INTERNATIONAL STANDARD

ISO 1005-6

Second edition
1994-08-01

Railway rolling stock material —

Part 6:
Solid wheels for tractive and trailing stock — Technical delivery conditions

Matériel roulant de chemin de fer —

Partie 6: Roues monoblocs pour le matériel moteur et pour le matériel remorqué — Conditions techniques de livraison

Reference number
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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 1005-6 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 13, *Railway rolling stock material*.

This second edition cancels and replaces the first edition (ISO 1005-6:1982), of which it constitutes a technical revision.

ISO 1005 consists of the following parts, under the general title *Railway rolling stock material*:

— *Part 1: Rough-rolled tyres for tractive and trailing stock — Technical delivery conditions*

— *Part 2: Tyres, wheel centres and tyred wheels for tractive and trailing stock — Dimensional, balancing and assembly requirements*

— *Part 3: Axles for tractive and trailing stock — Quality requirements*

— *Part 4: Rolled or forged wheel centres for tyred wheels for tractive and trailing stock — Quality requirements*

— *Part 6: Solid wheels for tractive and trailing stock — Technical delivery conditions*

— *Part 7: Wheelsets for tractive and trailing stock — Quality requirements*

— *Part 8: Solid wheels for tractive and trailing stock — Dimensional and balancing requirements*

— *Part 9: Axles for tractive and trailing stock — Dimensional requirements*

Annex A forms an integral part of this part of ISO 1005. Annex B is for information only.

Introduction

This second edition of ISO 1005-6 is the result of the efforts of ISO/TC 17/SC 13 to harmonize and rationalize further the differing regional and national practices of the technical delivery conditions for solid wheels for railway rolling stock.

In the negotiations for this purpose the following topics, in particular, were discussed:

— the selection of steel type;

— the heat-treatment condition; and

— the requirement and testing categories (see the following paragraph).

Although the term "requirement and testing category" is correct, for easy reference the term "testing category" is used in this part of ISO 1005.

During negotiations on the selection of steel types, it was intended to retain only four or five different steel grades and to harmonize these with those quoted in other International Standards. However, this has not yet been fully achieved, in particular for the direct-hardening steels in ISO 683-1, and for the time being the established grades will be retained. The specifications for the composition of similar grades were aligned with one another.

With reference to the selection of heat-treatment conditions, the chosen concept was to make full use, as far as possible, of the properties inherent in the individual steel grades. Consequently, for all grades the rim quenched and tempered condition (T) and the normalized conditon (N) may be agreed upon. The immersion quenched and tempered condition (E)[1)] was of decreasing importance and is only retained for special cases (see table 1, footnote 13).

The considerations referring to testing categories are covered in note 1 in 1.1, together with those on tolerance categories.

1) The symbol E may be changed at a later date.

Railway rolling stock material —

Part 6:
Solid wheels for tractive and trailing stock — Technical delivery conditions

1 Scope

1.1 This part of ISO 1005 specifies requirements for the manufacture and supply of rolled, forged or cast solid wheels of unalloyed steels for tractive and trailing stock in accordance with table 1 and clause 4.

NOTE 1 The compilation of an International Standard for material, testing and dimensional requirements of wheelset components and assembled wheelsets is difficult because of the different ways in which railways have developed, in both the commercial and operating sense, in various parts of the world. These different forms of development are characterized, for example, by railway systems in which freight services are integrated with intensive and perhaps high-speed passenger services and by systems largely dedicated to the haulage of freight. The infrastructures of these two systems are normally different, and this and commercial policy can determine the practice adopted by them in wheelset design in terms of materials and geometrical characteristics.

The relevant parts of ISO 1005 acknowledge, or will in a future revision acknowledge, these differences by providing in the relevant clauses two categories of material and related quality testing requirements designated as testing categories A and B and two tolerance categories for dimensional requirements designated as Y and Z.

The most obvious difference between categories A and B is that the mechanical properties are specified

— in the case of category A, on the basis of tensile and impact tests;

— in the case of category B, on the basis of hardness tests.

The differences between the values of the tolerance categories Y and Z are given

— for solid wheels in ISO 1005-8:1986 (see especially table 4);

— for wheelsets in ISO 1005-7.

Until now, within ISO/TC 17/SC 13, it was possible to clarify in detail the conditions under which one or the other testing and tolerance category is preferable. As a general guide it shall, however, be noted

— that the combination of testing category A with tolerance category Y is usually applied on railway systems where frequent or high-speed passenger operation is predominant;

— that the combination of testing category B and tolerance category Z is usually applied on railway systems where freight operation is predominant; and

— that the final combination of the categories shall be left to the discretion of the purchaser.

1.2 In addition to this part of ISO 1005, the requirements of ISO 404 are applicable.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 1005. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 1005 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 83:1976, *Steel — Charpy impact test (U-notch).*

ISO 377-1:1989, *Selection and preparation of samples and test pieces of wrought steels — Part 1: Samples and test pieces for mechanical test.*

ISO 377-2:1989, *Selection and preparation of samples and test pieces of wrought steels — Part 2: Samples for the determination of the chemical composition.*

ISO 404:1992, *Steel and steel products — General technical delivery requirements.*

ISO 1005-8:1986, *Railway rolling stock material — Part 8: Solid wheels for tractive and trailing stock — Dimensional and balancing requirements.*

ISO/TR 4949:1989, *Steel names based on letter symbols.*

ISO 4960:1986, *Cold-reduced carbon steel strip with a carbon content over 0,25 %.*

ISO 5948:1994, *Railway rolling stock material — Ultrasonic acceptance testing.*

ISO 6506:1981, *Metallic materials — Hardness test — Brinell test.*

ISO 6892:1984, *Metallic materials — Tensile testing.*

ISO 6933:1986, *Railway rolling stock material — Magnetic particle acceptance testing.*

ISO/TR 9769:1991, *Steel and iron — Review of available methods of analysis.*

ISO 10474:1991, *Steel and steel products — Inspection documents.*

3 Information to be supplied by the purchaser

The purchaser shall supply the following information in his enquiry and order:

a) the number of this part of ISO 1005;

b) the grade of steel (see 4.1 and table 1);

c) the type of heat treatment (see 4.2 and 6.5);

d) the testing category (see 4.3 and 7.3.1);

e) the dimensions of the wheel (see 5.4);

f) the degree of finish and the tolerance category (see 4.4 and 4.5).

Certain alternatives are permitted, and the purchaser may therefore state the following in his enquiry and order:

g) if, for wheels to be delivered in the normalized or quenched and tempered condition, lower phosphorus and sulfur contents are required (see table 1, footnote 4);

h) if the tape size shall be measured and marked (see 5.6 and 7.8.4);

i) if any special marking is required (see 5.6);

j) if, for cast wheels, any specific manufacturing process is required (see 6.2.2);

k) if shot peening is required (see 6.8);

l) whether optional tests and checks shall be carried out and, if so, which ones (see table 2), together with the following additional information:

   — in the case of hardness survey tests: whether the total wear depth is other than 35 mm (see 7.7.3.4);

   — in the case of static balancing tests: whether the amount and position of residual imbalance shall be marked (see 5.6) and whether, in the case of trailing stock, methods of correction other than those specified in 6.6 may be applied;

m) if optional dimensional checks are required and, if so, the number of wheels to be inspected (see table 2, footnote 8);

n) if, for the inspection of the manufacture and various quality requirements, the responsibility shall be other than that specified in 7.1.1, last paragraph;

o) if protection against corrosion is required and, if so, the method to be used (see 8.1).

NOTE 2 The specific clauses or parts of clauses, or the requirements in tables 1 and 2, which leave a choice between two or more alternatives open for an agreement asked for by the purchaser at the time of enquiry and order are marked in italics. If no such agreement is made, the alternative indicated as normal shall apply.

4 Classification

The solid wheels are classified according to the grade of steel, the heat-treatment condition on delivery, the testing category, the degree of finish, the tolerance category and any optional requirements [see items g) to o) of clause 3].

4.1 Grades of steel

This part of ISO 1005 covers the following grades of steel in accordance with the properties given in table 1:

a) rolled or forged wheels: C grades of table 1;

b) cast wheels: GC grades of table 1.

4.2 Types of heat-treatment condition on delivery

Depending on the agreements of the order, the wheels are supplied

a) normalized or normalized and tempered (symbol N); or

b) rim quenched and tempered[2] according to 6.5.2 (symbol T)[3].

In special less critical cases, forged or rolled wheels can also be delivered untreated (no symbol). In this case, the mechanical properties are to be agreed at the time of enquiry and order.

In special cases, immersion quenched and tempered wheels may also be supplied (symbol E, see second-last paragraph of the introduction).

4.3 Testing category

Wheels may be supplied according to testing categories A and B (for details see note 1 in 1.1 and table 2).

4.4 Degree of finish

See ISO 1005-8 for definitions of "unmachined", "rough machined", "half finished", "finished" and "ready for assembly".

4.5 Tolerance category

See ISO 1005-8 and the note 1 in 1.1.

5 Requirements

5.1 Chemical composition

5.1.1 The chemical composition of the wheels shall comply with the requirements given in table 1.

5.1.2 *Unless otherwise agreed, the requirements for the results of the product analysis, shall be considered to be complied with when the results of the cast analysis are in accordance with the relevant specifications in table 1.*

5.2 Mechanical properties

The mechanical properties of the wheels shall comply with the requirements given in table 1.

5.3 Appearance and soundness

5.3.1 General

5.3.1.1 The wheels shall be sound throughout and without any defects detrimental to their use.

5.3.1.2 Those portions remaining black (unmachined) shall blend smoothly into any machined portions.

The finish of the machined surfaces shall, unless otherwise specified in the order or its appended documents, be in accordance with ISO 1005-8.

5.3.2 Acceptance standard for magnetic particle test

When magnetic particle testing according to ISO 6933 is required (see table 2), the evaluation of magnetic particle discontinuity indications shall be based on an acceptance standard that is agreed upon when ordering. As far as possible, the position, shape, size, orientation and distribution of the discontinuities, and the service conditions for which the wheel is provided, shall be taken into account.

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2) In the first edition of ISO 1005-6:1982, this heat-treatment condition was covered under the term "surface treated". The term "tread hardened" is also frequently applied to this condition.

3) The symbol T may be changed at a later date.

5.3.3 Acceptance standard for ultrasonic acceptance tests

When ultrasonic acceptance tests are required (see table 2), the acceptance standard specified in ISO 5948 shall apply, unless otherwise agreed at the time of enquiry and order.

5.4 Machining allowances and dimensional tolerances

For the machining allowances and dimensional tolerances, see ISO 1005-8.

5.5 Residual imbalance

When the residual imbalance is to be checked (see table 2), the results shall conform to the requirements of ISO 1005-8 and the imbalance shall be marked in accordance with 5.6.

5.6 Marking

Each wheel shall be supplied with marks as specified in the order or its appended documents.

Unless otherwise specified, each wheel shall receive the following marks:

a) manufacturer's mark;

b) cast number, or a serial number which can be identified with the specific cast;

c) grade of steel and heat-treatment condition (see 4.2), including, if required, the testing and/or tolerance category;

d) date of manufacture (month and last two figures of the year of manufacture);

e) the inspector's mark, if the wheel is in accordance with 7.9;

f) if the static imbalance is to be checked (see table 2); the position of imbalance and, if it is specified, the value of the residual imbalance;

g) the tape size, if this is to be measured (see 7.8.4).

Unless otherwise specified, the position and type of the marks shall be as follows (for examples, see figures 1 and 2).

The marks pertaining to a) to e) shall, in the case of stamping, be made on a face of the hub, unless otherwise specified in the order. Stamps with acute-angled character forms shall not be used (see 6.4). In the case of cast wheels, the marks pertaining to a) to d) may be cast and the inspector's mark stamped on the back (i.e. on the inside) of the web.

If static balancing tests were agreed upon at the time of enquiry and order, the position of the imbalance shall be indicated by suitably coloured paint in a radial stripe of about 15 mm *width. When required, the imbalance value shall be given, in gram metres by painted numbers below the end of the stripe.*

If measurement of the tape size has been agreed upon at the time of enquiry and order, the tape size shall be clearly painted on the web and in characters at least 25 mm *in height.*

The surfaces of the wheel shall not have any marks in positions other than those specified in the order or its appended documents.

6 Manufacture

6.1 Steelmaking process

The wheels shall be made from steel produced by basic-oxygen, open-hearth, or electric-arc processes; other processes may be used by agreement between the manufacturer and the purchaser.

The steel shall be killed in the furnace or in the ladle and shall be bottom-poured or continuously cast, unless otherwise agreed.

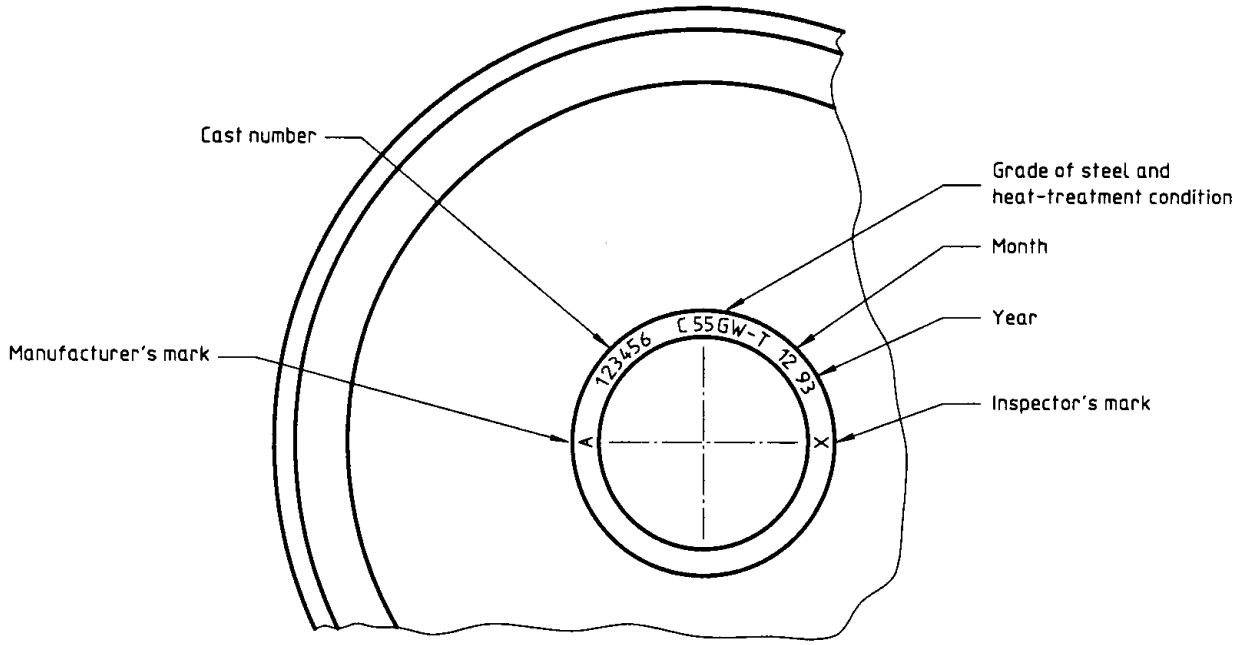


Figure 1 — Example for marking of rolled, forged or cast wheels by stamping (see 5.6)

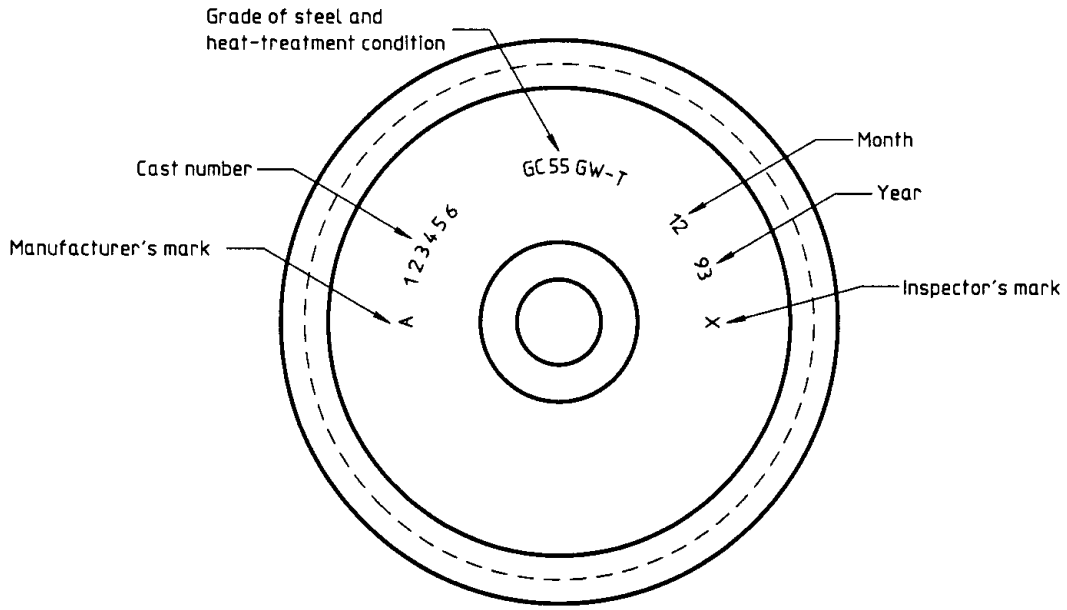


Figure 2 — Example for alternative marking of cast wheels with cast-on characters (see 5.6)

6.2 Manufacturing process

6.2.1 Rolled or forged wheels

Rolled or forged wheels shall be manufactured from ingots or blooms capable of producing two or more wheels after removal of discards. Special individual ingots may only be used with the prior agreement of the purchaser. Cropping and dressing shall be sufficient to eliminate unsound sections of the ingot (see also 6.3).

The sections of ingots or blooms shall be forged, pierced and rough shaped by a hammer or press. They shall be finally shaped by rolling or by die forging supplemented by sizing if necessary.

Suitable precautions shall be taken during hot-working in order to avoid damage of the material by excessive grain growth and by other defects caused by overheating.

NOTE 3 For the above purpose, the hot-working temperatures and the holding times at these temperatures should not be excessive. As a guideline, hot-working should not be done at temperatures above 1 260 °C and should terminate between 850 °C and 1 000 °C.

After forging or rolling, and, where applicable, sizing and stamping the identification marks, the wheels shall be left to cool. If the steel has not been degassed, suitable precautions, which may include for example slow cooling, shall be taken to avoid the formation of flakes (hydrogen cracking).

6.2.2 Cast wheels

Cast wheels shall be manufactured by pouring metal into moulds shaped to produce the wheel contour required, in accordance with a process acceptable to the purchaser and taking into account the requirements of ISO 1005-8. The upper part of the mould shall have risers, to feed metal back into the wheel during solidification and to produce a sound casting.

Cast wheels shall be permitted to cool in the moulds until they have solidified completely. Following removal of the mould, suitable precautions shall be taken to ensure that the wheels are not damaged by cooling too rapidly. If the steel has not been degassed, suitable precautions, which may include for example slow cooling, shall be taken to avoid the formation of flakes (hydrogen cracking).

6.3 Removal of defective sections

Defective sections which do not comply with the soundness characteristics specified in 5.3 shall be removed before or during the manufacture of the wheels.

6.4 Identification of the wheels during manufacture

All ingots, sections and wheels shall be suitably marked at each stage of manufacture so that, before delivery, each wheel can be identified as specified in 5.6. Where punched identification marks differ from the final identification marks defined in 5.6, they shall be sufficiently shallow not to remain visible on the finished wheel.

6.5 Heat treatment

6.5.1 The wheels shall undergo the heat treatment specified in the order or its appended documents (see 4.2).

6.5.2 Wheels to be rim quenched and tempered (T) or immersion quenched and tempered (E) shall be uniformly reheated to the correct temperature to refine the grain structure, and then the rims shall be quenched. Following quenching, the wheels shall be placed in a furnace for tempering to meet the requirements of table 1, and subsequently cooled under controlled conditions.

6.6 Machining and correction of imbalance

The conditions for machining shall be chosen so that the wheels comply with the requirements for surface quality and tolerances in 5.3 and ISO 1005-8.

Unless otherwise specified, correction of imbalance shall be obtained by turning off the centre of the fillet between the web and the rim, on the flange side (see figure 3). The thickness of the metal removed shall not exceed 4 mm, *and the dressed surface shall be carefully blended into the adjacent surfaces and comply with the requirements for surface roughness in ISO 1005-8.*

Under no circumstances may additional weights be attached.

Drilling of holes for balancing is not permitted for wheels of tractive stock. Prior agreement by the purchaser shall be obtained if this method of balancing is to be used for wheels for trailing stock.

Dimensions in millimetres

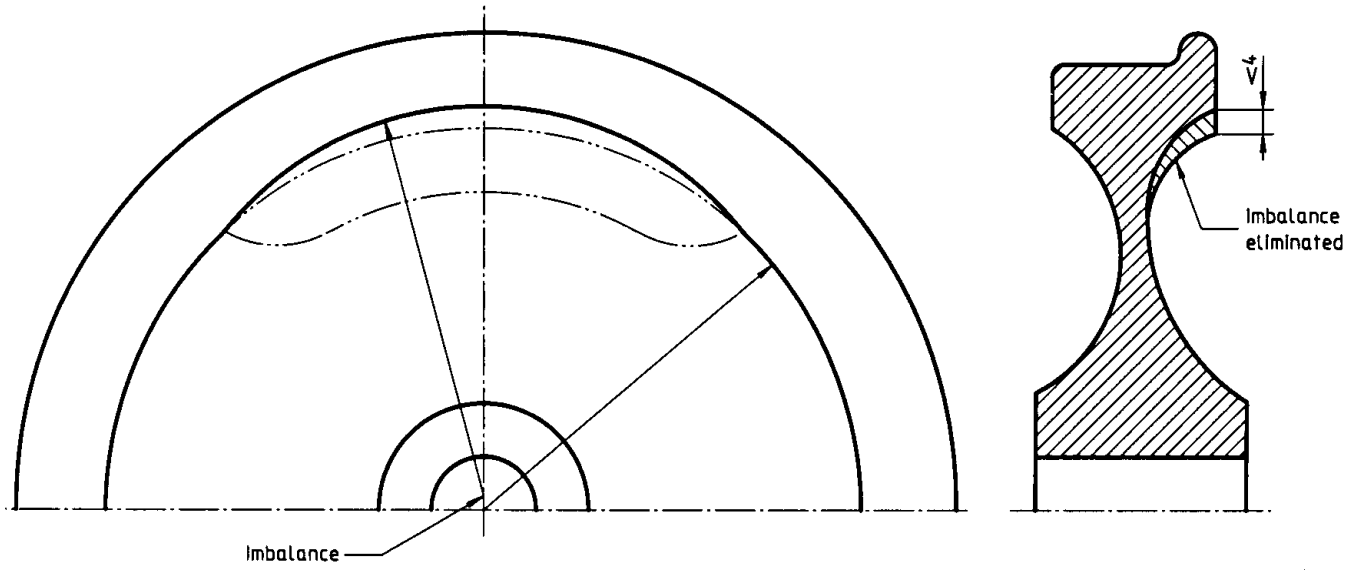


Figure 3 — Example for correction of imbalance

6.7 Removal of surface defects

6.7.1 Authorized repairs

With the exception of finished sections on which no retouching is authorized, superficial defects may be eliminated prior to static balancing and shot peening by chipping or machining or by soft grinding, provided that no heat cracking is produced, that the dimensional tolerances are maintained, and that the dressed surface is carefully blended into the adjacent surfaces. Where necessary, it shall be ensured by appropriate means, for example by a magnetic particle test, that any defect is completely eliminated.

6.7.2 Unauthorized repairs

Any welding, gas torch treatment, heating, electric burns, filling by metallization, electrolytic or chemical deposits, etc., and any retouching with the object of concealing a defect, are not permitted and shall result in the rejection of the complete test unit.

6.8 Shot peening

When shot peening is specified, the web surface shall be shot peened in accordance with the procedure specified in annex A. Shot peening shall be performed after any corrective surface preparation in the web area.

The peened appearance of surfaces, other than the web, shall not be a cause for rejection.

7 Inspection

7.1 Responsibilities and type of inspection

7.1.1 *The inspection to ensure compliance with the manufacturing methods (see clause 6) and with the quality requirements (see clause 5) may be carried out either*

a) under delegated inspection by the manufacturer's qualified department (see note 4); or

b) in the presence of the purchaser, the manufacturer's representative or a body designated by him.

Unless otherwise specified in the order, the inspection of manufacturing methods shall be considered to be delegated to the manufacturer's qualified department, and the inspection of quality requirements shall be as shown in table 2, column 5.

NOTE 4 *The term "qualified department" indicates, here and in the following text, a testing and certification department of the manufacturer independent of his manufacturing departments which is authorized, in accordance with ISO 10474, to issue inspection certificates of type 3.1.B.*

7.1.2 Delegation of inspection by the purchaser to the qualified department of the manufacturer does not remove the right of the purchaser to monitor the effectiveness of the manufacturing controls and of the testing and inspection methods.

In this respect, he shall be allowed to witness any of the tests made under the responsibility of the manufacturer and to inspect the recorded results.

7.2 Inspection of manufacture

Whether the inspection of manufacture is the responsibility of the manufacturer's qualified department or of the purchaser, the following shall apply.

7.2.1 The manufacturer shall advise the purchaser of the principal process which will be used in completing the order, and shall advise the purchaser of any subsequent fundamental changes which he proposes to introduce and which may affect the quality of the wheels and seek his prior agreement.

If the inspection remains the responsibility of the purchaser, his representative shall be allowed to inspect the manufacturing processes used in order to ensure compliance with the requirements of this part of ISO 1005 and the prior agreement.

7.2.2 At the time of submission for acceptance, the manufacturer shall certify that the manufacturing requirements of this part of ISO 1005 have been complied with (see 7.5).

7.3 Inspection of the characteristics of the wheels

7.3.1 Testing categories and types of tests

This part of ISO 1005 differentiates between a testing category A and a testing category B.

Table 2 specifies the types of tests included in these testing categories and whether these tests are mandatory or optional.

7.3.2 Test units

For each type of test, table 2, column 7 specifies the composition of the test unit for the relevant type of test, on the basis of the manufacturing characteristics of the wheels.

For specific inspection of the mechanical properties, each test unit shall be formed of wheels produced from the same cast and having undergone the same heat treatment. It may include wheels of a different shape. In the case of testing category A wheels, all the wheels of a test unit for testing the mechanical properties shall be of the same nominal diameter and rim section. In the case of testing category B wheels, a test unit may contain wheels of different nominal diameters and rim sections, provided that at least one hardness test is made for at least one wheel per nominal diameter and rim section.

7.3.3 Condition of wheels when submitted for inspection

When submitted for inspection, the condition of wheels shall comply with the requirements of table 2, column 6.

7.4 Submission for inspection by the purchaser

7.4.1 The purchaser or his representative or the body designated by him [see 7.1.1 b)] shall, where appropriate, be notified in writing (see 7.5.2) of the date of submission for inspection, stating the order reference number and the number of wheels in each test unit formed for testing the mechanical properties.

7.4.2 If inspections, which are to be carried out after machining in accordance with table 2, column 6, are the responsibility of the purchaser [see 7.1.1 b)], then the manufacturer may submit the material in two stages:

a) after the final heat treatment but before machining; and

b) in the final delivery condition.

7.5 Certification

7.5.1 Whether the inspection of manufacture is the responsibility of the manufacturer's qualified department or of the purchaser, the manufacturer shall certify that the manufacturing requirements of this part of ISO 1005 have been complied with. The final test certificate shall also include the results of the following tests:

— chemical analysis;

— tensile test (only for testing category A);

— impact test (only for testing category A);

— hardness survey test, if this is required (only for testing category A);

— rim hardness of each wheel tested (only for testing category B);

— hardness of each wheel tested, if tests on uniformity of rim hardness are required.

Furthermore, the certificate shall include statements that the results of the other mandatory tests and checks and of the ordered optional tests and checks (see table 2) were in conformance with the requirements.

7.5.2 The manufacturer shall provide the relevant certificate for those tests and checks for which he is responsible, at the following times:

a) if he has the delegated responsibility for all tests, at the time of delivery;

b) if the wheels are submitted in one stage for the inspection by the purchaser, his representative or a body designated by him, at the time of submission for inspection;

c) if, in accordance with 7.4.2, the wheels are submitted in two stages for the inspection by the purchaser, his representative or a body designated by him:

   — for tests and checks to be carried out,

   — after the final heat treatment but before machining: at the time of the first submission for inspection,

   — otherwise, at the time of the final submission for inspection.

7.6 Number of checks and tests

The number of wheels per test unit to be subjected to the checks and the number of tests per wheel are given in table 2, column 8 and 9.

7.7 Sampling and preparation of samples and test pieces

7.7.1 General

7.7.1.1 In cases where not every wheel is to be tested (see table 2, column 8), the inspector shall select at random the wheel(s) intended for testing.

7.7.1.2 If a residual stress test is required, this test shall be carried out before cutting out the sample segments for other tests.

7.7.1.3 When test pieces are to be taken from the wheels, the inspector shall outline, on each of the wheels selected for the tests, a sample segment from which the test piece(s) shall be cut out (see figure 4).

7.7.1.4 *Unless otherwise specified, the preparation and identification of samples and test pieces shall be carried out in accordance with the requirements of ISO 377-1 and ISO 377-2.*

7.7.1.5 The inspector's identification marks and stamps on samples and test pieces shall be retained and may not, unless otherwise agreed, be altered except in his presence.

7.7.2 Product analysis

When a product analysis is to be carried out, depending on the choice of the manufacturer and in accordance with ISO 377-2, the sample shall be taken from the following locations:

a) in the case of wheels of testing category A, from one of the wheels selected for the mechanical tests,

   1) either from chips representing a radial section of the wheel, or

   2) from the tensile test piece taken from position 1 in figure 4;

b) in the case of wheels of testing category B, from surplus material at the bore.

In cases of dispute, however, only the provisions in a)1) shall apply.

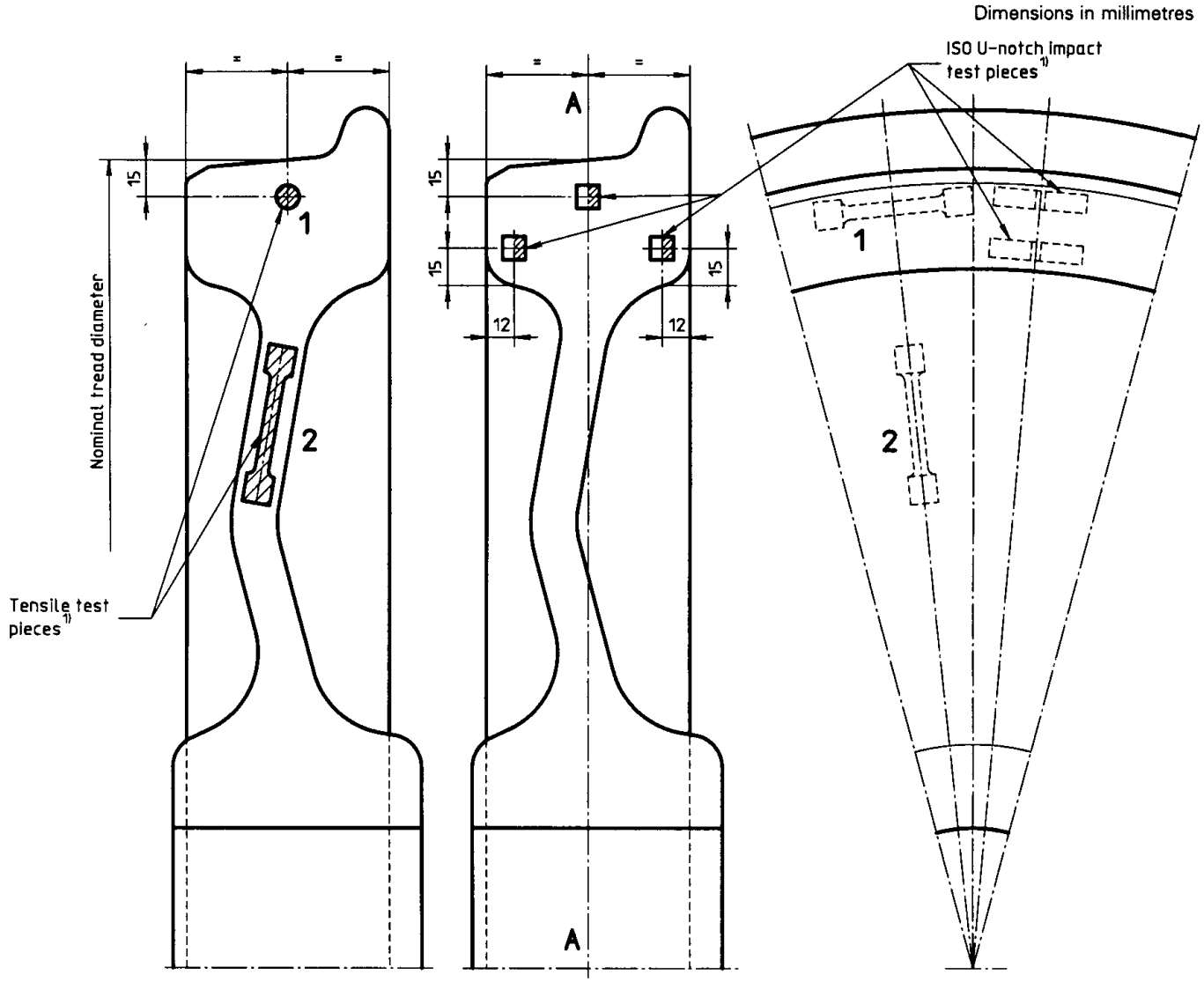
7.7.3 Mechanical tests

7.7.3.1 Tensile test

One test piece shall be taken from each test wheel from position 1 of the sample shown in figure 4.

In the case of rim-quenched and tempered wheels (T), one further tensile test piece shall be taken from position 2 shown in figure 4.

The test pieces shall be prepared in accordance with the requirements of ISO 6892, the test piece preferably having a diameter of at least 10 mm with a gauge length of 5 × diameter.



1) The position of the test pieces is related to the nominal tread surface.

Figure 4 — Position of tensile and impact test pieces

7.7.3.2 Impact test (U-notch)

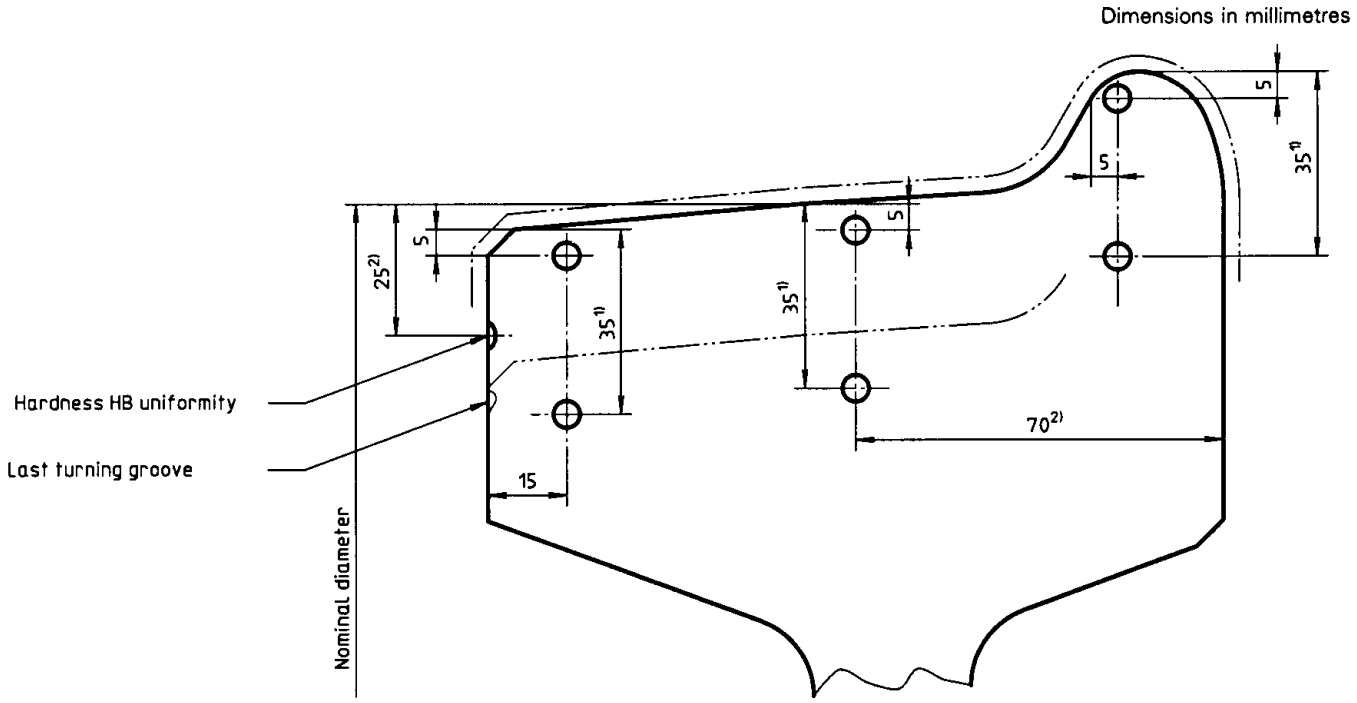
Three test pieces shall be taken from the sample at the positions shown in figure 4. The impact test pieces shall be marked to identify their longitudinal surfaces which are parallel to axle AA (see figure 4). The test pieces shall be prepared in accordance with the requirements of ISO 83. The longitudinal axis of the cylindrical bottom of the notch shall be parallel to axle AA in figure 4.

7.7.3.3 Rim-hardness test and uniformity of rim hardness

The wheels to be tested (see table 2) shall be subjected to a Brinell hardness test, according to ISO 6506, on the plane face of the rim on the side opposite the flange. The position selected for indentation shall be on a circumference with a radius approximately 25 mm less than that of the nominal tread diameter (see figure 5). The position shall, where appropriate, be prepared by grinding or milling in order to remove any decarburized material.

7.7.3.4 Hardness survey test

The test piece shall consist of a small plate comprising the complete radial section of the rim and its joint with the web, selected from the sample segment (see figure 5). One of its faces shall be prepared in accordance with ISO 6506. The six hardness indentations shall be situated on the three radial lines shown in figure 5.



1) Where the limit of the total tread wear is less than 35 mm, the indentations shall be made at the wear limit instead of the 35 mm distance.
2) Unless otherwise defined.

Figure 5 — Position of the Brinell hardness impressions

7.7.3.5 Residual stresses

See 7.7.1.2 and 7.8.2.4.

7.7.4 Checks for appearance and soundness

7.7.4.1 Magnetic particle test

The test piece is the wheel. For details of preparation see ISO 6933.

7.7.4.2 Ultrasonic test

The test piece is the wheel in the ordered heat-treatment condition and an appropriate surface condition (see ISO 5948).

7.7.4.3 Static imbalance

The test piece is the finished wheel.

7.8 Test methods

7.8.1 Chemical analysis

The chemical analysis shall be carried out in accordance with the methods defined by the corresponding International Standards (see ISO/TR 9769) or by any other appropriate methods including spectrographic ones. In the case of dispute, only test methods recommended by ISO shall be used.

7.8.2 Mechanical tests

7.8.2.1 Tensile test

The tensile test shall be carried out in accordance with the requirements of ISO 6892.

7.8.2.2 **Impact test** (with U-shaped notch)

The impact test shall be carried out in accordance with the requirements of ISO 83.

7.8.2.3 Brinell hardness

The Brinell hardness test shall be carried out in accordance with the requirements of ISO 6506.

The hardness survey test shall be carried out with a ball of nominal diameter of not more than 5 mm.

7.8.2.4 Checking of the residual stresses

Two marks 100 mm apart shall be made in the centre of the thickness of the rim, on the flat surface on the side opposite the flange; a radial cut from the top of the flange through to the bore shall then be made half-way between the two marks.

The distance between the marks shall then be measured; it shall have decreased by at least 1 mm.

7.8.3 Checks for appearance and soundness

7.8.3.1 Visual checks

The wheels shall be checked by visual inspection before delivery.

7.8.3.2 Magnetic particle test

The tests shall be carried out in accordance with ISO 6933.

7.8.3.3 Ultrasonic discontinuity detection test

The tests shall be carried out in accordance with ISO 5948.

7.8.4 Dimensional checks

The dimensions shall be checked for accordance with the requirements of ISO 1005-8. For this purpose, gauges may be applied. If the circumference (tape size) shall be measured instead of the diameter, this shall be agreed upon at the time of enquiry and order.

7.8.5 Static balance

The residual imbalance of the wheel shall be checked by means of a suitable device agreed by the purchaser.

7.9 Retests

The requirements for retests in ISO 404 shall apply, unless otherwise agreed.

7.10 Conclusion of the inspection

Any defects in appearance, dimensions or balancing, shall result in rejection of the wheel from acceptance. The same shall apply to any ultrasonic or magnetic particle examination revealing defects greater than those which may be tolerated.

Any other result not conforming with the requirements of this part of ISO 1005 shall result in the rejection of the corresponding test unit from acceptance, subject to the requirements for sorting and reprocessing of ISO 404.

Before delivery, all accepted wheels shall be marked by the inspector after the final inspection and the inspector's marks shall be placed in an adjacent position to the manufacturer's marks.

8 Delivery

8.1 Protection against corrosion during transport

If specified in the order, after inspection and before storage or despatch, at least all finished machined portions other than the tread profile of the accepted wheels shall be protected against corrosion by a method agreed with the purchaser.

NOTE 5 The efficiency of any protective coatings is only of limited life, especially under conditions of sea transport or in geographical regions of high humidity. Therefore, the delivered wheels should be inspected immediately on arrival at their destination, to see if a renewal of the protection is necessary.

8.2 Protection against mechanical damage during transport

The finished machined portions, especially the bores of the wheels, shall be provided with effective protection against mechanical damage before despatch.

Table 1 — Grade of steel, chemical composition, types of heat treatment in the delivery condition and mechanical properties

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Steel designations				Chemical composition according to cast analysis (product analysis) [1] % (m/m)						Heat-treatment condition [2]	Testing category [3]	Tensile properties [4] for test piece							Other mechanical properties			
for rolled or forged wheels		for cast wheels										1 (see figure 4)				2 (see figure 4)						
New [10]	Old [11]	New [10]	Old [11]	C max.	Si max.	Mn max.	P [5] max.	S [5] max.	Others			R_{eH} or $R_{p0,2}$ [6] N/mm²	R_m N/mm²	A [7] min. forged %	A [7] min. cast %	R_m max. N/mm²	A [7] min. forged %	A [7] min. cast %	KU [8] min. J	Rim hardness [9] HB	Hardness survey	Residual stress
C44GW-N-A	R1-N	GC44GW-N-A	RC1-N							N	A	12)	600 to 720	18	9	—	—	—	15	—	—	—
C44GW-N-B		GC44GW-N-B		0,46	0,40	0,90	0,040	0,040	13)		B	—	—	—	—	—	—	—	—	166 to 217	—	—
C44GW-T-A	R6-T	GC44GW-T-A	RC6-T	(0,48)	(0,43)	(0,95)	(0,045)	(0,045)		T14)	A	12)	770 to 890	15	8	15)	16	9	15	—	16)	17)
C44GW-T-B		GC44GW-T-B									B	—	—	—	—	—	—	—	—	197 to 277	—	—
C48GW-N-A		GC48GW-N-A								N	A	12)	630 to 750	17	8	—	—	—	14	—	—	—
C48GW-N-B		GC48GW-N-B		0,50	0,40	0,90	0,040	0,040	13)		B	—	—	—	—	—	—	—	—	174 to 223	—	—
C48GW-T-A	R7-T	GC48GW-T-A	RC7-T	(0,52)	(0,43)	(0,95)	(0,045)	(0,045)		T14)	A	12)	820 to 940	14	7	15)	16	8	15	—	16)	17)
C48GW-T-B		GC48GW-T-B									B	—	—	—	—	—	—	—	—	235 to 285	—	—
C51GW-N-A		GC51GW-N-A								N	A	12)	660 to 800	15	7	—	—	—	12	—	—	—
C51GW-N-B		GC51GW-N-B		0,54	0,40	0,90	0,040	0,040	13)		B	—	—	—	—	—	—	—	—	187 to 241	—	—
C51GW-T-A	R8-T	GC51GW-T-A	RC8-T	(0,57)	(0,43)	(0,95)	(0,045)	(0,045)		T14)	A	12)	860 to 980	13	6	15)	16	7	15	—	16)	17)
C51GW-T-B		GC51GW-T-B									B	—	—	—	—	—	—	—	—	248 to 302	—	—

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Steel designations				**Chemical composition according to cast analysis (product analysis) [1]** % (*m/m*)						**Heat-treatment condition [2]**	**Testing category [3]**	**Tensile properties [4] for test piece**							**Other mechanical properties**			
												1 (see figure 4)				2 (see figure 4)						
for rolled or forged wheels		**for cast wheels**		**C**	**Si**	**Mn**	**P [5]**	**S [5]**	**Others**			R_{eH} or $R_{p0,2}$ [6]	R_m	A [7] min.		R_m max.	A [7] min.		KU [8] min.	**Rim hardness [9]**	**Hardness survey**	**Residual stress**
New[10]	Old[11]	New[10]	Old[11]	max.	max.	max.	max.	max.				N/mm²	N/mm²	forged %	cast %	N/mm²	forged %	cast %	J	HB		
C55GW-N-A	R2-N	GC55GW-N-A	RC2-N							N	A	[12]	700 to 840	14	6	—	—	—	10	—	—	—
C55GW-N-B		GC55GW-N-B		0,58	0,40	0,90	0,040	0,040	[13]		B	—	—	—	—	—	—	—	—	197 to 255	—	—
C55GW-T-A	R9-T	GC55GW-T-A	RC9-T	(0,61)	(0,43)	(0,95)	(0,045)	(0,045)		T[14]	A	[12]	900 to 1 050	12	5	[15]	14	6	12	—	[16]	[17]
C55GW-T-B		GC55GW-T-B									B	—	—	—	—	—	—	—	—	255 to 311	—	—
C64GW-N-A	R3-N	GC64GW-N-A	RC3-N							N	A	[12]	800 to 940	11	5	—	—	—	10	—	—	—
C64GW-N-B		GC64GW-N-B		0,67	0,40	0,90	0,040	0,040	[13]		B	—	—	—	—	—	—	—	—	223 to 285	—	—
C64GW-T-A		GC64GW-T-A		(0,70)	(0,43)	(0,95)	(0,045)	(0,045)		T[14]	A	[12]	940 to 1 140	11	4	[15]	12	5	10	—	[16]	[17]
C64GW-T-B		GC64GW-T-B									B	—	—	—	—	—	—	—	—	277 to 341	—	—
C74GW-N-A		GC74GW-N-A								N	A	[12]	830 to 1 000	9	4	—	—	—	8	—	—	—
C74GW-N-B		GC74GW-N-B		0,77	0,40	0,90	0,040	0,040	[13]		B	—	—	—	—	—	—	—	—	235 to 311	—	—
C74GW-T-A		GC74GW-T-A		(0,80)	(0,43)	(0,95)	(0,045)	(0,045)		T[14]	A	[12]	1 040 to 1 240	9	3	[15]	10	4	8	—	[16]	[17]
C74GW-T-B		GC74GW-T-B									B	—	—	—	—	—	—	—	—	293 to 363	—	—

1) *Unless otherwise agreed, the requirements for the chemical composition shall be verified by cast analysis. However, in cases of dispute, the compositions according to product analysis shall be the deciding criteria.*

2) Heat-treatment condition:

N = Normalized or normalized and tempered

T = Rim quenched and tempered (The symbol T may be changed at a later date.)

3) See note 1 in 1.1 and table 2.

4) R_{eH} = Upper yield stress

$R_{p0,2}$ = 0,2 % proof stress (non-proportional elongation)

R_m = Tensile strength

A = Percentage elongation after fracture ($L_o = 5{,}65\sqrt{S_o}$).

5) *In the case of normalized (N) or rim quenched and tempered (T) wheels, a maximum phosphorus and sulfur content of* 0,035 % *for product analysis (and max.* 0,030 % *cast analysis) may be agreed upon at the time of enquiry and order.*

In the case of steel made by an acid process, by agreement at the time of enquiry and order, a maximum phosphorus and sulfur content of 0,055 % for product analysis (and max. 0,050 % for cast analysis) is permitted.

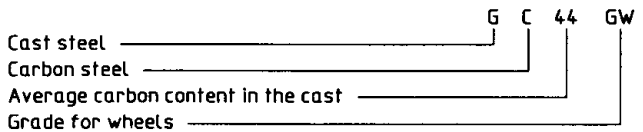
6) If the measured 0,5 % total elongation proof stress $R_{t0,5}$ of the steel is not greater than 600 N/mm^2, $R_{t0,5}$ can be given instead of R_{eH} or $R_{p0,2}$.

7) The low elongation values of cast wheels of category A require a "low stress" (curved plate) design if these wheels are subject to significant or severe on-tread braking.

8) KU = mean value of three ISO U-notch tests at room temperature (23 °C ± 5 °C). For the individual results, the conditions of ISO 404 apply.

9) The difference between the extreme hardness values measured on the rim of wheels of the same batch shall not exceed the values quoted. The uniformity of rim hardness shall be 30 HB.

10) The first part of the new designation is in accordance with the designation system for steel names described in ISO/TR 4949. The various symbols in the steel name have the following meaning:



The symbol after the first hyphen stands for the heat-treatment condition. The symbol T (treat hardened) will in future be reserved for tempered. If this could lead to confusion, the T should be replaced, for example by TM or TR (R for "rim quenched and tempered").

The symbol after the second hyphen stands for the testing category.

11) "Old" means designations according to the first edition of ISO 1005-6:1982.

12) To be given for documentary purposes.

13) Cr ⩽ 0,30 % (⩽ 0,28 %)

Cu ⩽ 0,30 % (⩽ 0,28 %)

Mo ⩽ 0,08 % (⩽ 0,08 %)

Ni ⩽ 0,30 % (⩽ 0,28 %)

V ⩽ 0,05 % (⩽ 0,05 %)

14) *In special cases, if the delivery of immersion-quenched (E) wheels is agreed upon, the tensile, impact and hardness values specified in this table for the heat-treatment condition T shall apply. However, for specially designed wheels, reduced rim tensile and hardness values may be agreed upon at the time of enquiry and order.*

15) The tensile strength value of the web shall be lower than the tensile strength value of the rim by at least: 100 N/mm^2 for C44GW and C51GW; 70 N/mm^2 for C55GW; 50 N/mm^2 for C64GW and C74GW.

16) The depth of the rim quenching effect, estimated from the results of the hardness tests (see 7.7.3.4) shall be not less than the total depth of wear.

The order or its appended documents may also specify the minimum hardness at the limit of the depth of wear.

17) The object of rim quenching and tempering is, in part, to produce favourable residual compression stresses circumferentially in the rim of the wheel. The manufacturer shall demonstrate that the procedure used for rim quenching and tempering results in an adequate magnitude of residual circumferential compression. One method of doing this is described in 7.8.2.4.

Table 2 — Type and number of tests and checks

1	2		3	4				5	6	7	8	9
	Tests and checks		Symbols	The tests and checks are mandatory (m) optional (o) for wheels in the heat-treatment condition[1]				Remarks		Test unit[2]	Number of wheels to be tested per test unit	Number of tests per wheel
				Category A		Category B		3)	4)			
				N	T	N	T					
1		Chemical analysis (see 5.1) — according to cast analysis		m[5]	m[5]	m[5]	m[5]	—	—	c	—	—
		— according to product analysis	PA	o	o	o	o	a	—	c	1	1
2	Mechanical tests	Tensile test		m	m	—	—	b	h	c, h	1	1
3		Tensile test, web		—	m[6]	—	—	b	h	c, h	1	1
4		Impact test (KU)		m	m	—	—	b	h	c, h	1	3
5		Rim hardness test	RH	—	—	m	m	a	h	c, h	10 % [7]	1
6		Hardness survey test	HS	—	o[6]	—	—	b	h	c, h	1	(see 7.7.3.4)
7		Testing the residual stress	RS	—	m[6]	—	—	b	h	c, h	1	1
8		Uniformity of rim hardness		o	o	o	o	a	h	c, h	100 %	
9	Appearance and soundness	Visual checks		m	m	m	m	a	—	w	100 %	1
10		Magnetic particle test and ultrasonic flaw detection test — for rolled or forged wheels	MP & US	o	o	m	m	a	—	w	100 %	1
		— for cast wheels						a	—	w	100 %	1
11	Dimensional checks			m[8]	m[8]	m[8]	m[8]	a	f	w	100 % [8]	1
12	Static balancing test		SB	o	o	o	o	a	f	w	100 %	1

1) N = Normalized or normalized and tempered

T = Rim quenched and tempered

2) c = Wheels from the same cast

c, h = Wheels from the same cast and the same heat-treatment cycle (see 7.3.2)

w = The wheel is the test unit.

3) *Unless otherwise agreed (see 7.1), the checks or tests are to be carried out*

a) under delegated inspection by the manufacturer's qualified department (see ISO 404); or
b) in the presence of the purchaser.

4) h = The tests shall not be carried out before the ordered heat treatment.

f = The acceptance tests are to be carried out in the final delivery condition.

5) When no product analysis is ordered, the manufacturer shall provide a certificate, at the time of first submission for inspection, for the results of his cast analysis.

6) In the special cases where, in accordance with table 1, footnote 13, the delivery in the immersion quenched and tempered condition (E) has been agreed upon, tensile tests on test pieces from the web, hardness survey tests and tests for the determination of residual stresses are not required.

7) However, for less than 20 wheels, at least two shall be tested.

8) For some of the dimensional characteristics, the checks are in accordance with ISO 1005-8, tables 3 to 5 (optional). If checks are agreed upon for these characteristics, the number of wheels to be tested shall also be agreed upon.

Annex A
(normative)

Procedure for shot peening web surfaces of wheels

A.1 General

A.1.1 When specified, shot peening of the web surfaces shall be performed in accordance with the requirements in A.1.2 and A.1.3.

A.1.2 Hardened steel shot of diameter 1,40 mm or larger should be used, 90 % of the shot having a hardness of 40 HRC to 50 HRC.

A.1.3 The shot-peening machine shall be equipped with a separator to remove broken shot continuously. Sufficient new shot should be added to ensure that at least 85 % of shot in the machine is of the specified size or larger.

A.2 Peening intensity

The peening intensity, when measured on a test strip of the kind described in A.3 under the conditions specified in A.4 to A.7, shall be sufficient to produce an average arc height of not less than 0,20 mm.

NOTE 6 The location of the test strips will vary with the plate design and cannot be precisely quantified in this annex.

A.2.1 Standard plate design (see figure A.1)

The test strip is located on the front plate near the hub fillet and on the back plate near the rim fillet.

A.2.2 Reverse plate design (see figure A.2)

The test strip is located on the front plate near the rim fillet and on the back plate near the hub fillet.

A.3 Test strip

Test strips shall be produced from steel of grade CS 70 according to ISO 4960, to the following dimensions: 2,4 mm ± 0,02 mm thick, 75 mm ± 0,4 mm long, 20 mm + 0/ − 0,1 mm wide. Strips shall be uniformly hardened and heat set between flat plates for a minimum of 2 h at 425 °C ± 15 °C. The surface finish shall be grey blue and unpolished or bright tempered. The strips shall have a hardness range of 450 HV to 520 HV and shall be flat to within 0,025 mm.

A.4 Holding fixture

The test strip shall be clamped in a holding fixture of the kind shown in figure A.3.

A.5 Location of the test strips on the wheel

Holding fixtures with the test strips clamped on shall be located on the wheels as follows:

a) In the case of a standard web design: on the front side of the web near the hub fillet and on the back side of the web near the rim fillet.

b) In the case of a reverse web design: on the front side of the web near the rim fillet and on the back side of the web near the hub fillet.

c) In the case of other web designs: on locations to be agreed upon at the time of enquiry and order.

A.6 Coverage

The minimum peening time of the product and the test strip shall be sufficient to ensure that full coverage is attained on the test strip.

A.7 Measurement of the arc height

The gauge for determining the curvature of the test strips is shown in figure A.4. The test strip is placed in the instrument so that the indicator stem rests against the non-peened surface. The curvature of the strip is determined by measuring the height of the combined longitudinal and transverse chords, i.e. measuring the displacement, in millimetres, of a central point on the non-peened surface from the plane of the four supporting balls of the gauge.

A.8 Frequency of test

The test shall be carried out at the beginning and end of each production run, but not less than once in every 8 h of operation.

A.9 Retest

If a test fails to meet the specified height of 0,20 mm, two retests shall be carried out. The average of the results of these retests and the original test shall be calculated. This average shall be not less than the specified 0,20 mm, and the results of both retests shall be not less than 0,20 mm.

A.10 Repeening

When test values fail to meet the requirements of A.5, corrective action shall be initiated and satisfactory test values obtained before proceeding with production peening. If the average value of the unsatisfactory test is within the range 0,16 to 0,19 mm, the last half of the batch of wheels peened prior to the unsatisfactory test, but subsequent to a satisfactory test, shall be repeened with an exposure time of at least half the original exposure. If the average value is less than 0,16 mm, all the wheels peened since the last satisfactory test shall be repeened with full exposure.

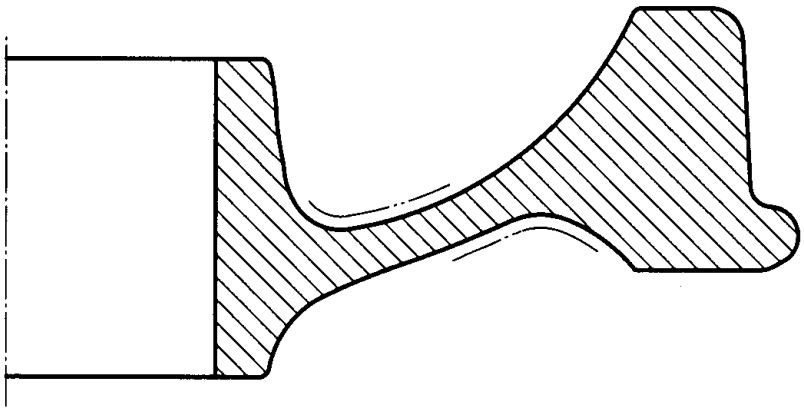


Figure A.1 — Location of peening test strips on the front side of the web near the hub fillet and on the back side of the web near the rim fillet of wheels of standard design

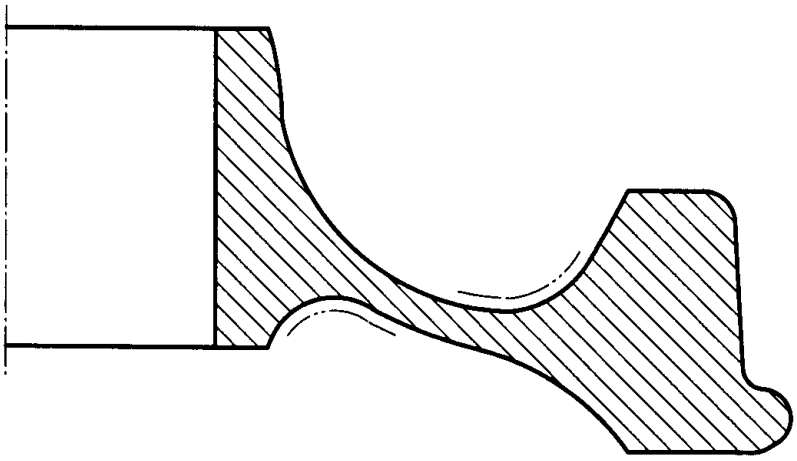


Figure A.2 — Location of peening test strips on the back side of the web near the hub fillet and the front side of the web near the rim fillet of reverse plate wheels

Dimensions in millimetres

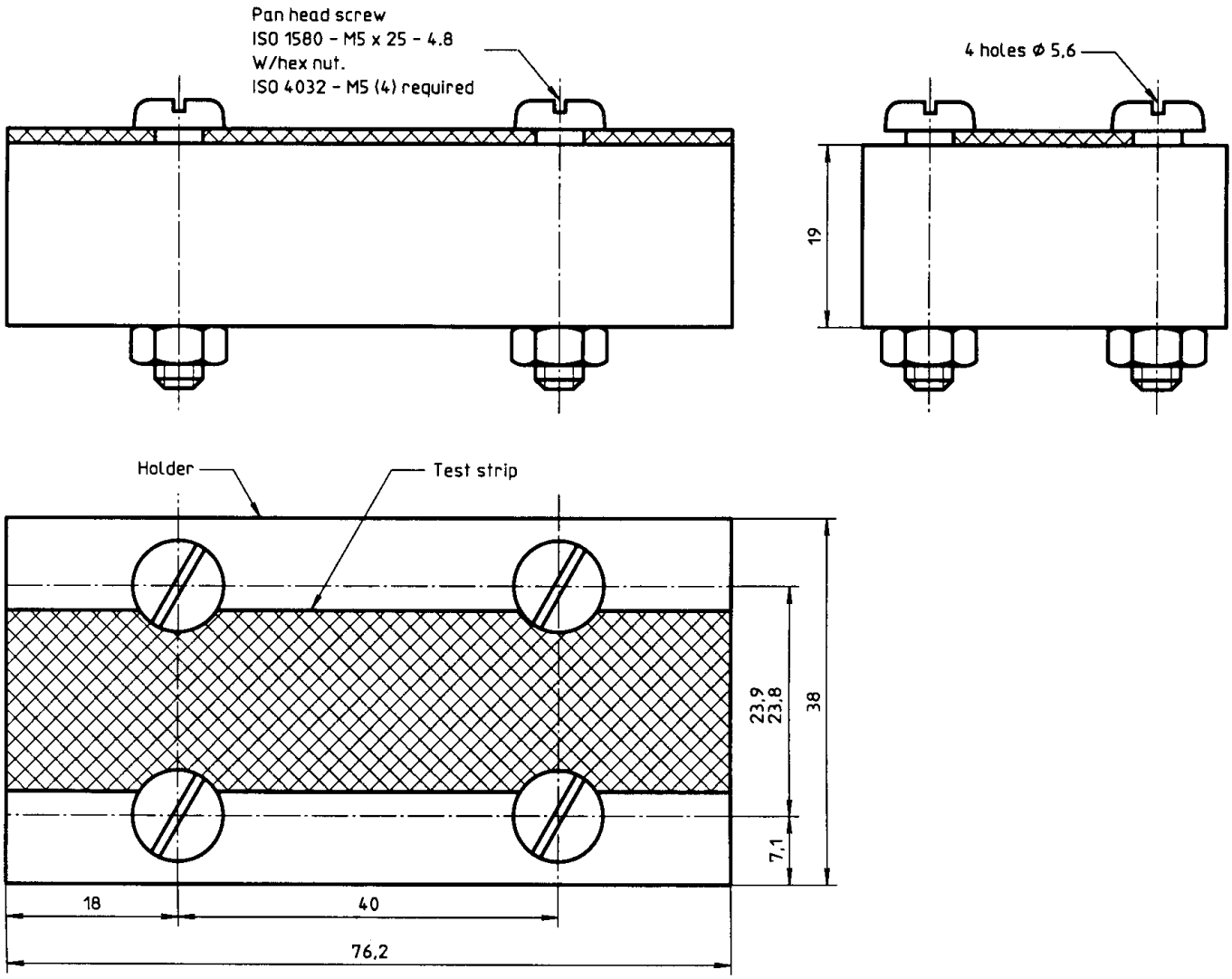


Figure A.3 — Assembled test strip and holder

Dimensions in millimetres

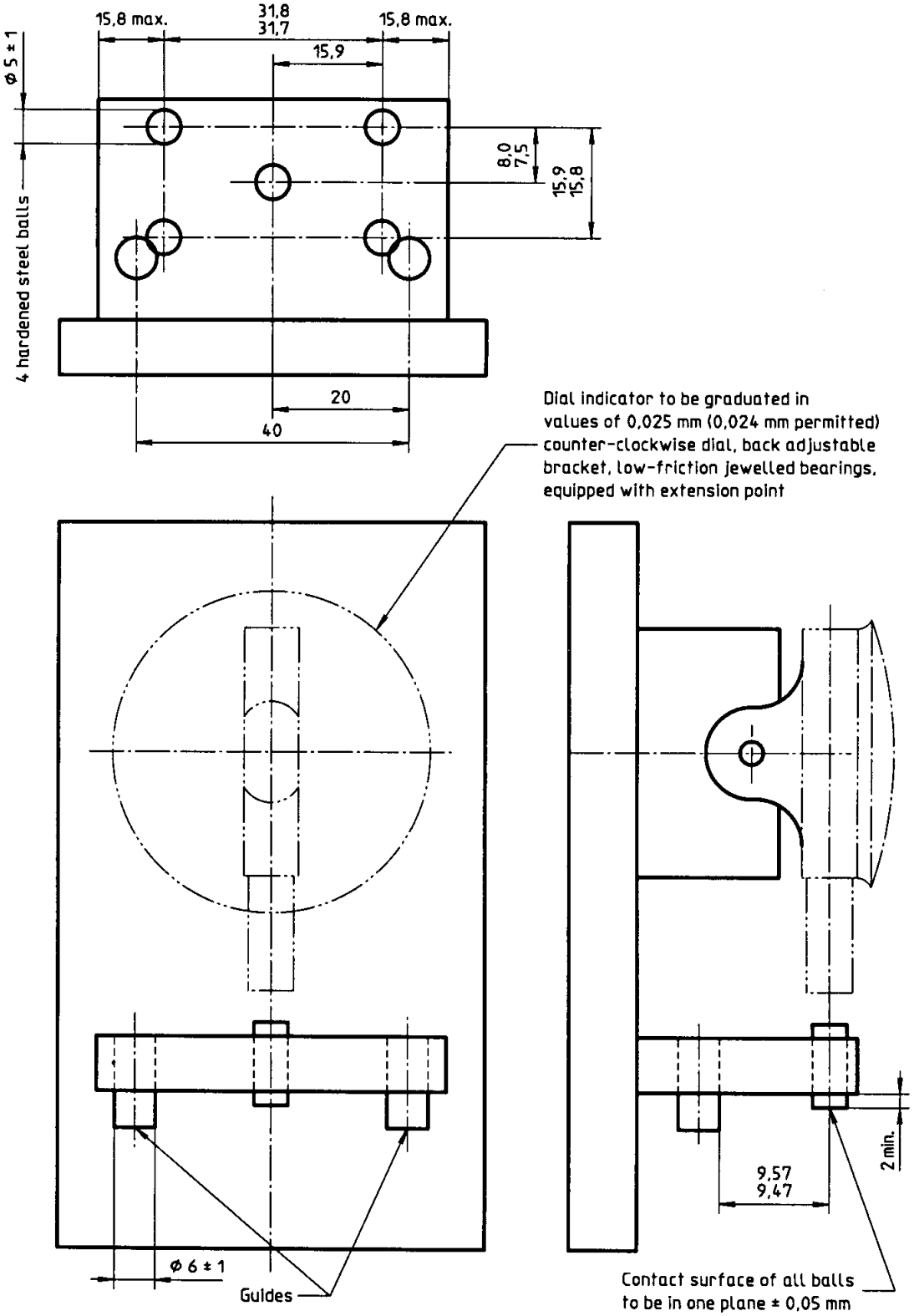


Figure A.4 — Almen gauge

Annex B
(informative)

Bibliography

[1] ISO 683-1:1987, *Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Direct-hardening unalloyed and low-alloyed wrought steel in form of different black products.*

[2] ISO 1005-7:1982, *Railway rolling stock material — Part 7: Wheelsets for tractive and trailing stock — Quality requirements.*

[3] ISO 4960:1986, *Cold-reduced carbon steel strip with a carbon content over 0,25 %.*