International Standard 7722

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

Aluminium alloy castings produced by gravity, sand, or chill casting, or by related processes — General conditions for inspection and delivery

Pièces moulées en alliages d'aluminium par gravité, en sable ou en coquille ou par des procédés connexes — Conditions générales de contrôle et de livraison

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Foreword

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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 7722 was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys.*

Aluminium alloy castings produced by gravity, sand, or chill casting, or by related processes — General conditions for inspection and delivery

1 Scope and field of application

This International Standard specifies the general conditions for inspection and delivery of aluminium alloy gravity, sand, and chill castings and aluminium alloy castings made by related processes.

It specifies the conditions for ordering, and the conditions for producing, testing and accepting castings.

It applies to all aluminium alloy gravity castings, in particular those the chemical and mechanical properties of which are defined in ISO 3522.

2 References

ISO 2092, *Light metals and their alloys — Code of designation based on chemical symbols.*

ISO 2378, *Aluminium alloy chill castings — Reference test bar.*

ISO 2379, *Aluminium alloy sand castings — Reference test bar.*

ISO 2859, *Sampling procedures and tables for inspection by attributes.*

ISO 3134/4, *Light metals and their alloys — Terms and definitions — Part 4: Castings.*

ISO 3522, *Cast aluminium alloys — Chemical composition and mechanical properties.*

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

ISO 6892, *Metallic materials — Tensile testing.*

3 Control levels

3.1 General

The intended use of the castings defines the minimum level of control to be prescribed by the customer, selected from the three categories defined in 3.2, 3.3 and 3.4.

If the level of control is not specified on ordering, the founder shall apply the minimum level of control (Type 3).

The control level defines the nature of the tests (see table 1) and their minimum frequency (see 10.2.2, 10.2.6 and table 2).

This choice will have an effect on the testing costs and the selected level shall be clearly stated when bids are invited and confirmed when ordering.

3.2 Type 1 control

This control relates to castings where the internal soundness and mechanical properties have to be verified. Internal soundness is the property of a metal which is free from faults such as porosity, cavities or detrimental discontinuities with regard to intended use. The level of internal soundness shall be defined by common agreement between the founder and the purchaser, on pre-production castings for example.

a) Metal control: chemical analysis of the bath and in some cases control of mechanical properties on separately cast test pieces.

b) Castings control: shape and dimensions; internal soundness verified by generally non-destructive tests; mechanical properties of the castings are controlled either on the castings themselves or on cast-on test pieces or cut test pieces.

c) Batch composition: the batch consists of castings:

- of the same alloy;
- defined by the same drawing;
- issued from the same cast[1)] and from the same charge of heat treatment.

3.3 Type 2 control

This control relates to castings for which the internal soundness and mechanical properties, although desirable, are not subjected to compulsory checks.

a) Metal control: chemical analysis of the bath and control of mechanical properties on separately cast test pieces, except in special cases referred to in note 6 of table 1.

1) The definition of "cast" shall be agreed upon between the founder and the customer, taking account of the production equipment of the foundry.

b) Castings control: shape and dimensions; the internal soundness control by non-destructive tests and the control of mechanical properties on cast-on test pieces or cut test pieces are left to the purchaser's initiative.

c) Batch composition: a batch is considered to be composed of castings obtained from charges of approximately similar composition, provided that they have all been cast in less than 8 h and that the batch does not exceed 1 000 kg.

3.4 Type 3 control

This control relates to castings with no particular requirements.

a) Castings control: appearance, shape and dimensions.

b) Batch composition: the batch can be defined by a tonnage, a number of casting or a production period, by agreement between the interested parties.

The various properties to be controlled are given in table 1.

4 Wording of enquiries and orders

4.1 General

Each consultation, enquiry or order shall convey, possibly through drawings, accompanying annexes or reference documents, all the information the founder requires to show the means and methods of manufacture and control suitable for the quality level required for the product in question.

This means that in addition to the actual definition of the product (drawing, material, administrative references, etc.) which is entirely his responsibility, in all cases the purchaser shall specify at the time of enquiry the control level (in accordance with clause 3) he has decided to achieve, depending on the conditions of use of the castings and in particular the non-destructive controls with their severity grades as defined in 8.2.3.2.

Moreover, if he intends to make these controls the responsibility of the founder, he shall state this clearly. Should this not be stipulated, the founder is only bound to verify the dimensions and appearance of the castings on receipt, this being in addition to the current manufacture control.

Whether or not the founder is contractually responsible for carrying out the controls, the conditions and severity grades of these controls are defined by reference to national standards or by agreement between the interested parties.

4.2 Essential information

4.2.1 Definition of the casting and wording of the order

a) designation or drawing number or casting number with an indication of the index where applicable;

b) designation of the alloy and condition of the consignment;

c) quantity and plus or minus tolerance on the quantity of castings;

d) time and/or rate of delivery;

e) drawing of the casting with main dimensions and indication of special tolerances on these dimensions, compulsory indication of the support surfaces and bearing components for the castings during machining and control operations;

f) if the tools are to supplied by the purchaser, the enquiry or order shall specify their design, condition, number and the controls to be carried out;

g) conditions of manufacture or control of pre-production castings, if required;

h) repair conditions (see 8.2.3.4);

j) marking of castings.

4.2.2 Definition of control level

a) the control level, as defined in clause 3;

b) standard, method, nature and frequency of the tests to be carried out by the founder or by the purchaser:

- properties to be checked and values to be obtained;
- surface smoothers of the casting and areas to be controlled;
- pressure tightness and test conditions;
- verification of batch homogeneity;
- mass and mass tolerances;
- other tests to be carried out by the founder or by the purchaser, whether or not they appear in this International Standard;

c) any specially defined area on the casting, if there is one;

d) acceptance conditions and criteria;

e) any necessary references to consultation documents.

4.2.3 Definition of acceptance

a) the intervention of an organization or an agent, authorized by the purchaser or his representative, or checks carried out by the founder;

b) the conditions of intervention (on casting, on finished castings, or as stated in the order specification);

c) place of acceptance, if this cannot be carried out at the founder's works and, in some cases, the body responsible for the tests for which the founder is not equipped (particularly for chemical composition);

d) batching and number of tests per batch; if these differ from the stipulations in 10.2.2;

e) order stipulations, conditions of acceptance and control documents to be supplied (see clause 10);

(1) without acceptance

(1.1) without statement or certificate;

(1.2) with statement of compliance with the order;

(1.3) with current manufacture control documents;

(1.4) with specific control certificate for the castings supplied;

(2) with acceptance;

(2.1) with acceptance certificate;

(2.2) with acceptance report.

5 Production and casting methods — Heat treatment

Unless otherwise stipulated, the production method (in particular the nature of the furnace charges), the casting method and the selection of the heat treatment cycle, if this is used, are left to the founder, who shall supply the castings in accordance with the contractual stipulations. With this in mind, all drawings, requirements or special information concerning internal soundness, pressure tightness, basic tolerances and the stability of the shapes, dimensions and appearance shall be communicated to the founder at the first consultation.

6 Shape and dimensions — Drawings and tools

The shape and dimensions of the castings, taking into account clearances, machining allowances and permissible dimensional deviations without indication of tolerance are defined by the following:

— the tools, when these are submitted by the purchaser and the founder has not been made responsible for checking them with regard to the drawings;

— the drawing of the as-cast part, when the founder is directly responsible, either for designing or checking the tools;

— the drawing of the as-cast part and, where applicable, by the pre-production casting(s) accepted by the purchaser, in the case of mass production.

In order to guide the founder in the selection of the appropriate casting method, the drawings shall state the special tolerances and main dimensions affecting the determining dimensions, the parts to be machined and the support and bearing elements of the castings during machining and control operations.

As far as possible, they shall state the clearance to be allowed for or at least indicate in which direction it shall have to be estimated with regard to the drawing — plus tolerance, minus tolerance or plus/minus tolerance; in the absence of such information, clearances shall be additional with regard to the drawing.

The founder may inform the purchaser of all the amendments which have had to be added to the drawing, with a view to obtaining sound castings. Close co-operation between the purchaser, the founder and the pattern maker is strongly recommended.

The founder is not obliged to check the compliance of the manufacture or control tools with the drawing submitted to him, unless he has been directly responsible for producing the tools; he is only obliged to do this if the purchaser has stipulated this clearly in the order.

7 Standard castings (mass production)

7.1 General

Before starting to mass produce a new casting or amending an old casting, the purchaser shall ask the founder to submit "pre-production castings". These shall be characteristic, for any inspection or test carried out by the purchaser, in accordance with the contractual specifications, of all the properties of the castings to be supplied by the founder to the purchaser, and shall enable founder and purchaser to co-operate as far as the finalization of certain manufacturing details are concerned, before starting mass production.

7.2 Recommended procedure

Unless otherwise specified, two stamped pre-production castings shall be submitted to the founder by the purchaser for acceptance. The latter shall subject the pre-production castings, as soon as possible, to all useful tests and to sufficient machining of the parts intended to be machined, to ensure that the internal soundness of the castings is adequate for their intended use.

If the pre-production castings are considered "acceptable" within the terms of the technical specifications, they shall be stamped by the purchaser, who shall keep one and return the other to the founder. Acceptance of these pre-production castings shall be recorded in an acceptance report.

If the pre-production castings are "not acceptable", they shall be returned to the founder for finishing, with all the reasons for rejection clearly stated within the terms of the technical specifications.

8 Characteristics and control

8.1 Basic conditions

The basic conditions determine the general delivery conditions for aluminium or aluminium alloys castings.

8.1.1 Characteristics and inspection of castings

8.1.1.1 Appearance

The surface condition of castings which are ready for delivery shall be examined visually without recourse to instruments.

Such defects as incipient cavities, cracks, etc., are likely to be considered determining factors, depending on the requirements of the order.

Unless otherwise specified in the order, the castings shall be carefully deburred by any appropriate means. Runners, risers and feeder heads shall be sheared off in order not to impede machining or impair casting appearance after mechanical finishing. Unless otherwise stated, the castings shall be delivered as-cast.

The first consultation and the order shall convey all necessary information for avoiding disputes; in particular in the case of castings to be subsequently protected or decorated, e.g. by anodizing, it is recommended that, whenever possible, a range of samples be used which presents all the characteristic aspects, whether these are permitted or not.

If the castings do not have the correct appearance, the accepting agent may require that light material removal be carried out in those parts where such an operation is acknowledged to be possible. Material removal shall naturally be in accordance with the dimensional tolerance requirements.

When the presence of cracks is suspected, a liquid penetrant examination may be required and this shall be stated in an additional clause or technical specifications.

Non-determining defects, which appear after the castings have been put into use and which result in an appearance which does not comply with the order, may be repaired in accordance with the conditions stated in 8.2.3.4, subject to agreement between the interested parties.

8.1.1.2 Checking the dimensions

If gauges are used for the checking, the purchaser shall send these gauges and drawings of them to the founder, as soon as the foundry tools are started; if the gauges are to be used by the founder, they shall be submitted to him for the casting inspection and an agreement shall be drawn up for the calibration of these tools.

The castings shall be controlled in delivery condition and the checks carried out, principally, at the reference temperature of 20 ± 5 °C. The dimensions of the as-cast parts and the machined parts shall be measured, depending on the size and dimensions, using instruments which can give the required accuracy.

For mass production, the controls shall be carried out on castings selected is accordance with the rules and sampling tables given in ISO 2859.

8.2 Special conditions

8.2.1 Applications

The special conditions required by the purchaser shall only be applied if they have been stated in the enquiry and the order.

8.8.2 Properties and examination of the metal or the alloy

8.2.2.1 Chemical composition

The limits of the chemical composition of the aluminium alloys are fixed, individually, by reference to a standard (for example: ISO 3522, table 1) or to a specification accepted by the interested parties.

Sampling for chemical tests shall be carried out on samples taken either separately from a metal mould with metal from the same cast (more thorough method) or from cast-on test blocks for this purpose (subject to a segregation risk).

For the spectral analysis of castings or test blocks, it is strongly advised that they be re-melted for the subsequent chilling of an adequate test piece and every precaution shall then be taken to preserve the initial composition of the alloy.

8.2.2.2 Tensile test — Separately cast test pieces

The order shall define, by reference to a standard or a specific specification sheet:

— the shape and dimensions of the test pieces for tensile testing;

— the characteristics to be obtained (for example: ISO 2378 and ISO 2379).

These test pieces shall be cast at the same time and with the same metal as that used for the batch castings.

For heat-treated castings, separately cast test pieces shall be heat-treated with the batch of castings to which they relate.

There shall be a sufficient number of test pieces for carrying out the standard tests and the additional tests specified in 10.2.6 and 10.2.7.

8.2.2.3 Hardness test

A hardness test may be carried out on the heads of separately cast tensile test pieces, in accordance with the stipulations of ISO 6506.

8.2.3 Properties and examination of castings

8.2.3.1 Physical properties

8.2.3.1.1 Roughness

The method for measuring or assessing by comparison the required values and the places in question shall be stated at the first consultation.

8.2.3.1.2 Macroscopic examination

The macroscopic examination shows any porosity or cavities and, after the appropriate metallographic etching, the grain dimensions.

The order shall specify the areas to be examined.

8.2.3.1.3 Microscopic examination

The microscopic examination makes it possible to define the alloy structure accurately, i.e. to determine qualitatively the nature, shape and distribution of the components as well as the size of the grains and the properties of the dendrites.

The order shall state the areas to be examined and stipulate an agreement on the reference microscopic examinations and the standards of acceptance, which shall be agreed between the purchaser and the founder.

8.2.3.1.4 Mass and mass tolerances

The masses shall be assessed at the first consultation and shown on the accompanying drawings.

Where necessary, the mass tolerances shall be finally agreed on once the first castings have been made.

8.2.3.2 Non-destructive controls

8.2.3.2.1 General

This concept covers all the controls, the aim of which is to check the internal soundness of the castings, by detecting defects which are not visible by simple visual examination, such as radiography, impregnation tests, ultrasonic testing; also included under this heading are surface condition examination by visual means or using viso-tactile comparison specimens.

Applying the principle stated in 8.2.1, the purchaser shall specify in his enquiry, in accordance with the standards:

— the nature of the non-destructive controls he intends to carry out or have carried out;

— the part(s) of the casting submitted to these controls;

— the severity grades for assessing the detrimental or otherwise nature of any defects which may be revealed.

Whether or not the founder is contractually responsible for carrying out these controls, the conditions and severity grades shall be defined by reference to standards, or otherwise by agreement between the interested parties.

8.2.3.2.2 Radiography or radioscopy

If a radiographic or radioscopic examination is specified in the order, it shall state the areas to be examined. It is essential that the acceptance limits be defined with respect to a standard record or to reference radiographs.

8.2.3.2.3 Crack impregnation

Crack impregnation with dyes reveals any discontinuities which open at the surface.

The technique of crack impregnation shall be agreed on and the order shall state the time at which crack impregnation shall be carried out and, for each casting section to be examined, the type of discontinuity to be taken into account and the severity grade.

8.2.3.2.4 Pressure tightness

The pressure tightness requirements, which shall be met by the castings, shall be stated in the enquiry or on the attached drawings: roughing down stage of the casting, nature of the fluid, temperature, test pressure, method of pressurization (internal or external), duration of pressure application, permissible fluid leakage rate. [1)]

NOTE — The safety of the staff carrying out these tests shall be carefully supervised, in particular during tests under gas pressure.

8.2.3.3 Mechanical properties

8.2.3.3.1 Tensile test — Test pieces adjoining or taken from the castings

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

For level 1 and in accordance with an agreement between the interested parties, the test pieces of suitable dimensions may be adjoining the castings themselves or taken from the castings.

In such cases:

— their location and dimensions shall be agreed between the founder and the purchaser;

— their characteristics may be different from those obtained with separately cast test pieces and shall be agreed between the founder and the purchaser.

8.2.3.3.2 Hardness test

Hardness measurements shall be carried out on castings in locations agreed between the interested parties, in accordance with the provisions of ISO 6506.

This measurement may have the purpose of checking:

— either the hardness itself as a property, particularly in the case of heat treated alloys;

— or the homogeneity of the batches.

8.2.3.4 Defect repair

The purpose of defect repair is to restore to the castings the qualities required on the order, if any of these qualities are impaired by the defects. Repair is not, however, meant to be an operation which simply hides defects. The normal deburring operations and the preparation of the support and bearing elements are not considered to be repairs.

1) If the castings are intended to contain a fluid and where absolute pressure tightness is not required, the order may specify, for example, a permissible fluid leakage volume during pressure application.

When no characteristic casting internal soundness is required, the founder is the only judge of and is responsible for the occasion and selection of the method of repair from those listed below, unless there is any specific agreement in the order. If however, the founder feels that the defect is such that it is likely to affect the solidity of the casting, he shall inform the purchaser.

When a characteristic internal soundness is required, no repair may be carried out without the client's authorization and his agreement on the repair method as well as means of inspecting this operation.

The repair may consist, depending on the circumstances, of carrying out, in accordance with the rules of the art, either a filler metal by means of a suitable welding method or an operation to position a threaded stud or machined element. If the casting has been subjected to heat treatment before welding repair, this heat treatment shall be restarted, unless otherwise specified by the purchaser.

To prevent leaks in castings which should be pressure tight, it is possible, but only with the written agreement of the purchaser, to have recourse to impregnation; then the casting shall be subjected to the pressure test after the impregnation process has been completed.

The impregnation method and chosen products shall be submitted beforehand for the approval of the purchaser and shall under no circumstances adversely affect the manufacture or use of the castings treated in this way.

9 Marking of the castings

If the castings are to be marked, this shall be specified in the order.

The order shall also state, by reference to the as-cast casting drawing, the position, designation and methods used to produce these markings.

If this information is not given and the dimensions of the castings and their conditions of use permit it, each casting shall be stamped in hollow or in relief (in principle when out of the foundry) with the following markings, preferably in the following order:

a) designation of the alloy (unless otherwise agreed in accordance with ISO 2092);

b) mark of the founder;

c) mark or number of the tool (in accordance with the drawing or order specification);

d) year of manufacture (if required);

e) any other information (cast number or individual number for example) if required, as agreed previously between the interested parties.

If nothing is specified in the order, the founder may, if he wishes, stamp his mark on the casting.

10 Acceptance

10.1 General

10.1.1 When no receipt is required, the castings may be delivered:

a) without statement or certificate;

b) with a statement of compliance with the order: a document in which the founder states that the castings supplied comply to the requirement of the order, without details of any test results;

c) with a current production inspection report: a document in which the founder states that the castings supplied comply with the requirements of the order and in which he gives the results of current production inspection tests on products from the same production process as the delivery, but not necessarily relating to the castings delivered;

d) with a test report which specifically covers the castings supplied: a document which contains the results of all the prescribed tests and which states that they apply to the castings supplied.

10.1.2 When receipt of delivery is to be acknowledged, this shall be stated in the enquiry so that is included explicitly in the contract with details of the corresponding manufacture and inspection costs and related items. Depending on the circumstances, the documents to be supplied are as follows:

a) certificate of acceptance: document signed by the receiving agent appointed by the purchaser[1], containing the results of all the tests prescribed for the batch in question;

b) acceptance report: when the acceptance certificate is signed by special agreement by the founder and the purchaser, or his representative[2], it is called an acceptance report.

10.1.3 Final acceptance shall take place at the foundry when the acceptance certificate or report is submitted, subject to those controls which may only be carried out later on the purchaser's premises within the time stipulated by the order.

10.1.4 In the event of a dispute concerning the results obtained by the purchaser, an arbitration test shall be carried out in a laboratory approved by the interested parties.

10.2 Acceptance procedure

10.2.1 Place of acceptance

The sample selection, preparation of test pieces and the tests stipulated in the order shall be carried out at the foundry.

1) This agent may, for all or some of the operations and by mutual agreement, be a member of the inspection staff at the foundry.

2) Not on the foundry staff.

10.2.2 Batching

The size of the batches depends on the inspection level (see clause 3).

10.2.3 Submission for acceptance

Submission for acceptance, sample selection and the acceptance tests which may be carried out on the spot, shall be carried out in the foundry.

The founder shall inform the purchaser in due time of the date of submission for acceptance.

This note shall state the number of castings submitted from each cast, as well as the relevant order references; it constitutes a certificate stating that the prescribed manufacturing conditions have been complied with and that the individual tests, if required, have been carried out.

The representative, who has been given free access to the place where the castings are stored, shall call there on the day stipulated in the written invitation or within 5 days of that, failing which, in order to avoid disturbing the production cycle, the founder may carry out the acceptance test himself and submit the acceptance report to the purchaser.

10.2.4 Checking of batch homogeneity

The homogeneity of each of the batches is checked by hardness measurements. This test shall be carried out on castings and positions agreed between the interested parties.

Unless otherwise agreed, the recorded hardness values shall not differ from each other by more than 20 Brinell units; moreover, they shall not be lower than those agreed by comparison with the measurements taken from the separately cast tensile test piece heads.

If the results of the hardness test carried out on the castings in accordance with the percentages given in table 3 differ by more than 20 Brinell units, the test shall be carried out on all the castings in the batch in question.

10.2.5 Marking the samples and the test pieces

The test pieces shall, in principle, be cast in the presence of the accepting agent, on the understanding, however, that the casting operations can, under no circumstances, be delayed by his absence.

The samples shall be selected by the accepting agent [1]; like the test pieces, they shall be stamped in his presence.

While the test pieces are being prepared, if the stamp marks have to be removed or displaced, such operations may only be carried out in the presence of the accepting agent.

10.2.6 Number of tests per batch

Unless otherwise stated in the order, the number of tests per batch, and also the number of castings to be selected for the tests, are as stated in tables 2 and 3.

10.2.7 Check tests

If the test results are unsatisfactory and the user agrees to this, two additional tests shall be carried out for each inadequate test.

The batch is considered to comply with the requirements, when the two check tests meet the minimum mechanical requirements specified.

For sand cast test pieces, if a machining fault is visible on the test piece, a single check test shall be carried out, subject to agreement by the purchaser.

It may, however, be rejected if a single check test gives unsatisfactory results.

10.2.8 Acceptance approval

If all the conditions stipulated in the order, in accordance with this International Standard, are met, the batch shall be considered to comply and shall be accepted by the purchaser, subject to controls which may only take place later on the purchaser's premises within the time interval stipulated in the order.

1) This agent may, for all or some of the operations and by mutual agreement, be a member of the inspection personnel at the foundry.