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Specification for

Pre-hardened and tempered carbon and low alloy round steel wire for springs for general engineering purposes

Spécification pour le fil rond en acier au carbone et acier faiblement allié prétrempés et revenus pour les ressorts d'usage mécanique général

Spezifikation für gehärtete und angelassene niedriglegierte runde Stahldrahtsorten für Federn für den allgemeinen Maschinenbau

British Standards Institution

Gr 5

Contents

Foreword

This edition of BS 2803, prepared under the direction of the Iron and Steel Standards Committee, has been very extensively revised and is now retitled and fully metricated. BS 2803 : 1956 is now withdrawn.

For the convenience of the user, separate sections cover the requirements for carbon and low alloy steel wires.

Provision has been made for the supply of wire according to the type of duty for which the manufactured springs are intended and to which appropriate grade designations are allocated.

Standard and preferred sizes of wire have been added to the specification. The size ranges listed may not be available, however, from every manufacturer without restriction.

British Standard Specification for

Pre-hardened and tempered carbon and low alloy round steel wire for springs for general engineering purposes

Section one. General

1. Scope

This British Standard specifies the requirements for pre-hardened and tempered plain carbon and low alloy round steel wire, supplied in coils or straight lengths, suitable for the manufacture of mechanical springs for static and dynamic applications. It is generally applicable to wire sizes in the range from 0.25 mm to 12.5 mm.

NOTE. Pre-hardened and tempered wire is defined as wire which has been hardened and tempered by a continuous process to produce a structure of tempered martensite so that it needs no further hardening and tempering after spring forming.

2. References

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

3. Information to be supplied by the purchaser

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

(a) The number of this British Standard i.e. BS 2803.

(b) The wire designation (see 3.2).

(c) The nominal diameter of the wire (see tables 5 and 10).

(d) The tensile strength range if grade 685A55 is ordered (see table 10).

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

(1) condition of wire (see 4.4);

(2) non-destructive testing (see 8.4);

(3) packing and identification (see clause 10).

(f) Any other special requirements.

3.2 The wire shall be designated by the number of this British Standard, a six digit number corresponding to the chemical composition of the steel, together with the two letters corresponding to the quality code as given in tables 3 and 8.

Example: BS 2803, 730A65, HS, 2.80 mm. (High duty static low chromium vanadium spring wire of 2.80 mm diameter.)

4. Manufacture

4.1 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 %.

4.2 Chemical composition. The chemical compositions of the steels specified in sections two and 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).

4.3 Freedom from defects

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

4.3.2 The rod from which the wire is drawn shall be free from harmful surface defects, pipe and other flaws (see also 4.4 for finished wire).

4.3.3 Should it be necessary to grind the wire to meet the specified defect and decarburization limits given in tables 6, 7, 11 and 12, the grinding shall be at a stage during manufacture such that all residual grinding marks are completely eliminated by subsequent drawing.

4.4 Condition of finished wire

4.4.1 Wire shall be supplied in the pre-hardened and tempered condition.

4.4.2 The wire shall be free from harmful surface defects. If required, the level of non-metallic inclusions present in the wire and the method used to assess the level shall be agreed by the purchaser and supplier at the time of the enquiry and order.

4.4.3 Wire supplied in coil, unless otherwise agreed between the manufacturer and purchaser, shall run out straight from the coil. Attention is drawn to the need for precautions when releasing the binders.

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

5. Selection of test pieces

5.1 All tests shall be carried out on the material in the condition in which it is to be supplied to the user. Apart from straightening the test pieces prior to testing if necessary, they shall not be treated in any way which may make them unrepresentative of the batch of which they are a sample.

5.2 Test pieces for mechanical tests shall be taken from each end of every 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.

5.3 Test pieces for surface defect examination shall be selected as specified in 5.2, except for the NS quality (see table 3) for carbon steels where the sampling rate shall be at the discretion of the wire manufacturer to ensure compliance with the requirements of clause 15 for carbon steel wires and clause 20 for low alloy steel wire.

6. Mechanical testing

6.1 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 preset 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 tensile strength for all qualities of carbon steel wire shall be in accordance with the values shown in table 5 and for low alloy steel wire, in accordance with the values shown in table 10.

For non-standard sizes the tensile strength shall be that applicable to the next larger standard size.

6.2 Torsion test. The torsion test shall be applied to all qualities of wire in the size range 1.5 mm to 10 mm diameter inclusive.

The test piece shall withstand being twisted, without failure, 10 turns in a gauge length equivalent to 100 × the wire diameter. If the gauge length is greater or less than 100 × the wire diameter, the number of twists shall be adjusted in proportion to the gauge length. The test shall be continued until fracture occurs, when the primary fracture shall be perpendicular to the axis of the wire and the surface shall not split. During fly-back of the wire, secondary fractures may occur and these shall be ignored.

6.3 Bend test. The bend test shall be applied to all qualities of wire of 3 mm and larger diameters.

The wire shall not show sign of failure when bent through 180° to form a 'U' around a mandrel of diameter equal to one and a half times the wire diameter.

In carrying out the test, the wire shall be free to move longitudinally in the forming device.

To avoid the need for holding an excessive number of mandrel sizes, the wire shall be deemed to have complied with the specification if it is bent around a mandrel smaller than that specified.

6.4 Wrapping test. The wrapping test shall be applied to all qualities of wire of diameters of 1 mm up to and including 3 mm.

The wire shall not show sign of failure when coiled eight complete turns around a mandrel of diameter equal to that of the wire.

7. Dimensions and tolerances

7.1 Standard sizes. The nominal diameters shown in tables 5 and 10 for carbon and low alloy wire respectively are the standard sizes, the first preference in sizes being shown in bold type.

7.2 Diameter tolerances and ovality. The minimum and maximum diameters shall be measured by micrometer at the same section on a straight piece of wire.

Ovality is defined as the difference between the maximum and the minimum axes of the wire, measured at any one cross section.

Each measurement shall be within the tolerance for diameter and ovality given in table 1 for the appropriate nominal diameter of wire.

Table 1. 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
0.25	0.40	± 0.005	± 0.008	0.005	0.008
0.40	1.00	± 0.010	± 0.015	0.010	0.015
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	12.50	± 0.06	± 0.08	0.06	0.08

7.3 Straight length tolerances. When supplied in straight lengths, the lengths shall not be less than those given in the order and shall not exceed the positive tolerances given in table 2.

Table 2. Tolerances on length of straight lengths

Lengths		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

8. Examination for defects

8.1 General. All qualities of wire shall be examined for surface defects either by the method specified in 8.2 or by that specified in 8.3. Where deemed necessary, the aforementioned tests may be supplemented by continuous testing of the whole coil (see 8.4). Tests for decarburization shall be as specified in 8.5 and, where appropriate for internal defects, as specified in 8.6.

Material shall comply with the specific requirements listed in sections two and three, according to quality.

8.2 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 A 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.

8.3 Deep etch test. For the deep etch test, a test piece of 250 mm in length shall be taken and prior to pickling shall be stress relieved for a minimum of 10 min at a temperature of 400 °C to 500 °C. The cold test piece shall then be 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.

8.4 Continuous non-destructive test. By agreement between the purchaser and the supplier, wire intended for use in dynamic duty springs may be continuously inspected by eddy current or ultrasonic methods of non-destructive test 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.

8.5 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

8.6 Internal defects. A metallographic test for internal defects is applicable to HD quality (see table 3) wire only. Representative samples of the wire shall be examined for defects on a polished and very lightly etched longitudinal section at a magnification of x175 to x225 diameters.

9. Retests

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

For wire in coils, 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.

9.2 If all the additional test pieces pass all the tests, the coil or the bundles representing the product to 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.

10. 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 and 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 number of this British Standard and the ordering designation, including details of cast identification and an agreed indication of the actual tensile strength on sizes 2.24 mm and smaller. In the interests of safety, coils dressed to run out straight shall carry a warning label pointing out the need for care when releasing binders. Any other marks may be agreed between the purchaser and the manufacturer.

NOTE Marking BS 2803 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 two. Specific requirements for carbon steel wires

11. General

This section gives the specific requirements for the various qualities of pre-hardened and tempered carbon steel wires suitable for the manufacture of mechanical springs for static and dynamic applications.

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

12. Production range and quality codes for carbon steel wires

Carbon steel wire shall be supplied in one of the four qualities given in table 3 according to the application.

Table 3. Production range and quality codes for carbon steel wires

Wire application	Quality code	Steel grade	Range of diameters (inclusive)
			mm
Normal duty static	NS	095A65	0.25 to 12.5
High duty static	HS	094A65	0.25 to 12.5
Normal duty dynamic	ND	094A65	0.25 to 12.5
High duty dynamic	HD	093A65	1.00 to 12.5

13. Chemical composition of carbon steels

13.1 The chemical composition of the carbon steels shall be as shown in table 4.

Table 4. Chemical composition of carbon steel wires

Element	095A65		094A65		093A65	
	min.	max.	min.	max	min.	max.
	%	%	%	%	%	%
Carbon	0.55	0.75	0.55	0.75	0.55	0.75
Silicon	–	0.30	–	0.30	–	0.30
Manganese	0.60	1.20	0.60	1.20	0.60	1.20
Sulphur	–	0.050	–	0.040	–	0.030
Phosphorus	–	0.050	–	0.040	–	0.030

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

14. Standard sizes and tensile strengths for carbon steel wires

The standard sizes and tensile strengths for carbon steel wire are given in table 5. Wire of HD quality shall not be supplied in sizes below 1.00 mm. (See table 3.)

Table 5. Standard sizes and tensile strengths for carbon steel wires

Nominal diameter	Tensile strength		Nominal diameter	Tensile strength	
	min.	max.		min.	max.
mm	N/mm²	N/mm²	mm	N/mm²	N/mm²
0.25	1910	2170	**3.15**	1530	1680
0.315	1900	2150	3.35	1520	1670
0.40	1880	2130	**3.55**	1500	1650
0.50	1860	2110	3.75	1490	1640
0.63	1840	2080	**4.00**	1480	1630
0.80	1810	2060	4.25	1470	1620
1.00	1770	2000	**4.50**	1450	1600
1.06	1760	1990	4.75	1440	1590
1.12	1750	1975	**5.00**	1430	1580
1.18	1740	1960	5.30	1410	1560
1.25	1730	1945	**5.60**	1400	1550
1.32	1720	1930	6.00	1380	1530
1.40	1710	1915	**6.30**	1370	1520
1.50	1690	1890	6.70	1360	1510
1.60	1680	1870	**7.10**	1350	1500
1.70	1665	1850	7.50	1340	1490
1.80	1650	1835	**8.00**	1320	1470
1.90	1640	1820	8.50	1310	1460
2.00	1630	1800	**9.00**	1300	1450
2.12	1620	1780	9.50	1290	1440
2.24	1605	1760	**10.00**	1280	1430
2.36	1600	1750	10.60	1270	1420
2.50	1580	1730	**11.20**	1260	1410
2.65	1570	1720	11.80	1250	1400
2.80	1560	1710	**12.50**	1240	1390
3.00	1540	1690			

NOTE 1. Sizes printed in bold, underlined type are to be preferred.
NOTE 2. All nominal diameters over 10 mm are not necessarily available in all steel grades.

15. Decarburization, surface and internal defects in carbon steels

15.1 **Decarburization.** For the purposes of this standard, a zone of complete decarburization shall be defined as one composed wholly of free ferrite.

A zone of partial decarburization is characterized by the presence of variable amounts of ferrite spines at the grain boundaries of the tempered martensite.

An area of carbon gradient is defined as one where the tempered martensite etches lighter than that of the core of the wire, but which is free from recognizable ferrite.

The total radial depth of decarburization or the proportions of complete or partial decarburization and of carbon gradient shall not be greater than the limits given in table 6.

Table 6. Decarburization limits for carbon steel wires

Quality code	Percentage of wire diameter			
	Total depth of decarburization	Complete decarburization	Partial decarburization	Carbon gradient
NS	4 % of wire diameter or 0.25 mm, whichever is smaller	0.8 % or 0.05 mm, whichever is smaller	1 % or 0.06 mm, whichever is smaller	remainder
HS	3 % of wire diameter or 0.20 mm, whichever is smaller	Nil	0.75 % or 0.05 mm, whichever is smaller, limited to 50 % ferrite content	remainder
ND	1.5 % of wire diameter or 0.12 mm, whichever is smaller	Nil	0.375 % or 0.03 mm, whichever is smaller, limited to 25 % ferrite content	remainder
HD	0.5 % of wire diameter or 0.01 mm, whichever is smaller	Nil	Nil	0.5 % or 0.01 mm, whichever is smaller

15.2 **Surface defects.** The limits of radial depth of seams or other surface defects shall not be greater than those given in table 7, according to quality.

Table 7. Surface defect limits for carbon steel wires

Quality code	Defect limit
NS	3 % of wire diameter or 0.20 mm, whichever is smaller
HS	2 % of wire diameter or 0.15 mm, whichever is smaller
ND	1 % of wire diameter or 0.10 mm, whichever is smaller
HD	Nil

15.3 Internal defects. (See 4.3.2 and specifically for HD quality.) Lamination, gross inclusions or severe segregation shall not be present through any part of the section.

Section three. Specific requirements for low alloy steel wires

16. General

This section gives the specific requirements for the various qualities of pre-hardened and tempered low alloy steel wire suitable for the manufacture of mechanical springs for static and dynamic applications.

The wire shall comply with the requirements of section one and appropriate requirements of section three, according to quality.

17. Production range and quality codes for low alloy steel wires

Low alloy steel wire shall be supplied in one of three qualities according to the application given in table 8.

18. Chemical composition of low alloy steels

18.1 The chemical composition of the low alloy steels shall be as shown in table 9.

Table 8. Production range, grades and quality codes for low alloy steel wires

Wire application	Quality code	Steel grade	Range of diameters (inclusive)
			mm
High duty static	HS	735 A50 730 A65 685 A55	1.00 to 12.5
Normal duty dynamic	ND	735 A50 730 A65 685 A55	1.00 to 12.5
High duty dynamic	HD	735 A50 730 A65 685 A55	1.00 to 12.5

Table 9. Chemical composition of low alloy steel wires

Element	735A40		730A65		685A55	
	min.	max.	min.	max.	min.	max.
	%	%	%	%	%	%
Carbon	0.46	0.54	0.57	0.72	0.50	0.60
Silicon	0.10	0.35	0.15	0.30	1.20	1.60
Manganese	0.60	0.90	0.50	0.90	0.50	0.80
Sulphur	–	0.035	–	0.025	–	0.025
Phosphorus	–	0.035	–	0.30	–	0.03
Chromium	0.80	1.10	0.35	0.60	0.50	0.80
Vanadium	0.15	–	0.10	0.30	–	–

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

19. Standard sizes and tensile strengths for low alloy steel wires

The standard sizes and tensile strengths for low alloy steel wire shall be as given in table 10.

Table 10. Standard sizes and tensile strengths for low alloy steel wires

Nominal diameter	Tensile strength							
	735A50		730A65		695A55			
					Range 1		Range 2	
	min.	max.	min.	max.	min.	max.	min.	max.
mm	N/m²	N/m²	N/m²	N/m²	N/m²	N/m²	N/m²	N/m²
1.00	1970	2120	1910	2060	1950	2100	2100	2250
1.06	1950	2100	1895	2045	1940	2090	2090	2240
1.12	1940	2090	1885	2035	1930	2080	2080	2230
1.18	1930	2080	1880	2030	1930	2080	2080	2230
1.25	1915	2065	1870	2020	1920	2070	2070	2220
1.32	1900	2050	1860	2010	1910	2060	2060	2210
1.40	1880	2030	1845	1995	1900	2050	2050	2200
1.50	1870	2020	1830	1980	1890	2040	2040	2190
1.60	1850	2000	1820	1970	1880	2030	2030	2180
1.70	1830	1980	1805	1955	1870	2020	2020	2170
1.80	1815	1965	1795	1945	1860	2010	2010	2160
1.90	1800	1950	1780	1930	1850	2000	2000	2150
2.00	1780	1930	1760	1910	1830	1980	1980	2130
2.12	1770	1920	1750	1900	1820	1970	1970	2120
2.24	1750	1900	1735	1885	1810	1960	1960	2110
2.36	1740	1890	1720	1870	1800	1950	1950	2100
2.50	1720	1870	1710	1860	1790	1940	1940	2090
2.65	1700	1850	1690	1840	1770	1920	1920	2070
2.80	1685	1835	1670	1820	1760	1910	1910	2060
3.00	1670	1820	1650	1800	1750	1900	1900	2050
3.15	1655	1805	1640	1790	1735	1885	1885	2035
3.35	1635	1785	1620	1770	1720	1870	1870	2020
3.55	1620	1770	1605	1755	1710	1860	1860	2010
3.75	1600	1750	1595	1745	1700	1850	1850	2000
4.00	1580	1730	1580	1730	1680	1830	1830	1980
4.25	1570	1720	1560	1710	1670	1820	1820	1970
4.50	1560	1710	1550	1700	1660	1810	1810	1960
4.75	1540	1690	1535	1685	1645	1795	1795	1945
5.00	1530	1680	1520	1670	1630	1780	1780	1930
5.30	1520	1670	1510	1660	1620	1770	1770	1920
5.60	1505	1655	1490	1640	1610	1760	1760	1910
6.00	1490	1640	1470	1620	1590	1740	1740	1890
6.30	1480	1630	1460	1610	1580	1730	1730	1880
6.70	1460	1610	1445	1595	1570	1720	1720	1870
7.10	1450	1600	1430	1580	1560	1710	1710	1860
7.50	1440	1590	1410	1560	1550	1700	1700	1850
8.00	1430	1580	1400	1550	1540	1690	1690	1840
8.50	1415	1565	1380	1540	1530	1680	1680	1830
9.00	1400	1550	1380	1530	1520	1670	1670	1820
9.50	1390	1540	1380	1530	1510	1660	1660	1810
10.00	1380	1530	1370	1520	1500	1650	1650	1800
10.60	1380	1530	1370	1520	1490	1640	1640	1790
11.20	1370	1520	1360	1510	1480	1630	1630	1780
11.80	1360	1510	1350	1500	1470	1620	1620	1770
12.50	1360	1510	1350	1500	1460	1610	1610	1760

NOTE 1. Sizes printed in bold, underlined type are to be preferred.
NOTE 2. All grades of steel are not necessarily available in sizes greater than 10 mm.

20. Decarburization, surface and internal defects in low alloy steels

20.1 Decarburization. For the purposes of this standard, a zone of complete decarburization in low alloy steels shall be defined as one composed wholly of free ferrite.

A zone of partial decarburization is characterized by the presence of variable amounts of ferrite spines at the grain boundaries of the tempered martensite.

An area of carbon gradient is defined as one where the tempered martensite etches lighter than that of the core of the wire, but which is free from recognizable ferrite.

The total radial depth of decarburization and the proportions of complete or partial decarburization, and of carbon gradient shall not be greater than the values given in table 11.

Table 11. Decarburization limits for low alloy steel wires

Quality code	Percentage of wire diameter			
	Total depth of decarburization	Complete decarburization	Partial decarburization	Carbon gradient
HS	3 % of wire diameter or 0.20 mm, whichever is smaller	Nil	0.75 % or 0.05 mm, whichever is smaller, limited to 50 % ferrite content	remainder
ND	1.5 % of wire diameter or 0.12 mm, whichever is smaller	Nil	0.375 % or 0.03 mm, whichever is smaller, limited to 25 % ferrite content	remainder
HD	0.5 % of wire diameter or 0.01 mm, whichever is smaller	Nil	Nil	0.5 % or 0.01 mm, whichever is smaller

20.2 Surface defects. The radial depth of seams or other surface defects shall not be greater than those given in table 12 according to quality.

Table 12. Surface defect limits for low alloy steel wires

Quality code	Defect limit
HS	2 % of wire diameter or 0.15 mm, whichever is smaller
ND	1 % of wire diameter or 0.10 mm, whichever is smaller
HD	Nil

20.3 Internal defects. (See 4.3.2 and specifically for HD quality.) Lamination, gross inclusions or severe segregation shall not be present through any part of the section.

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 13 shows the permitted variations in product analysis.

The variations may occur either above or below the individual element range 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 masses up to and including 5 tonnes.

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

(c) At least eight samples from the same cast for delivered masses 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 of 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 13. Permitted variations of product analysis from specified ranges

Element	Range in which maximum of specified elemt falls	Variation on specified range			
		Carbon steels		Low alloy steels	
		Over (max.)	Under (min.)	Over (max.)	Under (min.)
	%	%	%	%	%
Carbon	Over 0.50	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 2.0	0.07	0.07	0.07	0.07
Manganese	Over 0.70 to 1.0	0.04	0.04	0.04	0.04
	Over 1.0	0.05	0.05	0.05	0.05
Nickel	Up to 1.0	–	–	0.03	0.03
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 1837 Methods for the sampling of iron, steel, permanent magnet alloys and ferro-alloys
BS 4545 Methods for the 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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The following BSI references relate to the work on this standard:
Committee reference ISE/26 Draft for comment 78/76876 DC

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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:

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British Internal Combustion Engine Manufacturers' Association
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British Wire Netting Association
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Music Wire Export Association
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