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British Steel | Sections Plates & Commercial Steels

Scunthorpe Rod Mill
PO Box 7, Brigg Road,
Scunthorpe, North Lincolnshire, DN16 1BQ
United Kingdom
Tel: (44) 01724 404040
Fax: (44) 01724 282656 Sales Fax: (44) 01724 381438

Our Ref: pd6635

2nd August 1999

Mr. I. P. N. Johnson
KTS Wire Industries
Park Mills
South Street
Morley
West Yorks
LS27 8AT

Dear Ian

PD 6635 - Non-alloy steel rod for drawing and/or cold rolling

As you may be aware, BSi has issued a "Published Document" with the above title.

You will no doubt recall the background to this document. Following the publication in 1995 of the European Standard for Wire Rod (BS:EN10016, Parts 1 - 4), it was widely felt that the standard did not fulfil the requirements of the UK wiredrawing industry, particularly in respect of surface quality (maximum defect depths), the facility to order high carbon steel to tensile strength ranges, and one or two other parameters. Under the auspices of UK Steel, a Working Group, representing both the wiredrawing and rod rolling sectors, was set up to address these issues. The end result, after numerous discussions and drafts, is PD6635. Please accept the enclosed complimentary copy.

The obvious intention now is that PD6635 should be widely used, and should replace - over a period of time - customer in-house specifications. During the course of the next few weeks, the Customer Technical Support team and I will be in contact with you to offer assistance and advice on any aspects of this transition process where you may envisage difficulty.

In the interests of economy (PD6635 costs £18 per copy - no discounts, not even for British Steel !!), you are the only recipient of this letter within your company. I should be grateful if you would make its contents known to those of your colleagues who need to be aware.

If you have any questions or comments in the meantime, I will be pleased to try to answer them.

Many thanks for your co-operation.

Yours sincerely

J. H. BODDY

PUBLISHED DOCUMENT

PD 6635:1999

Non-alloy steel rod for drawing and/or cold rolling — General purpose rod, rimmed and rimmed substitute low carbon steel rod, rod for special applications — Requirements and tests

ICS 77.140.60; 77.140.65

Committees responsible for this Published Document

The preparation of this Published Document was entrusted to Technical Committee ISE/71, Steel rod for wire drawing, upon which the following bodies were represented:

Process Plant Association
UK Steel Association
Welding Manufacturers' Association (BEAMA Ltd.)

This Published Document, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 March 1999

Amendments issued since publication

Amd. No.	Date	Text affected

The following BSI references relate to the work on this standard:
Committee reference ISE/71

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Foreword

This Published Document has been prepared by Technical Committee ISE/71. It is derived from BS EN 10016 Parts 1-4, with the data being presented in a single document, and with the addition of mechanical properties. The publication of this PD is necessary because UK practice in the steel wire industry differs from that in the rest of Europe; particularly the practice of specifying mechanical properties rather than chemical composition. It is anticipated that the publication of this PD will assist in the preparation of the UK view for the revision of EN 10016.

Compliance with a Published Document does not 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 11 and a back cover.

1 Scope

1.1 This Published document is applicable to the following types of non-alloy steel rod:

a) general purpose rod for drawing and/or cold rolling;

b) rod of low carbon, low silicon, rimmed and rimmed-substitute steel with high ductility for drawing and/or cold rolling;

c) rod with improved characteristics intended for drawing and/or cold rolling.

NOTE The cross-section of the rod may be round, square, rectangular, hexagonal, half-round or another shape and as a general rule of nominal size 5 mm or above (see EURONORM 17): the surface is smooth.

1.2 It is not applicable to the following products for which standards exist or are published such as:

— steel rod intended for heat treatment

(see BS EN 10083 and 10084 and EURONORM 85 and 86);

— rod of free-cutting steels (see BS EN 10087);

— steel rod for cold heading and cold extrusion (see EURONORM 119);

— steel rod intended for the production of electrodes and products for welding (see EURONORM 133);

— steel rod for welded fabric for reinforcement for concrete (see DD ENV 10080);

— steel rod for wire for high fatigue strength mechanical springs, such as valve springs.

1.3 In addition to the requirements of this standard the general technical delivery requirements specified in BS EN 10021 apply.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of this Published Document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references the latest edition of the publication referred to applies.

BS EN 10002-1, *Metallic materials — Tensile testing — 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 and steel products.*

BS EN 10027-1, *Designation systems for steel — Part 1: Steel names : Principal symbols.*

BS EN 10027-2, *Designation systems for steel — Part 2: Steel numbers.*

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

BS EN 10079, *Definition of steel products.*

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

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

EURONORM 17[1)], *General purpose rod of non-alloy steel for drawing — Dimensions and tolerances.*

ISO 3887, *Steel, non-alloy and low alloy — Determination of depth of decarburization.*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition.*

DD ENV 10247, *Micrographic examination of the inclusion content of steels using pictures.*

3 Terms and definitions

For the purposes of this Published Document the following definitions apply in addition to the definitions of ISO 14284, BS EN 10020, BS EN 10021, BS EN 10052 and BS EN 10079.

3.1

heat analysis

chemical analysis representative of the heat determined by the steelmaker at his discretion in a manner of his choice

3.2

product analysis

chemical analysis carried out on a sample of the delivered product

4 Classification and designation

4.1 Classification

The classification of the steel grades defined by chemical composition covered by this Published Document according to BS EN 10020 is indicated in Tables 1, 5 and 9 for the corresponding steel grades.

4.2 Designation

4.2.1 *Steel names*

For the steel grades defined by chemical composition covered by this Published Document, the steel names as given in Tables 1, 5, and 9 are allocated in accordance with BS EN 10027-1.

4.2.2 *Steel numbers*

For steel grades defined by chemical composition covered by this Published Document the steel numbers as given in Tables 1, 5 and 9 are allocated in accordance with BS EN 10027-2.

5 Production process

The steelmaking and fabrication processes shall be made known to the purchaser. Those processes that are specifically agreed shall not be changed without prior agreement of the purchaser.

6 Common requirements

6.1 General

The manufacturer is responsible, using whatever means thought fit for inspecting the production from the point of view of the various quality criteria specified. In view of the fact that it is impossible in practice to inspect coils of rod apart from at the ends of the coils delivered, it cannot be proved that value greater than the specified limits is to be found in the coil as a whole.

NOTE Statistical evaluation of performances applicable to all coils may be agreed between the purchaser and the manufacturer at the time of ordering.

6.2 Internal soundness and surface quality for all types of rod

The rod shall have no internal and/or surface imperfections such as: shrink holes, segregation, cracks, folds, incrustations, notches, scabs, rolling burrs, damage, which could be prejudicial to its correct use.

6.3 Inspection of non-metallic inclusions

The method for inspecting non-metallic inclusions and the assessment criteria for it shall be agreed at the time of ordering, as far as possible with reference to DD ENV 10247.

6.4 Method of delivery

The products shall be delivered by heat or part of a heat. The number of heats per delivery shall be minimized as far as possible.

6.5 Delivery condition

Rod shall be supplied in the as-rolled state, in coils of one continuous length with non-aligned turns, but capable of being unwound in a regular manner during subsequent processing. The coils shall be cut back at both ends to provide a product of uniform shape and properties.

7 Requirements for general purpose rod

7.1 Chemical composition and mechanical properties

For grades specified by chemical composition, the values shown in Table 1 apply. The permissible deviations of the product analysis relative to the actual heat analysis are given in Table 2. At the request of the purchaser at the time of ordering, the manufacturer shall notify indicative values of tensile strength. For grades specified by tensile strength, the values shown in Table 3 apply.

7.2 Depth of surface defects and soundness

The rod shall not have any surface discontinuities of depth greater than the values shown in Table 4. The relevant classes shall be agreed at the time of order and enquiry. These limit values apply for the test chosen in accordance with **11.5.1** and **11.6.2.**

7.3 Core segregation

In the absence of other provisions the following requirements shall be met. By agreement at the time of ordering, rod of steel grade C60D or steel grades with higher carbon content shall be inspected for core segregation. Not more than 10 % of the samples shall be of class 4; class 5 is not allowed (see annex A). It is recommended to do this evaluation as part of a quality assurance system.

8 Requirements for rimmed and rimmed-subsitute low-carbon steel rod

8.1 Chemical composition and mechanical properties

For the heat analysis, the values shown in Table 5 apply. The permissible deviations of the product analysis in relation to the actual heat analysis are given Table 6. Unless otherwise specified at the time of ordering, rod of diameter 5,5 mm and above shall have the maximum tensile strength values shown in Table 7.

8.2 Depth of surface defects and soundness

The rod shall not have any surface discontinuities of depth greater than the values shown in Table 8. These limit values apply for the test chosen according to **11.5.1** and **11.6.2.**

9 Requirements for rod for special applications

9.1 Chemical composition and mechanical properties

For grades specified by chemical composition, the values shown in Table 9 apply. The permissible deviations of the product analysis relative to the actual heat analysis are given in Table 10. At the request of the purchaser at the time of ordering, the manufacturer shall notify indicative values of tensile strength. For grades specified by tensile strength, the values shown in Table 3 apply.

9.2 Depth of surface defects and soundness

The rod shall not have any surface discontinuities of depth greater than one of the classes shown in Table 11. The relevant class shall be agreed at the time of order and enquiry. These limit values apply for the test chosen according to **11.5.1** and **11.6.2.**

9.3 Core segregation

If so agreed at the time of enquiry and order, rod of grade C60D2 or grades with a higher carbon content shall be inspected for carbon segregation. Not more than 5 % of the samples tested shall be of class 4; class 5 is not allowed (see annex A). It is recommended to do the evaluation as part of a quality assurance system.

9.4 Depth of decarburization

The specifications given below concerning the depth of decarburization and the inspection procedure relating to it apply only to grades C42D2 to C98D2.

9.4.1 *Complete decarburization*

The rod shall not display complete decarburization.

9.4.2 *Partial decarburization*

The rod shall not display partial decarburization of depth greater than the values given in Table 12. The maximum point of decarburization shall not exceed twice the limit of Table 12. These limit values are applicable to the test described in **11.5.2**.

10 Dimensions, mass and tolerances

The dimensions, mass and tolerances of the products shall be in accordance with the requirements of EU 17.

11 Inspection and testing

11.1 Inspection and inspection documents

The provisions of BS EN 10021 and BS EN 10204 shall apply.

11.2 Extent of inspection

If the order is accompanied by a request for an inspection certificate, the inspection shall be carried out in accordance with Table 13.

11.3 Acceptance unit and number of samples and test pieces

The acceptance unit is composed of rod of the same diameter or equivalent dimension, originating from the same heat and rolled as a single continuous lot unless otherwise agreed. If specific inspection is required the number of test pieces in Table 14 shall apply.

NOTE For rod for special wire applications a higher frequency of sampling may be agreed. If the non-specific inspection is required the performance statistics or suitable data may be used.

11.4 Test of chemical composition

Where it has been agreed to verify the chemical composition on the product, the samples shall be taken and prepared in accordance with ISO 14284.

11.5 Test of decarburization, surface defects, non-metallic inclusions and core segregation

11.5.1 For testing for surface defects, total decarburization, non-metallic inclusions and core segregation, the test pieces shall be taken from one end of the cropped coil (see 6.6).

11.5.2 Testing for decarburization shall be carried out on the rod in the as-rolled condition, in accordance with ISO 3887 with the following exceptions.

Decarburization is inspected by a microscope on a transverse metalloagraphic test piece suitably etched, with a magnification of × 200. The depth of decarburization of the sample is considered as being the average of 8 measurements at the ends of 4 diameters located 45° to each other, starting from the zone of maximum decarburization. Starting from a defective zone shall be avoided. In the calculation of the above average value, any measuring point of the seven remaining situated in a local surface defect shall not be taken into account in the calculation.

11.5.3 For the determination of non-metallic inclusions and core segregation, the tests shall be carried out on the rod in the as-rolled condition and in accordance with **6.4**, **7.3** and **9.3**.

11.6 Test methods

11.6.1 *Test of chemical composition*

The methods to be applied for the verification of the product analysis shall be agreed at the time of ordering, with reference to existing European Standards, where these are available. For arbitrational analyses, the methods shall be the subject of agreement between the parties concerned.

11.6.2 *Test for surface defects*

The method to be used for revealing surface defects shall be chosen by the manufacturer.

11.6.3 *Tensile test*

The tensile test should be performed on rod in the as-rolled condition, in accordance with BS EN 10002-1.

11.6.4 *Test for core segregation*

The method for determining the core segregation shall be by macrographic examination on a transverse section of the sample as specified in annex A.

12 Marking

Each coil in each consignment shall be marked with the following information:

— dimensions of the cross-section of the rod;

— designation of the steel grade;

— cast number;

— manufacturer's name and symbol;

— any subsequently agreed information.

The marking shall withstand pickling. The durability of the labels utilized for marking shall be agreed at the time of ordering.

Table 1 — Chemical analysis (heat analysis) for general purpose rod[1) 2)]

Steel grade[3)]		Heat analysis									
Steel name	Steel number	C %	Si[4) 5)] %	Mn[6)] %	P % max.	S % max.	Cr % max.	Ni % max.	Mo % max.	Cu[7) 8)] % max.	Al[9)] % max.
C4D	1.0300	≤ 0,06	≤ 0,30	0,30-0,60	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C7D	1.0313	0,05-0,09	≤ 0,30	0,30-0,60	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C9D	1.0304	≤ 0,10	≤ 0,30	≤ 0,60	0,035	0,035	0,25	0,25	0,08	0,30	—
C10D	1.0310	0,08-0,13	≤ 0,30	0,30-0,60	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C12D	1.0311	0,10-0,15	≤ 0,30	0,30-0,60	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C15D	1.0413	0,12-0,17	≤ 0,30	0,30-0,60	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C18D	1.0416	0,15-0,20	≤ 0,30	0,30-0,60	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C20D	1.0414	0,18-0,23	≤ 0,30	0,30-0,60	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C26D	1.0415	0,24-0,29	0,10-0,30	0,50-0,80	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C32D	1.0530	0,30-0,35	0,10-0,30	0,50-0,80	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C38D	1.0516	0,35-0,40	0,10-0,30	0,50-0,80	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C42D	1.0541	0,40-0,45	0,10-0,30	0,50-0,80	0,035	0,035	0,20	0,25	0,05	0,30	0,01
C48D	1.0517	0,45-0,50	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C50D	1.0586	0,48-0,53	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C52D	1.0588	0,50-0,55	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C56D	1.0518	0,53-0,58	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C58D	1.0609	0,55-0,60	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C60D	1.0610	0,58-0,63	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C62D	1.0611	0,60-0,65	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C66D	1.0612	0,63-0,68	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C68D	1.0613	0,65-0,70	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C70D	1.0615	0,68-0,73	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C72D	1.0617	0,70-0,75	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C76D	1.0614	0,73-0,78	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C78D	1.0620	0,75-0,80	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C80D	1.0622	0,78-0,83	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C82D	1.0626	0,80-0,85	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C86D	1.0616	0,83-0,88	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C88D	1.0628	0,85-0,90	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01
C92D	1.0618	0,90-0,95	0,10-0,30	0,50-0,80	0,035	0,035	0,15	0,20	0,05	0,25	0,01

[1)] Elements not included in this table may not be added intentionally to the steel without the agreement of the purchaser, except those intended for finishing the cast.

[2)] The addition of microalloying elements can be agreed between the manufacturer and purchaser at the time of ordering.

[3)] Quality non-alloy steel according to EN 10020.

[4)] For rod intended for galvanization the allowed lower limit of silicon content should be specified at the time of ordering.

[5)] By agreement at the time of ordering the maximum silicon level for grades C4D to C20D may be further restricted.

[6)] For grades from C15D onwards, for the manganese content a different range from the one indicated in the table, but of the same amplitude, can be agreed at the time of ordering with a maximum value not exceeding 1,20 %.

[7)] A maximum copper content of 0,20 % should be agreed at the time of ordering.

[8)] For steels C48D to C92D, Cu + Sn < 0,25 %.

[9)] By agreement at the time of ordering the value for aluminium can be fixed at 0,02 % to 0,06 %. The value for silicon can then be fixed at ≤ 0,10 % on request.

Table 2 — Permissible deviations in the product analysis in relation to the actual heat analysis for general purpose rod

Element	Steel grade	Permissible deviation in product analysis %
C	C4D to C20D	± 0,02
	C26D to C82D	± 0,03
	C86D to C92D	± 0,04
Si	All grades	± 0,04
Mn	All grades	± 0,06
P and S	All grades	± 0,005

Table 3 — Mechanical properties for general purpose rod and rod for special applications

Steel grade	Ultimate tensile strength R_m N/mm²
T700	650/750
T750	700/800
T800	750/850
T850	800/900
T900	850/950
T950	900/1000
T1000	950/1050

Table 3 — Mechanical properties for general purpose rod and rod for special applications *(continued)*

Steel grade	Ultimate tensile strength R_m N/mm²
T1050	1000/1100
T1100	1050/1150
T1150	1100/1200

Carbon content shall be selected by the manufacturer to achieve the specified properties. Other major elements shall be as follows:-

Si 0.10 - 0.30 %
Mn 0.50 - 0.80 %
S 0.030 % max.
P 0.030 % max.

The specified properties apply to a mean value of at least 5 samples taken from each cast or batch

Table 4 — Limit values for the depth of surface discontinuities for general purpose rod

Class	Maximum surface defect depth (% of nominal rod diameter) measured radially
I	4.0
II	3.0
III	2.0

Table 5 — Chemical analysis (heat analysis) for rimmed and rimmed-substitute low carbon steel rod[1)]

Steel grade[2)]		Heat analysis										
Steel name	Steel number	C % max.	Si % max.	Mn %	P % max.	S % max.	Cr[3)] % max.	Ni[3)] % max.	Mo % max.	Cu[3)] % max.	Al[4)] % max.	N % max.
C2D1	1.1185	0,03	0,05	0,20-0,35	0,020	0,020	0,10	0,10	0,03	0,10	0,01	0,007
C3D1	1.1187	0,05	0,05	0,20-0,40	0,025	0,025	0,10	0,10	0,03	0,15	0,05	—
C4D1	1.1188	0,06	0,10	0,20-0,45	0,025	0,025	0,15	0,15	0,03	0,15	0,05	—

[1)] Elements not included in this table should not be added intentionally to the steel without the agreement of the purchaser, except those intended for finishing the cast.

[2)] Special non-alloy steel according to EN 10020

[3)] The sum of the contents Cu + Ni + Cr shall not exceed:

— for steel grade C2D1, 0,25 %;
— for steel grade C3D2, 0,30 %;
— for steel grade C4D1, 0,35 %.

[4)] For steels grade C3D1 and C4D1 a lower maximum limit should be specified at the time of ordering.

[5)] Boron, up to a level of 0,010 % may be specified at the time of ordering.

Table 9 — Chemical analysis (heat analysis) for rod for special applications[1) 2)] *(continued)*

Steel grades[3)]		Heat analysis										
Steel name	Steel number	C %	Si[4)] %	Mn[5)] %	P % max.	S % max.	Cr[6)] % max.	Ni[6)] % max.	Mo % max.	Cu[6) 7) 8)] % max.	Al[9)] % max.	N[10)] % max.
C78D2	1.1252	0,76-0,80	0,10-0,30	0,50-0,70	0,020	0,025	0,10	0,10	0,02	0,15	0,01	0,007
C80D2	1.1255	0,78-0,82	0,10-0,30	0,50-0,70	0,020	0,025	0,10	0,10	0,02	0,15	0,01	0,007
C82D2	1.1262	0,80-0,84	0,10-0,30	0,50-0,70	0,020	0,025	0,10	0,10	0,02	0,15	0,01	0,007
C86D2	1.1265	0,84-0,88	0,10-0,30	0,50-0,70	0,020	0,025	0,10	0,10	0,02	0,15	0,01	0,007
C88D2	1.1272	0,86-0,90	0,10-0,30	0,50-0,70	0,020	0,025	0,10	0,10	0,02	0,15	0,01	0,007
C92D2	1.1282	0,90-0,95	0,10-0,30	0,50-0,70	0,020	0,025	0,10	0,10	0,02	0,15	0,01	0,007
C98D2	1.1283	0,96-1,00	0,10-0,30	0,50-0,70	0,020	0,025	0,10	0,10	0,02	0,15	0,01	0,007

1) Elements not included in this table may not be added intentionally to the steel without the agreement of the purchaser, except those intended for finishing the cast.

2) The addition of microalloying elements can be agreed between the manufacturer and purchaser at the time of ordering.

3) Special non-alloy steel according to EN 10020.

4) For rod intended for galvanization the allowed lower limit of silicon content should be specified at the time of ordering.

5) For the manganese content, a different range from the one indicated in the table can be agreed at the time of ordering with a maximum value not exceeding 1,20 % and with an amplitude of 0,20 %.

6) The sum of the contents Cu + Ni + Cr shall not exceed 0,30 %.

7) Cu + Sn ≤ 0,15 %.

8) For certain applications the Cu content may be restricted to 0,12 % max. by agreement.

9) By agreement at the time of ordering, the value for aluminium can be fixed at 0,02 to 0,06 %. The value for silicon can then be fixed at ≤ 0,10 % on request.

10) If, in accordance with note 9), the Al content is fixed at 0,02 to 0,06 %, the limit value for N shall be agreed at the time of ordering.

Table 10 — Permissible deviations in the product analysis in relation to the actual heat analysis for rod for special applications

Element	Steel grade	Permissible deviation in product analysis %
C	C3D2 to C20D2	± 0,02
	C26D2 to C82D2	± 0,03
	C86D2 to C98D2	± 0,04
Si	All grades	± 0,04
Mn	All grades	± 0,06
P and S	All grades	± 0,005

Table 11 — Limit values for the depth of surface discontinuities for rod for special applications

Class	Maximum surface defect depth (% of nominal rod diameter) measured radially
IV	1.5
V	1.0

Table 12 — Limit of the depth of partial decarburization

Nominal diameter d_N mm	Limit values mm
$5 < d_N \leq 8$	0,10
$8 < d_N \leq 30$	1,2 % of d_N

Table 13 — Extent of inspection

Type of test	General purpose rod (clause 7)	Low carbon steel rod (clause 8)	Rod for special applications (clause 9)
Surface defects	0	+	+
Decarburization	0	−	+
Non-metallic inclusions	−	0	0
Core segregation	0	−	0
Product analysis	0	0	0
Tensile strength	0	0	0

+ = carried out

− = is not carried out

0 = is only carried out if part of the options and/or is agreed at time of ordering

Table 14 — Acceptance unit and number of samples and test pieces

Type of requirement	Number of samples or test pieces
Product analysis	3, from 3 different coils originating from the same heat, but not necessarily rolled as a single continuous lot
Permissible depth of surface defects	1 for every 20 tons with a minimum of 3
Permissible depth of decarburization	
Non-metallic inclusions	
Tensile strength	
Core segregation	10

Annex A (normative)
Determination of core segregation

A.1 Scope

This annex is applicable for rod made from continuously cast steel with a carbon content of at least 0,40 % C and defined in this Published Document.

The method described further is a macrographic method aimed at determining and evaluating the core segregation present in continuously cast high carbon rod by revealing the carbon segregation.

A.2 Definition

For the purpose of this standard, the following definition applies.

A.2.1 Core segregation

Core segregation is the local variation in chemical composition which can be noticed over a cross-section of rod by macrographic examination. It concerns primarily the segregation resulting from the steelmaking process. This segregation takes place concurrently for many elements: carbon, phosphorus, manganese, sulfur, etc. This is the reason why we can examine core segregation by revealing specifically the carbon segregation. Grain boundary cementite, which is particularly influenced by the thermal history of the rod (from liquid steel to rod) and of its size can also cause problems in further processing. This justifies the use of specific methods for evaluating the presence of grain boundary cementite, which is related to carbon segregation, but not be confused with core segregation.

A.3 Principle

The chemical heterogeneity is revealed by chemical etching of a cross-section of the rod in a nital solution. The images observed by macrographic examination are compared with the pictures of the reference chart and classified accordingly.

A.4 Preparation of samples

A.4.1 *Cutting*

The surface to be examined is a transverse section of each sample to be examined. This is obtained by gradually cutting at low speed. In any case excessive heating is to be avoided by appropriate cooling.

A.4.2 *Polishing*

The sample is first polished stepwise, whereby the finishing will be carried out with diamond paste of final grain size 1 μm. After mirror polishing the sample is carefully washed with water and dried in alcohol.

A.4.3 *Etching*

The polished surface is etched at ambient temperature in the nital solution during about 10 seconds. The nital solution is a solution of 2 ml of nitric acid (20 = 1,33 g/ml) in 100 ml of ethanol. After etching the surface is dried in alcohol.

A.5 Evaluation of the segregation

The etched surface is observed with a binocular microscope with illumination under a small angle with a magnification so as to obtain about the same dimension as for the reference pictures. The pictures in the chart are limit references for each class concerned. Actual pictures are compared, positioned and graded within the reference chart. They obtain the class of the reference picture equal or worse than the picture under observation.

A.5.1 *Classes of segregation*

Figure A.1 presents 5 classes of segregation.

Class 1: without segregation zone

Class 2: core segregation with slight contrast (medium grey)

Class 3: core segregation with medium contrast (dark grey)

Class 4: core segregation with pronounced contrast (small black core)

Class 5: core segregation with heavy contrast (big black core).

A.5.2 *Evaluation of the test results*

It is generally accepted that a large number of results is required for a statistically significant evaluation of the core segregation of a cast or a shipment. The value of the assessment of the core segregation on an individual sample has only a relative value. For this reason and for limiting the number of tests to an economically acceptable level it is advisable to use the determination of the segregation a part of a quality assurance system.

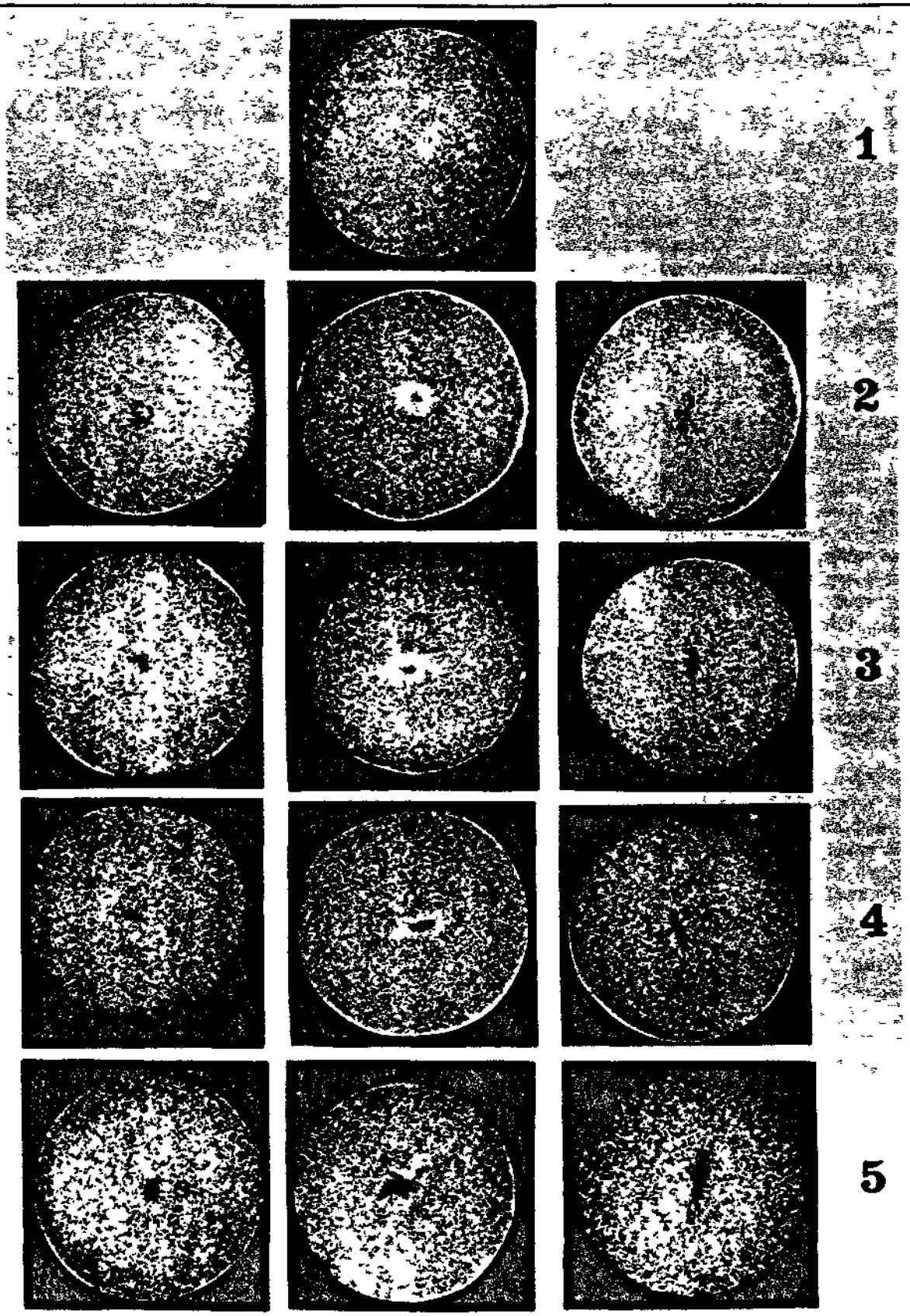

Figure A.1 — Five classes of segregation

Annex B (informative)

Information to be supplied by the purchaser

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

a) quantity to be delivered;

b) product denomination (rod);

c) cross-section (round, square, hexagonal, etc.);

d) reference to the dimensional standard;

e) nominal dimensions;

f) reference to this Published Document;

g) steel name or steel number (see 4.2);

h) dimensions and mass of coils;

i) surface condition (where different from the as-rolled condition);

j) where applicable, indication of the type of descaling (chemical or mechanical);

k) where applicable, the type of inspection and inspection document in accordance with EN 10021 and EN 10204 respectively (see 8.1);

l) where applicable, the method of binding and labelling;

m) where applicable, if the steel grade shall be suitable for galvanization;

n) where applicable, suitability for direct drawing;

o) where applicable, suitability for patenting.

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