इंटरनेट मानक

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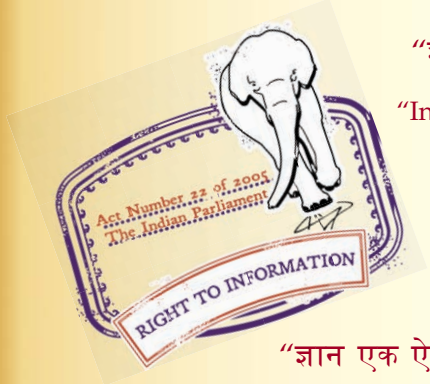
Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 11709 (2007): Technical delivery conditions for investment castings of steel [MTD 14: Foundry]



"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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भारतीय मानक

इस्पात की प्रयुक्त ढलाई की तकनीकी सुपुर्दगी की स्थितियाँ

(दूसरा पुनरीक्षण)

Indian Standard

TECHNICAL DELIVERY CONDITIONS FOR INVESTMENT CASTINGS OF STEEL

(Second Revision)

ICS 77.140.80

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

October 2007

Price Group 5

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Foundry and Steel Casting Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard is formulated with a view to guide the foundry industry and consumers of investment castings with regard to the technical delivery conditions thereof.

This standard was first published in 1986 and subsequently revised in 1995. In view of the experience gained during the period, the Committee, decided to take up the revision of the standard. In this revision, assistance has also been drawn from ISO 16468 : 2005 'Investment casting (steel, nickel alloys and cobalt alloys) — General technical requirements'.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

TECHNICAL DELIVERY CONDITIONS FOR INVESTMENT CASTINGS OF STEEL

(Second Revision)

1 SCOPE

1.1 This standard outlines technical conditions for supply of investment castings of steel.

1.2 Where a material or a product specification lays down different conditions, those conditions shall apply. In special cases, variations on these conditions may be as agreed to between the purchaser and the manufacturer at the time of enquiry and order.

1.3 The test methods and test requirements are governed by the product specification.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
228 (in parts)	Methods for chemical analysis of steels (*revised*)
1154 : 2000	Temporary corrosion preventive fluid, soft film, solvent deposited, water displacing — Specification (*first revision*)
1599 : 1985	Method for bend test (*second revision*)
1608 : 2005	Metallic materials — Tensile testing at ambient temperature (*third revision*)
1757 : 1988	Method for Charpy impact test (V-notch) for metallic material (*second revision*)
2595 : 1978	Code of practice for radiographic testing (*first revision*)
3407	Method for creep testing of steel at elevated temperature:
(Part 1) : 1983	Tensile creep testing (*first revision*)
(Part 2) : 1983	Tensile creep stress rupture testing (*first revision*)
3658 : 1981	Code of practice of liquid penetrant flaw detection (*first revision*)
3703 : 1980	Code of practice for magnetic particle flaw detection (*second revision*)
5530 : 2004	Recommendations for production, rectification and repair of steel castings by metal arc welding process (*second revision*)
6601 : 1987	Permissible deviations in chemical composition for products analysis of steel castings (*first revision*)
6907 : 1992	Steel castings — Methods of sampling (*first revision*)
7666 : 1988	Ultrasonic examination of ferritic castings of carbon and low alloy steel — Recommended procedures (*first revision*)
9565 : 1995	Acceptance standards for ultrasonic inspection of steel castings (*first revision*)
10181 : 1982	Method for determination of magnetic permeability of iron and steel
10461	Resistance to inter-granular corrosion of austenitic stainless steels—Method for determination:
(Part 1) : 1994	Corrosion test in nitric acid medium by measurement of loss in mass (Huey Test) (*first revision*)
(Part 2) : 1994	Copper sulphate/sulphuric acid test (Monypenny straus test) (*first revision*)
10724 : 1990	Acceptance standard for magnetic particle inspection of steel casting (*first revision*)
11166 : 1993	Permissible deviations on dimensions, surface roughness and mass of steel castings made with investment casting process (*first revision*)
11732 : 1995	Acceptance standards for dye penetrant inspection of steel castings (*first revision*)
12938 : 1990	Acceptance standards for radiographic inspection of steel castings

3 TERMINOLOGY

For the purpose of this standard the following definitions shall apply.

3.1 Investment Casting — An investment casting is one that is produced in a mould shell obtained by investing (surrounding) an expendable pattern with a bonded refractory. The expendable pattern may be made of wax, urea, plastic or other material and is removed by heating or any other process prior to filling the mould with liquid metal.

3.2 Melting Process — Primary heat shall be made by electric furnace process with or without separate refining, such as argon-oxygen-decarburization (AOD), vacuum-oxygen-decarburization (VOD), vacuum-induction-melting (VIM), etc, unless otherwise specified in the individual specification or agreed upon between the purchaser and the manufacturer. Primary heats may be used directly for producing castings or converted into ingot, bar, shot or other suitable form, for later remelting as a sub-heat.

3.3 Re-melting Process — Sub-melts shall be produced from primary melt metal in suitable batch sizes by electric induction furnace with or without atmosphere protection such as vacuum or inert gas unless otherwise specified in the individual specification or agreed upon between the purchaser and the manufacturer. Foundry returns (Reverts-gates, sprues, risers and rejected castings) shall not be re-melted except in primary melts. Additions of upto 5 percent by weight, are permitted for compositional adjustments and deoxidation.

4 WORKING OF ENQUIRIES AND ORDERS

4.1 Each enquiry and order shall provide the following information.

4.1.1 Designation and, where necessary, identification mark of the casting.

4.1.2 The quantity, delivery schedule and permissible variance on the quantity of castings.

4.1.3 The number of drawings provided.

4.1.4 If the die/tooling is supplied by the purchaser, its design, its condition, its number and the inspection to be carried out.

NOTE — Where a die/tooling is supplied by the purchaser, the manufacturer would not be held responsible for the dimensional accuracy and surface finish of the castings unless otherwise agreed.

4.1.5 The reference numbers of all standards or specifications applicable.

4.1.6 The method of inspection, specially in case of non-destructive tests required in accordance with **7.2.1.4.**

4.1.7 Indication of special requirements in accordance with **7.2.**

4.1.8 Grade and quality of steel, and if appropriate, the method of melting and additional properties.

4.1.9 Important dimensions with indication of their datum points in the drawing provided.

4.1.10 Class of permissible deviations on dimensions, surface roughness and mass, in accordance with IS 11166.

4.1.11 Submission, where appropriate, of sample castings for approval before bulk manufacture along with quantity required.

4.1.12 Place of purchaser's inspection, if applicable when the test cannot be carried out at the manufacturer's works.

4.1.13 *Methods of Batching*

4.1.14 Methods of statistical control to be used, if applicable.

4.1.15 Restrictive clauses on repairs by welding, if any.

4.1.16 Procedure for identifying in accordance with **8.1**, machining, packing, loading, dispatch and destination.

4.1.17 *Type of Inspection*

4.1.17.1 *Inspection without certification*

With no certification of compliance, no statement of routine control test results and no works certificate.

4.1.17.2 *Non-specific inspection*

Non-specific inspection is carried out by the manufacturer on a cast resulting from the same production process but not necessary on the products supplied.

a) *Documents*

1) *Statement of compliance with the order* — A document by which the manufacturer states that the castings supplied comply with the requirements of the order without giving any test results.

2) *Statement of routine control test results* — A document by which manufacturer states that the castings supplied comply with the requirements of the order and in which he gives the results of routine control tests carried out on the products made by the same method of manufacture as those supplied, but not necessarily on the particular castings supplied.

4.1.17.3 *Specific inspection*

Specific inspection means the inspection carried out on the castings delivered in order to ascertain that these comply with the requirements of the order.

a) *Documents*

1) *Certificate of acceptance* — The certificate of acceptance contains the results of all the prescribed tests carried out on samples taken from the castings or on the test blocks in accordance with the conditions specified for forming of batches. The acceptance procedures may be carried out by one of the following means as agreed to at the time of enquiry and order:

i) by the competent department at the manufacturer's works, or

ii) in the presence of the purchaser or by any authority appointed by him.

In case (i) the acceptance certificate is issued by the representative of the competent department and in case (ii) by the purchaser or the representative of the organization appointed. In some special cases the acceptance procedure may also be carried out by an organization which is independent of the purchaser and the manufacturer, the tests being carried out outside the manufacturing works. In this case, representative of this organization has to sign the acceptance certificate. If there is no specific stipulation from the purchaser or an agreement to the contrary, the supplier can presume that the acceptance procedures may be carried out by the competent department (*see* Note 2) at the works (*see* Table 1).

2) *Acceptance report* — When it is agreed that the certificate of acceptance specified in **4.1.17.3** (a)(1) shall also be signed by the purchaser or his representative, it is called the Acceptance Report.

NOTES

1 Both the castings and the test blocks used for inspection are known as the product.

2 The competent department at the manufacturer's works means the inspection department, which is different from the Production Department. In certain cases, this department may be subjected to approval by the purchaser.

b) *Symbols for the documents* (*see* Table 1).

5 MANUFACTURE

5.1 Unless otherwise specified at the time of enquiry and order, the choice of the method of melting, moulding, running, heat treatment, etc is left to the discretion of the manufacturer.

5.2 Cleaning and Dressing

All the castings shall be cleaned, have the ceramic removed and be dressed sufficiently to allow them to respond to heat treatment and to be adequately examined.

5.3 Repair and Fabrication Welding

Any repair and fabrication welds required shall be carried out in accordance with IS 5530. Unless any restrictive clauses are specified to the contrary at the time of enquiry and order, the castings may be welded without prior approval of the purchaser.

Table 1 Type of Document Required for Various Types of Inspection and Testing and Their Symbols

(*Clause* 4.1.17.3)

Sl No.	Type of Inspection and Testing	Type of Document	Symbols
(1)	(2)	(3)	(4)
i)	Non-specific inspection and testing	No document or statement of compliance or Test report	 SC TR
ii)	Specific inspection and testing carried out by the qualified department (*see* Note 2) of the manufacturer's factory	Inspection certificate signed by the representative of the qualified department of the works	IC
iii)	Specific inspection and testing carried out in the presence of the purchaser or of a body named by him	Inspection certificate signed by the purchaser or the representative of body named by him Or Inspection report signed by the manufacturer or the purchaser or his representative	ICP IR
iv)	Specific inspection and testing carried out by an independent body, the tests being carried out outside the production works	Inspection certificate signed by the independent body	ICP
v)	Continuous inspection	By agreement between the interested parties	

6 SELECTION OF SAMPLES AND PREPARATION OF TEST PIECES

6.1 Unless otherwise specified, the test piece may be cast separately from the casting.

6.1.1 *Test Pieces*

Except for routine control tests or where otherwise agreed to, the test pieces whether cast in the same shell along with castings or separately, should be from the same melt and should be heat treated along with the castings they represent. In case of classification by batches, some test pieces shall be put with each batch for heat treatment.

6.1.2 The thickness or diameter of a cast test bar is ordinarily 18 ± 3 mm. However, a different size may be agreed to between the manufacturer and the purchaser.

6.1.3 Test bars with different thicknesses and corresponding mechanical properties as well as the conditions under which they are to be used (location in the case of attached blocks, method of removal, etc), may form the subject of agreement when ordering. In such a case, the thickness of the test bar may be maintained neatly equal to the ruling section thickness of the casing concerned. However, the height and length of the test bar shall be each is kept at least 3 times its thickness. The ruling section thickness shall be indicated by the purchaser in the enquiry and order.

6.2 Mechanical Test

6.2.1 The mechanical properties specified are those which are to be obtained when test at 30 ± 10°C from test bars either cast separately from or attached to the castings to which they refer. The test values so exhibited represent, therefore, the quality of the steel from which the castings have been poured, they do not necessarily represent the properties of the castings themselves.

6.2.2 *Tensile Test at Ambient Temperature*

The shape and the dimensions as well as test method, shall comply with IS 1608.

6.2.3 *Tensile Test at Elevated Temperature*

Dimensions of the test piece shall be the same as those used for the test at ambient temperature. The test temperature shall be as agreed to between the purchaser and the manufacturer.

6.2.3.1 Proof stress at elevated temperature shall be determined in accordance with IS 1608.

6.2.4 *Creep Testing and Stress Rupture Testing at Elevated Temperatures*

Dimensions of the test piece and the test methods shall comply with the requirements of IS 3407 (Parts 1 and 2) or as per the agreement between the purchaser and the manufacturer.

6.2.5 *Impact Test*

This test shall be carried out on V-notch Charpy test pieces in accordance with IS 1757.

6.2.6 *Hardness Test*

This test shall be carried out after removal of the decarburized layer. The type of hardness test, location of indentation, etc, may be mutually agreed to between the purchaser and the manufacturer.

6.2.7 *Bend Test*

The bend test shall be carried out in accordance with IS 1599.

6.3 Chemical Test

Samples for chemical analysis are obtained either from the test block or more generally from the ladle. The sample shall be sufficient to allow three determinations.

6.3.1 The quantitative analysis of the elements is determined by gravimetric, colorimetric, spectrometric or any other standard method of analysis, after removal of decarburized layer. The shape and dimensions of the test samples should be specified by the purchaser, if the analysis would be done at his end. When the analysis is carried out by spectrography, the measurement is effected on a point of the sample, which represents its mean chemical composition. In case of disagreement about the results obtained by spectrography, the results obtained by chemical analysis in accordance with the relevant part of IS 228 shall be taken as being reliable.

6.3.1.1 The permissible deviation in product analysis from the limits specified shall be as given in IS 6601.

6.3.2 *Residual Elements*

Elements not specified in the required chemical composition of the respective standard shall not ordinarily be added to the steel and all reasonable precautions shall be taken to prevent contamination from the scrap, etc, to keep them as low as practicable. Analysis and reporting of the analysis in the test certificate for residual elements shall be done only when so specified by the purchaser in the enquiry and order. However, the manufacturer shall ensure that the residual elements are within the limits, when such limits are specified by the purchaser in the enquiry and order.

6.3.3 *Intergranular Corrosion Test*

This test is done on stainless steel castings only and it shall be carried out in accordance with IS 10461 (Parts 1 and 2) or as agreed to between the purchaser and the manufacturer.

6.4 Magnetic Tests

6.4.1 The specified characteristic is normally magnetic induction. The choice of other properties shall be subject to agreement between the parties.

6.4.2 In order to determine the magnetic induction, unless there are special indications, the measuring procedure to be used and the shape of the test piece shall comply with IS 10181.

7 INSPECTION

7.1 General Requirements

The general requirements give the normal general supply conditions for steel castings. The conditions of inspection shall be as covered under **4.1.17**.

7.1.1 *Visual Examination of Castings*

7.1.1.1 *Shape and dimensions*

The shape and dimensions of the castings shall comply with the requirements of the enquiry and order or as may be mutually agreed upon. Permissible deviations shall be in conformity with IS 11166 unless otherwise agreed.

7.1.1.2 *Surface condition*

The surface of the castings shall be free from defects that will adversely affect the utility and machining of the castings. Surface defects which are not prejudicial to the proper use of castings cannot be a reason for rejection. Unless specified otherwise at the time of enquiry and order the castings are delivered in the unmachined condition, but duly dressed and cleaned of all moulding materials and heat treatment scales. Method of sampling shall be as given in IS 6907 in case of checking on sample basis. For surface quality of steel casting other international standards may also be followed as per agreement between the purchaser and the manufacturer.

7.1.1.3 Unless otherwise specified, the castings shall be coated by the supplier with any of the rust preventives to avoid rusting of the castings in transit.

7.1.1.4 In the event of any casting proving defective from foundry causes in the course of preparation, machining or election, such castings may be rejected notwithstanding any previous certification of satisfactory testing and/or inspection.

7.1.2 *Examination of Material*

The material is characterized by its mechanical properties and/or, when required by the product standard by its chemical composition. For special steels, the properties given below may be supplemented by their own particular basic properties.

7.1.2.1 *Mechanical properties*

a) *Tensile test at ambient temperature*:
   1) Tensile strength;
   2) Yield strength; and
   3) Elongation.

   NOTE — In the event of non-availability of a test bar for any reason the purchaser at his discretion may agree to have the tensile test conducted on a test piece taken from a casting. In that case, it may be stated for information that properties so obtained may go down to as low as 80 percent of those obtainable from test bars.

b) *Hardness test (specific to certain products)* — Following an agreement between the purchaser and the manufacturer, the tensile test may be replaced by hardness test. However, this test may also be used concurrently with the tensile test to check the homogeneity of a supply.

   NOTE — Due to variation of section thickness in actual casting, the hardness as measured on the castings may deviate from that specified for the test bars by ± 20 percent.

c) *Reduction of area or impact test (Charpy V-notch) at ambient temperature* — One of the properties shall be applicable. However, the purchaser, if so desires, may ask for both the properties at the time of enquiry and order.

d) *Bend test* — The test bar shall be capable of being bent to the stipulated angle. In order to meet the requirements of this test, the guided bend specimens shall have no cracks or other open defects each exceeding 3 mm measured in any direction on the convex surface or at the corner of the specimen after bending.

7.1.2.2 *Chemical analysis*

The chemical purity and composition limits are given in the product standards. The specified ranges of chemical composition are based on the results of the 'ladle analysis' and if so specified at the time of enquiry and order, the manufacturer shall provide a certificate indicating the content for each element specified in the standard for the product.

7.1.2.3 If the depth of total decarburization is specified in the enquiry and order as relevant factor, then unless otherwise stated in the enquiry and order, the depth of the decarburized layer shall be restricted to a maximum of 2 percent of the relevant section thickness but subject to a maximum allowed depth of 0.5 mm.

7.2 Special Requirements

The purchaser shall specify the special requirements, if any like microstructure, inter-granular corrosion test, etc, to supplement the general requirements on the enquiry and order. The conditions of inspection are specified on the order in accordance with **4.1.17.1** or **4.1.17.3**.

7.2.1 *Inspection of the Castings*

The purchaser shall in all cases specify on the enquiry and order the inspection which has been decided to carry out in relation to the service conditions of the castings and specifically the non-destructive tests together with their severity levels as defined in **7.2.1.4**. In addition, if he proposes to make the founder responsible for these inspection procedures, he shall clearly state this on the enquiry and order. In the absence of such a statement or otherwise in the absence of contractual agreement subsequent to founder's quotation for the inspection methods, the founder need only check for dimensions, shape and surface appearance in accordance with **7.1.1.1** and **7.1.1.2**.

7.2.1.1 *Machining allowances and tolerances on dimensions and mass*

a) Machining allowances and tolerances on dimensions and mass shall be as specified on the drawing supplied, otherwise they shall conform to IS 11166. Verification of the dimensions is carried out on castings in the state of delivery at the reference temperature of 30 ± 10°C. The dimensions of unmachined and machined parts are measured by means of instruments, which allow a precision compatible with the required tolerances. The purchaser shall indicate the datum points for machining and marking out. It is desirable for him to supply the drawing of the finished component.

b) *Proof machining* — Proof machining is an operation sometimes carried out on castings in order to ensure, before supply, that a casting is free of surface and near-surface defects that may otherwise appear in the course of final machining, causing downtime and delays which often involve expensive machine tools. When proof machining is done, it is carried out as a preliminary coarse machining operation on a few important surfaces that will, thereafter, undergo the final finish machining. The proof machined dimensions, unless otherwise agreed, shall be as per IS 11166.

NOTES

1 Where such proof machining is done not merely on a few important surfaces but on all the surfaces that are ultimately finish machined, then such an operation is called 'Rough Machining'.

2 Proof machining and rough machining are sometimes also carried out to improve the 'as cast' dimensional accuracy of castings, so as to make them fit to be loaded with appropriate fixtures, on to the machine tools used for finish machining.

c) *Definition of mass* — The mass of an investment casting shall be taken to mean the mass after all normal fettling operations are carried out but prior to doing any machining or drilling; that is, the mass shall include any stock kept for any machining operation, unless otherwise agreed to.

7.2.1.2 *Surface inspection*

The examination of the surface is ordinarily carried out visually in adequate lighting in the state of delivery without optical aids. The surface condition and the method of examination thereof may be the subject of a special agreement between the purchaser and the manufacturer. Method of sampling, if sampling technique is agreed to shall be as per IS 6907.

7.2.1.3 *Repair of casting*

a) Unless otherwise specified by the purchaser on the enquiry and order, castings may be rectified by welding. All repairs by welding shall be carried out in accordance with the procedure laid down in IS 5530. If castings have been subjected to non-destructive testing by agreement between the purchaser and the manufacturer, the castings shall be re-examined in the area of repair following any rectifying operation performed on the castings.

b) To form the basis of an agreement between the purchaser and the supplier in this respect, the following classification shall apply considering the extent of repair:

   1) A weld repair involving a depth not exceeding 20 percent of the wall thickness or 25 mm, whichever is lower, shall be termed as a minor repair.

   2) Any weld repair exceeding the above shall be termed as a major repair. Also any single repair having an area exceeding 250 mm square for every millimetre of wall thickness shall also be deemed to be a major repair, regardless of the considerations mentioned in (1) above.

   3) If so specified in the enquiry and order, major repair welds shall be documented on drawings or photographed showing location and extent of the weld and the welding procedure followed. If so specified, documentation shall be submitted to the purchaser at the time of dispatch of concerned casting.

c) *Carbon equivalent* — Unless otherwise specified in the enquiry and order or otherwise agreed to, the carbon equivalent (C.E.), for the purpose of guidance in determination of the pre-and post-weld treatment applicable to

carbon and low alloy steels, shall be computed as follows:

$$\text{Carbon equivalent (C.E.)} = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$

In case of high alloy steels, the definition of C.E. shall be subject to agreement between the purchaser and the manufacturer.

7.2.1.4 *Non-destructive tests*

a) Non-destructive testing shall be applied if so specified in the enquiry and order. Under this heading are grouped the tests, which aim at revealing defects which cannot be revealed by a simple visual examination, such as dye penetrant, magnetic particle, ultrasonic, X-ray radiographic or gamma-radiographic inspection. Also included under this heading are tests on the surface condition by visual or visual tactile examination. The purchaser shall specify in the enquiry and order:
   1) The type of non-destructive testing which he intends to carry out or to have carried out,
   2) The area or the areas of the casting to which these tests apply and the types of discontinuity where relevant,
   3) Whether all or what proportion of the castings are to be tests,
   4) The severity level defining the acceptability or non-acceptability of defects which may be revealed, and
   5) Whether the manufacturer is or is not contractually responsible for carrying out the tests.

b) Unless otherwise agreed upon, when non-destructive testing is to be done, the castings shall be examined as follows:
   1) Ultrasonic examination as per IS 7666,
   2) Magnetic particle examination as per IS 3703,
   3) Liquid penetrant examination as per IS 3658, and
   4) Radiographic examination as per IS 2595.

c) Unless otherwise agreed upon the following shall be the aceptance standards:
   1) IS 9595 for ultrasonic inspection,
   2) IS 10724 for magnetic particle inspection,
   3) IS 11732 for liquid penetrant inspection, and
   4) IS 12938 for radiographic inspction.

NOTE — In case of austenitic grades, ultrasonic inspection and magnetic particle inspection may not ordinarily be feasible.

7.2.1.5 *Pressure tightness test*

a) Pressure tightness tests are carried out on unmachined or machined castings. The pressure tightness test conditions (test pressure, fluid temperature and time), as well as interpretation of the results are as defined in existing standards; otherwise by agreement or as stipulated in the enquiry and order. The castings which are required to be leak proof to a fluid (air, water, oil, petroleum vapour etc), under pressure indicated in the enquiry and order are tested with that fluid at the specified pressure for the test time indicated. If these castings are only intended to contain a liquid at atmospheric pressure, they are filled with such a liquid for the time necessary to verify freedom from leakage. In the case of castings for pressure vessels, reference shall be made to test standards relating to such vessels.

b) The castings submitted to the test shall not be oxidized and shall not receive any protective coating or covering before the test. The castings shall not be peened, plugged or impregnated to stop leakages. However, unless otherwise specified at the time of enquiry and order, rectification and up gradation of a casting by welding may be carried out in accordance with the approved procedure as laid down in the relevant clause of the standard.

7.2.1.6 *Specified ferrite range in austenitic and austenitic-ferritic stainless steels*

7.2.1.6.1 Where a range of permissible ferrite content is specified in the enquiry and order, the chemical composition of the melt shall be controlled such that the ferrite content as determined by a mutually agreed procedure shall be in conformance with the specified ferrite content range.

7.2.1.6.2 The specified ferrite content shall be as agreed upon between the manufacturer and the purchaser. If both minimum and maximum ferrite contents are specified, the minimum range specified of ferrite content shall be 10 percent. The minimum specified ferrite content shall be no lower than the percent necessary to achieve the minimum mechanical properties required for the alloy.

7.2.1.6.3 Should the purchaser wish to have the ferrite content determined by either the magnetic response or metallographic methods, the purchaser should specify such requirements at the time of enquiry and order.

8 MARKING, PROTECTION AND PACKING

8.1 Marking of the Castings

If agreed to between the purchaser and the manufacturer, each casting shall bear, recessed or raised and at a place which shall remain unmachined, all or some of the following identifications:

a) Number or identification mark by which it is possible to trace the melt and the heat treatment batch from which it was made;

b) Manufacturer's initials or trade-mark; and

c) Other identification marks in accordance with any agreement between the purchaser and the manufacturer.

NOTE — It is recommended that minimum markings be used.

8.2 Protection

If the order so specifies, the unmachined or machined castings may be submitted to a specified protective treatment, as given in IS 1154. If not, the castings shall be coated with any rust preventive to protect them during transit only as specified in **7.1.1.3**.

8.3 Packing

The castings shall ordinarily be supplied appropriately packed to protect them from damage during handling and transport. The packages shall be suitably marked to enable linking them with the concerned dispatch documents. If mutually agreed to, any or all of the markings stated in **8.1** may also be marked on the packages.

9 PURCHASER'S INSPECTION

9.1 General

If the supply is subject to purchaser's inspection, this shall be stated in the enquiry and order so that the correspondingly increased cost of manufacture, testing, etc, may be implicitly included in the contract. The purchaser's inspection may be carried out by a representative of the manufacturer or by a representative of the purchaser. The inspection by the representative of the purchaser, shall however, be specified in the enquiry and order. In the case of inspection by a representative of manufacturer, the latter supplies a certificate of acceptance in conformity with **4.1.17.3** (a)(1)(i). The final acceptance is carried out in the foundry by handling over of the acceptance report except for inspection, which can only take place later at the purchaser's works, within limits specified by an agreement between the purchaser and the manufacturer. Selection of samples, preparation of test pieces and the tests defined in the order shall normally be carried out at the foundry, unless otherwise agreed.

9.2 Procedure for Purchaser's Inspection

9.2.1 *Formation of Batches*

a) *By cast* — The products are of the same type. They come from the same cast and where necessary, have undergone the same heat treatment procedure.

b) *By batch* — The products may come from casts of the same grade and/or heat treatments having the same cycles, which may or may not be identified. In this case, the batch is limited to a number of castings or a tonnage which is fixed by the purchaser or the manufacturer and which constitute this the unit of acceptance, the homogeneity of the batch is verified by hardness tests carried out on 5 percent of the castings (or at least 5 castings) per batch or by an agreement between the purchaser and the manufacturer. The hardness is measured at the same place on each casting. Each hardness value obtained shall not deviate by more than 10 percent from the average of the hardness values of all the castings representing the batch, measured at comparable section thickness. If this is not the case, the manufacturer may either:

1) Subject all the castings in the batch to testing to eliminate those which do not correspond to the condition of homogeneity and to subject them to a fresh heat treatment, or

2) Subject the whole batch to a fresh heat treatment, before presenting it again for purchaser's inspection.

3) In certain cases when agreed to between the parties other methods for making up of batches by means of statistical control may be used.

9.2.2 *Submission for Purchaser's Inspection*

The manufacturer shall inform the purchaser at an appropriate time, the date on which the castings shall be submitted for inspection. He shall indicate the number of the castings that will be submitted for each melt and the reference of the order under which they are made. This constitutes a certificate stating that the manufacturing conditions specified have been complied with and that any individual examination which may have been specified has been carried out. The purchaser's representative who is permitted access to the places where the castings are stored, will present himself on the day specified in the written notice of within the next five days, otherwise in order to avoid disturbance in the manufacturing cycle, the manufacturer may carry out the inspection operation

himself and submit to the purchaser the certificate of acceptance.

9.2.2.1 *Rights and duties of the accepting agent*

The accepting agent will have free access at any suitable time to the places where the products to be inspected are manufactured and stored. He may indicate the parts of the acceptance units or the products from which the samples shall be selected in accordance with the specification. He shall have the option of attending to the selection of samples, the preparation (machining and treatment) of test pieces and the carrying out of the tests. An accepting agent who visits the workshops shall respect all the safety regulations in force at the works, if possible. The acceptance procedures shall be carried out in accordance with normal production requirements.

9.2.3 *Validity of Tests*

No cognizance is taken of the tests where unsatisfactory results are not attributable to the quality of the material but are the result of:

a) either incorrect mounting of the test pieces or abnormal operation of the test machine; or
b) defective preparation of the test piece; or
c) fracture of the tensile test piece outside the gauge length; or
d) casting defects observed in the test piece.

In the above cases a new test piece may be selected from the test block belonging to the same batch and the results obtained may be substituted for those corresponding to the defective test piece.

9.2.4 *Re-test*

In cases other than those mentioned in **9.2.3**, where the results of the mechanical tests carried out on the test pieces do not comply with the requirements of the product standard, the manufacturer may, unless otherwise agreed upon, adopt one of the following procedures:

a) He may repeat the mechanical test (including the inter-granular corrosion test, where applicable) which failed on two additional test pieces. If the results obtained from both these test pieces are satisfactory, then the material represented shall be considered to be satisfying the requirements of the product standard. Should any of the two new test pieces fail to give satisfactory results, the manufacturer may follow the procedure indicated in (c).
b) In case of impact tests, if the average value obtained from three tests does not reach the specified value or if one of the individual values does not reach two-thirds of the specified minimum, three additional test pieces selected from a test bar coming from the same batch shall be tested and the average of the six tests shall be recalculated. If the new average satisfies the specified average value, the material shall be considered to be satisfying the requirement of the product standard. Should the new mean not reach the specified or if one minimum, the manufacturer may follow the procedure indicated in (c).
c) He may submit the castings and test bars to a new heat treatment and then carry out all the mechanical tests required in the product standard on the test bars, and the inter-granular corrosion test, if required.

9.2.4.1 Should they fail again, the castings and test bars may be submitted once more to a final heat treatment and undergo all the relevant tests required by the product standard once more. In no case shall the castings and test bars be submitted to more than two additional heat treatments (excluding tempering).

9.2.5 *Grading of Reprocessing*

Unless otherwise specified, the manufacturer may reserve the right to grade or subject the products to heat treatment, either before or after the re-tests and present these products as a new acceptance unit in accordance with the procedures in **9.2.1** and **9.2.2** without prejudice to the purchaser. The manufacturer shall indicate to the accepting agent, the method of grading used or the type of heat treatment applied.

9.2.6 *Conditions of Acceptance*

If all the conditions required in the order are fulfilled in accordance with this standard, the batch is considered to conform and shall be accepted by the purchaser without prejudice to the inspection which can only take place later at the purchaser's works within the time specified by an agreement between the purchaser and the manufacturer.

9.3 Rounding Off Test Results

9.3.1 *Mechanical and Chemical Properties*

The results of the mechanical and chemical tests shall be rounded off, using the rules specified in IS 2.

9.3.2 *Dimensions*

Rounding off of the results of measured dimensions and shape is not required.

10 AGREED MANUFACTURING PROCEDURE

10.1 Under normal circumstances, the manufacturing procedure is left to the discretion of the manufacturer.

However, for certain supplies, where castings are produced in large numbers, the purchaser or the manufacturer may request at the time of enquiry and order, the benefit of a manufacturing approval. In this case, a programme of manufacture and inspection is drawn up by common agreement. The parties shall agree to a certain number of satisfactory preliminary tests and the manufacture of a pilot series of castings.

All these conditions taken together constitute approval tests of the manufacture by the purchaser. Where the results are satisfactory, the purchaser may place subsequent orders with the manufacturer in accordance with these programmes of manufacture and inspection.

11 RECORD AND COMPLAINTS

11.1 Unless otherwise specified in the enquiry and, the manufacturer shall maintain the record of all the chemical and mechanical tests performed by him for a minimum period of two years from the date of supply.

11.2 If a complaint is made by the purchaser concerning a supply, the manufacturer shall be given reasonable time to examine merits of the complaint and the castings in question shall remain available for his examination.

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BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones : 2323 0131, 2323 3375, 2323 9402

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :		Telephone
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110 002	2323 7617, 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V. I. P. Road, Kankurgachi, KOLKATA 700 054	2337 8499, 2337 8561, 2337 8626, 2337 9120
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