

British Standard: Aerospace Series Specification for Preformed corrosion-resisting steel wire rope (ISO diameters and strengths)

Foreword

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31st March 2014.

BS W 13:1973+A1:2014 supersedes BS W 13:1973, which is withdrawn.

Text introduced or altered by Amendment No. 1 is indicated in the text by tags A1 A1. Minor editorial changes are not tagged.

This British Standard specifies requirements for preformed corrosion-resisting steel wire rope conforming to BS ISO 2020-1, *Aerospace – preformed flexible steel wire rope for aircraft controls – Part 1: Dimensions and loads* and BS ISO 2020-2:1997, *Aerospace – Preformed flexible steel wire rope for aircraft controls – Part 2: Technical specification*.

BS ISO 2020-1 specifies diameter, construction and minimum breaking strength of the rope, all of which are in accordance with Recommendation No. 3310 of l'Association Internationale des Constructeurs de Material Aerospatiale (A.I.C.M.A.) and with the United States Military Specification MIL-DTL-83420M. Size of rope, larger than 6.4 mm (¼ in) diameter, though included in MIL-DTL-83420M, are seldom used in modern aircraft, and have been omitted from this standard.

The nominal size of rope is now expressed in terms of diameter rather than of minimum breaking strength (in hundredweights) as in earlier British Standards for aircraft wire rope. Construction is of 7 × 7 or 7 × 19 according to size, 7 × 14 being no longer used. The strength/weight ratio of the new rope is higher than that in the previous standards but a direct comparison is not possible because of the change in the method of expressing the nominal size.

In order to meet the severe conditions in which wire rope operates in the control systems of modern aircraft, some aspects are more fully specified than in earlier standards. In Section 2 the composition of the wire, examined for compliance with the general requirements of BS 6S 100:2010, is now specified. Dimensional tolerances for the wire and grade of tensile strength are also given.

Section 3 of the specification, which deals with the manufacture of the rope, specifies the construction in greater detail than in earlier standards and introduces limits for length of lay. An internal lubricant is added with the aim of achieving a longer life. An elongation test is included to establish that the elongation is within specified limits at stated increments of load.

Reference is made in this British Standard to the latest issue of the following:

BS A 4, *Test pieces and test methods of metallic materials for aircraft – Metric units*

BS EN 10264-4, *Steel wire and wire products – Steel wire for ropes – Part 4: Stainless steel wire*

BS ISO 2020-1, *Aerospace – Preformed flexible steel wire rope for aircraft controls – Part 1: Dimensions and loads*

Def Stan 01-5, *Fuels, lubricants and associated products*

Def Stan 91-51, *Grease, aircraft: helicopter oscillating Bearing NATO code: G-366, Joint service designation: XG-284*

and the following standards at the edition shown

BS 6S 100:2010, *Aerospace series – Procedure for inspection, testing and acceptance of wrought steels (other than plate, sheet strip and tube)*

BS ISO 2020-2:1997, *Aerospace – Preformed flexible steel wire rope for aircraft controls – Part 2: Technical specification*

Other British Standards in this series for wire ropes are:

BS W 9 Preformed galvanized carbon steel wire rope.

BS W 11 Preformed corrosion-resisting steel wire rope.

BS W 12 Preformed galvanized carbon steel wire rope (ISO diameters and strengths).

Information on SI units is given in BS ISO 80000-1, *Quantities and units – Part 1: General* and BS 350, 'Conversion factors for units', to which reference should be made when required.

1. General

1.1 Scope

[A1] This British Standard specifies requirements for preformed corrosion-resisting steel wire rope in accordance with BS ISO 2020-1 and BS ISO 2020-2. **[A1]**

The standard is in three sections, the first covering scope and definitions, the second the properties of the wire from which the rope is made, and the third the dimensions, construction and testing of the wire rope.

An appendix to the standard outlines the precautions which should be taken during handling of wire rope.

1.2 Definitions*

For the purposes of this British Standard the following definitions apply:

- (1) *Wire*. Each cylindrical steel element.
- (2) *Strand*. An element of rope consisting of an assembly of several wires of appropriate shape and dimensions spun helically in one or more layers.
- (3) *Wire rope*. A construction of several strands wound helically in one or more layers.
- (4) *Preforming*. The process by which the wires in the strand, and the strands in the rope, are formed during rope manufacture into the shape that they will assume in the finished rope.
- (5) *Nominal diameter*. The value by which the diameter of the wire, strand or rope is designated.
- (6) *Measured diameter*. That diameter which is obtained by measuring in accordance with a prescribed method (see 3.2.2).
- (7) *Length of lay*. The pitch of the helix of the axis of the strand (or wire) in the longitudinal axis of the rope (or strand).
- (8) *Core wire (king wire)*. The centre wire of each strand.
- (9) *Centre or core strand (of a wire rope)*. A straight strand composed of wires as for the other strands.
- (10) *Elongation*. That length by which the rope extends between defined upper and lower limits of load (i.e. between first and second reading), expressed as a percentage of the gauge length measured at the lower limit.

2. Corrosion resisting steel wire for the manufacture of wire rope

2.1 Steel quality

2.1.1 Chemical composition. The cast analysis shall conform to the following limits.

	%	
	Min.	Max.
Carbon	—	0.12
Silicon	0.20	1.00
Manganese	0.5	2.00
Phosphorus	—	0.045
Sulphur	—	0.030
Chromium	17.00	19.00
Nickel	8.0	11.00

[A1] NOTE The nearest equivalent steel is X5CrNi18-10 (1.4301) to BS EN 10264-4. **[A1]**

* The definitions given relate only to this standard but where appropriate are in accordance with **[A1]** ISO 2532 **[A1]**. 'Steel wire ropes vocabulary'.

2.1.2 The steel shall comply with the general requirements of Section 1 of British Standard 6S 100:2010.

2.1.3 The steel shall be manufactured by an electric process.

2.1.4 The complete analysis of every cast shall be supplied to the inspector.

2.1.5 The ingots, blooms or billets shall be overall dressed in accordance with **A1** 11.1 of BS 6S 100:2010 **A1**.

2.1.6 For deep etch tests, samples shall be taken in accordance with **A1** 14 **A1** of **A1** BS 6S 100:2010 **A1**.

2.2 Rods

2.2.1 Rods for wire shall be made from billets complying with 2.1.

2.2.2 The rods shall be examined visually for signs of surface imperfections and shall be free from harmful defects. In addition a 200 mm length shall be cut from each end of each coil and shall be subjected to a deep etch test.

Test samples shall be immersed in either:

(1) A solution containing 10 % by volume of concentrated nitric acid and 3½ % by volume of hydrofluoric acid (40 % HF) in water at 60 °C for not less than 10 nor more than 15 minutes.

(2) Any alternative solution approved by the Inspecting Authority.

If any sample from a coil exhibits harmful defects after this test, the coil from which the sample was taken shall be rejected but may be re-submitted for deep etch testing after suitable cropping by the manufacturer.

2.2.3 **Susceptibility to intercrystalline corrosion.** A test piece shall be selected to represent each coil and shall be immersed for 72 hours in a boiling solution having the following composition:

111 g copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)

98 g sulphuric acid (S.G. 1.84)

made up to 1 litre with distilled water.

Precautions shall be taken during boiling to prevent concentration due to evaporation. Each test piece shall be dropped on a metal or stone surface, and shall emit a clear metallic ring. The test piece shall then be bent through an angle of 90° over a radius of three times its diameter and shall withstand this treatment without cracking.

2.3 Wire manufacture

2.3.1 **Condition.** The wire shall be made from rods complying with 2.2 and shall be supplied in the cold drawn condition with no subsequent heat treatment.

2.3.2 **Surface finish and freedom from defects.** The wire shall be examined visually for signs of surface imperfections, and shall be free from harmful defects. The standard of surface finish shall be agreed between the manufacturer and the purchaser and stated on the order.

2.4 Size tolerances

2.4.1 **Tolerance.** The tolerance on the diameter of the wire shall not exceed that given in the table below. The cross section shall be circular to within half the given tolerances:

Nominal wire diameter		Tolerance
From	Up to and including	
mm	mm	mm
0.20	0.25	± 0.005
0.25	0.375	± 0.008
0.375	0.475	± 0.010
0.475	0.60	± 0.013

2.4.2 Diameter of wire. The diameter shall be taken as the mean of two micrometer measurements made at right angles to each other on a straight piece of wire. Individual measurements shall lie within the diameter tolerance.

2.5 Samples for tests

The inspector shall select from each end of each coil of finished wire a test sample of sufficient length to provide for each of the tests required by 2.6, 2.7 and 2.8.

2.6 Tensile strength test

2.6.1 A tensile strength test shall be made on a portion of each sample in accordance with $\boxed{A_1}$ BS 4 A 4 $\boxed{A_1}$.

2.6.2 The tensile strength of the wire shall be calculated on the nominal diameter.

2.6.3 The tensile strength of the wire shall be not less than that given below for the appropriate nominal wire diameter. The variation in tensile strength of all the wires in any one layer of the rope shall be not greater than 295 N/mm².

Nominal wire diameter		Minimum tensile strength
From	Up to but not including	
mm	mm	N/mm ²
0.10	0.20	2060
0.20	0.25	1960
0.25	0.30	1865
0.35	0.40	1815
0.40	0.50	1765
0.50	0.60	1715

NOTE. King wires may be of a lower tensile grade and strength range but shall comply with this standard in every other respect. (See 3.5.1.2).

2.7 Ductility wrap test

A portion of each sample shall be wrapped for eight complete close turns around a mandrel having a diameter equal to the wire diameter, and unwrapped seven turns without fracture.

2.8 Test for intercrystalline corrosion

A portion of each sample shall be subjected to the test specified in 2.2.3 omitting the ringing portion of the test.

2.9 Re-tests

Should any test piece fail to meet the test requirements, two further test pieces in respect of each failure shall, if the wire manufacturer so desires, be cut from the same end of the coil of wire from which the failed test piece was cut, and shall be subjected to the tests in 2.6 to 2.8. If both the additional test pieces fulfil the test requirements, the coil shall be accepted but if either fail the coil shall be deemed not to comply with this standard.