International Standard,

a) if not more than one wire in any diameter group fails to pass any of the tests specified, and

b) if two or more wires of any diameter group fail to pass any of the tests specified, all the remaining wires of that group in the rope shall be re-tested in respect of the tests in which these wires have failed; if the number of wires which fail in these new tests is less than two, the rope shall be deemed to comply with this International Standard.[1)]

5.2.7.2 Using acceptance method B (see 4.1.4.3)

Wires from the rope comply with this International Standard,

a) if not more than 5 % of all wires exceed the tolerances on diameter or height;

b) if not more than 3 % of all wires fall below the minimum values for tensile strength;

c) if not more than 5 % of all wires fall below the minimum values for bends or torsions or both;

d) if the total percentage of all wires with these defects does not exceed 10 %;

e) if, in addition to the above, the percentage of the wires tested that are allowed to fall below the minimum values for mass of galvanized coating is not more than 5 %.

If, in any of the above-mentioned tests, a particular wire fails on more than one test, it shall be considered as one defect only.

5.3 Independent tests

In the case of dispute between the manufacturer or supplier and the purchaser over any test result, the manufacturer or supplier shall have the right to have independent tests carried out by a testing authority agreed between the manufacturer or supplier and the purchaser.

If the results of these tests are satisfactory, the rope shall be considered to comply with the specification.

6 Inspection facilities

6.1 When so specified by the purchaser, the manufacturer or supplier shall accord the purchaser or his representative all reasonable facilities to satisfy himself that the rope and its components are in accordance with this International Standard.

1) In view of the limited number of wires involved in any diameter group, it is considered adequate to adopt, for practical purposes, a limitation of less than two for those wires which fail in 5.2.7.1b) as a result of re-testing.

The complication of taking a percentage of a smaller number of wires for test purposes is thereby avoided.

6.2 Unless otherwise agreed, all tests and inspection shall be made at the manufacturer's works before despatch.

6.3 When tests are carried out at the manufacturer's works, he shall supply all the necessary test pieces, apparatus and labour, and the testing shall be to the satisfaction of the purchaser or his representative.

7 Certificates

7.1 General

The types of certificate described in 7.2 to 7.4 are recognized. The certificates required by the purchaser shall be stated in the purchaser's order.

7.2 Works certificate

With this certificate the manufacturer or supplier acknowledges the conditions as specified in the purchaser's order (see annex A).

7.3 Full works certificate

The full works certificate gives the results of the tests requested by the purchaser in his order (see annex B).

7.4 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 are laid down in the certificate of acceptance, which is equivalent to the full works certificate.

8 Packing

Ropes shall be supplied on reels. The ropes shall be protected, in transit, against damage by moisture, dust or dirt.