BSI

Amendment No. 1
published and effective from 30 April 1986
to BS 1429 : 1980

Specification for annealed round steel wire for general engineering springs

Revised text

AMD 5068
April 1986

Table 2. Maximum tensile strength for annealed wire according to steel grade

Delete the existing table and substitute the following.

Table 2. Maximum tensile strength for annealed wire according to steel grade

Steel grade	Maximum tensile strength
	N/mm^2
090A65	730
070A72	730
060A96	820
735A50	800
685A55	800

NOTE. The maximum tensile strength for grade 090A65 is based on a general usage of approximately 0.65 % to 0.70 % carbon. The higher manganese content specified in table 5 is normally associated with the lower carbon content for large diameter wires.

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Table 5. Chemical composition (cast analysis)

Delete the existing table and substitute the following.

Table 5. Chemical composition (cast analysis)

Steel grade	C		Si		Mn		S	P	Cr		V
	Min.	Max.	Min.	Max.	Min.	Max.			Min.	Max.	Min.
	%	%	%	%	%	%			%	%	%
090A65	0.55	0.75	–	0.30	0.60	1.20			–	–	–
070A72	0.70	0.75	0.10	0.35	0.60	0.80			–	–	–
060A96	0.93	1.00	0.10	0.35	0.50	0.70	See note	See note	–	–	–
735A50	0.46	0.54	0.10	0.35	0.60	0.90			0.80	1.10	0.15
685A55	0.50	0.60	1.20	1.60	0.50	0.80			0.50	0.80	–

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Table 6. Minimum hardness requirements

Delete the existing table and substitute the following.

Table 6. Minimum hardness requirements

Steel grade	Oil quenched from temperature of	Minimum hardness
	°C	
090A65	820 to 850	720
070A72	820 to 850	720
060A96	800 to 830	750
735A50	850 to 880	680
685A55	900 to 930	680

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Back cover

In two places delete the committee reference 'ISE/26' and substitute 'ISM/26'.

BSI

BS 1429 : 1980

UDC 62–272 : 669.14–426 :
669.14.018.27–153

Specification for

Annealed round steel wire for general engineering springs

Spécification pour le fil d'acier recuit rond pour ressorts d'usage mécanique général

Spezifikation für geglühten runden Stahldraht für allgemeine Maschinenfedern

British Standards Institution

Gr 3

Contents

Foreword

This British Standard has been prepared under the direction of the Iron and Steel Standards Committee and specifies the requirements for annealed steel wire for springs that are to be heat treated after manufacture. The standard has been extensively revised and is now metricated and retitled. BS 1429 : 1948 is now withdrawn.

A range of carbon steels and two types of alloy steel have been retained. Provision has been made however for various qualities to be supplied that are related to the intended application of the wire. These are identified by an appropriate quality code.

The concept of standard or preferred sizes is not appropriate for this standard. The size ranges listed for each grade may not be available from every manufacturer without restriction.

British Standard Specification for

Annealed round steel wire for general engineering springs

Section one. General

1. Scope

This British Standard specifies the requirements for annealed, or annealed and lightly drawn round steel wire, supplied in coils or straight lengths, suitable for the manufacture of mechanical springs by cold-forming which are hardened and tempered after forming.

It is generally applicable to wire sizes in the range from 1.00 mm to 16 mm.

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Products and quality coding

Wire is available in three qualities related to application and shall be designated by the quality code given in table 1.

Table 1. Production range and quality codes

Wire application	Quality code	Range of diameters (inclusive)
		mm
Normal duty static	NS	1.0 to 16.0
High duty static and normal duty dynamic	ND	1.0 to 16.0
High duty dynamic	HD	1.0 to 16.0

4. Information to be supplied by the purchaser

The following information shall be given on the enquiry or order.

(a) The number of this British Standard, i.e. BS 1429.

(b) The steel grade (see clause 12 and table 5).

(c) The wire quality code (see clause 3)

(d) The diameter of the wire

(e) Any applicable requirements from the appropriate clauses for:

(1) surface finish and condition of wire (see 5.4),
(2) hardness testing (see 7.2),
(3) non-destructive testing (see 9.3),
(4) packing and identification (see clause 11).

(f) Any other special requirements.

Example: 2.80 mm diameter 0 70 % to 0.75 % carbon steel normal duty static spring wire in the annealed condition.

Order as BS 1429, 070A72, NS, 2 80 mm, annealed.

Section two. Manufacture, testing and packing

NOTE. The requirements of the clauses in section two are applicable to all steel grades and qualities of wire

5. Manufacture

5.1 Steelmaking process. The steel may be made by any process except that air and mixed air-oxygen bottom blown converter processes shall not be used. In the case of the oxygen process, the nitrogen content of the steel shall not exceed 0.008 %

5.2 Chemical composition. The chemical compositions of the steels specified in section three are based on cast analysis. On request, the wire manufacturer shall supply the cast analysis for the specified elements Any subsequent analytical checks shall take into consideration the heterogeneity normal to the steel (see appendix A).

5.3 Freedom from defects. The ingots, blooms or billets shall be so prepared as to remove surface imperfections which might produce defects in the wire made from them.

The rod from which the wire is drawn shall be free from harmful surface defects, pipe and other flaws (see also 5.4 for finished wire).

Should it be necessary to grind the wire to meet the decarburization and defect levels specified in 15.1 and 15.3 (see tables 7 and 8), the grinding shall be at a stage during manufacture such that all residual grinding marks are completely eliminated by subsequent wire drawing

5.4 Condition of finished wire

5.4.1 Wire shall be supplied in the annealed or annealed and lightly drawn condition (see 7.1)

5.4.2 Wire shall be supplied with an annealed or a bright drawn finish and shall be free from harmful defects (see clause 9). The level of non-metallic inclusions present in the wire and the method of assessment shall be agreed by the purchaser and the supplier at the time of ordering.

5.4.3 Wire supplied in coil shall lie dead and be free from corkscrew set.

5.4.4 The straightness of wire supplied in lengths shall conform to tolerances to be agreed between the manufacturer and the purchaser.

6. Selection of test pieces

6.1 With the exception of the hardening test, all tests shall be carried out on the material in the condition in which it is to be supplied to the purchaser. Apart from straightening prior to testing, the test pieces shall not be treated in any way which may make them unrepresentative of the batch of which they are a sample

6.2 Test pieces for mechanical tests shall be taken from each end of every coil, unless the coil mass is less than

75 kg when one test piece shall be taken from each coil. These small coils shall be identifiable as the product of a larger coil. Wire supplied in straight lengths shall be grouped in such a manner as to be clearly identified with the coil from which the lengths have been cut. Two test pieces selected at random from the lengths shall then be considered to be representative of that coil of wire.

6.3 Test pieces for surface defect examination shall be selected as specified in 6.2 except for the NS quality for which the sampling rate shall be at the discretion of the wire manufacturer to ensure compliance with the requirements of clause 15.

7. Mechanical testing

7.1 **Tensile test.** The procedures for mechanical testing shall be in accordance with the requirements of BS 4545. In routine testing with fixed gear type tensile testing machines, the straining rate shall be pre-set to give a rate of separation of the grips not greater than 40 % of the test length per minute.

NOTE. BS 4545 stipulates that the tensile strength shall be calculated on the nominal dimensions of the wire unless otherwise specified.

The maximum tensile strength for wire supplied in the annealed condition shall be in accordance with the values shown in table 2.

Table 2. Maximum tensile strength for annealed wire according to steel grade

Steel grade	Maximum tensile strength
	N/mm²
070A72	730
060A96	820
735A50	800
685A55	800

Refer to AMD 5068 April 86 Lenew. th

The tensile strength for annealed and lightly drawn wire shall, if required, be agreed between the purchaser and the supplier.

7.2 **Hardening test.** A hardening test is applicable to wire diameters of 3.0 mm and over. The test piece shall be hardened by quenching in oil from the appropriate temperature shown in table 6. For the purpose of the test a flat shall be ground on the surface of the hardened test piece, removing at least 0.20 mm.

Vickers hardness tests in accordance with the requirements of BS 427 shall be carried out on this flat. The minimum hardness values to be obtained shall be as given in table 6.

The preferred method for testing hardness is the Vickers test, but in cases where a purchaser states a preference a Rockwell test may be carried out in accordance with BS 891 and this shall be indicated at the time of ordering and an appropriate minimum Rockwell hardness value agreed.

7.3 **Bend test.** The bend test shall be carried out as follows.

(a) *Wire sizes* 6.5 mm *and under.* The test piece shall be bent, cold, by steadily applied pressure or by a succession of blows and flattened close until it assumes the position indicated in the following sketch without showing signs of failure.

Figure 1. Position of wire for bend test

(b) *Wire sizes over* 6.5 mm. The test piece shall be bent through 180 °, cold, by steadily applied pressure or by a succession of blows, over a former of diameter equal to the diameter of the wire without showing signs of failure.

8. Dimensional tolerances

8.1 **Diameter tolerance and ovality.** The minimum and maximum diameters shall be measured by micrometer at the same cross section on a straight wire. Ovality is defined as the difference between the minimum and maximum axes of the wire at the same cross sections. Each measurement shall be within the tolerance for diameter and ovality given in table 3 for the appropriate diameter of wire.

Table 3. Tolerances on diameter and ovality

Nominal wire diameter		Tolerance on diameter		Maximum ovality	
Over	Up to and including	Wire in coil	Wire in straight lengths	Wire in coil	Wire in straight lengths
mm	mm	mm	mm	mm	mm
1.00	1.90	± 0.015	± 0.02	0.015	0.02
1.90	3.15	± 0.02	± 0.03	0.02	0.03
3.15	5.60	± 0.03	± 0.05	0.03	0.05
5.60	8.50	± 0.04	± 0.06	0.04	0.06
8.50	10.00	± 0.05	± 0.07	0.05	0.07
10.00	16.00	± 0.06	± 0.08	0.06	0.08

8.2 **Straight length tolerance.** When supplied in straight lengths, the lengths shall not be less than those given in the order and shall not exceed the plus tolerance given in table 4.

Table 4. Tolerances on length of straight lengths

Length		Plus tolerance
Over	Up to and including	
mm	mm	mm
–	160	By agreement
160	315	2
315	500	3
500	800	4
800	1250	5
1250	2000	7
2000	–	13

9. Examination for defects

9.1 General. All qualities of wire shall be examined for surface defects by the method specified in 9.2 or by that specified in 9.3. Where deemed necessary, the aforementioned tests may be supplemented by continuous non-destructive testing of the whole coil, (see 9.4). Tests for decarburization shall be as specified in 9.5 and where appropriate, for internal defects as specified in 9.6. Materials shall comply with the specific requirements listed in section three according to quality.

9.2 Magnetic particle test. For the magnetic particle test, a test piece of 250 mm in length shall be taken and subjected to a magnetizing current of 20 amperes per mm of wire diameter. Examination for surface defects shall be carried out by the use of magnetic particle fluorescent 'ink'. Any defects indicated by this test shall be noted and further examined by taking metallographic sections through the defect for the purpose of measuring the depth.

9.3 Deep etch test. For the deep etch test, a test piece of 250 mm in length shall be taken and immersed in a boiling solution of 50 % by volume of concentrated hydrochloric acid and 50 % of water for a period of time equivalent to 1 s for every 0.025 mm of diameter with a maximum of 2.5 min, after which the wire shall be examined at a magnification of x5 to x12 diameters. Any defects indicated by this test shall be further examined by taking metallographic sections through the defects revealed by the deep etch test and their depth measured.

9.4 Non-destructive test. A non-destructive test shall be made if agreed between the purchaser and the supplier. Wire intended for use in dynamic duty springs (ND and HD quality) may be continuously inspected by eddy current or ultrasonic methods of suitable sensitivity. The maximum depth of defect, the marking and the allowable number of such defects in any one coil shall be agreed between the purchaser and the supplier.

9.5 Decarburization. All qualities of wire shall be examined for decarburization by taking cross sections and mounting in suitable plastic to support the edge of the specimen during subsequent metallographic preparation After polishing and etching with a reagent consisting of a solution of either nitric or picric acid in alcohol, viz. Nital or Picral, the cross section shall be examined at a magnification of x175 to x225 diameters.

9.6 Metallographic test for internal defects. A metallographic test for internal defects is applicable to HD quality wire only. The wire shall be examined for internal defects on a polished and very lightly etched longitudinal section at a magnification of x175 to x225 diameters.

10. Retests

10.1 Should a test piece fail any of the tests, additional test pieces shall be taken from the appropriate coil or product of a coil and retested.

For wire in coil, two additional test pieces shall be taken from each end of the same coil. Part of the coil may be discarded before taking the new test pieces. For wire supplied in lengths, four additional test pieces shall be taken at random from the same bundle or bundles representing the product of the coil.

10.2 If all the additional test pieces pass all the tests, the coil or the bundles representing the product of the coil shall be deemed to comply with the requirements of this British Standard. Should any of them fail, the coil or corresponding bundles shall be deemed not to comply with the requirements of this British Standard.

11. Packing and identification

Consignments of wire shall be suitably protected against corrosion during transport. If special protections are required, these shall be agreed at the time of enquiry or order.

Wire in coil or bundles of lengths shall be securely tied and shall carry a suitable label or labels on which shall be shown the ordering designation including the number of this British Standard and details of cast identification. Any other marks required shall be agreed between the purchaser and the manufacturer.

NOTE. Marking BS 1429 on or in relation to a product is a claim by the manufacturer that the product has been manufactured in accordance with the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility.

Section three. Specific requirements

12. General

The specific requirements are for the three qualities of annealed and lightly drawn wire suitable for the manufacture of mechanical springs for static and dynamic applications

The wire shall comply with the requirements of sections one and two and the appropriate requirements of this section according to quality.

Table 5. Chemical composition (cast analysis)

Steel grade	C		Si		Mn		S	P	Cr		V
	Min.	Max.	Min.	Max	Min.	Max.			Min.	Max.	Min.
	%	%	%	%	%	%			%	%	%
070A72	0.70	0.75	0.10	0.35	0.60	0.80			–	–	–
060A96	0.93	1 00	0 10	0.35	0.50	0.70	See	See	–	–	–
735A50	0.46	0.54	0.10	0.35	0.60	0.90	note	note	0 80	1.10	0.15
685A55	0.50	0.60	1.20	1.60	0.50	0.80			0.50	0.80	–

NOTE. Sulphur and phosphorus contents depend on wire quality code i e

NS 0 05 % max for both elements

ND 0.04 % max. for both elements

HD 0 03 % max. for both elements

Refer to AMD 5068 April 86 - Leaflet

13. Chemical composition

13.1 The chemical composition of the various grades of steel shall be as shown in table 5.

13.2 If a product analysis is required it shall be carried out in accordance with the requirements of appendix A.

14. Hardening test

When a hardening test is made as specified in **7.2**, the steel shall meet the appropriate minimum hardness given in table 6.

Table 6. Minimum hardness requirements

Steel grade	Oil quenched from temperature of	Minimum hardness HV
	°C	
070A72	820 to 850	720
060A96	800 to 830	750
735A50	850 to 880	680
685A55	900 to 930	680

Refer to AMD 5068 April 86 Levenit

15. Decarburization, surface defects

15.1 Decarburization. For the purposes of this standard, a zone of complete decarburization is defined as one composed wholly of free ferrite. Partial decarburization is defined as areas where the proportion of ferrite, as compared with the proportion of pearlite or spheroidized carbide, is in excess of the ferrite occurring in the core of the sample.

Partial decarburization shall not have a radial depth greater than that given in table 7 for each quality code. For the NS quality only, a maximum of 20 % of the radial depth given in table 7 may be complete decarburization.

Table 7. Partial decarburization

Quality code	Maximum partial decarburization
NS	3 % of wire diameter or 0.20 mm whichever is smaller.
ND	1 % of wire diameter or 0.10 mm whichever is smaller.
HD	0.25 % of wire diameter or 0 01 mm whichever is smaller.

15.2 Surface defects. The radial depth of seams or other surface defects shall not be greater than that given in table 8 according to quality.

Table 8. Surface defect levels

Quality code	Maximum defect depth
NS	3 % of wire diameter of 0.20 mm whichever is smaller.
ND	1 % of wire diameter or 0.10 mm whichever is smaller.
HD	Nil.

Appendix A

Product analysis and permitted variations

A.1 Analysis of the product may vary from the cast analysis due to heterogeneity arising during the casting and solidification of the ingot. Table 9 shows the permitted variations in product analysis.

The variations may occur either above or below the individual element ranges but shall not be applied both above and below the specified range for any one element in any one cast of steel.

A.2 If the chemical analysis of any wire falls outside the limits of permissible variation from the specified composition range for a significant element, that wire shall be deemed not to comply with the requirements of this British Standard.

A.3 In the event of the results of the analysis of a single sample falling outside the permitted variations on the product analysis, further samples shall be selected for check analysis from the remainder of the consignment, as follows.

(a) At least two samples from the same cast for delivered mass up to and including 5 tonnes.

(b) At least five samples from the same cast for delivered mass over 5 tonnes and up to and including 20 tonnes.

(c) At least eight samples from the same cast for delivered mass over 20 tonnes.

The results of the analysis of these samples shall fall within the limits of permissible variation. If any of these further samples are proved to be outside the limits for permissible variation for any significant element the consignment shall be deemed not to comply with the requirements of this standard.

A.4 Samples for product analysis shall be taken in accordance with the requirements of BS 1837 and, in the event of dispute, analysed in accordance with the appropriate methods of British Standard Handbook no. 19.

Table 9. Permitted variations of product analysis from specified range

Element	Range in which maximum of specified element falls	Variation on specified range			
		Carbon steels		Alloy steels	
		Over (max.)	Under (min.)	Over (max.)	Under (min.)
	%	%	%	%	%
Carbon	0.25 to 0.50	0.03	0.03	0.03	0.03
	Over 0.50 to 1.05	0.04	0.04	0.03	0.03
Silicon	0.10 to 0.35	0.03	0.03	0.03	0.03
	Over 1.0 to 1.6	–	–	0.07	0.07
Manganese	Up to 1.0	0.04	0.04	0.04	0.04
Chromium	Up to 0.60	–	–	0.03	0.03
	Over 0.60 to 1.25	–	–	0.04	0.04
Vanadium	Up to 0.30	–	–	–	0.03
Sulphur	Up to 0.030	0.005	–	0.003	–
	Over 0.030 to 0.040	0.006	–	0.004	–
	Over 0.040 to 0.050	0.008	–	0.005	–
Phosphorus	Up to 0.030	0.005	–	0.003	–
	Over 0.030 to 0.040	0.006	–	0.004	–
	Over 0.040 to 0.050	0.008	–	–	–

Standards publications referred to

BS 427 Method for Vickers hardness test
Part 1 Testing of metals
BS 891 Method for Rockwell hardness test
Part 1 Testing of metals
BS 1837 Methods for the sampling of iron, steel, permanent magnet alloys and ferro-alloys
BS 4545 Methods for mechanical testing of steel wire
Handbook No. 19 Methods for the sampling and analysis of iron, steel and other ferrous metals

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Attention is drawn to the fact that this British Standard does not purport to include all the necessary provisions of a contract

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The following BSI references relate to the work on this standard.
Committee reference ISE/26 Draft for comment 78/76833 DC

ISM26

Cooperating organizations

The Iron and Steel Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations

British Cast Iron Research Association
British Constructional Steelwork Association
British Internal Combustion Engine Manufacturers' Association
British Ironfounders' Association
British Railways Board
British Shipbuilders
*British Steel Industry
*British Steel Industry (Wire Section)
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National Association of Drop Forgers and Stampers
Oil Companies Materials Association
Process Plant Association
Royal Institute of British Architects
*Society of Motor Manufacturers and Traders Limited
Steel Casting Research and Trade Association
Water-tube Boilermakers' Association

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard

British Wire Netting Association
Fencing Contractors' Association
Furnishing Spring Makers' Federation
Music Wire Export Association
Patented Steel Wire Association
Society of Chain Link Fencing Manufacturers
Spring Research and Manufacturers' Association

Amendments issued since publication

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