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WROUGHT STEELS

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WAR EMERGENCY

BRITISH STANDARD SCHEDULE 970 : 1942

WROUGHT STEELS

IN THE FORM OF BARS, BILLETS, LIGHT FORGINGS AND STAMPINGS UP TO 6 IN. RULING SECTION

FOR GENERAL ENGINEERING PURPOSES

(Revised October, 1942)

(En SERIES)

[Superseding B.S. 5005, 5008, 5010 and part of 5006]

Price 5/- net, post free

BRITISH STANDARDS INSTITUTION
Incorporated by Royal Charter
28 VICTORIA STREET, LONDON, S.W.1
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B.S. 5005 : 401	En. 21R.
B.S. 5005 : 402	En. 22T.
B.S. 5005 : 501	En. 23T.
B.S. 5005 : 502	En. 30.
B.S. 5005 : 503	En. 24Z.
B.S. 5005 : 601	En. 18T.

B. B.S. 5006. STEEL BARS

B.S. 5006 : 105	En. 32.
B.S. 5006 : 205	En. 6.
B.S. 5006 : 206	En. 32.

C. B.S. 5008. VALVE STEELS

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B.S. 5008 : 603	—
B.S. 5008 : 701	—

D. B.S. 5010. SPRING STEELS

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B.S. 5010 : 801	En. 45.

CO-OPERATING ORGANISATIONS

The Iron and Steel Industry Committee under which this British Standard was prepared consists of representatives from the following Government Departments and Scientific and Industrial Organisations:

Admiralty
Board of Trade
Crown Agents for the Colonies
High Commissioner for India
Home Office
Ministry of Aircraft Production
Ministry of Supply
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Alloy Steels Bar Association
Association of Consulting Engineers
Association of Drop-Forgers and Stampers
British Cast Iron Research Association
British Constructional Steelwork Association
British Corporation and Register of Shipping and Aircraft
British Electrical and Allied Manufacturers' Association
British Engineers' Association
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British Steel Wire Industries Association
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THIS SCHEDULE having been approved by the Iron and Steel Industry Committee and endorsed by the Chairman of the Engineering Divisional Council was published under the authority of the General Council as a British Standard on 26th October, 1942.

First Published, July, 1941
First Revision, October, 1942

The Institution desires to call attention to the fact that this Schedule does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, the British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the Committees charged with the revision of the standards to which they refer.

A complete list of British Standards, indexed and cross-indexed for reference, will be found in the Institution's Handbook.

This Schedule requires reference to the following :

B.S. 18. Tensile Testing of Metals.
B.S. 131. Forms of Notched Bar Impact Test Pieces.
B.S. 240. Part 1. Brinell Hardness, Methods and Tables for.
Part 2. Hardness of Steel Balls for Brinell Hardness Testing.
B.S. 427. Tables of Diamond Pyramid Hardness Numbers.
B.S. 860. Table of Approximate Comparison of Hardness Numbers.

BRITISH STANDARD WAR EMERGENCY SCHEDULE OF

WROUGHT STEELS

FOR GENERAL ENGINEERING PURPOSES

FOREWORD TO FIRST ISSUE : JULY, 1941

It has been recognised for some time that revision of B.S. 5005 : 1924 was necessary, as it was inadequate in presenting the best selection of wrought steels for automobiles and, moreover, it has not been sufficiently well recognised in using these specifications (particularly 5005/402) that the tests quoted can only be obtained on material of limited mass.

Meantime, under the Chairmanship of Dr. W. H. Hatfield, F.R.S., the Technical Advisory Committee of the Special and Alloy Steels Committee of the Steel Control of the Ministry of Supply, composed of steelmakers, representatives of the Services and the B.S.I., working in consultation with important consumers, has been engaged on a rationalisation of specifications for special and alloy steels to meet war conditions. This Committee placed its services unreservedly at the disposal of the B.S.I. and is acting in an advisory capacity in the preparation of War Emergency British Standard Specifications to give effect to its recommendations for special and alloy steels.

Advantage has been taken of the valuable work of the T.A.C. in preparing, at the request of the Materials Committee of the Production Executive, this new series of specifications with a view to providing a comprehensive schedule of steels for general use in the industry.

Concurrently with this, is being issued British Standard 971.

This represents part of the work of the T.A.C. and is a classification in 33 groups of all the steels regarded as acceptable standard steels for war purposes supplied in the form of billets, bars and light forgings, up to and including 6-in. ruling section. In this, certain steels are recommended as the most suitable and these, together with the alternatives given, provide the basis of the present publication. The two issues are to be regarded as complementary.

Attention is particularly directed to British Standard 971 for the large amount of valuable and informative data which are included to facilitate the task of designers in selecting the most suitable, and, at the same time, the most economical steel, with particular reference to the influence of mass.

It has been the endeavour to make the following specifications as informative as possible, and data is given regarding 'mass effect' appertaining to each of the types of steel dealt with.

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GENERAL CLAUSES

GENERAL

1. The steels dealt with in this schedule shall comply in all respects with the requirements herein laid down, and may be subjected to both the chemical analysis and the mechanical tests, unless it is specified that only the mechanical tests will be applied.

MANUFACTURE

2. *a.* All steel shall be manufactured in accordance with the best current practice.

b. A sufficient discard shall be made from each ingot to secure freedom from piping and harmful segregation, and other defects.

c. Billets or bars for forging shall be rough machined, chipped, ground or otherwise prepared so as to remove all surface defects which might produce defects in the bars, forgings or drop-forgings made therefrom.

d. All forgings and drop-forgings shall be finished in a workmanlike manner and shall be free from flaws and surface defects.

e. All bars shall be sound, commercially straight and free from piping and surface defects.

f. If required a prolongation shall be left on each forging or drop-forging for test purposes.
Alternatively, by agreement, representative samples from the same cast may be provided for testing for each batch of forgings or drop-forgings, heat treated together. See also Clause 6.

HEAT TREATMENT DEFINITIONS

3. *a. Heat Treatment.* An operation or combination of operations involving heating and cooling in the solid state for the purpose of obtaining certain desired conditions or properties.

b. Annealing. A heating and cooling operation implying usually relatively slow cooling. The purpose of such a heat treatment may be :

(i) To induce softness and improve machinability.
(ii) To remove stresses.
(iii) To refine the grain.
(iv) To obtain other desirable physical properties of a material.

c. Full Annealing. Heating above the upper critical temperature range (say 50°C. to 100°C. above) and holding above that range for a sufficient length of time, followed by slow cooling. (See under *b* Annealing, for the purpose of this treatment.)

d. Sub-Critical Annealing. Heating certain steels to a temperature below the carbon change point, and thereby producing a resolved or spheroidised structure.

e. Normalising. Heating as for *c* Full Annealing, followed by cooling in still air. The purpose of this treatment is to refine the grain size, improve the mechanical properties and the uniformity of structure of the material.

f. Quenching. Rapid cooling of a heated material.

g. Hardening. Heating to and quenching from a temperature above the critical temperature range, for the purpose of increasing the hardness.

h. Tempering. Reheating hardened steel to some temperature below the lower critical temperature, followed by a suitable rate of cooling, the principal object being to increase the ductility.

i. Case-Hardening. (Carburising.) Adding carbon to the surface by heating the steel above its upper critical temperature in contact with a carburising medium (solid, liquid or gaseous), followed by suitable heat treatment, for the purpose of hardening the surface.

j. Blank Carburising. The carburising procedure without the carburising medium.

k. Surface Hardening. The hardening of the surface layer by heat treatment alone, such as induction hardening or flame hardening.

l. Nitriding. Surface hardening by adding nitrogen to certain iron-base alloys, the latter being heated in contact with ammonia gas or other suitable nitrogenous material at a temperature below the critical temperature range (without subsequent quenching).

m. Blank Nitriding. The nitriding procedure without the nitriding medium.

n. Cyaniding. Surface hardening by carbon and nitrogen absorption, the material being heated at a suitable temperature in contact with a cyanide salt, followed by quenching.

GENERAL DEFINITIONS

4. *a. Yield Stress.** Yield stress is the lowest stress at which the elongation of the test piece increases without increase of load.
For practical purposes the yield stress is defined as the stress at which a visible permanent increase occurs in the distance between gauge points on the test piece observed when using the dividers ; or at which, when the load is increased at a moderately fast rate, there is a distinct

* From B.S. 18 Tensile Testing of Metals.

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drop of the testing machine lever, or in hydraulic machines, a hesitation in the movement of the gauge finger.

For the steels covered by the present specifications, values for the yield point are quoted in italics. These values are considered to be representative for the materials concerned, but are not to be used as acceptance values except by special arrangement between the purchaser and the manufacturer.

It frequently happens especially with steels of tensile strength over 50 tons/sq. in. that the yield point is ill-defined. In the case of a steel which does not show a well defined yield point, the yield point is to be interpreted as the 'proof stress' corresponding to 0·5 per cent permanent elongation.

*b. Proof Stress.** Proof stress is the stress which is just sufficient to produce a permanent elongation equal to a specified percentage of the original gauge length.

It can be determined (*a*) by direct measurements of the gauge length after various loads have been applied to the test piece and removed, or (*b*) from the load-elongation curve by drawing a line parallel to the straight portion of the curve, and distant from it by an amount representing the required permanent elongation, thus determining the load at which the line cuts the curve.

Alternatively, if the specification requires only a minimum value of the proof stress, the material shall be deemed to have passed the proof test if, when the specified proof stress is applied to the test piece for a period of 15 seconds and removed, the test piece shall not have acquired a permanent elongation greater than the specified percentage of the gauge length.

c. Sample. A sample is that portion of the material selected for testing.

d. Test Bar. A test bar is the sample after preparation for heat treatment.

e. Test Piece. A test piece is the sample or test bar as finally prepared for testing.

f. Ruling Section. In some of the following specifications indication is given of the size of round bar which will permit the attainment of certain mechanical properties in the given steel. It is essential when selecting the type of steel to be used that the designer should satisfy himself that the desired properties can be obtained in the sections dealt with. For any particular item being produced from the billet, bar, or forging supplied, that part which is most important from the point of view of the mechanical properties obtained after heat treatment, is characterised as the ruling section and the ruling section should always be referred to its equivalent in the form of round bar.†

* From B.S.18 Tensile Testing of Material.

† See information on ruling section in B.S. 971.

MECHANICAL TESTS

5. *a.* Mechanical tests shall be conducted using testing machines that are maintained in good working condition and properly calibrated.

b. Tensile Test. The tensile test shall be carried out in accordance with the requirements laid down in B.S.18.

Tensile test pieces from bars, billets, forgings and drop-forgings shall conform to the dimensions of British Standard Test Piece C, or if the test bar is too small, to the dimensions of the largest round subsidiary test piece that can be obtained (see Appendix B, p. 112) having a gauge length equal to four times the square root of the area. Should a tensile test piece break outside the middle half of its gauge length (see Fig. 2) the test may, at the option of the manufacturer, be discarded.

c. Izod Impact Test. The Izod impact test shall be carried out in accordance with the requirements laid down in B.S. 131 (see Figs. 4 to 10, Appendix B, p. 112).

d. Bend Test. A bend test may be substituted for an Izod impact test, in specifications calling for the latter, should the bar size be too small for the production of the standard Izod impact test pieces, i.e., less than half-inch diameter or thickness. The details for dimensions and conditions for these bend tests should be adjusted according to the tensile strength and nature of the material being tested. The following are intended as a guide only for materials up to 55 tons/sq. in. tensile strength.

(i) *Round, Square and Hexagonal Bars.* Unless otherwise specified the bars shall be bent round a pin or mandrel of a radius equal to the diameter or thickness of the bar, until the sides are parallel. The bar shall withstand such bending without developing cracks or other signs of failure.

(ii) *Flat Bars.* Bend test pieces for flat bars shall be of the full thickness of the material and shall be bent through an angle of 180° over a radius equal to the smaller thickness as shewn in Fig. 3 (see Appendix B, p. 112); the bar shall withstand such bending without developing cracks or other signs of failure.

e. Brinell Hardness Tests. The Brinell hardness test shall be carried out in accordance with the requirements laid down in B.S. 240 using a 10 mm. diameter ball, and a load of 3000 kg, where possible. The equivalence between Brinell hardness numbers and Diamond Pyramid hardness numbers (B.S. 427) as stated in B.S. 860 shall be accepted.

f. Transverse Properties. In the present series of specifications mechanical properties in a transverse direction are not stated and the values quoted all refer to longitudinal tests. Where mechanical properties in the

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transverse direction are required, some modifications are necessary appropriate to each case. The changes will in general be in the direction of reducing the Elongation and the Izod impact values, and the order of the modification is essentially governed by the size, form and type of material involved. Where it is agreed that such tests are necessary, suitable values should be agreed upon in each case between the purchaser and the manufacturer.

PROVISION OF TEST PIECES

6. Unless otherwise specified, samples for test purposes shall be prepared as follows:

a. Number of Tests. The numbers of tests required to ascertain whether the material conforms with the requirements laid down, should be agreed between the purchaser and the manufacturer and is necessarily governed by the particular application of the material.

Unless otherwise agreed, the number of tensile and impact tests taken from any batch of bars of similar sizes from the same cast and heat treated together, should be 2 per cent of the number of bars, whilst the number of bars subjected to Brinell test should be not less than 10 per cent. In any case the number of tests required per cast or heat treatment batch should be stated on the order.

b. Location of Test Piece. For bars, billets, forgings and drop-forgings of uniform cross section over 1½ in. in thickness or diameter, and for forgings or drop-forgings of irregular sections, when practicable, the longitudinal axis of the test pieces shall coincide with a position midway between the centre and surface of the test sample and shall be parallel to the axis of the piece in the direction in which the metal is most drawn out. The test piece must be cut from the heat treated bar or forging subsequent to treatment.

c. Bars for Machining which are supplied in the finally heat treated condition. The sample shall be cut off the bar and shall not be further heat treated or mechanically worked after its removal from the bar. Materials too hard to machine should have test pieces separately prepared as under *d*.

Materials not supplied in the finally treated condition.

It is important when ordering the steel that the steel manufacturer should be advised of the ruling dimensions of the parts as heat treated.

d. Bars for Machining which are not in their finally heat treated condition. Test samples may be heat treated in the size as cut from the bars or billets or they may be forged and/or machined to the ruling dimension of the forging and heat treated in that size. Where it is

necessary to remove the surface, they shall be heat treated as near that size as possible.

In the case of hard steels, however, for which the tensile strength specified for a steel in the finally heat treated condition exceeds 80 tons per sq. in., the test bar may be machined to test piece dimensions with or without a grinding allowance on the effective diameter before heat treatment.

In such cases, the properties obtained are representative of those for parts treated in 0·564 in. dia. section and do not represent larger sections.

e. Bars or Billets for Forging. Test samples may be taken from material in bar or billet sections where this does not differ appreciably as regards ruling size from that of the forgings to be produced. Where it is considered by either the purchaser or the manufacturer that owing to the nature of the steel and the dimensions of the forging the results of testing in bar or billet size would not be representative of what would be obtained on the actual forgings, then test samples shall be prepared by forging special test bars of diameter equivalent to the ruling dimension of the forging in the form in which it will be heat treated in actual production. Such test samples shall then be put through the representative heat treatment for the parts concerned.

*f. Large Forgings and Large Drop-Forgings.** Where integral test samples are specified by the purchaser, unless otherwise arranged, the diameter of the prolongation to form the test bar left on the forging or drop-forging shall approximate to the ruling thickness of the forging or drop-forging, and except as specified in para. (ii) below shall not be finally severed until after the heat treatment of the forging or drop-forging.

(i) *Length of Prolongation.* In general where only tensile tests are required the prolongation shall be not less than 7 in. long. Where both tensile and Izod impact tests are required the prolongation shall be not less than 11 in. long, unless such prolongation is 2⅛ in. or over in width or diameter, in which case a length of 7 in. is sufficient.

(ii) *Case Hardening Steels.* To avoid difficulty in machining case hardening steel, the prolongation may be marked for identification with its forging and severed prior to heat treatment, and cementation of the test bar substituted by blank carburising or, by agreement, omitted altogether, but its subsequent heat treatment shall be carried out simultaneously with and similarly to the forging or drop-forgings it represents.

* These specifications are confined to bars, billets, stampings and light forgings up to 6 in. ruling section.

Also see note in Clause 4 *f*, page 12.

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g. Small Forgings and Small Drop-Forgings (ruling section not greater than 1⅛ in. diameter). A separate test bar representing the same cast as used for the forgings shall be employed. This test bar shall be 1⅛ in. diameter, or the full size of the original bar if less than 1⅛ in., and similarly and simultaneously heat treated with the forgings which it represents, and the test piece shall be machined from it after heat-treatment. The sample provided for the preparation of test bars shall be not less than 7 in. long for tensile, and not less than 11 in. long for tensile and Izod impact tests.

h. Test Bars for Case-Hardening Steel. The mechanical tests specified for case-hardening steel shall be made on the core of a case-hardened test bar of 1⅛ in. diameter, or a similar non-cemented test bar which has been blank carburised, refined and hardened as specified in the individual specification (see Clause 6*d*.).

i. Test Bars for Case-Hardened Forgings, Drop-Forgings and Parts. Cementation of the test bars representing case-hardened forgings, drop-forgings and parts may be omitted, but the heat treatment otherwise shall be carried out simultaneously with and similarly to the forgings or parts they represent.

j. Small Test Bars for Case-Hardening Steel. When the test bar is smaller than 1⅛ in. the physical properties stated in the individual specification may be modified. The extent of the modification shall be determined by experiments on test bars of similar material 1⅛ in. diameter and the size of the test bars respectively.

HEAT TREATMENT OF BARS AND BILLETS FOR FORGING AND OF FORGINGS AND DROP-FORGINGS.

7. Generally, bars and billets for forging are required to be delivered in the as rolled or forged condition unless the order states otherwise. It is recognised, however, that for certain steels possessing definite air-hardening characteristics there may be liability to set up a dangerous condition in the bars or billets if they are allowed to cool after hot-working without some care being given to the conditions of cooling. It is incumbent upon the manufacturer in such cases to take suitable steps to ensure that the condition in which the materials are supplied shall be reasonably safe. For this purpose the manufacturer may employ a controlled rate of cooling after hot working or alternatively may apply a reheating operation for the purpose of softening or for minimising residual internal stresses in the steels.

In the case of forgings and drop-forgings the condition in which the parts are supplied is affected in some cases by the desire to have a machinable condition. Such a condition may be the final heat treated condition, or alternatively a softened or annealed condition, as

provided in the individual specifications, or as arranged between the purchaser and the manufacturer.

If for any forgings or drop-forgings, machinability as supplied is not in question, then they may be supplied as forged (unless otherwise arranged), subject to being rendered reasonably safe as indicated above for bars and billets.

ALTERNATIVE TREATMENT FOR CASE-HARDENING STEELS

8. By suitable selection of composition and method of manufacture it is possible to omit the refining treatment after carburising some types of case-hardening steels. In such cases the treatment after carburising is to reheat the material to the final hardening temperature usually 760/800°C. and quench in oil or water according to the type of steel employed. Such treatment is referred to as the 'single quench' treatment. It is not recommended that the single quench treatment should be employed except by arrangement with the manufacturer of the steel who would in that case supply a grade of steel suitable for such treatment. Another alternative heat treatment which is occasionally employed is that of quenching direct from the carburising treatment, but this is not recommended.

MARGINS OF MANUFACTURE

9. The margins of manufacture for steel bars for machining shall be accordance with those given in Tables 3, 4 and 5 (pages 107-109).

INSPECTION

10. The representative of the engineer (or of the purchaser) shall have reasonable access to the works of the manufacturer for the purpose of inspection of the manufacture at various stages.

TESTING FACILITIES

11. The manufacturer shall supply the material required for testing free of charge, and shall, at his own cost, furnish and prepare the necessary test pieces and supply labour and appliances for such testing as may be carried out on his premises in accordance with this schedule. Failing facilities at his own works for making the prescribed tests, the manufacturer shall bear the cost of carrying out the test elsewhere.

APPROVED METALLURGISTS

12. It is to be noted that in order to facilitate delivery during the emergency period the Ministry of Aircraft Production and the Chief Inspector of Armaments, Ministry of Supply, authorised the Technical Advisory Committee of the Special and Alloy Steels Committee to

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approve the selection of an experienced metallurgist in each company who should have the responsibility of authorising the use of material somewhat outside the limit of specified analysis as indicated in Clause 13, paragraph *f*.

The approved metallurgist shall have similar discretionary power regarding minor departure from limiting sizes indicated in Table 2.

The above functions of the approved metallurgists apply where the steel maker is the supplier of material heat treated to the test condition, or where he is charged with the responsibility for inspection decisions by the inspecting authority concerned.

The approved metallurgist shall act in this manner as regards the B.S. En. series of Specifications unless otherwise arranged.

RELAXATIONS IN REGARD TO SPECIFICATIONS

13. During the emergency period the following relaxations shall apply to certain items in the specifications.

A special note is added in the case of those specifications to which these general relaxations do not apply.

a. Ultimate tensile stress. An allowance of 2½ per cent down on a minimum stress and 2½ per cent up on a maximum stress.

A corresponding percentage allowance is to be made on Brinell hardness numbers.

b. Yield Point. An allowance of 2½ per cent down.

c. Elongation. An allowance of 15 per cent of the specified value in the downward direction.

d. Izod Impact Value. An allowance of 20 per cent down.

e. Nitriding Steels. Bars of over 2½ in. diameter to specification B.S. En. 41 may be forged or machined to 2½ in., and heat treated in that size for the purpose of tests.

f. Chemical composition. Discretionary powers are vested in the steelworks' approved metallurgist to authorise the use of material somewhat outside the specified limits of analysis. The relevant facts are to be recorded on the test certificate or other relevant document.

g. Optional elements. These are included in specifications En. 8, 12, 23, 30, 38, 39, 40, 53, 56M, 56A-M, 58 and 58A primarily for use at the discretion of the steelmaker in order to secure the desired properties. Although the user may explicitly call for the optional element addition in the light of his experience, counter advice would be tendered if it were thought that the use of the optional element was unnecessary and that valuable alloys would be wasted thereby. The lower limits of the range of optional elements as an intentional addition should, in general

principle, be the maximum content permitted as an incidental or residual content. For low alloy steels in general, the percentages of elements up to the following amounts should be looked upon as incidental: Nickel 0·40 per cent, Molybdenum 0·15 per cent and Vanadium 0·05 per cent.

h. For the purpose of effective rationalisation it is implied that a composition shall not be employed for a dimension of bar, the desired properties of which can be obtained by a less rich composition. The Committee is well aware of exceptions, which are permissible from a manufacturing point of view, where a too rigid definition of this ruling would unnecessarily call for duplication of casts and hence hamper supplies.

SPECIFICATION REFERENCE SYMBOLS

In making reference to other specifications the following abbreviations have been adopted:

T.A.C.	Technical Advisory Committee of the Special and Alloy Steels Committee of the Steel Control, Ministry of Supply. The numbers refer to the classification numbers as given in the T.A.C. report issued as B.S. 971.
B.S.	British Standard Specification.
S.	British Standard Specification for Aircraft Materials (Steels). The prefix number indicates the latest issue, e.g., 4.S.11 indicates that S.11 has had four issues.
D.T.D.	Specification issued by the Directorate of Technical Development of the Ministry of Aircraft Production.
V.	V. Series in B.S./S.T.A. 5.
S.A.E.	Society of Automotive Engineers, U.S.A.
A.M.S.	Aeronautical Material Specification prepared by the S.A.E.

TENSILE RANGE REFERENCE SYMBOLS

It will be noted that as regards the different tensile conditions coming under a number of the individual specifications, a new series of letters from N to Z has been adopted so that the same letters always represent the same lower limit of the tensile range. The later letters in the alphabet have been adopted for this purpose to avoid confusion with

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the letters previously used, A, B, C, etc. The symbols now read as follows :

Reference symbol	Tensile strength (tons sq. in.)	Reference symbol	Tensile strength (tons sq. in.)
N.	30	U.	60
P.	35	V.	65
Q.	40	W.	70
R.	45	X.	75
S.	50	Y.	80
T.	55	Z.	100

NOTE

This series of specifications for special and alloy steels includes a few for carbon steels of a type which have for many years been in common use by the Ministry of Aircraft Production. It does not however purport to cover the whole range of carbon steels for all service requirements. The series relates to material in the form of bars, billets, forgings and drop forging but does not refer to material in the form of plates, sheet, strip, tube and wire.

TABLE 2. B.S. En. 12 to 30. PERMITTED STEELS FOR HARDENING AND TEMPERING 40 to 100 tons per sq. in. Ultimate Tensile Stress

BARS, BILLETS, LIGHT FORGINGS AND STAMPINGS UP TO 6 in. RULING SECTION

The mechanical properties specified are obtainable within the limits of thickness or ruling section named below

See also Clause 13, paragraph *h*. (page 19)

B.S.	Type of Steel.		C.	Si.	Mn.	Ni.	Cr.	Mo.	V.	40/50 tons tensile.	45/55 tons tensile.	50/60 tons tensile.	55/65 tons tensile.	60/70 tons tensile.	65/75 tons tensile.	70/80 tons tensile.	75/85 and 80/90 tons tensile.	100 tons min. tensile.
B.S. En. 12	TAC.8A.	"40" Carbon.	·30/·45	·10/·35	1·50 max.	1·00 max. (opt.)	—	—	—	Above 4" up to 6"*	—	—	—	—	—	—	—	—
B.S. En. 13	TAC.8B.	Manganese-Nickel-Molybdenum.	·15/·25	·10/·35	1·40/1·80	·40/·70	—	·15/·35	—	all sizes	—	—	—	—	—	—	—	—
B.S. En. 14	TAC.8W.	Carbon-Manganese.	·20/·30	·10/·35	1·30/1·80	·40 max.	—	—	—	up to 4"	up to 2½"	—	—	—	—	—	—	—
B.S. En. 15	TAC.9B.	Carbon-Manganese Steel Higher Tensile.	·30/·40	·10/·35	1·30/1·70	—	—	—	—	Above 4" up to 6"	up to 2½"	up to ⅞"	—	—	—	—	—	—
B.S. En. 16	TAC.9A, TAC.10A, TAC.11A, TAC.12A, TAC.13B.	Manganese-Molybdenum.	·25/·40	·10/·35	1·30/1·80	—	—	·20/·35	—	—	Above 2½" up to 6"	Above ⅞" up to 4"	up to 2½"	up to 1⅛"	up to ⅞"	—	—	—
B.S. En. 17	TAC.9A, TAC.10A, TAC.11A, TAC.12A, TAC.13B.	Manganese-Molybdenum.	·30/·40	·10/·35	1·30/1·80	—	—	·35/·55	—	—	—	Above 4" up to 6"	Above 2½" up to 4"	Above 1⅛" up to 2½"	Above ⅞" up to 1⅛"	—	—	—
B.S. En. 18	TAC.9C, TAC.10B, TAC.11B.	1 per cent Chromium.	·35/·45	·10/·35	·60/1·20	—	·80/1·20	—	—	—	Above 2½" up to 4"	up to 2½"	up to 1⅛"	—	—	—	—	—
B.S. En. 19	TAC.9D, TAC.10C, TAC.11C, TAC.12B, TAC.13C, TAC.14E.	1 per cent Chromium-Molybdenum.	·35/·45	·10/·35	·50/·80	—	·90/1·50	·20/·40	—	—	Above 2½" up to 6"	Above ⅞" up to 4"	Above 2½" up to 4"	Above 1⅛" up to 2½"	Above ⅞" up to 1⅛"	up to 1⅛"	—	—

* When supplied without Nickel also for sizes up to 4 in.

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TABLE 2 (continued)

The mechanical properties specified are obtainable within the limits of thickness or ruling section named below

See also Clause 13, paragraph *h* (page 19)

B.S.	Type of Steel.		C.	Si.	Mn.	Ni.	Cr.	Mo.	V.	40/50 tons tensile.	45/55 tons tensile.	50/60 tons tensile.	55/65 tons tensile.	60/70 tons tensile.	65/75 tons tensile.	70/80 tons tensile.	75/85 and 80/90 tons tensile.	100 tons min. tensile.
B.S. En. 24	TAC.10E, TAC.11E, TAC.12C, TAC.13A, TAC 14A, TAC.15A, TAC.16A.	1½% Nickel-Chromium-Molybdenum.	·35/·45	·10/·35	·45/·70	1·30/1·80	·90/1·40	·20/·35	—	—	—	—	above 4" up to 6"	above 2½" up to	above 1⅛" up to 2"	up to 1⅛"	up to 1⅛"	up to 1⅛" if oil hardened
B.S. En. 25	TAC.11G, TAC.12D, TAC.13E, TAC.14B, TAC.15B, TAC.16B.	2½% Nickel-Chromium-Molybdenum. (med. carbon)	·27/·35	·10/·35	·50/·70	2·30/2·80	·50/·80	·40/·70	—	—	—	—	—	above 4" up to 6"	above 2½" up to 6"	above 1⅛" up to 4"	above 1⅛" up to 2½"	above 1⅛" up to 2½" if oil hardened
B.S. En. 26	TAC.13F, TAC.14C, TAC.15C, TAC.16C.	2½% Nickel-Chromium-Molybdenum. (high carbon)	·36/·44	·10/·35	·50/·70	2·30/2·80	·50/·80	·40/·70	—	—	—	—	—	above 4" up to 6"	above 2½" up to 6"	above 1⅛" up to 6"	above 1⅛" up to 6"	above 1⅛" up to 4" if oil hardened
B.S. En. 30	TAC.15D.	4¼% Nickel-Chromium.	·25/·35	·10/·35	·35/·60	3·75/4·50	1·00/1·50	·65 max. (opt.)	—	—	—	—	—	—	—	—	—	up to 2½". (A.H. & T.) above 4" up to 6" (O.H. & T.)

TABLE 2A. NON-PERMITTED STEELS* FOR HARDENING AND TEMPERING 40 to 100 per tons sq. in. Ultimate Tensile Stress

BARS, BILLETS, LIGHT FORGINGS AND STAMPINGS UP TO 6 in. RULING SECTION

The mechanical properties specified are obtainable within the limits of thickness or ruling section named below

See also Clause 13, paragraph *h* (page 19).

B.S.	Type of Steel.		C.	Si.	Mn.	Ni.	Cr.	Mo.	V.	40/50 tons tensile.	45/55 tons tensile.	50/60 tons tensile.	55/65 tons tensile.	60/70 tons tensile.	65/75 tons tensile.	70/80 tons tensile.	75/85 and 80/90 tons tensile.	100 tons min. tensile.
B.S. En. 21	TAC.9E.	3% Nickel.	·25/·35	·10/·35	·35/·75	2·75/3·50	·30 max.	—	—	—	up to 4"	up to 2½"	—	—	—	—	—	—
B.S. En. 22	TAC.10D, TAC.11D.	3½% Nickel.	·35/·45	·10/·35	·50/·80	3·25/3·75	·30 max.	—	—	—	—	up to 4"	up to 2½"	—	—	—	—	—
B.S. En. 23	TAC.10F, TAC.11F, TAC.12E, TAC.13D.	3% Nickel-Chromium.	·25/·35	·10/·35	·45/·70	2·75/3·50	·50/1·00	·65 max. (opt.)	—	—	—	all sizes	all sizes	all sizes	up to 2½"	—	—	—
B.S. En. 27	TAC.11H, TAC.12F, TAC.13G, TAC.14D.	3% Nickel-Chromium-Molybdenum.	·25/·35	·10/·35	·70 max.	3·00/3·75	·50/1·30	·20/·65	—	—	—	—	all sizes	all sizes	all sizes	up to 4"	—	—
B.S. En. 28	TAC.12G, TAC.13I, TAC.14F, TAC.15D.	3½% Nickel-Chromium-Molybdenum.	·25/·40	·10/·35	·70 max.	3·00/4·50	·75/1·50	·20/·65	—	—	—	—	—	all sizes	all sizes	up to 4"	up to 2½"	—
B.S. En. 29	TAC.11I, TAC.12H, TAC.13H, TAC.14G, TAC.16E.	3% Chromium-Molybdenum.	·15/·35	·10/·35	·65 max.	0·40 max.	2·50/3·50	·30/·70	—	—	all sizes	all sizes	all sizes	all sizes	up to 4"	up to 4"	—	up to 2½" if oil hardened.

* The non-permitted steels given in this table are not classified in detail as to permitted size as has necessarily been done in Table 2 for the permitted steels. These steels can only be supplied under special permission from the Iron and Steel Control who, before granting such permission, will take into account the specific purpose for which the steel is required.

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FREE CUTTING STEEL BARS FOR MACHINING

The material covered by this specification is the same as that covered by Grade 4 of B.S. 32. Steel bars for the Production of Machined Parts.

Chemical composition. The steel shall comply with the composition given below for specification B.S. En. 1 or B.S. En. 1A as may be specified by the purchaser.

B.S. En. 1. The steel shall contain :

Carbon	not more than	0·20 per cent.
Silicon	not more than	0·10 per cent.
Manganese	not less than	0·60 and not more than 1·20 per cent.
Sulphur	not less than	0·20 and not more than 0·30 per cent.
Phosphorus	not more than	0·10 per cent.

B.S. En. 1A. The steel shall contain :

Carbon	not less than	0·07 and not more than 0·15 per cent.
Silicon	not more than	0·10 per cent.
Manganese	not less than	0·80 and not more than 1·20 per cent.
Sulphur	not less than	0·20 and not more than 0·30 per cent.
Phosphorus	not more than	0·07 per cent.

Heat treatment. The bars shall be delivered in one of the following finishes as specified by the purchaser :

Bright	Cold Rolled, Cold Drawn, Turned or Ground.
Blue	Reeled (round section only).
Black	Mill Finish (i.e. as delivered from the rolls).

Mechanical properties. Test pieces after removal from the bars as delivered shall not be annealed, hammered or otherwise treated. The mechanical properties obtained from the test piece shall be as follows :

	Cold Rolled or Cold Drawn	Other Finishes
Ultimate tensile stress, not less than	28 tons per sq. in.	25 tons per sq. in.
Elongation, not less than	14 per cent.	26 per cent.

These steels are sometimes used for parts which are to be case-hardened. In such cases the heat treatment and carburising should follow the procedure given under B.S.En.32, i.e., 0·15 per cent carbon case-hardening steel.

With little or no modification these specifications cover the essentials in the following classifications and specifications :

TAC.1, V.1, V.1A, SAE.1112, SAE.1113, AMS.5010A

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MILD STEEL

BARS AND BILLETS FOR FORGING
FORGINGS AND DROP-FORGINGS
BARS FOR MACHINING

Suitable for a tensile range of 28 to 33 tons per sq. in. normalised or up to 45 tons per sq. in. for the cold drawn condition.
The purchaser should state when ordering, for which of the conditions the material is required.
This specification is equivalent to, and supersedes B.S.5005/201.

Chemical composition. The steel shall contain :

Carbon	not less than	0·15 and not more than 0·25 per cent.
Silicon	not less than	0·05 and not more than 0·20 per cent.
Manganese	not less than	0·40 and not more than 0·80 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

For cold drawn bars a lower carbon content and/or a higher manganese content (up to 1·25 per cent) may be supplied.

(i) Bars and billets for forging shall be delivered as rolled or forged, unless the order states otherwise.
(ii) Forgings and drop-forgings shall be delivered in the normalised condition, unless the order states otherwise.
(iii) Bars for machining shall normally be delivered as rolled, alternatively, by arrangement, cold drawn bars may be supplied.
(iv) The range of temperature for normalising shall be between 880°C. and 910°C.

Mechanical properties. The following mechanical properties shall be obtained from the test pieces selected and prepared as stated in the appropriate general clauses. Alternatively for bars of 1 in. dia. and under, by agreement between purchaser and manufacturer, tensile tests may be carried out on the full section of the bar, and in such cases the elongation per cent shall be measured on a gauge length equal to four times the square root of the area of cross section of the bar.

	As rolled or normalised	Cold drawn bars not exceeding 1¼ in.*
Ultimate tensile stress, tons per sq. in.	not less than 28 and not more than 33.	not less than 35 and not more than 45.
Elongation, per cent.	not less than 25.	not less than 15.

With little or no modification this specification covers the essentials in the following classifications and specifications :

TAC.2B, TAC.3D, BS.32-2, V.3; SAE.1020, SAE.1022, AMS.5070.

* For cold drawn bars in sizes above 1¼ in. the carbon range employed should be as follows :

Carbon Range	Ruling Section
0·25–0·30 per cent	Bars above 1¼ in. up to and including 1¾ in.
0·30–0·35 per cent	Bars above 1¾ in. up to and including 3 in.

MILD STEEL SUITABLE FOR COLD PROCESSING

BARS AND BILLETS FOR FORGING
BARS FOR MACHINING

Suitable for a minimum tensile strength of 20 tons per sq. in. in the annealed condition and 26 tons per sq. in. in the normalised condition. The purchaser should state when ordering for which of the conditions the material is required.

Chemical composition. The steel shall contain :

Carbon	not more than	0·20 per cent.
Silicon	not more than	0·15 per cent.
Manganese	not more than	0·80 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. (i) Bars and billets for forging shall be delivered as rolled or forged, unless the order states otherwise.
(ii) Bars for machining shall normally be delivered as rolled.
(iii) The range of temperature for normalising shall be between 880°C. and 910°C.

Mechanical properties. When tests are required the following mechanical properties shall be obtained from the test pieces selected and prepared as stated in the appropriate general clauses :

	Hot rolled or normalised	Annealed
Ultimate tensile stress, tons per sq. in.	not less than 26	not less than 20
Elongation, per cent	not less than 28	not less than 28

NOTE. The B.S. Specification 5006/207 covers similar material when required in the form of cold rolled strip.

With little or no modification this specification covers the essentials in the following classifications and specifications :

DTD.299, V.2. SAE.1010, SAE.1015, SAE.1016, AMS.5060A.

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"20" CARBON STEEL (HOT ROLLED OR FORGED)

BARS AND BILLETS FOR FORGING

BARS FOR MACHINING

Suitable for a tensile range of 25 to 35 tons per sq. in.
The material covered by this specification is the same as that covered by British Standard 2.S.21.

Chemical composition. The steel shall contain :

Carbon	not more than	0·25 per cent.
Silicon	not less than	0·10 and nor more than 0·35 per cent.
Manganese	not more than	1·00 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. (i) Bars and billets for forging shall be delivered as hot rolled or forged.

(ii) Bars for machining shall be delivered in the as hot rolled condition.

Mechanical properties. The following mechanical properties shall be obtained from the test pieces selected and prepared as stated in the appropriate general clauses. Alternatively, for bars of 1 in. dia. and under, by agreement between purchaser and manufacturer, tensile tests may be carried out on the full section of the bar, and in such cases the elongation per cent shall be measured on a gauge length equal to four times the square root of the area of cross section of the bar.

Ultimate tensile stress	not less than 25 and not more than 35 tons per sq. in.
Elongation	not less than 25 per cent.

Where material of this type is supplied with a cold worked finish, the mechanical properties should be modified as follows :

Ultimate tensile stress	not less than 28 tons per sq. in.
Elongation	not less than 17 per cent.

With little or no modification this specification covers the essentials in the following classifications and specifications :

TAC.3A, V.3, SAE.1020, SAE.1022.

"25" CARBON STEEL (NORMALISED)

BARS AND BILLETS FOR FORGING

FORGINGS AND DROP-FORGINGS

BARS FOR MACHINING

Suitable for a tensile range of 28 to 38 tons per sq. in.
The material covered by this specification is similar to that covered by British Standard 2.S.71.

Chemical composition. The steel shall contain :

Carbon	not more than	0·30 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not more than	1·20 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. (i) Bars and billets for forging shall be delivered as rolled or forged, unless the order states otherwise.

(ii) Forgings and drop-forgings shall be delivered in the normalised condition, unless the order states otherwise.

(iii) Bars for machining shall be delivered in the normalised condition, unless the order states otherwise.

(iv) The heat treatment to be given to the steel shall be as follows : Normalise at a temperature of between 850°C. and 880°C.

Mechanical properties. The following mechanical properties shall be obtained from the test pieces selected and prepared as stated in the appropriate general clauses. Alternatively, for bars of 1 in. dia. and under, by agreement between purchaser and manufacturer, tensile tests may be carried out on the full section of the bar, and in such cases the elongation per cent shall be measured on a gauge length equal to four times the square root of the area of cross section of the bar.

Ultimate tensile stress	not less than 28 and not more than 38 tons per sq. in.
Elongation	not less than 25 per cent.
Izod impact value	not less than 20 ft. lb.
Brinell hardness number	114/179.

With little or no modification this specification covers the essentials in the following classifications and specifications :

TAC.3B, V.3, SAE.1020, SAE.1022, SAE.1025.

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"30" CARBON STEEL (HARDENED AND TEMPERED)

BARS AND BILLETS FOR FORGING
FORGINGS AND DROP-FORGINGS
BARS FOR MACHINING

Suitable for tensile ranges of 30/40 (N) and 35/45 (P) tons per sq. in. The material covered by this specification is similar to that covered by British Standard S.77 and supersedes B.S.5005/202.
The purchaser should state when ordering, for which of the ranges N or P the material is required.

Chemical composition. The steel shall contain :

Carbon	not less than	0·25 and not more than 0·35 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not less than	0·50 and not more than 1·20 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. (i) Bars and billets for forging shall be delivered as rolled or forged, unless the order states otherwise.

(ii) Forgings and drop-forgings shall be delivered in the finally heat treated condition, unless the order states otherwise.

(iii) Bars for machining shall be delivered in the finally heat treated condition, unless the order states otherwise.

(iv) The heat treatment to be given to the steel shall be as follows :
Harden in oil from a temperature of 860°/890°C.
Temper by heating to a suitable temperature between 550°C. and 680°C. and quenching in water or oil, or cooling in air, at the option of the manufacturer.
For certain purposes, water hardening and tempering may be adopted as an alternative to oil hardening and tempering, by agreement between purchaser and manufacturer.

Mechanical properties. The mechanical properties obtained from the test pieces selected and prepared as stated in the appropriate general clauses shall be as follows :

		Range N	Range P
Ultimate tensile stress	tons per sq. in.	not less than 30	not less than 35
Yield point	*tons per sq. in.*	*not less than 17*	*not less than 20*
Elongation, per cent		not less than 25	not less than 25
Izod impact value, ft. lb.		not less than 25 for bars 2½ in. dia. or width across flats and under.	not less than 20 for bars 2½ in. dia. or width across flats and under.
Brinell hardness number		118/197	140/223

Mass effect. This carbon steel does not respond very appreciably to oil hardening treatment and when sizes above 2½ in. diameter or ruling section are employed the properties in the centre of the section will differ from those of the material near the surface. For bars above 2½ in. diameter Izod impact values should not be called for. When water hardening and tempering is adopted, the influence of section in modifying the properties obtained is reduced.

With little or no modification this specification covers the essentials in the following classifications and specifications :

TAC.3C, V.4, DTD.398,
SAE.1030.

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35/45 TON BRIGHT CARBON STEEL

BARS FOR MACHINING

The material covered by this specification is similar to that covered by British Standard 3.S.1, and supersedes B.S.5006/205.

Chemical composition. The steel shall contain :

Carbon	not less than	0·15 and not more than 0·40 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not less than	0·50 and not more than 0·90 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. The bars shall be supplied in the cold rolled, drawn or machined condition. They may, however, at the manufacturer's option, be reheated before or after cold working—in the latter case to a temperature not exceeding 620°C.

Mechanical properties. The mechanical properties obtained from test pieces selected and prepared as stated in the appropriate general clauses shall be as follows :

Ultimate tensile stress	not less than 35 and not more than 45 tons per sq. in.
Elongation	not less than 15 per cent.
Izod impact value*	not less than 20 ft. lb. for bars up to and including ¾ in. in diameter (or width across flats). not less than 15 ft. lb. for bars over ¾ in. and up to and including 1⅛ in. diameter (or width across flats). not less than 10 ft. lb. for bars over 1⅛ in. diameter (or width across flats).

Mass effect. The effect of mass is chiefly reflected in the difference in values to be expected from the Izod impact value in various sizes. Except in those cases where the bright finish is produced from as rolled or normalised material (by machining or grinding) some lack of uniformity in hardness may be expected across the section of the bar,

* The relaxation in Clause 13, paragraph *d*, does not apply to the Izod impact value.

a harder condition existing near the surface ; such differences are minimised if the heat treatment mentioned above is applied after cold working.

With little or no modification this specification covers the essentials in the following classifications and specifications :

TAC.4, B.S.32-1, B.S.46-Part 1-No. 3, SAE.1022, SAE.1030, SAE.1035.

35/45 TON BRIGHT CARBON STEEL (FREE MACHINING)

BARS FOR MACHINING UP TO 2 IN. DIAMETER OR WIDTH ACROSS FLATS

This is a free machining modification of B.S. En. 6, for certain restricted applications.

Chemical composition. The steel shall comply with the composition given below for B.S. En. 7 or B.S. En. 7A as may be specified by the purchaser.

B.S. En. 7. The steel shall contain :

Carbon	not less than	0·10 and not more than 0·30 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not less than	0·50 and not more than 1·75 per cent.
Sulphur	not less than	0·10 and not more than 0·30 per cent.
Phosphorus	not more than	0·06 per cent.

B.S. En. 7A. (Suitable for case-hardening.) The steel shall contain :

Carbon	not less than	0·12 and not more than 0·18 per cent.
Silicon	not more than	0·25 per cent.
Manganese	not less than	1·00 and not more than 1·50 per cent.
Sulphur	not less than	0·08 and not more than 0·15 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. The bars shall be supplied in the cold rolled, drawn or machined condition. They may, however, at the manufacturer's option, be reheated after cold working to a temperature not exceeding 620°C.

continued overleaf.

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Mechanical properties. The mechanical properties obtained from test pieces selected and prepared as stated in the appropriate general clauses shall be as follows:

Ultimate tensile stress	not less than 35 and not more than 45 tons per sq. in.
Elongation	not less than 15 per cent.
Izod impact value*	not less than 20 ft. lb. for bars up to and including ¾ in. diameter (or width across flats). not less than 15 ft. lb. for bars over ¾ in. and up to and including 1⅛ in. diameter (or width across flats). not less than 10 ft. lb. for bars over 1⅛ in. diameter (or width across flats).

Mass effect. The effect of mass is chiefly reflected in the difference in values to be expected from the Izod impact value in various sizes. Also, some lack of uniformity in hardness may be expected across the section of the bar, a harder condition existing near the surface.

With little or no modification these specifications cover the essentials in the following classifications and specifications:

TAC.4N, V.1B (En.7A), 3.S.1 (N), SAE.1115, SAE.1117, SAE.1118, AMS.5022A.

* The relaxation in Clause 13, paragraph *d*, does not apply to the Izod impact value.

"40" CARBON STEEL (AS ROLLED OR NORMALISED)

BARS AND BILLETS FOR FORGING
FORGINGS AND DROP-FORGINGS
BARS FOR MACHINING

Suitable for a tensile range of 35 to 45 tons per sq. in.
The material covered by this specification is the same as that covered by British Standard 3.S.6 and supersedes B.S.5005/203.

Chemical composition. The steel shall contain:

Carbon	not less than	0·30 and not more than 0·45 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not more than	1·50 per cent.
Nickel (opt.)††	not more than	1·00 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. (i) Bars and billets for forging shall be delivered as rolled or forged unless the order states otherwise.

(ii) Forgings and drop-forgings shall be delivered in the normalised condition, unless the order states otherwise.

(iii) Bars for machining shall be delivered normalised unless the order states otherwise.

(iv) The heat treatment* to be given to the steel shall be as follows: Normalise at a temperature of between 830°C. and 860°C.

Mechanical properties. The mechanical properties obtained from test pieces selected and prepared as stated in the appropriate general clauses shall be as follows:

Ultimate tensile stress	not less than 35 and not more than 45 tons per sq. in.
Yield point	*not less than 17 tons per sq. in.*
Elongation	not less than 20 per cent.
Izod impact value†	not less than 10 ft. lbs.

Brinell hardness number 140/223.

With little or no modification this specification covers the essentials in the following classifications and specifications:

TAC.5, B.S.46-1/1, V.4A, SAE.1035, SAE.1036, SAE.1040, AMS.5080.

†† See Clause 13, paragraph *g*, page 18.
* For the hardened and tempered condition of this steel see B.S. En. 12.
† The relaxation in Clause 13, paragraph *d*, does not apply to the Izod impact value.

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"55" CARBON STEEL (NORMALISED OR COLD WORKED)

BARS AND BILLETS FOR FORGING
FORGINGS AND DROP-FORGINGS
BARS FOR MACHINING

Suitable for a tensile strength of 45 tons per sq. in. min.
The material covered by this specification is similar to that covered by British Standard S.70.
The purchaser should state when ordering for which of the conditions (normalised or cold worked) stated below, the material is required.

Chemical composition. The steel shall contain :

Carbon	not less than	0·50 and not more than 0·60 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not less than	0·50 and not more than 0·80 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. (i) Bars and billets for forgings shall be delivered as rolled unless the order states otherwise.

(ii) Forgings and drop-forgings shall be delivered in the normalised condition unless the order states otherwise.

(iii) Bars for machining shall be delivered in the normalised condition.

(iv) The heat treatment given to the steel shall be as follows :

Normalise at a temperature between 830°C. and 860°C.
Alternatively for special purposes the material may be supplied in the bright rolled, bright drawn or rolled and ground condition as specified by the purchaser.

Mechanical properties. The mechanical properties obtained from the test pieces selected and prepared as stated in the appropriate general clauses, shall be as follows :

	Normalised	Bright rolled or drawn
Ultimate tensile stress, tons per sq. in.	not less than 45	not less than 50 and not more than 65.
Yield point, tons per sq. in.	*not less than 22*	—
Elongation, per cent	not less than 18	not less than 12·5
Brinell hardness number	192/269	229/293

With little or no modification this specification covers the essentials in the following classifications and specifications :

TAC.6A, 3S24, V.5,
SAE.1055

"55" CARBON STEEL (HARDENED AND TEMPERED)

BARS AND BILLETS FOR FORGING
FORGINGS AND DROP-FORGINGS
BARS FOR MACHINING

Suitable for tensile ranges of 50/60 (S) tons per sq. in. and 55/65 (T) tons per sq. in.
The material covered by this specification in range T is the same as that covered by British Standard S.79.
The purchaser should state when ordering for which of the ranges S or T the material is required.

Chemical composition. The steel shall contain :

Carbon*	not less than	0·50 and not more than 0·60 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not less than	0·40 and not more than 0·75 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. (i) Bars and billets for forging shall be delivered as rolled unless the order states otherwise.

(ii) Forgings and drop-forgings shall be delivered in the finally heat treated condition unless the order states otherwise.

(iii) Bars for machining shall be delivered in the finally heat treated condition unless the order states otherwise.

(iv) The heat treatment to be given to the steel shall be as follows :
Harden in oil from a temperature of 810°/840°C.
Temper at a temperature between 550°C. and 650°C. and cool in air.

Mechanical properties. The mechanical properties obtained from test pieces selected and prepared as stated in the appropriate general clauses shall be as follows :

	Range S	Range T
Limiting ruling section	1⅛ in.	1⅛ in.
Ultimate tensile stress, tons per sq. in.	not less than 50	not less than 55
Yield point, tons per sq. in.	*not less than 30*	*not less than 35*
Elongation, per cent	not less than 18	not less than 15
Brinell hardness number	217/293	241/311

Mass effect. This material cannot be relied on to give the properties quoted above in sizes above 1⅛ in. ruling section. For larger sections a higher carbon content up to 0·70 per cent may be employed.

With little or no modification this specification covers the essentials in the following classifications and specifications :

TAC.6B, V.5, SAE.1055.

* See reference to carbon content in the paragraph on 'Mass effect.'

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"60" CARBON-CHROMIUM STEEL

BARS AND BILLETS FOR FORGING
FORGINGS AND DROP-FORGINGS
BARS FOR MACHINING

Suitable for tensile ranges of 55/65 (T) tons per sq. in. or 65/75 (V) tons per sq. in.

The material covered by this specification is similar to that covered by B.S. 681.

The purchaser should state when ordering, for which of the conditions T or V the material is required.

Chemical composition. The steel shall contain :

Carbon	not less than	0·50 and not more than 0·70 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not less than	0·50 and not more than 0·80 per cent.
Chromium	not less than	0·50 and not more than 0·80 per cent.
Sulphur	not more than	0·05 per cent.
Phosphorus	not more than	0·05 per cent.

Heat treatment. (i) Bars and billets for forging shall be delivered as rolled or forged unless the order states otherwise.

(ii) Forgings and drop-forgings shall be delivered in the softened or in the finally heat treated condition as stated on the order.

(iii) Bars for machining shall be delivered in the softened condition for subsequent heat treatment, or in the finally heat treated condition as stated on the order.

(iv) The heat treatment to be given to the steel shall be as follows :
Harden in oil from a temperature of 800°/850°C.
Temper at a suitable temperature not less than 450°C.

Mechanical properties. The mechanical properties obtained from test pieces selected and prepared as stated in the appropriate general clauses shall be as follows :

	T	V
Limiting ruling section	2½ in.	2½ in.
Ultimate tensile stress, tons per sq. in.	not less than 55	not less than 65
Yield point, tons per sq. in.	*not less than 38*	*not less than 45*
Elongation, per cent	not less than 15	not less than 12
Izod impact value, ft. lb.	not less than 25	not less than 12
Brinell hardness number	241/311	285/352

Mass effect. The above properties are obtainable in sizes up to 2½ in. ruling section.

For larger sizes than 2½ in. ruling section, the Izod impact values should not be called for.

With little or no modification this specification covers the essentials in the following classifications and specifications :

TAC.7A, TAC.7B,
also B.S.5010/603 (spring steel).

B.S. En. 12
[Superseding B.S. 5005/204]

"40" CARBON STEEL

(HARDENED AND TEMPERED)

BARS AND BILLETS FOR FORGING
FORGINGS AND DROP-FORGINGS
BARS FOR MACHINING

Suitable for a tensile range of 40 to 50 tons per sq. in.
The material covered by this specification is the same as that covered by British Standard 2S.76, and supersedes B.S.5005/204.

Chemical composition. The steel shall contain :

Carbon	not less than	0·30 and not more than 0·45 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not more than	1·50 per cent.
Nickel (opt)*	not more than	1·00 per cent.
Sulphur	not more than	0·06 per cent.
Phosphorus	not more than	0·06 per cent.

Heat treatment. i. Bars and billets for forging shall be delivered as rolled or forged unless the order states otherwise.

ii. Forgings and drop-forgings shall be delivered in the finally heat treated condition unless the order states otherwise.

iii. All bars for machining shall be delivered in the finally heat treated condition unless the order states otherwise.

iv. The heat treatment to be given to the steel shall be as follows :
Harden in oil from a temperature of 850°/880°C.
Temper at a suitable temperature between 450°C and 680°C.

* See Clause 13, paragraph *g*, page 18.

continued overleaf.

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Mechanical properties. The mechanical properties obtained from test pieces selected and prepared as stated in the appropriate general clauses shall be as follows :

Ultimate tensile stress, tons per sq. in.	not less than 40
Yield Point, tons per sq. in.	*not less than 28*
Elongation, per cent	not less than 22
Izod impact value, ft. lb. ruling sections below 4 in.	not less than 35
[r]ruling sections 4 in. and over	not less than 25
Brinell hardness number	163/241

Mass effect. The above properties are obtainable with suitable selection of composition and treatment in all sizes up to 6 in. ruling section.

With little or no modification this specification covers the essentials in the following classifications and specifications :

TAC.8A, V.4A,
SAE.1035, SAE.1036, SAE.1040.

[r] The relaxation in Clause 13, paragraph *d*, does not apply to the Izod impact value for ruling sections of 4 in. and over.

MANGANESE-NICKEL-MOLYBDENUM STEEL

BARS AND BILLETS FOR FORGING
FORGINGS AND DROP-FORGINGS
BARS FOR MACHINING

Suitable for a tensile strength of 40 tons per sq. in. min.

The material covered by this specification is the same as that covered by DTD.510.

Chemical composition. The steel shall contain :

Carbon	not less than	0·15 and not more than 0·25 per cent.
Silicon	not less than	0·10 and not more than 0·35 per cent.
Manganese	not less than	1·40 and not more than 1·80 per cent.
Nickel	not less than	0·40 and not more than 0·70 per cent.
Molybdenum	not less than	0·15 and not more than 0·35 per cent.
Sulphur	not more than	0·05 per cent.
Phosphorus	not more than	0·05 per cent.

Heat treatment. (i) Bars and billets for forging shall be delivered as rolled or forged unless the order states otherwise.

(ii) Forgings and drop-forgings shall be delivered in the finally heat treated condition unless the order states otherwise.

(iii) Bars for machining shall be delivered in the finally heat treated condition unless the order states otherwise.

(iv) The heat treatment to be given to the steel shall be as follows :
Harden in oil from a temperature of 850°/890°C.
Temper at a suitable temperature between 550°C and 670°C.

Mechanical properties. The mechanical properties obtained from test pieces selected and prepared as stated in the appropriate general clauses shall be as follows :

Ultimate tensile stress, tons per sq. inch	not less than 40
Yield Point, tons per sq. in.	*not less than 30*
Elongation, per cent	not less than 22
Izod impact value, ft. lb.	not less than 40
Brinell hardness number	163/241

Mass effect. The above values are obtainable in all sizes up to 6 in. ruling section.

With little or no modification, this specification covers the essentials in the following classifications and specifications :

TAC. 8B, V.8.

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