

Steel castings — General technical delivery requirements

Introduction Though this Japanese Industrial Standard was prepared based on ISO 4990 : 1986, *Steel castings — General technical delivery requirements* issued as the first edition in 1986 without changing technical contents, the portions with dotted underlines are items wherein the specified contents of the original International Standard are changed, or items which do not exist in the original International Standard.

1 Scope The scope shall be follows.

- a) This Standard specifies general matters common to the manufacture, test, and inspection of steel castings.
- b) In the case where the standard for steel casting materials differs from this Standard, that steel castings standard applies.
- c) This Standard specifies a series of additional requirements capable of applying to steel castings. Those requirements apply only in the case where specified by the purchaser.

Remarks : The corresponding International Standard to this Standard is given as follows.

ISO 4990 : 1986, *Steel castings — General technical delivery requirements*

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards indicated below shall be applied.

- JIS B 0403 *Casting—System of dimensional tolerances and machining allowances*
- JIS G 0565 *Method for magnetic particle testing of ferromagnetic materials and classification of magnetic particle indication*
- JIS G 0567 *Method of elevated temperature tensile test for steels and heat-resisting alloys*
- JIS G 0575 *Methods of copper sulfate-sulfuric acid test for stainless steels*
- JIS G 0581 *Methods of radiographic test and classification of radiographs for steel castings*
- JIS G 0588 *Visual examination and classification of surface quality for steel castings*
- JIS G 5131 *High manganese steel castings*
- JIS Z 2201 *Test pieces for tensile test for metallic materials*
- JIS Z 2202 *Test pieces for impact test for metallic materials*
- JIS Z 2241 *Method of tensile test for metallic materials*
- JIS Z 2242 *Method of impact test for metallic materials*
- JIS Z 2243 *Brinell hardness test—Test method*
- JIS Z 2343 *Method for liquid penetrant testing and classification of the indication*
- JIS Z 2344 *General rule of ultrasonic testing of metals by pulse echo technique*
- JIS Z 8401 *Rules for rounding off of numerical values*

3 Definitions For the main terms used in this Standard, the following definitions apply.

- a) **non-specific inspection and testing** Inspection and testing carried out by the manufacturer in accordance with his own procedures, on test blocks or castings made by the same manufacturing process, but not necessarily on the test blocks or casting actually supplied.
- b) **specific inspection and testing** Inspection and testing carried out on the test lot to be supplied, in order to verify whether these products comply with the requirements of the order.
- c) **statement of compliance with the order; SC** Document in which the manufacturer states that the products supplied are in compliance with the requirements of the order, without mention of any test result.
- d) **test report; TR** Document in which the manufacturer states that the products supplied are in compliance with the requirements of the order and in which he supplies the results of the routine works inspection tests, carried out on test blocks or castings made by the same manufacturing process as the consignment, but not, therefore, necessarily applying to the actual products supplied.
- e) **inspection certificate; IC** Certificate containing the results of all the tests specified.

By agreement when ordering, the inspection and testing procedures may be carried out, at the discretion of the purchaser :

- 1) by the qualified department (see the Note (1)) of the manufacturer's works (IC);
- 2) in the presence of the purchaser or a body designated by him (ICP);

The inspection certificate is signed by the representative of the qualified department, and by the purchaser or the representative of the designated body.

In certain special cases, by agreement when ordering, the inspection and testing procedures may also be carried out by a body independent of the purchaser and the manufacturer, the tests being carried out outside the production works. In that case, the inspection certificate shall be signed by the representative of that body.

Note (1) qualified department : An inspection and testing department different from the production department.

In certain cases, this department may be subject to approval by the purchaser.

- f) **inspection report; IR** Where the inspection certificate specified in case 2) of e) shall, by agreement, be signed by the manufacturer and purchaser or his representative, it is known as the inspection report.

4 Information to be supplied by the purchaser The information to be provided to the manufacturer by the purchaser shall be as follows.

- a) The enquiry and order shall include the particulars given in 1) to 3).
 - 1) A description of the casting(s) by pattern number and/or drawing. When a pattern is supplied, a description of the pattern equipment shall be included. When no drawing is supplied the casting is purchased on the basis of as per pattern. In that case the foundry shall not be responsible for the dimensions of the part.

Dimensional tolerances including machining allowances and the datum points for machining and measuring shall be noted on the drawing.

All modifications to be made to the drawing, or patterns, for the technical requirements of the manufacturer, shall form the subject of an agreement between the manufacturer and the purchaser.
 - 2) The material standard and grade of steel.

- 3) The type of document (see Annex 2).
- b) Where appropriate, the enquiry and order shall include additional information, for example that listed in 1) to 6).
 - 1) Indication of any supplementary requirements in accordance with clause 9.
 - 2) Size of a test lot [see 6.2.2.a)].
 - 3) Procedures for marking, in accordance with clause 7 and 9.b).1), machining, protection, packaging, loading, dispatching and the destination.
 - 4) The submission, when appropriate, of sample castings for approval before production quantities are produced. (see 5.3)
 - 5) Methods of statistical control to be used (if any).
 - 6) Other options in the specification.
- c) Inspection procedures shall conform to Annex 1 (normative), including the place of inspection for the purchaser, if the inspection cannot be performed at the manufacturer's works.

5 Conditions of manufacture

5.1 Steelmaking Unless otherwise specified, the steelmaking process is left to the discretion of the manufacturer [see 9 a) 1) to 9 a) 4)].

5.2 Foundry practice — Heat treatment Unless otherwise agreed at the time of enquiry and order or specified in the material standard, the selection of the method of casting, moulding, heat treatment, etc., is left to the discretion of the manufacturer [see 9 e), and 9 g) 1) to 9 g) 3)].

5.3 Cleaning and dressing All the castings shall be cleaned and dressed sufficiently to determine compliance with the requirements of 6.2.3 a) and 9 i) 5). Additional dressing may be agreed to at the time of enquiry and order.

5.4 Repair by welding The repair by welding shall be as follows.

- a) Repair by welding is welding operation executed in a manufacturing process by the manufacturer in order to conform to quality requirements of steel castings. In the case of no agreement at the point of time of inquiry and ordering the manufacturer may repair by welding steel castings without previous approval by the purchaser.
- b) The parties concerned with delivery can agree on the following items.
 - 1) The manufacturer shall define a major defect subject to the agreement between the manufacturer and the purchaser, and shall obtain the prior approval by the purchaser for the major weld repair on the defined major defect.
 - 2) The manufacturer, when requested by the purchaser, presents a repair/weld procedure.
 - 3) The manufacturer, when requested by the purchaser, executes the confirmation test of a weld execution method.

6 Testing and inspection

6.1 Non-specific information and testing The non-specific information and testing shall be as follows.

- a) Steel castings and their manufacture are executed by the manufacturer according to an suitable

testing and inspection, and it is certified to conform to requirements of the specification.

- b) When requested in ordering, the manufacturer supplies the inspection certificate to the purchaser.
- c) When requested in ordering, the manufacturer supplies the statement of compliance with the order on which compliance with the non-specific inspection and testing specified in 6 and 9 is stated and/or the test report to the purchaser.

6.2 Specific inspection and testing

6.2.1 Document If one of the documents for specific inspection and testing (see Annex 2 table 1) is ordered, the inspection and tests are to be carried out in accordance with 6 and/or 9 and reported.

6.2.2 Sampling, preparation of test pieces and mechanical and chemical test methods and requirements The purchaser and the manufacturer may agree with each other concerning items specified in a) to e).

- a) **Formation of test lots** As the lot of a mechanical test, any one of the following apply.
 - 1) **Classification by cast** A mechanical test is executed for the test block wherein each cast is loaded simultaneously with steel castings and heat treated.
 - 2) **Classification by the shape of steel castings** A test block is sampled for each lot of steel castings wherein the same shaped steel casting is casted per each cast.
 - 3) **Classification by steel grade** For the lot of steel castings wherein the same steel grade is casted, a test block is sampled by classifying in accordance with the specification of “the mass of a test lot” of 9.
 - 4) **Other classification** A test block is prepared per each lot of steel castings which is classified by another statistical technique, and a mechanical test is executed.
- b) **Test block** A test block shall be as follows.
 - 1) A test block shall be sampled from the same cast as that casted into the steel castings. However, when casts have been gathered in a ladle before casting, the gathered casts shall be considered as one cast. The sampling procedure of a test block when a plurality of steel casts are casted into one product, shall be determined by the manufacturer in the case of no-agreement between the supplier and the purchaser.
 - 2) The shape of test block shall be as shown in either Figure a), b) or d) [however, in the case of JIS G 5131, c) may also be used], and the test block shall be casted separately from the product or integrally therewith. In the latter case, the position and the method of attachment shall, when there is no agreement between the parties concerned with delivery, be determined by the manufacturer.

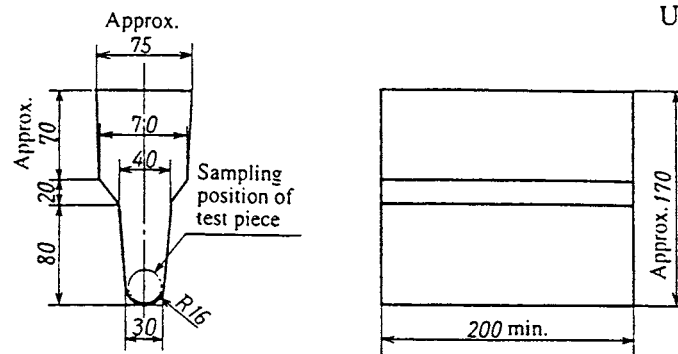
The test block casted integrally with the product shall not be removed from the product before completion of the heat treatment of the product.

In the case where there is a hindrance against the working process to be executed before heat treatment of the steel castings for the test block casted integrated with the steel castings, it can be removed there from. However, in heat treatment, it shall accompany the steel casting proper by an appropriate method likely to become heat treatment conditions representing the castings proper.

- 3) In order to confirm mechanical properties representing the steel castings, the test block other than a) to d) in Fig. 1 may be agreed between the supplier and the purchaser. In this case, the following items shall be agreed.
 - 3.1) The grade and sampling method of the test block

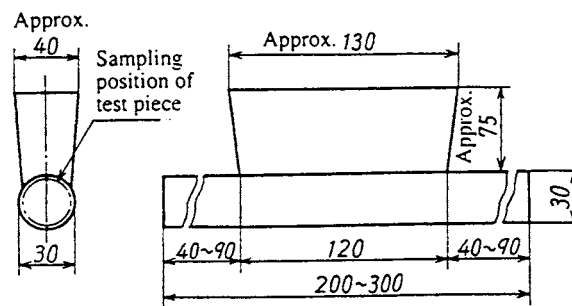
- 3.1.1) The grade and method of attachment of an accompanying test block
 - 3.1.2) The sampling position and the sampling method from a product
 - 3.1.3) Separately casted test block
 - 3.2) The dimensions and the shape of a test block
 - 3.3) Sampling time of a test block
 - 3.4) The sampling position and the cutting method of a test piece from the test block.
 - 3.5) Mechanical properties
- 4) A test block is generally sampled per each cast, and heat treated by the same method as that for steel castings.
- For the same method herein, the test block is heat treated by loading simultaneously with the steel castings, or for at least the following items in heat treatments to be executed for the steel castings, both shall agree with each other.
- 4.1) A retention temperature is within the same control range.
 - 4.2) Cooling is carried out by the same method.
- 5) When mechanical tests are requested by the purchaser for steel castings wherein all stress relief annealing to be executed in the post process of heat treatment is completed, the treating of a test block shall be agreed between the supplier and the purchaser.
- 6) The manufacturer prepares the number of test blocks necessary for sampling at least one set of test pieces for the test specified in the steel castings material standard.
- 7) The mechanical property obtained from the test piece sampled from the test block of 2) shall be as specified in the steel castings material standard.
- c) **Mechanical tests** The types and methods of mechanical tests shall be as follows.
- 1) The mechanical tests including the following items in ordering shall be as agreed between the supplier and the purchaser.
 - 1.1) In the case where tests other than the mechanical tests specified in the steel castings material standard are additionally specified, the following items shall be agreed according to the type.
 - 1.1.1) The sampling procedure of a test piece and its dimensions
 - 1.1.2) Test method
 - 1.1.3) Criteria for acceptance or rejection
 - 1.2) The purchaser, when a high temperature tensile test, a hardness test, and a flattening test are requested, shall agree with the manufacturer in accordance with 9.
 - 1.3) The purchaser, when the purchaser or its representative is made to attend at, shall agree upon the general conditions concerning 9 and Annex 1 (normative) with the manufacturer.
 - 2) The manufacturer executes the mechanical tests specified in the steel castings material standard in accordance with Table 1.
 - 3) The manufacturer executes the mechanical tests by use of the test block of 6.2.2 b).
 - 4) The manufacturer generally executes the mechanical tests in a manufacturing plant.
 - 5) When the test results are considered to be inadequate because of the following reasons, the test may be cancelled and the test may be executed again by use of spare test block.
 - 5.1) Inadequate setting of the test piece to the testing machine or wrong operations of the testing machine.

Unit : mm



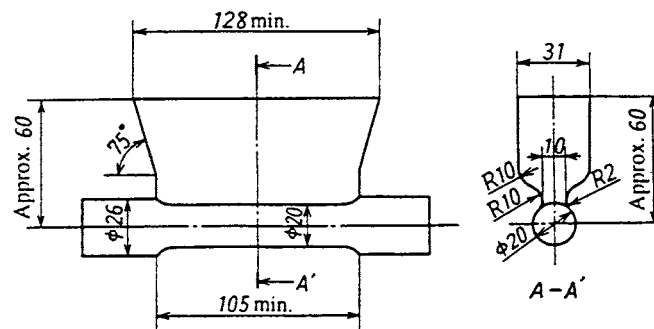
Remarks : The test piece shall be taken from the position near the lower portion of the test block indicated by a chain double-dashed in Figure.

(a)

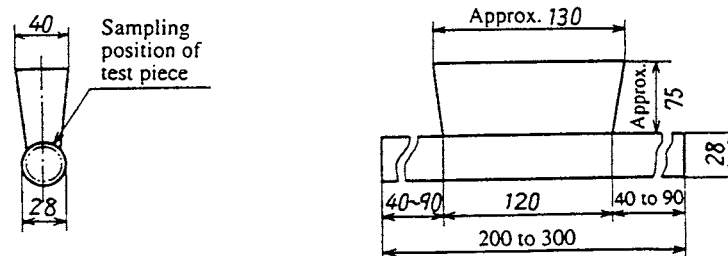


Remarks : The test piece shall be taken from the position near the lower portion of the test block indicated by a chain double-dashed in Figure.

(b)



(c)



Remarks : The test piece shall be taken from the position near the lower portion of the test block indicated by a chain double-dashed in Figure.

(d)

Fig. 1 Shapes and dimensions of test block

- 5.2) Preparation miss of the test piece or presence of flaws considered unrelated to the quality of material.
- 5.3) The case in which the test piece breaks at a point outside the range of 1/4 of the gauge length from the center thereof and the breaking strength does not conform to the specified value.

Table 1 Classification of Mechanical Tests and Method of Testing

Classification	Dimensions of test piece and method of taking test piece	Method of testing	Remarks
Tensile test	Use No. 14 A test piece specified in JIS Z 2201 (provided that parallel part diameter is 14 mm), and take one test piece from the specimen shown in Figure.	In accordance with JIS Z 2241.	Test piece taking method in the case of centrifugal steel castings shall be agreed between the parties concerned with delivery.
Impact test	Use No. 4 test piece ⁽²⁾ specified in JIS Z 2202, and take three test pieces from the specimen shown in Figure.	In accordance with JIS Z 2242 ⁽³⁾ .	In the case of centrifugal cast steel pipes, the test piece taking method shall be agreed between the parties concerned with delivery.

Notes ⁽²⁾ According to the dimensions of the centrifugal cast steel pipe, the width of the test piece may be changed to 7.5 mm or 5.0 mm.

⁽³⁾ The temperature at test shall be in accordance with each individual standard of steel castings.

- d) **Retest** The retest of a mechanical test shall be performed as specified in Table 2.
- e) **Analysis test** The chemical composition, unless otherwise specified, shall be in accordance with the values of heat analysis. However, the purchaser may execute individually “check analysis” in the test block or the test piece representing cutting, batch or steel castings, and “product analysis” in the finished steel castings in accordance with 9.
 - 1) **Cast analysis** The analytical sample used for cast analysis is sampled from molten steel or a test block.
 - 2) **Cast analysis value** The cast analysis value shall be as specified in steel castings material standard.
 - 3) **Sampling of cast analysis sample** Sampling of a cast analysis sample shall be as follows.
 - 3.1) A sample for cast analysis shall be taken from a ladle by a necessary amount for every cast. When molten steel is gathered in one ladle from a plurality of furnaces, the gathered steel shall be treated as one cast.
 - 3.2) When one piece of steel castings is casted with molten steel from a plurality of furnaces without gathering the molten steel into one ladle, the analysis value of molten steel from each furnace shall be prepared.
 - 3.3) For the sample for molten steel analysis, an amount sufficient for analyses of three times shall be secured.
 - 4) **Method of analysis and analytical value** The method for analysis shall be as specified in the steel castings material standard.
 - 5) **Rounding off of analytical values** The analytical value shall be expressed by percentage, calculated to the digit next to the lowest digit of the specified value, and rounded off in accordance with JIS Z 8401.

Table 2 Retest

Method	Contents
Retest	When the specified value has not been satisfied in the tensile test, a retest shall be performed using test pieces two times the predetermined number taken (two spare test pieces) from a group of test blocks from which the unsuccessful test pieces have been taken. When all of the test pieces satisfy the specified value, the products shall be considered as acceptable. In the case where any one of them is rejected, the retest may follow the requirements specified in the retest under reheat treatment.
	(1) Case wherein in the impact test, the mean value of three tests is specified. When the mean value of three tests does not conform to the specified value but it is not less than 85% of the specified value, a retest shall be performed with further three test pieces. When the mean value of all the six test pieces conform to the specified value, the products shall be considered as acceptable. (2) Case wherein in the impact test, a value other than the mean value of three impact tests is specified. When the three test values conform to specified individual value, respectively, but the mean value is under the specified value, and when the mean value is not less than 85% of the specified value, or when the mean value of the three tests conforms to the specific value but the test value of one of three test pieces is under the specified individual value, a retest shall be performed with further three test pieces. When the three individual test values are all above the specified individual value and the mean value of the six test pieces conforms to the specified value, the products shall be considered as acceptable. In the case where any one of them is rejected, the retest may follow the requirements specified in the retest under reheat treatment.
Retest after re-heat treatment	When the mechanical test results do not conform to the specified value, the retest may be performed after re-heat treatment of the test blocks. In the retest, the number of test pieces shall be the same as in the first test, and all of the mechanical tests (including an intergranular corrosion test, if the purchaser requires) shall be performed again. The steel casting themselves shall be also re-heat treated, the number of the re-heat treatments being limited to 2 times.

When the carbon equivalent is expressed, the calculation is executed according to the calculation formula specified in the steel castings material standard, and the total sum shall be rounded off in accordance with **JIS Z 8401**.

- 6) When there is a doubt on the analysis value or the analytical result between the supplier and the purchaser, the doubt can be checked by use of a wet method.

6.2.3 Requirements concerning the inspection, appearance and dimensions of steel castings The requirements concerning the inspection, appearance and dimensions of steel castings shall be as follows.

- a) **Appearance test and inspection** The manufactures shall conduct the appearance test and inspection as follows.

- 1) The appearance test of a surface capable of testing and inspecting steel castings shall be performed visually with the naked eye.
- 2) The appearance test shall be performed under an adequate brightness and an adequate angle.
- 3) Adhering matters such as sand, scale, etc. on the surface of steel castings which interfere the appearance test shall be removed by grinding, shot-blasting, sand-blasting, etc.
- 4) There shall be no harmful flaws, cracks, blowholes, etc., for adequate use of steel castings.

Remarks 1 The purchaser may specify the roughness of a casting surface for the following items prior to ordering according to 9.

- 1) Portion in which the roughness is specified.
- 2) Specified roughness
- 3) Exchange of roughness measuring method or boundary samples.

2 The purchaser may specify the criteria concerning the appearance of casting surface and the marks left after the removal of risers and weirs prior to ordering according to 9.

- 1) Portion to be applied
- 2) Tolerance limit based on **JIS G 0588**

3 The purchaser may request application of the rust preventive treatment of steel castings irrespective of the presence or not of machining.

- b) **Nondestructive test** The purchaser may agree upon nondestructive tests such as a magnetic particle test, a radiographic test, a penetration test, and an ultrasonic test prior to ordering between the purchaser and the supplier according to 9.

Remarks 1 The purchaser may request the authorization of capability (grading of skill) of a tester engaging in the nondestructive test to the manufacturer.

- 2 The manufacturer shall determine the main points for the authorization of capability of a tester engaging in the nondestructive test, perform the evaluation of skill of the tester and when requested by the purchaser, shall prepare so that related documents thereof can always be presented prior to the nondestructive test operation.

- c) **Shape, dimensions, machining allowances and tolerances on dimensions** The shape, dimensions, machining tolerances and tolerances on dimensions shall be as follows.

- 1) The purchaser shall indicate the reference point of machining or supply the working drawing of steel castings, if necessary, to the manufacturer prior to ordering.

- 2) The shape and dimensions of steel castings shall be as given with drawings or a model.
- 3) The delivery state of steel castings shall be as agreed upon between the supplier and the purchaser.
- 4) When there is no-agreement between the supplier and the purchaser, tolerances on dimensions as cast of the length wall thickness, and draft angle of steel castings cast in a sand mold shall be as specified in JIS B 0403.

6.3 Inspection The inspection shall be as specified in Annex 1 (normative).

7 Marking Though the marking is as requested by the purchaser, unless otherwise specified, the manufacturer shall mark as follows on each steel casting or a lot accepted by the test and inspection.

Further, a small steel casting is classified for each batch or each lot, the marking for identification can be performed by classifying each batch or each lot to be arranged into a label the classified division.

- a) **marking method** Marking is performed in a raised or recessed state on steel casting.
- b) **marking position** Marking is performed on the non-machined surface of steel castings.
- c) **marking items** Though items to be marked are as follows, a portion thereof may be omitted as agreed upon between the supplier and the purchaser (*).
 - 1) Manufacturer's name, abbreviation or trademark
 - 2) Grade or material name of steel
 - 3) Identification of cast number of lot

Note (*) The marking is preferably performed by a necessary minimum limit.

8 Complaints If complaints are made, the following points apply.

- a) If a complain is made, an adequate time for investigation of the truth or false of the complain is given to the manufacturer.
- b) The steel castings being an object for the complaint shall be stored or reserved in a state of being examined.
- c) For treatment of a complaint, it shall be dissolved by examining sincerely between the supplier and the purchaser.

9 Supplementary requirements One or more of the following supplementary requirements shall be applied, but only when specified in the enquiry and order. Details of these supplementary requirements shall be agreed upon by the manufacturer and purchaser at the time of enquiry and order, in which event the specified tests shall be carried out by the manufacturer before delivery of the castings.

a) **General considerations**

- 1) **Steelmaking process** The steel shall be made by one of the following methods :

- a) in an open hearth furnace;
- b) in an electric arc furnace;
- c) in an induction furnace;
- d) in a basic oxygen vessel.

- 2) **Reporting of the steelmaking process** The steelmaking process shall be reported to the purchaser.

- 3) **Agreed manufacturing procedure** When the castings are manufactured in bulk, the purchaser may ask to approve the manufacturing process. A programme of manufacture and inspection shall be agreed upon. The parties shall agree to a certain number of satisfactory preliminary tests and the manufacture of a sample series of castings. All these conditions taken together constitute an approved test of manufacture by the purchaser. When the results are satisfactory, the purchaser may place subsequent orders with the manufacturer in accordance with these programmes of manufacture and inspection.
- 4) **Dividing up the cast** The castings shall be delivered according to casts.
- 5) **Mass of test lots** The mass of the test lot shall be one of the following :
 - a) 500 kg;
 - b) 1 000 kg;
 - c) 5 000 kg.

Other methods for making up the test lots for testing by statistical means may be used. Such alternative methods shall be specified in the enquiry and order for bulk manufacture.

- 6) **Mass and tolerances on mass** The mass of a casting shall be either of a mass calculated with the drawing or the mass of a sample with true dimensions. In the first case, possible modifications adopted for casting or molding as well as machining allowances, shall be taken into account. For machine molded casting, the mass of a casting which has true dimensions may be considered to the average mass of the first five castings manufactured. In the case where the casting exceeds the allowance limit to the calculated value with actual dimensions, it may be discarded.

Remarks 1 The density for calculation of a mass of a casting, shall be as agreed upon between the supplier and the purchaser.

- 2 The allowance limit of the mass of a casting shall be determined for each molding method like steel castings with, for example, machine molded casting, a casting for a production system which is individually produced with a model, and the casting with drawing type, or rotating type, and the value shall be agreed upon between the supplier and the purchaser.

b) **Inspection documents**

- 1) **Certificate** A certificate shall be as follows.

- 1.1) **Test report** A test report shall be submitted to the purchaser. The test report shall contain the results of the chemical analysis and/or mechanical tests, including the results of any other test required by the specification and/or ordered by the purchaser.

Further, it shall also include a statement that castings are manufactured in accordance with all the requirements of the specification.

- 1.2) **Signature** The test report shall be signed by an authorized agent of the manufacturer.
- 1.3) **Presentation** The test report shall be submitted within seven working days of shipment of the castings.
- 2) **Traceability** Test reports shall be equipped with traceability required for a casting represented by them.
- 3) **Manufacture results** When manufacture results such as heat treatment, repair by welding, etc., are specified, the manufacture results shall be reported to the purchaser.

c) **Chemical analysis for residual elements**

- 1) **Report** The manufacturer shall determine the percentage of unintentionally present elements

- (residual elements) listed for the composition of steel being poured and shall report the results to the purchaser.
- 2) **Other residual elements** Chemical analysis for other residual elements not listed in the specification shall be agreed between the interested parties.
- d) **Mechanical tests** When tests other than the mechanical tests specified in a steel casting material standard are additionally specified, sampling points of a test piece, dimensions of the test piece, a test method and criteria for rejection or acceptance shall be agreed upon according to the grade between the supplier and the purchaser.
- 1) **Proof stress at 0.2% at elevated temperature** The dimensions of the test pieces and the methods of tests shall meet the conditions of **JIS Z 2201**. The proof stress at elevated temperature shall be determined in accordance with the requirements of **JIS G 0567**. The test procedure shall be as specified in the material standard or shall be agreed between the interested parties.
 - 2) **Tensile test of specific steel castings** The tensile test may be replaced by a Brinell hardness test to be carried out in compliance with specifications in **JIS Z 2243**. The hardness range shall be specified in the order.
 - 3) **Hardness test of steel castings** When the hardness test of a steel casting proper is specified, the purchaser shall agree on the following items.
 - 3.1) Type of test
 - 3.2) The number of pieces to be sampled or the sampled ratio
 - 3.3) Measuring position
 - 3.4) Criteria on acceptance or rejection
 - 4) **Impact test at low temperature** Impact properties at low temperatures shall be determined. The requirements of test blocks and the test method shall be in accordance with **6.2.2 b)** and **6.2.2 c)**. Test temperatures and absorption energy values shall be specified in the individual specifications of the product or shall be agreed between the interested parties. The lateral expansion and the fracture of sheerness shall be agreed upon between the supplier and the purchaser.
 - 5) **Flat test** Flat test applies in the case of centrifugal steel castings. The conditions of flat shall be agreed between the interested parties.
- e) **Homogeneity of the test lot** In the case where the hardness test of a steel casting proper is carried out in order to certify the homogeneity of a lot, the following items shall be agreed.
- 1) Type of test
 - 2) The number of test pieces to be sampled and the sampling rate
 - 3) Measuring position
 - 4) Tolerance range
 - 5) In the case where the result of a hardness test does not comply, all steel castings of the lot are tested, and only the steel castings which do not comply with conditions of homogeneity are reheat treated or all the steel castings are reheat treated.
- f) **Test blocks**
- 1) **Test blocks representative of the castings** Test blocks shall be taken at an agreed location in the castings. The size of the test blocks, the corresponding mechanical properties, and the conditions under which the test block are to be taken (site for test pieces, location in the case of the attached blocks, cutting etc.) shall be agreed between the interested parties.

- 2) **Heat treatment of separately cast test blocks** Test blocks shall be heat treated in the same furnace together with the castings which they represent.
- 3) **Test blocks attached to the castings** When the test blocks are attached to the castings, the attachment zone and the method shall be agreed between the interested parties.

The attached test blocks shall not be detached before the manufacturer has finished heat treatment of the castings, or if the purchaser or his representative is present for these tests, before the castings have been marked by the purchaser or his representative. The test blocks are marked after heat treatment.

However, in the case where there is hindrance to a working process to be performed before heat treatment of a steel casting, that may be detached. When heat treated, it shall be attached again to the casting proper by an adequate method.

- 4) **Test block** For the size of a $d \times d$ test block, $d \times d$ may suffice instead of a) to d) of Fig. 1 in 6.2.2 b). Herein, the d is a representative section wall thickness. The representative section shall be specified by the purchaser in offer or in order. When the representative section wall thickness of a steel casting exceeds 50 mm, dimensions of the test block shall be agreed between the parties concerned.
- 5) **Test block representative of a lot** A lot which is represented by a test block shall be any one of the following.
 - 5.1) **Classification by cast** A casting steel which is one cast, charged simultaneously with a test block, and heat treated.
 - 5.2) **Classification by shape of a steel casting** A steel casting which is the same shape product and casted by one cast.
 - 5.3) **Classification of steel type** A steel casting which is casted by the same steel type, and classified by a quantity or mass. In this case, a test block is heat treated by the same method as that for a steel casting.
 - 5.4) **Other types** A steel casting which is classified by other technical or statistical requests.

g) **Heat treatment**

- 1) **Method of heat treatment** A method for heat treatment applied to a steel casting shall be reported to the purchaser.
- 2) **Details of heat treatment** Details of heat treatment applied shall be reported to the purchaser.
- 3) **Quench and tempered steel casting** A steel casting quenched and tempered is marked with QT.

h) **Repair by weld**

- 1) **Prior agreement relating to major repair welds** Prior agreement relating to major defect repair shall be as follows.
 - 1.1) Major repair welds shall be subjected to prior approval of the purchaser.
 - 1.2) The repair by weld is recorded with a drawing or a photograph which indicates the position and range of the weld part. Those records shall be submitted to the purchaser in supply of record or in order.

i) **Non-destructive tests**

- 1) **Liquid penetrant inspection** The castings shall be tested by liquid penetrant inspection in order to detect any surface discontinuity. The test method shall be in accordance with JIS Z 2343. The test range and tolerance standards shall be agreed between the purchaser and the supplier.

- 2) **Magnetic particle inspection** The castings shall be tested by magnetic particle inspection in order to detect discontinuities on and near to the surface. The test method shall be in accordance with **JIS G 0565**, or shall be agreed between the supplier and the purchaser.
- 3) **Radiographic examination** The castings shall be examined by X- or γ -rays in order to detect internal discontinuities. The test method shall be in accordance with **JIS G 0581**. The test range and the tolerance standards are agreed between the supplier and the purchaser.
- 4) **Ultrasonic inspection** The steel castings shall be tested by ultrasonics in order to detect internal discontinuities. The test method shall be in accordance with **JIS Z 2344**, or agreed between the supplier and the purchaser. The test range and permissible limits shall be agreed between the supplier and the purchaser.
- 5) **Appearance and inspection** The supplier and the purchaser shall agree upon the following items, and perform a surface test under an adequate brightness.
 - 5.1) **Roughness of cast surface** The purchaser shall specify the roughness of a cast surface on the following items.
 - 1) roughness specified portion
 - 2) specified roughness
 - 3) exchange of roughness measuring method or limit sample.
 - 5.2) **Cast surface appearance or the like** The purchaser shall specify criteria for acceptance or rejection standard relating to cast surface appearance and traces after removal of a riser and a weir.
 - 1) applied portion
 - 2) allowance limit based on **JIS G 0588**
- 6) **Tests before and after weld repair** When steel castings are repaired by welding, the manufacturer shall perform the tests of the portions repaired by welding in accordance with Table 3 according to each testing method required for the steel castings. The permissible limits shall be agreed upon between the supplier and the purchaser.

Table 3 Test of portions repaired by welding

Testing method required for steel castings	Test inside groove after defect removal ⁽⁵⁾	Test after repairing by welding ⁽¹⁰⁾		Remarks
		Testing method	Time of test	
Appearance test (VT)	VT ⁽⁵⁾	VT ⁽⁵⁾	After repairing by welding ⁽⁸⁾	—
Penetration test (PT)	PT	PT	After repairing by welding ⁽⁸⁾	—
Magnetic particle test (MT)	MT	MT	After repairing by welding ⁽⁸⁾	—
Ultrasonic test (UT)	PT (or MT) ⁽⁶⁾	UT ⁽⁷⁾	After repairing by welding ⁽⁸⁾	—
Radiographic test (RT)	PT (or MT) ⁽⁶⁾	RT ⁽⁷⁾	Prior to final heat treatment	May be after final heat treatment

Notes ⁽⁵⁾ The manufacturer determines the joined test with PT (or MT) as an auxiliary means of VT.

⁽⁶⁾ The manufacturer determines the application of UT (or RT) for verifying a complete elimination of an unacceptable defect detected by UT (or RT).

⁽⁷⁾ PT (or MT) shall also be applied.

- (^u) When the heat treatment is to be performed after repairing by welding, the test shall be performed after the final heat treatment.
 - (^v) Magnetic particle or liquid penetrant examination of surface prepared for welding shall be performed to verify removal of discontinuities found unacceptable by the inspection method specified for the casting.
 - (^{uu}) Repair welds shall be examined by the non-destructive inspection method specified in the enquiry and orders.
- j) **Miscellaneous tests** The purchaser may request the following miscellaneous tests subject to the agreement between the supplier and the purchaser.
- 1) **Pressure tightness test** Pressure tightness tests shall be carried out on unmachined or machined castings.
 - 1.1) Conditions such as test period, test pressure, test time, etc., shall be agreed between the supplier and the purchaser, or shall be as specified in the corresponding standard. Only if steel castings receiving pressure tightness with the liquid specified in enquiry contains the liquid at atmospheric pressure, they shall be filled with the liquid stated on the order for the time necessary to verify freedom from leakage. The coating submitted to the test shall not be oxidized and shall not receive any protective coating or covering before the tests. In the case of pressure vessel castings, reference shall be made to the test conditions indicated in the test standards for these vessels. The manufacturer shall be responsible for the satisfactory performance of the castings under the pressure-tightness test.
 - 1.2) The steel casting rejected in a pressure tightness test may be retested after weld repairing as agreed upon between the supplier and the purchaser, or after repairing by another method.
 - 2) **Magnetic characteristic tests** The test method and requested characteristic values shall be as agreed between the supplier and the purchaser.
 - 3) **Permeability measuring test** The test method shall be agreed between the supplier and the purchaser.
 - 4) **Corrosion resistance test** The corrosion resistance test shall be as follows.
 - 4.1) The test method shall be in accordance with either of JIS G 0575 on the test method agreed between the supplier and the purchaser.
 - 4.2) The corrosion resistance shall be as specified in the steel casting material standard.
 - 5) **Micro-structure test and macro-structure test** The macro-structure test and the micro-structure test shall be as follows.
 - 5.1) The purchaser may specify the structure test of the cast proper on the test block.
 - 5.2) The test position, test method, and criteria shall be as agreed upon between the purchaser and the supplier.
 - 6) **Other tests** Other tests shall be as agreed upon between the purchaser and the supplier.

Annex 1 (normative)

General conditions for specific inspections and tests

1 Inspection conditions

1.1 Place of inspection The final inspection is generally carried out at the foundry, except for agreed tests which can only be undertaken at the purchaser's factory.

The selection of samples, the preparation of test pieces and the tests themselves shall be carried out, unless agreed upon to the contrary, in the manufacturer's works.

The word sample covers, according to the type of test carried out, the sample block or a casting representative of the product delivered.

Where the works of the manufacturer does not have the necessary means, the inspections may be carried out at another place agreed between the parties.

1.2 Submission for inspection The manufacturer shall arrange with the purchaser, by mutual agreement and in good time, the date of submission for inspection.

If the representative does not present himself at the agreed date, the manufacturer, in order to avoid interruption of the manufacturing cycle, may himself carry out the inspection and deliver the inspection certificate to the purchaser, unless expressly prohibited.

1.2.1 Rights and duties of the inspection representative The inspection representative shall have free access at any suitable time to the places in which the products to be inspected are manufactured and stored. He may indicate the samples to be selected in accordance with the specification. He shall have the option of attending the selection of samples, the preparation (machining and treatment) of the test pieces and carrying out the tests. However, an inspection representative who visits the workshops shall respect all the safety regulations in force in the works and shall be accompanied, as far as possible, by a representative of this works.

1.3 Conditions of acceptance If all the requirements of the order, and this Standard, are fulfilled, the test lot is considered to conform but is accepted by the purchaser without prejudice to the inspection which may take place later at the purchaser's works within the time limits specified by agreement between the interested parties.

2 Rounding-off of test results

2.1 Mechanical and chemical properties The results of the mechanical and chemical tests shall be rounded off using either the rules specified in the standards on methods of tests, or, when the value obtained contains a greater number of significant figures than the guaranteed value, in accordance with JIS Z 8401.

2.2 Dimensional properties The results of dimensional measurements shall not be rounded off.

3 Records Unless otherwise specified on the order, the manufacturer shall maintain records of results of all the chemical and mechanical tests performed by the foundry for a minimum period of 5 years.

4 Validity of the tests Test results not in compliance with the specification are not valid when due to

- a) defective assembly of the test piece or abnormal functioning of the test machine
- b) defective manufacture of the test piece
- c) a break in the tensile-test piece outside the reference marks
- d) defects in the casting shown in the test piece

In all cases, a new test piece may be taken from the same sample block or from another sample block belonging to the same test lot and the results obtained can be substituted for those corresponding to the defective test piece.

Annex 2 (normative)

Details relating to tests, inspections, and reports

1 Scope This Annex 2 specifies details of the tests, inspections and reports which relate to the standard text 6 and 9.

2 Check analysis and product analysis by the purchaser

2.1 Check analysis

- a) The purchaser may perform a check analysis on a steel casting and a test block or a test piece representing a steel casting, a batch on the steel casting.
- b) The number of samples shall be as agreed between the supplier and the purchasers.
- c) Chips shall be taken from a portion at least 6 mm below the surface of a steel casting.
- d) The tolerable variation value of the check analysis performed by the purchaser on the cast analysis performed by the manufacturer, shall be as agreed between the supplier and the purchaser.

2.2 Product analysis

- a) The purchaser may perform a product analysis on a steel casting and a finish steel casting representing a batch on the steel casting.
- b) The number of samples, and a sampling position shall be as agreed between the supplier and the purchaser.
- c) Chips shall be sampled from a portion at least 6 mm below the surface of the steel casting.
- d) The tolerable variation value of the product analysis performed by the purchaser on the cast analysis performed by the manufacturer, shall be as agreed between the supplier and the purchaser.
- e) The purchaser shall be responsible for the damage on a steel casting caused by sampling from a finish steel product.

2.3 Chemical analysis of residual elements

- a) The manufacturer should preferably report to the purchaser by analyzing also the residual elements (elements not added intentionally) which are given in the casted steel casting material standard.
- b) The chemical analysis of other residual elements which are not contained in the standard, shall be as agreed between the supplier and the purchaser.

3. Report documents The manufacturer and the purchaser shall specify the certificate, report, results report, records, etc., from Annex 2 Table 1 prior to order and agree with each other.

Remarks : If not specified in order, it is generally not required to submit the inspection certificate by the manufacturer.

**Annex 2 Table 1 Report documents list (statement of compliance,
inspection certificate, test report, and records)**

Classification	Summary	Remarks
Presentation time	Within 7 actual working days from delivery of a steel casting	
Signature	Signature by the authorized agent of the manufacture	
Traceability	A report document shall be equipped with traceability	
Collation of an article in question	The article in question shall be traceable.	
Storage of record	A record shall be stored for at least five years.	When not specified in order, the records of results of all chemical and mechanical tests in a manufacturing factory shall be stored for at least five years.
Statement of compliance with the order (SC)	"Statement of Compliance" shall be submitted.	
Test report (TR)	"Test Report" is generally not submitted.	Description of a statement wherein chemical composition, mechanical test results, specification required items, results of tests specified by the purchaser, and being manufactured in accordance with all specification requirements, are indicated. When the above mentioned report is requested, it shall be submitted.
Inspection certificate (IC) (ICP)	"Written Reports of the Inspections" "Inspection Certificate" are generally not submitted.	(IC) : signature of a representative of an approval part of the manufacturer. (ICP) : signature of a representative of the purchaser or alternates. They are submitted when the above mentioned reports with signature are requested.
Inspection report (IR)	"Inspection Report" is generally not submitted.	Signatures of representatives of the manufacturer and the purchaser. When the above mentioned report with the signatures is requested, it is submitted.
Other result report	It is generally not submitted.	When a technical test, a nondestructive test, and a special test result other than specified ones are requested to be reported, they are submitted.
Heat treatment record	It is generally not submitted.	When a heat treatment record is requested to be reported, it is submitted.
Permission of major defects weld repair and their records	Prior approval by the purchaser shall be received. They are recorded with a drawing or a photograph, which are submitted in delivery.	
Results of manufacture	Report { ①Melting process ②Results of chemical analysis of residual elements ③Tensile test value at high temperature and proof stress value ④Brinell hardness test results ⑤Result of impact test at low temperature ⑥Nondestructive test results of weld groove part and weld repair part ⑦Inter granular test results ⑧Magnetic characteristics test result ⑨Pressure proof test result	When actual results of manufacture are requested to be reported, they are submitted.