

Wrought steels for mechanical and allied engineering purposes — Requirements for carbon, carbon manganese and alloy hot worked or cold finished steels

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Committees responsible for this Published Document

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- Society of Motor Manufacturer's and Traders Association
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Contents

	Page
Committees responsible	Inside front cover
Foreword	iii
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Designation	2
5 Information to be supplied by the purchaser	3
6 Manufacturing process	4
7 Requirements	4
8 Inspection and testing	9
9 Marking	12
10 Specific requirements for hot rolled or normalized or softened steels and for steels supplied as cold finished bar	12
11 Specific requirements for quenched and tempered steels including steels capable of surface hardening by nitriding for special applications	25
12 Specific requirements for case hardening steels	30
13 Specific requirements for tolerances	32
14 Cut end condition	36
Annex A (informative) Correlation between steels from BS 970-1:1983, PD 970:2005 and current nationally adopted European Standards	37
Bibliography	43
Figure 1 — Types of deviation from square	34
Figure 2 — Edge camber of wide flats	35
Table 1 — Permitted variations of product analysis from specified range	6
Table 2 — Reference symbols for tensile strength ranges of hardened and tempered material	7
Table 3 — Surface quality classes for cold finished products (excluding flats)	9
Table 4 — Surface quality classes for cold finished flat bars examined by visual inspection	9
Table 5 — Hot rolled or normalized or softened steels: chemical composition and mechanical property requirements	13
Table 6 — Normalizing requirements	14
Table 7 — Steels supplied as cold finished bar: chemical composition and mechanical property requirements	15
Table 8 — Quenched and tempered steels including steels capable of surface hardening by nitriding: chemical composition and mechanical property requirements	25
Table 9 — Quenched and tempered steels: heat treatment and maximum hardness requirements in the softened condition	29
Table 10 — Hardenability requirements for 708H37	30

	Page
Table 11 — Case hardening alloy steels: chemical composition and hardenability requirements	30
Table 12 — Case hardening carbon manganese and low alloy steels: chemical composition and mechanical property requirements	31
Table 13 — Case hardening steels: heat treatment and maximum hardness requirements	32
Table 14 — Thickness tolerances for wide flats	33
Table 15 — Deviation from squareness of edges for wide flats	34
Table 16 — Tolerances for hot rolled round, square and hexagon bars suitable for cold finishing	36
Table A.1 — Correlation between steels from BS 970-1:1983, PD 970:2005 and current nationally adopted European Standards	37

Foreword

This Published Document has been prepared by Technical Committee ISE/31. It supersedes PD 970:2001, which is withdrawn.

Some errors in PD 970:2001 have been corrected and some steel grades that are in regular use in the UK have been introduced as they did not have equivalents in the newly published European Standards and the withdrawal of BS 970 in which they were listed had resulted in them not being identified within any current document.

BS 970-1:1996 is to be withdrawn and has been largely replaced by BS EN 10083:1991 (soon to be revised), BS EN 10084:1998, BS EN 10087:1999, BS EN 10088:1995, BS EN 10095:1999 and BS EN 10250-4:2000.

BS 970-2:1988 is withdrawn and has been replaced by BS EN 10089:2002. BS 970-3:1991 is withdrawn and has been replaced by BS EN 10277:1999 and BS EN 10278:1999. BS 970-4 is withdrawn and has been replaced by BS EN 10090:1998.

The series of European Standards listed below covers heat treatable and engineering steels for both black and cold finished bar that were present in BS 970-1:1996 and BS 970-3:1991, or other European Standards.

Steel grades

BS EN 10083-1, *Quenched and tempered steels — Part 1: Technical delivery conditions for special steels.*

BS EN 10083-2, *Quenched and tempered steels — Part 2: Technical delivery conditions for unalloyed quality steels.*

BS EN 10083-3, *Quenched and tempered steels — Part 3: Technical delivery conditions for boron steels.*

BS EN 10084, *Case hardening steels — Technical delivery conditions.*

BS EN 10085, *Nitriding steels — Technical delivery conditions.*

BS EN 10087, *Free cutting steels — Technical delivery conditions for semi-finished products, hot rolled bars and rods.*

BS EN 10088-1, *Stainless steels — Part 1: List of stainless steels.*

BS EN 10088-3, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods and sections for general purposes.*

BS EN 10089, *Hot rolled steels for quenched and tempered springs — Technical delivery conditions.*

BS EN 10090, *Valve steels and alloys for internal combustion engines.*

BS EN 10095, *Heat resisting steels and nickel alloys.*

BS EN 10250-2, *Open die steel forgings for general engineering purposes — Part 2: Non-alloy quality and special steels.*

BS EN 10250-3, *Open die steel forgings for general engineering purposes — Part 3: Alloy special steels.*

BS EN 10250-4, *Open die steel forgings for general engineering purposes — Part 4: Stainless steels.*

BS EN 10267, *Ferritic-pearlitic steels for precipitation hardening from hot working temperatures.*

BS EN 10277-1, *Bright steel products — Technical delivery conditions — Part 1: General.*

BS EN 10277-2, *Bright steel products — Technical delivery conditions — Part 2: Steels for general engineering purposes.*

BS EN 10277-3, *Bright steel products — Technical delivery conditions — Part 3: Free-cutting steels.*

BS EN 10277-4, *Bright steel products — Technical delivery conditions — Part 4: Case-hardening steels.*

BS EN 10277-5, *Bright steel products — Technical delivery conditions — Part 5: Steels for quenching and tempering.*

BS EN ISO 683-17, *Heat-treated steels, alloy steels and free-cutting steels — Part 17: Ball and roller bearing steels.*

Dimensions, tolerances and surface quality

BS EN 10058, *Hot rolled flat steel bars for general purposes — Dimensions and tolerances on shape and dimensions.*

BS EN 10059, *Hot rolled square steel bars for general purposes — Dimensions and tolerances on shape and dimensions.*

BS EN 10060, *Hot rolled round steel bars — Dimensions and tolerances on shape and dimensions.*

BS EN 10061, *Hot rolled hexagon steel bars — Dimensions and tolerances on shape and dimensions.*

BS EN 10092-1, *Hot rolled spring steel flat bars — Part 1: Flat bars — Dimensions and tolerances on shape and dimensions.*

BS EN 10092-2, *Hot rolled spring steel flat bars — Part 2: Ribbed and grooved spring leaves — Dimensions and tolerances on shape and dimensions.*

BS EN 10221, *Specification for surface quality classes for hot rolled bars and rods — Technical delivery conditions.*

BS EN 10250-1, *Open die steel forgings for general engineering purposes — Part 1: General requirements.*

BS EN 10278, *Dimensions and tolerances of bright steel products.*

BS EN 20286-2, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

UK Steel Standard UKS01, *Semi-finished steel products for the manufacture of hot rolled bar, rod and sections*¹⁾[1].

Any steel grade that has previously appeared in BS 970:1983 and is now specified as an equivalent grade in one of the above European Standards is cross-referenced in Annex A which is informative.

This Published Document is not to be regarded as a British Standard.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a Published Document does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 43 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

¹⁾ UKS01 is available from UK Steel, EEF, Broadway House, Tothill Street, London SW1H 9NQ.

1 Scope

This Published Document specifies the technical purchase and supply requirements for the following wrought semi-finished products manufactured from a range of carbon, carbon manganese, low alloy, free-cutting, case-hardening and through hardened steels for the following special applications:

- blooms;
- billets;
- slabs;
- bars;
- rod;
- flats and wide flats.

NOTE These wrought steels may be supplied in the hot formed condition or as thermally treated black bar. Cold finished bar may be subjected to pre- or post-thermal treatment.

It does not specify any boron, micro-alloyed, stainless steels or any products delivered as forgings, which are all covered by other standards (see Foreword).

It does not apply to direct cast products.

PD 970 is presented in the style of a European Standard and references other European Standards (e.g. test methods) wherever possible. The traditional seven digit alphanumeric UK designation is maintained, though it is important to note that the “A”, “M” and “H” system (nominally representing Analysis, Mechanical and Hardenability) should not be confused with other nomenclature. This applies equally to the conventional tensile strength range designations, namely P through to Z which are still used in this document.

Certain other aspects such as requirements for steelmaking, deoxidation and grain size have been revised to reflect modern technology.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 131-1, *Notched bar tests — Part 1: The Izod impact test of metals.*

BS EN 10002-1, *Tensile testing of metallic materials — Part 1: Method of test at ambient temperature.*

BS EN 10020, *Definition and classification of grades of steel.*

BS EN 10021, *General technical delivery requirements for steel and iron products.*

BS EN 10045-1, *Charpy impact test on metallic materials — Part 1: Test method (V- and U-notches).*

BS EN 10052, *Vocabulary of heat treatment terms for ferrous products.*

BS EN 10058, *Hot rolled flat steel bars for general purposes — Dimensions and tolerances on shape and dimensions.*

BS EN 10059, *Hot rolled square steel bars for general purposes — Dimensions and tolerances on shape and dimensions.*

BS EN 10060, *Hot rolled round steel bars for general purposes — Dimensions and tolerances on shape and dimensions.*

BS EN 10061, *Hot rolled hexagonal steel bars for general purposes — Dimensions and tolerances on shape and dimensions.*

BS EN 10079, *Definition of steel products.*

BS EN 10204, *Metallic products — Types of inspection documents.*

BS EN 10278, *Dimensions and tolerances of bright steel products.*

BS EN 20286-2:1993, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

BS EN ISO 642, *Steel hardenability test by end quenching (Jominy test).*

BS EN ISO 643, *Steels – Micrographic determination of the apparent grain size*.

BS EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*.

BS EN ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*.

BS EN ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*.

DD ENV 606, *Bar coded transport and handling labels for steel products*.

3 Terms and definitions

For the purpose of this Published Document the terms and definitions given in BS EN 10020, BS EN 10021, BS EN 10052 and BS EN 10079 and the following apply.

3.1

ruling section

equivalent diameter of that portion of a product at the time of heat treatment that is most important in relation to mechanical properties

3.2

limiting ruling section

largest diameter in which certain specified mechanical properties are achieved after a specified heat treatment

3.3

equivalent diameter

diameter at the time of heat treatment of a hypothetical very long bar, effectively of infinite length and uniform circular cross-section, which, if subjected to the same cooling conditions as the product would have a cooling rate at its axis equivalent to that at the slowest cooling position in the product or relevant part

NOTE 1 This definition applies to any product or part of a product.

NOTE 2 The same cooling conditions means the same initial and final temperature and the same cooling medium.

4 Designation

The steel grades shall be designated in accordance with the system used previously in BS 970. “A” grades shall refer to close limits of chemical composition where no mechanical properties or hardenability are required. “M” and “H” grades shall refer to mechanical and hardenability requirements which are specified in combination with a chemical composition which may be wider than that given for “A” grades.

NOTE Material may be ordered and supplied without heat treatment where appropriate test pieces have been heat treated and tested to prove the capability of the material to meet the required properties.

Unless otherwise agreed at the time of enquiry or order the products shall be delivered in the untreated, i.e. hot worked condition.

5 Information to be supplied by the purchaser

5.1 Mandatory information to be supplied at the time of enquiry and order

The following information shall be supplied by the purchaser at the time of enquiry and order:

- a) the quantity to be delivered, e.g. 2 t;
- b) the shape of the product, e.g. round, hexagon, flat;
- c) the dimensions and tolerances on dimensions and shape;
- d) the number of this Published Document (PD 970:2005);
- e) the intended application of the product and, where known, its intended end use;
- f) the steel grade;
- g) if ordered in accordance with the mechanical property requirements of **10.1**, the limiting ruling section required for non free cutting steels (see Table 5);
- h) if ordered in accordance with the requirements of **10.2**, the condition, the size, and where appropriate, the tensile strength ranges required (see Table 7);
- i) if ordered in accordance with the mechanical property requirements of Clause **11**, the ruling section and tensile strength ranges required (see Table 8);
- j) if ordered in accordance with the hardenability requirements of Clauses **11** or **12**, the hardness value(s) at the required distance(s) (see Table 10 and Table 11);
- k) the delivery condition of the material to be supplied (see **6.3**).

5.2 Options

A number of options are defined in this document and listed below. If the purchaser does not indicate his wish to implement one or more of these options, the supplier shall supply in accordance with the basic specification of this Published Document (see **5.1**):

- a) any requirement on steelmaking process (see **6.1**);
- b) any requirement on re-melted steel (see **6.1**);
- c) any requirement on deoxidation (see **6.2**);
- d) any requirement concerning minimum reduction ratio of rolled products (see **6.3.2**);
- e) any requirement for the sulfur content if different from the standard limits (see **7.1.2**);
- f) if a steel containing lead (or other element having similar effect) is required (see **7.1.3**);
- g) any additional cast/product analysis (see **7.1.5**);
- h) size of test bar (see **7.2.1**);
- i) any special requirement on grain size and the method of measurement (see **7.3.1**);
- j) any special requirement concerning determination of non-metallic inclusion content (see **7.3.2**);
- k) any requirement on shearability for billets, slabs and bars;
- l) any requirement for internal soundness (see **7.4**);
- m) any requirements relating to surface quality, surface defects and their removal (see **7.5.1** for hot rolled products and **7.5.2** for cold finished products);
- n) any requirement concerning suitability of bars, flats and rod for cold finishing (see **7.5.1.2**);
- o) any requirement on surface removal for subsequent plating (see **7.5.2.2**);
- p) any requirement on decarburization (see **7.6**);
- q) whether Izod impact is required (see **8.2.2**);
- r) location of test pieces (see **8.2.4.2**);
- s) any requirement on the type of inspection document, in accordance with BS EN 10204 (see **8.5**);
- t) any requirements concerning special marking of the products (see Clause **9**);
- u) tolerances for semi finished product (see **13.1**);
- v) whether sawn ends are required (see **14**).

6 Manufacturing process

6.1 Melting process

The primary melting process shall be via the EAF (Electric Arc Furnace) or BOS (Basic Oxygen Steelmaking) route at the steelmaker's discretion. The mixed air, open hearth and Bessemer processes shall not be used.

NOTE Steelmaking and refining may be carried out in a ladle or ladle furnace. Additional remelting processes [using VAR (Vacuum Arc Remelting) and ESR (Electro Slag Remelting)] may be specified at the time of enquiry and order.

6.2 Deoxidation

The steels covered by this Published Document (including substitutes for those traditionally produced as rimming, balanced or semi-killed) shall be killed.

NOTE They are generally produced by continuous casting, although killed ingot steels may be supplied.

Unless otherwise agreed at the time of enquiry and order, the killing technique shall be left to the discretion of the steelmaker.

6.3 Condition of material on delivery

6.3.1 General

Blooms, billets, slabs, black bars and rod shall be supplied as rolled or as forged unless otherwise agreed at the time of enquiry and order.

Cold finished bars shall be supplied in the condition stated on the order.

Normalized or quenched and tempered bars, including those that are subsequently cold drawn, shall be supplied to the specified mechanical properties and in the condition stated in the order.

NOTE Material used in the non heat treated condition may be supplied to Brinell hardness values, by agreement at the time of enquiry and order.

6.3.2 Reduction ratio

Where central soundness in the end product is important, the supplier shall make the purchaser aware in writing that a minimum reduction ratio of 4:1 from the cast product (based on cross-sectional area) is required.

NOTE For hot rolled or forged bar products a minimum reduction ratio can be agreed.

6.4 Heat treatment

The heat treatment to be given to the test bars and to material required in the finally heat treated condition shall be as specified in Table 6, Table 9 and Table 13. Where applicable, a suitable quenchant shall be used and the quench media reported to the purchaser.

7 Requirements

7.1 Chemical composition

7.1.1 Composition ranges

The chemical composition of the steel, based on cast analysis, shall conform to the requirements of the appropriate material specification as given in the relevant tables:

- Table 5: Hot rolled or normalized or softened steels;
- Table 7: Cold finished bar;
- Table 8: Quenched and tempered steels including nitriding grades;
- Table 10: 708H37;
- Table 11: Case hardening alloy steels with hardenability requirements;
- Table 12: Case hardening carbon manganese and low alloy steels with mechanical property requirements.

7.1.2 Sulfur and phosphorus contents

Carbon, carbon manganese and low alloy steels shall be supplied with sulfur and phosphorus contents of 0.035 % maximum unless otherwise specified at the time of enquiry and order [see 5.2e)].

NOTE 1 If specified at the time of enquiry and order, a sulfur range, e.g. 0.020 % to 0.040 % may be specified to improve machinability (see 7.1.3).

NOTE 2 Where specifically ordered, a lower content of sulfur and phosphorus, with each element at 0.025 % maximum, may be supplied. This is recommended for certain alloy nitriding steels and for tensile strengths of 1 225 MPa and greater. Other limits may be agreed at the time of enquiry and order.

7.1.3 Steels with improved machinability characteristics

Steels containing lead may be supplied by agreement between the purchaser and the supplier at the time of enquiry and order. Where leaded steels are to be supplied, if a specific lead range is not requested by the purchaser the lead content shall be not less than 0.12 % and not greater than 0.35 % on the cast analysis, and shall be evenly and finely distributed.

The supplier shall ensure that the addition of any other elements such as calcium, bismuth, selenium and tellurium, which may be added to improve machinability properties of certain steels, is agreed at the time of enquiry and order.

7.1.4 Residual elements

Elements not specified in the specification(s) called up by the order shall not be added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat or to achieve anticipated or specified properties.

In carbon, carbon manganese and alloy steels, the following maxima shall be considered as incidental: chromium (Cr) 0.40 %, nickel (Ni) 0.40 %, copper (Cu) 0.40 %, molybdenum (Mo) 0.10 %.

NOTE In addition, at the time of enquiry and order, a limit can be agreed on the maximum combination of copper and tin. For example, the percentage of copper plus ten times the percentage of tin to be a maximum of 0.60.

7.1.5 Product analysis

The permissible deviations in the product analysis in relation to the specified limits for cast analysis shall be as specified in Table 1.

NOTE The purchaser can specify at the time of enquiry and order that the chemical composition on product analysis needs to be verified.

Table 1 — Permitted variations of product analysis from specified range

Element	Permissible maximum content in the cast analysis	Permissible deviation ^a
C	≤ 0.30	±0.02
	>0.30, ≤ 0.50	±0.03
	>0.50, ≤ 1.05	±0.04
Si	≤ 0.40	±0.03
Mn	≤ 1.00	±0.04
	>1.00, ≤ 1.70	±0.06
P	≤ 0.025	±0.005
	>0.025, ≤ 0.040	±0.006
	>0.040, ≤ 0.060	±0.008
S	≤ 0.025	±0.005
	>0.025, ≤ 0.040	±0.006
	>0.040, ≤ 0.060	±0.008
	>0.060, ≤ 0.10	±0.010
	>0.10, ≤ 0.30	±0.03
Cr	≤ 2.00	±0.05
	>2.00, ≤ 3.50	±0.10
Mo	≤ 0.30	±0.03
	>0.30, ≤ 0.65	±0.04
Ni	≤ 2.00	±0.05
	>2.00, ≤ 5.00	±0.07
^a “±” means that in one cast the deviation may occur over the upper value or under the lower value of the specified ranges but not both at the same time.		

7.2 Mechanical properties

7.2.1 General

For through hardened steels, the mechanical properties attainable from any steel composition and heat treatment shall be dependent on the ruling section.

The individual steel specifications of this Published Document show the limiting ruling section to which the stated mechanical properties apply, and the purchaser shall select a steel which is specified to give the required properties in the appropriate ruling section at the time of heat treatment.

Because of the effect of section size, the properties for carbon and carbon manganese case-hardening steels are given for different test bar sizes in the oil-quenched condition, i.e. 13 mm, 19 mm and 29 mm, however the 19 mm size shall be used except by agreement.

When “M” grade steels are ordered, the properties given shall be for a test bar of 19 mm.

NOTE 1 It is customary to test steel to specified mechanical properties using a standard size of test bar.

NOTE 2 For alloy case hardening steels, verification of hardenability can be provided by calculation or by testing at the supplier's discretion. Hardenability bands for these steels are included in Clause 12. These hardenability bands may be used as a guide to estimate the tensile strength of a ruling section at the time of heat treatment.

NOTE 3 All the specified mechanical properties in this Published Document refer to tests taken in the longitudinal direction.

7.2.2 Reference symbols for tensile strength ranges of quenched and tempered material

The various tensile ranges for the different specifications shall be designated with the reference symbols P to Z, as given in Table 2.

Table 2 — Reference symbols for tensile strength ranges of hardened and tempered material

Reference symbol	Tensile strength MPa
P	550 to 700
Q	625 to 775
R	700 to 850
S	775 to 925
T	850 to 1 000
U	925 to 1 075
V	1 000 to 1 150
W	1 075 to 1 225
X	1 150 to 1 300
Y	1 225 to 1 375
Z	1 550 minimum

NOTE 1 This method of specifying tensile strength is different to that used in all European Standards where properties for different section thicknesses are specified.

NOTE 2 It is important to note that these letters should not be confused with the letters used in European steel designations as given in BS EN 10027-1.

7.3 Technological properties

7.3.1 Structure and grain size

Steels shall be supplied either coarse or fine grained at the supplier's discretion unless agreed otherwise at the time of enquiry and order.

NOTE Fine grained steels are normally produced by aluminium (Al) treatment though other methods may be used.

The hardenability (for H grades) and impact toughness (where specified for M grades) specified in this document shall apply only to aluminium treated fine grained steels.

If a coarse grained steel is required, any associated hardenability, toughness or impact property requirements shall be agreed separately.

Case carburizing steels shall be supplied fine grained (aluminium treated) unless specifically ordered otherwise.

Aluminium treated steels shall be considered fine grained if the total Al content is 0.015 % or greater. However, in cases of dispute, or when specifically requested, the grain size shall be measured in accordance with BS EN ISO 643.

7.3.2 Cleanliness

If required, specifications for the degree of freedom from non-metallic inclusions and their methods of determination shall be agreed between the purchaser and supplier in writing at the time of enquiry and order.

7.4 Internal soundness

Requirements for internal soundness shall be agreed between the purchaser and supplier in writing at the time of enquiry and order.

7.5 Surface finish and quality

7.5.1 Hot rolled products

7.5.1.1 Surface finish

All products shall have a finish appropriate to the manufacturing processes applied.

NOTE Minor surface imperfections, which may occur under normal manufacturing conditions, may be present.

7.5.1.2 Surface quality

Where appropriate, requirements relating to the surface quality of the products shall be agreed in writing at the time of enquiry and order.

If suitability for cold finishing is required, this shall be agreed in writing at the time of enquiry and order.

The permissible defect depth, and when appropriate the method of removal, shall be agreed in writing at the time of enquiry and order.

Surface defects shall not be removed from the wrought product by scarfing or repaired by welding.

NOTE 1 Scarfing of semi-finished products may be used providing it is not deleterious to the product.

NOTE 2 It is more difficult to detect and eliminate surface discontinuities from coiled products than from cut lengths. This should be taken into account when agreements on surface quality are made.

7.5.2 Cold finished products

7.5.2.1 General

Precision ground bars shall include bars supplied in the hot rolled and ground, cold drawn and ground or turned and ground conditions.

NOTE 1 Cold finished steel bars are processed from the hot worked, normalized or heat treated condition to achieve a bright surface with greater dimensional accuracy.

NOTE 2 Machining and/or grinding reduces or removes decarburization and also surface irregularities.

7.5.2.2 Surface finish

Drawn products shall have a smooth, bright surface. Products in the final heat treated condition shall be free from loose surface scale but their surface might be discoloured.

Isolated pores, pits and grooves can be present but in the case of rounds, their depth shall not exceed 50 % of the ordered tolerance class measured on the actual diameter.

NOTE For hexagons, squares and flats one cannot achieve (for manufacturing reasons) the same quality of surface finish as for rounds.

The depth of surface imperfections shall not be greater than ISO-tolerance h11 of BS EN 20286-2:1993 measured on the actual size.

Material requiring subsequent plating shall be subjected to surface removal, as agreed at the time of enquiry and order.

7.5.2.3 Surface quality

Since surface defects cannot be completely avoided in the manufacture of hot rolled products and since they are retained when drawing, the manufacturer shall ensure that agreements regarding surface quality shall be made.

The surface quality of the products shall be one of the classes according to Table 3 or Table 4 as appropriate.

NOTE 1 If agreed at the time of enquiry or order, crack detection can be carried out to an agreed surface quality standard.

For Table 3 or Table 4 products, if there is no agreement at the time of enquiry or order, the supplier shall deliver in accordance with surface quality Class 1.

NOTE 2 As surface defects cannot be eliminated without removal of material, it is recommended that a minimum stock removal of 2 % per side be removed.

Products in the “technically defect free by manufacture” condition shall only be available in the machined or machined and ground conditions.

7.6 Decarburization levels

Levels of decarburization and their method of measurement (e.g. BS EN ISO 3887) shall be specified by the purchaser at the time of enquiry and order.

Table 3 — Surface quality classes for cold finished products (excluding flats)

Class	Permissible defect depth ^a	Product form ^b		
		Rounds	Squares	Hexagons
1	Max. 0.3 mm for $d \leq 15$ mm Max. 0.02 d for $15 < d \leq 100$ mm	+	+	+
2	Max. 0.2 mm for $d \leq 20$ mm Max. 0.01 d for $20 < d \leq 75$ mm Max. 0.75 mm for $d > 75$ mm	+	+ ^c	+ ^c
3	Technically defect free by manufacture	+ ^d	+ ^d	—

^a d is the nominal diameter of bar or distance across flats for squares and hexagons.
^b “+” indicates available in these classes; “—” indicates not available in these classes.
^c Eddy current crack detection is not possible for all sizes in this class.
^d Material normally produced by surface removal.

Table 4 — Surface quality classes for cold finished flat bars examined by visual inspection

Class 1		Class 2	
Wider or flat face	Narrower or edge face	Wider or flat face	Narrower or edge face
Maximum defect depth 0.2 mm on thicknesses up to and including 20 mm, then 1.0 % on thicknesses over 20 mm.	Maximum defect depth 1.0 % of ordered width.	Maximum defect depth 0.15 mm on thicknesses up to and including 20 mm, then 0.75 % on thicknesses over 20 mm.	Maximum defect depth 0.75 % of ordered width.

8 Inspection and testing

8.1 Tensile strength of 1 225 MPa or greater

Where the tensile strength of alloy steel is specified as 1 225 MPa minimum or higher (e.g. conditions Y or Z), the test bar shall be machined to test piece size, plus a grinding allowance if required, before heat treatment. In such cases, the properties obtained shall be representative of those parts that are heat treated in the same ruling section as that of the test piece, and shall not represent larger ruling sections.

8.2 Selection and preparation of test bars for tensile and impact tests

8.2.1 Material not supplied in the finally heat treated condition

Where the ruling section of the material does not differ appreciably from that of the parts to be produced, test samples shall be taken directly from the material and heat treated in the original size. Alternatively, when it is considered either by the purchaser or supplier that the results of heat treating in the original size would not be representative of the properties that would be obtained on the parts to be produced, test samples shall be forged and/or machined to test bars of a diameter (or equivalent diameter) corresponding to the ruling section of the parts at the time of heat treatment.

For the purpose of subsequent orders, these tests shall be taken as representing all sizes of material from the same cast where the ruling section of the parts does not exceed the ruling section of the test bar already tested.

8.2.2 Bars for machining supplied in the finally heat treated or cold drawn condition

The samples shall be cut from the heat treated bars or cold drawn bars and shall not be further heat treated or mechanically worked after their removal.

One tensile test and, where relevant, three Charpy 2 mm V-notch impact tests shall be taken from each batch of bars of similar size from the same cast and heat treated together, when applicable.

NOTE The Izod impact test may be used instead of the Charpy V-notch test.