International Standard ISO 2604/8

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Steel products for pressure purposes — Quality requirements —
Part 8 : Plates of weldable fine grain steels with high proof stress supplied in the normalized or quenched and tempered condition (thicknesses from 3 to 70 mm)

Produits en acier pour appareils à pression — Spécifications de qualité — Partie 8 : Tôles en aciers soudables à grains fins à haute limite conventionnelle d'élasticité livrées à l'état normalisé ou trempé et revenu (épaisseurs de 3 à 70 mm)

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2604/8 was prepared by Technical Committee ISO/TC 17, *Steel*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Steel products for pressure purposes — Quality requirements — Part 8 : Plates of weldable fine grain steels with high proof stress supplied in the normalized or quenched and tempered condition (thicknesses from 3 to 70 mm)

1 Scope and field of application

This part of ISO 2604 specifies the quality requirements for plates for pressure purposes of thicknesses from 3 to 70 mm of weldable fine grain steels (see note 1) with high proof stress supplied either in the normalized or normalized plus tempered condition [see steels in table 1a)] or in the quenched and tempered or precipitation-hardened condition [see steels in table 1b) and see note 2].

Each steel type is subdivided into

— a basic grade

— an elevated temperature grade (symbol H : high temperature)

— a low temperature grade (symbol L).

NOTES

1 Under fine grain steels are here understood steels with a grain size 6 or finer according to the grain size charts in ISO 643.

2 Unless otherwise indicated, the term "quenched and tempered" when used also covers the precipitation-hardened condition.

3 ISO 2604/4 and ISO 2604/7 cover quality requirements for plates for pressure purposes manufactured from other types of steel than those given in tables 1a) and 1b). It is intended to combine these two parts of this International Standard into one at a later date.

2 References

ISO 148, *Steel — Charpy impact test (V-notch).*

ISO/R 377, *Selection and preparation of samples and test pieces for wrought steel.*

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

ISO 643, *Steels — Micrographic determination of the ferritic or austenitic grain size.*

ISO/R 783, *Mechanical testing of steel at elevated temperatures — Determination of lower yield stress and proof stress and proving test.*

ISO 2566/1, *Steel — Conversion of elongation values — Part 1 : Carbon and low alloy steels.*

ISO 2604, *Steel products for pressure purposes — Quality requirements —*

Part 4 : Plates.

Part 7 : Carbon steel plate (thicknesses over 100 to 250 mm). [1]

ISO 2605, *Steel products for pressure purposes — Derivation and verification of elevated temperature properties —*

Part 1 : Yield or proof stress of carbon and low alloy steel products.

Part 3 : An alternative procedure for deriving the elevated temperature yield-proof stress properties when data are limited. [1]

ISO 6892, *Metallic materials — Tensile testing.*

3 General requirements

3.1 Information to be supplied by the purchaser

3.1.1 The purchaser shall state on his enquiry and order the requirements given below :

a) the plate dimensions and tolerances (see 3.7);

b) the steel type [see tables 1a) and 1b)];

c) the inspection procedures and type of documents (see 3.8, 3.13 and 4.2).

1) At present at the stage of draft. Pending publication of these drafts as International Standards it will be necessary for the relevant requirements to be agreed by the purchaser and the manufacturer.

3.1.2 Certain alternatives are permitted by this part of ISO 2604 and the purchaser may also state on his enquiry and order his requirements as follows, but if no such statement is made, supply will be at the option of the manufacturer :

a) if plates for hot-forming are required, the heat-treatment condition of supply (see 3.3.2 and 3.10.1.5);

b) if a maximum copper content of 0,30 % (m/m) is required [see table 1a) and table 1b), note 5];

c) if a product (check) analysis is required (see 3.4.2);

d) if additional mechanical tests are required (see 3.5.1.3);

e) any special requirements for freedom from defects (see 3.6.2);

f) if the V-notch impact tests shall be carried out on longitudinal instead of transverse test pieces (see table 5, column 3) or at another temperature than the lowest (see 3.11.2);

g) the details of non-destructive tests, if required (see 3.10.3 and 3.11.3);

h) if elevated temperature proof stress tests are required and, if so, the testing temperature selected from table 4 (see 4.2.1.2);

i) if a verification of the elevated temperature proof stress values of table 4 without specific tests is required and, if so, the procedure to be applied (see 4.2.1.3).

NOTE — The optional requirements given under c), d), f) g) and h) are only applicable if under 3.1.1 c) an inspection certificate or an inspection report was ordered.

3.2 Manufacture of the steel

3.2.1 Unless otherwise stated on the enquiry and order, the steelmaking process within the provisions of 3.2.2 shall be at the option of the steel manufacturer.

3.2.2 The steel shall be produced by the open hearth, electric or one of the basic oxygen processes or by a combination of these processes. Other processes may be used by agreement between the interested parties[1]. If he so requests, the purchaser shall be informed of the steelmaking process used.

3.2.3 All steels shall be fully killed and be from casts with addition elements capable of producing a fine grain.

3.3 Heat treatment

3.3.1 Normal heat treatments

3.3.1.1 Plates of the steel types covered in table 1a) shall be supplied in the normalized or, if appropriate, in the normalized plus tempered condition.

The application of controlled temperatures during and after rolling or forming may take the place of normalizing, provided that the specified properties are complied with and can also be obtained after a further normalizing treatment.

3.3.1.2 Plates of the steel types covered in table 1b) shall, according to the choice of the manufacturer, be supplied

— either in a quenched and tempered condition

— or in a precipitation-hardened condition (see note 2 to clause 1).

The type of heat treatment intended by the manufacturer shall be indicated in the offer.

The purchaser shall be informed of the details of the heat treatment carried out by the producer. If during further processing of the steels a heat treatment must be undertaken by the user, details of suitable conditions for it should be provided by the manufacturer.

3.3.2 Other heat-treatment conditions

By agreement between the interested parties, the plates may be delivered in a condition other than those given in 3.3.1 (see, however, 3.10.1.5), for example for hot forming.

3.4 Chemical composition

3.4.1 Ladle analysis

The chemical composition of the individual steel types covered by this part of ISO 2604 may — depending on the type of alloy additions selected by the manufacturer and on the thickness of the product — be different. It shall, however, in each case comply with the requirements for the results of the cast analysis given for the relevant steel type in table 1a) or 1b).

As the chemical composition influences the welding characteristics, the manufacturer shall describe in his confirmation the type of alloy which he will supply. For this purpose, he shall indicate for the carbon content and, for the contents of the following other elements in as far as these are added to the steel, the limiting values for the cast analysis of his type of alloy :

Si, Mn, Al, B, Cr, Cu, Mo, N, Nb, Ni, Ti, V, Zr.

1) Such as the user, purchaser, and manufacturer of the equipment, the producer of the supplied construction material and the inspection and/or certifying authority.

3.4.2 Product analysis

3.4.2.1 If a check analysis on samples taken from the products in accordance with 3.4.2.2 is required, the permissible deviations given in table 2 shall apply to the limiting values given according to 3.4.1 by the manufacturer for the ladle analysis.

3.4.2.2 If a check analysis on the product is required, the number of samples to be taken shall be agreed between the interested parties.

The samples shall be taken either from the test pieces used for the verification of the mechanical properties, or from drillings through the whole thickness of the plate at the same location, as for the mechanical test samples. The requirements of ISO/R 377, covering the method of selection and preparation of the samples for chemical analysis, shall apply.

3.4.3 Cases of dispute

In cases of dispute, the methods for chemical analysis shall be in accordance with the relevant International Standards. If no International Standard is available, the methods to be used shall be agreed between the interested parties.

3.5 Mechanical and technological properties

3.5.1 Mechanical properties

3.5.1.1 The tensile properties at room temperature to be obtained on test pieces selected, prepared and tested in accordance with 3.10.1 and 3.11.1 are given in tables 1a) and 1b).

3.5.1.2 The impact properties to be obtained on test pieces selected, prepared and tested in accordance with 3.10.1 and 3.11.2 are given in table 3.

3.5.1.3 If heat treatments different from, or additional to, those given in 3.3.1 are to be carried out after the delivery of the plates (which may have an adverse effect on the mechanical properties), the purchaser may require, at the time of enquiry and order, additional mechanical tests on additional samples. In this case, the heat treatment of the samples and the mechanical properties to be obtained on them shall be agreed between the interested parties at the time of enquiry and order.

NOTES

1 The mechanical properties can be affected by heating or reheating during fabrication. Purchasers who intend to heat or reheat any of the steels are advised to discuss the application and proposed heating or reheating treatment with supplier.

2 If plates of normalized fine grain steels are hot-formed, they shall have the same mechanical properties as specified in this part of ISO 2604, provided that the steel has not been heated to more than 1 100 °C and that, after forming, it has been cooled to a temperature below the transformation temperature and then normalized at the specified temperature.

However, the final normalizing may be omitted provided that

a) the hot-forming is done in one operation at the normalizing temperature;

b) if hot-forming is done in more than one operation, the plate is cooled to a temperature below the transformation temperature before the last operation, and this operation is then carried out at the normalizing temperature.

3.5.2 Weldability

The steels covered by this part of ISO 2604 are generally regarded as being weldable. However, the general weldability of the steels cannot be guaranteed as the behaviour of the steel during and after welding is dependent not only on the steel, but also on the welding conditions and the final use for which the steel is employed. Therefore, where appropriate, the welding procedure shall be agreed between the interested parties at the time of enquiry and order.

3.6 Surface condition and soundness

3.6.1 The plates shall have a workmanlike finish and shall be clean and free from surface and internal defects likely to have an adverse effect.

3.6.2 Any special requirements for freedom from defects shall be agreed between the parties concerned at the time of enquiry and order.[1)]

3.6.3 The requirements for surface defects, rectification and internal defects given in ISO 404 shall apply.

3.6.4 Before delivery or submission for acceptance, the surface defects shall be removed by the supplier by grinding, provided that the final thickness complies with the minimum tolerance and that the resulting depression is properly smoothed off in relation to the remainder of the surface. If the thickness has to be reduced below the minimum accepted value, this repair shall be carried out only with the agreement of the user or his representative. Large surface defects may, by agreement with the user or his representative, be repaired by grinding (possibly by chiselling), followed by welding and levelling of the weld. This operation shall be carried out under the following conditions :

a) The defects shall be completely eliminated before any filler metal is applied.

b) The total surface to be repaired shall not exceed 2 % of the surface area of the face of the plate in question.

c) The complete removal of the defects shall not reduce the thickness of the plate by more than 20 % of the nominal thickness.

d) It shall be verified that, after the total elimination of the defect, the two above conditions are complied with. Every

1) For hot-rolled steel plates and wide flats, see ISO 7788, *Steel — Surface finish of hot-rolled plates and wide flats — Delivery requirements.*

facility shall be given to the accepting agent (or to the representative of the user) to enable him if necessary to carry out the same verification.

e) The repair shall be carried out by qualified welders accepted by the user or his delegate, using a low hydrogen welding process and following a procedure suitable for the composition of the steel used for the plate and further heat treatments. This procedure shall be accepted by the user (or his representative). The welds shall be sound, without discontinuity or break. The filler metal, which shall be completely melted and joined throughout to the base metal shall finally present an excess thickness of at least 1,5 mm. This excess shall then be levelled by grinding (possibly preceded by chiselling) to give the repaired plate a technically smooth and uniform surface.

f) An examination of the quality of the repair shall be carried out ultrasonically, magnetoscopically, by dye penetration or, where applicable, by radiography. The technique used for the examination and the qualification of the operator shall be agreed by the user or his representative.

g) The repair of the defects shall be carried out before the final heat treatment.

h) In cases where plates are delivered untreated, repair by means of welding shall be followed by a post-weld heat treatment.

3.6.5 The position of repairs of defects shall be carefully marked and pointed out to the user. These marks shall be mentioned in the acceptance report.

3.7 Dimensions and tolerances

3.7.1 The dimensions of the plates shall be stated on the enquiry and order.

3.7.2 Until the relevant International Standards are available, the tolerances on dimensions and mass shall be agreed between the interested parties and stated on the enquiry and order.

3.7.3 The requirements of ISO 404 shall apply.

3.8 Inspection procedures

The purchaser shall indicate on his enquiry and order which of the inspection procedures listed in ISO 404 is to be followed.

NOTE — The inspection procedure selected shall, if appropriate, be compatible with the requirements of the International Standard covering the use of the product.

In cases where specific inspection and testing is ordered the specifications in 3.9 to 3.12 apply.

3.9 General rules for carrying out specific inspection and testing

The requirements of ISO 404 covering the following shall apply :

a) place of inspection and testing;

b) submission for inspection and testing;

c) rights of the inspector.

3.10 Number, selection and preparation of samples and test pieces

3.10.1 Mechanical tests

3.10.1.1 The requirements of ISO/R 377, covering the identification and preparation of samples and test pieces, shall apply.

3.10.1.2 For plates not exceeding 5 000 kg in mass and 15 m in length, one test sample sufficient for the required test pieces (see table 5 and 4.2.1.2) shall be taken from one end of each plate as rolled[1].

3.10.1.3 For plates exceeding 5 000 kg in mass or 15 m in length, one test sample sufficient for the required test pieces (see table 5 and 4.2.1.2) shall be taken from each end of each plate as rolled[1].

3.10.1.4 The test samples shall be selected from a position halfway between the edge and the axis of the plate.

3.10.1.5 The test samples shall be cut from the plate after this has been heat treated in accordance with 3.3.1.

If plates of normalized fine grain steels are to be delivered in a condition other than that given in 3.3.1.1 the test samples shall be subjected to a reference heat treatment complying with the requirements in table 1a) and the purchaser shall be informed of the actual heat treatment applied.

If plates of quenched and tempered fine grain steels are to be supplied in a condition other than that given in 3.3.1.2, tests on test pieces from reference heat-treated samples may be agreed at the time of enquiry and order. In this case the details of the reference heat treatment and the values to be obtained shall also be agreed at the time of enquiry and order (see also 3.5.1.3).

1) The term "plate as rolled" refers to the unit plate from a slab, or rolled directly from an ingot, in its relation to the location and number of specimens, not to its condition. If the plate is sheared or otherwise cut into smaller pieces after rolling, the tests made on test samples taken from the original plate shall apply unless the pieces are heat treated separately in which case each heat-treated piece shall be tested separately, (two test samples are required if the pieces weigh over 5 000 kg).

3.10.1.6 From each test sample, test pieces shall be taken in accordance with the conditions given in table 5.

3.10.2 Visual and dimensional inspection

Every plate shall be inspected visually and appropriate checks shall be made for compliance with the dimensional tolerances.

3.10.3 Non-destructive testing

If non-destructive testing is required by the order, every plate shall be tested, unless otherwise agreed between the interested parties.

3.11 Test methods

3.11.1 Tensile test at room temperature

3.11.1.1 The tensile test shall be carried out in accordance with ISO 6892.

3.11.1.2 The tensile strength R_m, the yield strength R_e and the elongation A shall be determined.

For the verification of the yield strength R_e, the upper yield stress R_{eH} or the 0,5 % total elongation proof stress $R_{t0,5}$ or the 0,2 % proportional elongation proof stress $R_{p0,2}$ may be determined.

However, in case of dispute, the upper yield stress value R_{eH} or, if no yield phenomenon occurs, the proof stress $R_{p0,2}$ shall be deciding.

The percentage elongation shall be reported with reference to a $5{,}65\sqrt{S_o}$ gauge length. If other gauge lengths are used, the corresponding elongation on $5{,}65\sqrt{S_o}$ shall be obtained by reference to ISO 2566/1. In cases of dispute, a gauge length of $5{,}65\sqrt{S_o}$ shall be used.

3.11.2 Impact test

The tests shall be carried out in accordance with ISO 148 at a temperature selected from table 3 and agreed between the interested parties at the time of enquiry and order. If no agreement has been made, the tests shall be carried out at the lowest temperature for which an impact value is indicated in table 3 for the relevant steel type and test piece orientation.

3.11.3 Non-destructive testing

If non-destructive tests for internal soundness, by methods such as radiography, ultrasonics, magnetic particle detection, or dye penetrants are required by the purchaser, this shall be the subject of agreement at the time of the enquiry and order. Any such agreement shall include details of the test procedure, and rules for acceptance or rejection.

3.12 Retests

The requirements of ISO 404 shall apply except in the case of impact tests. In this latter case, the following procedure shall be used.

If the average of three impact values is lower than the specified value, or if any one value is lower than 70 % of this specified value, three additional test pieces shall be taken from the same sample and tested. The average value of the six tests shall be not less than the specified value. Not more than two of the individual values may be lower than the specified value and not more than one may be lower than 70 % of this value.

3.13 Documents

The purchaser shall state at the time of enquiry and order which of the documents permitted by ISO 404 are to be provided (see also 3.8).

3.14 Marking

3.14.1 The plates shall be marked legibly and, if requested, indelibly to show :

a) the identification symbols for the type of steel, as given in tables 1a) or 1b);

b) the brand of the manufacturer of the plates;

c) symbols, letters or numbers which relate the test certificates, test pieces and products to each other.

3.14.2 Unless the provisions of 3.14.4 are valid, the symbols, letters or numbers shall be stamped or painted on a corner of each plate such that they read in the direction of rolling.

3.14.3 If paint is used for marking, it shall be free of lead, copper, zinc and tin.

3.14.4 On plates which are bundled or boxed, the information in 3.14.1 may be marked on the box, or on a tag securely attached to the bundle or box in which they are shipped.

4 Special requirements for plates in steel types having specified elevated temperature properties

4.1 Mechanical properties

4.1.1 For the elevated temperature grades (P xxx QH), the minimum elevated temperature proof stress values are given in table 4.

4.1.2 At the time of enquiry and order, it may be agreed that the minimum proof stress values of table 4 shall also apply for the low temperature grade of the relevant steel type.

4.2 Verification and testing

4.2.1 Elevated temperature proof stress

4.2.1.1 General

If so required, the elevated temperature proof stress values shall, according to the agreements at the time of enquiry and order, be verified either by specific tests (see 4.2.1.2) or without specific tests (see 4.2.1.3).

NOTE — The values given in table 4 are only provisional. International Standards now under preparation and covering the use of plates for pressure purposes will probably require that, if it is intended to use such provisional values for design purposes under application of the normal safety factor, the compliance of the deliveries with the required provisional values is to be verified.

4.2.1.2 Verification by specific tests

When the verification by specific tests has been agreed, one test shall be made on each cast using a test sample prepared in accordance with 3.10.1, and with the test piece taken at a position adjacent to one of the test pieces used for the tensile test at room temperature. If plates of more than one thickness are to be supplied from one cast, then the test shall be made on the thickest plate.

The proof stress tests at elevated temperature shall be carried out in accordance with ISO/R 783 at a temperature selected from table 4 and agreed between the interested parties at the time of enquiry and order.

For retests, the requirements of ISO 404 shall apply.

NOTE — The results of such elevated temperature tensile tests should, together with information on the product thickness, the room temperature tensile properties and the chemical composition of the material, also be communicated to

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so that at a future revision of this part of ISO 2604 enough data for the derivation of reliable minimum elevated temperature proof stress values are available.

4.2.1.3 Verification without specific tests

By the presentation of assessed data of earlier tests carried out on plates which were manufactured according to the same directives as the plates to be supplied, it shall be verified that such plates fulfil with sufficient confidence the requirements of table 4.

The details of the procedure shall be agreed between the interested parties as far as possible on the basis of the derivation and verification procedures described in ISO 2605/1 or ISO 2605/3.

NOTE — According to 3.4, a steel delivered under the same designation (for example type P 355 NH) may or may not contain certain alloying elements, such as niobium and vanadium. These differences in composition may even, in cases where the room temperature properties are the same, cause certain differences not yet known in detail in the elevated temperature properties. This and the statement in the note to 4.2.1.1 should carefully be considered by interested parties before a verification of the elevated temperature proof stress values without specific tests is agreed.