INTERNATIONAL STANDARD

ISO 16468

First edition
2005-08-01

Investment castings (steel, nickel alloys and cobalt alloys) — General technical requirements

Moulages à la cire perdue (acier, alliages de nickel et alliages de cobalt) — Exigences générales techniques

Reference number
ISO 16468:2005(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16468 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 11, *Steel castings*.

Investment castings (steel, nickel alloys and cobalt alloys) — General technical requirements

1 Scope

This International Standard specifies technical requirements for castings (steel, nickel alloys and cobalt alloys) produced by the investment-casting process. The International Standards specifying metallurgical material requirements for steel, nickel alloy and cobalt alloy casting grades are listed in the Bibliography.

The requirements stated in this International Standard form an integral part of the material specification. In cases of conflict, the requirements of this specification take precedence over the individual material specification requirements.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4986, *Steel castings — Magnetic particle inspection*

ISO 4987, *Steel castings — Penetrant inspection*

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

ISO 4993:1987, *Steel castings — Radiographic inspection*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 11970, *Specification and approval of welding procedures for production welding of steel castings*

ISO 13520, *Determination of ferrite content in austenitic stainless steel castings*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
primary heat
master
mother heat
melt
quantity of metal processed in a single furnace or refining vessel at one time, in such a manner as to produce the desired composition and properties

3.2
sub-heat
melt
production heat
daughter heat
portion of a primary heat remelted for pouring into castings

3.3
investment casting
lost wax casting
metal casting that is produced in a ceramic shell using an expendable pattern

NOTE The expendable pattern may consist of wax, plastics or other material, and is removed prior to filling the mould with liquid metal.

3.4
shell
ceramic mould

4 Materials and manufacture

4.1 Melting process

Primary heats shall be made by the 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 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.

4.2 Remelting process

Sub-heats shall be produced from primary-heat metal in suitable batch sizes by an 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 manufacturer. Revert (gates, sprues, risers, and rejected castings) shall not be remelted except in primary heats. Additions of up to 5 %, by mass, are permitted for compositional adjustments and deoxidation.

5 Inspection and testing

5.1 General requirements

The general requirements for inspection and testing shall be in accordance with ISO 4990, except as described in 5.2.

5.2 Sampling

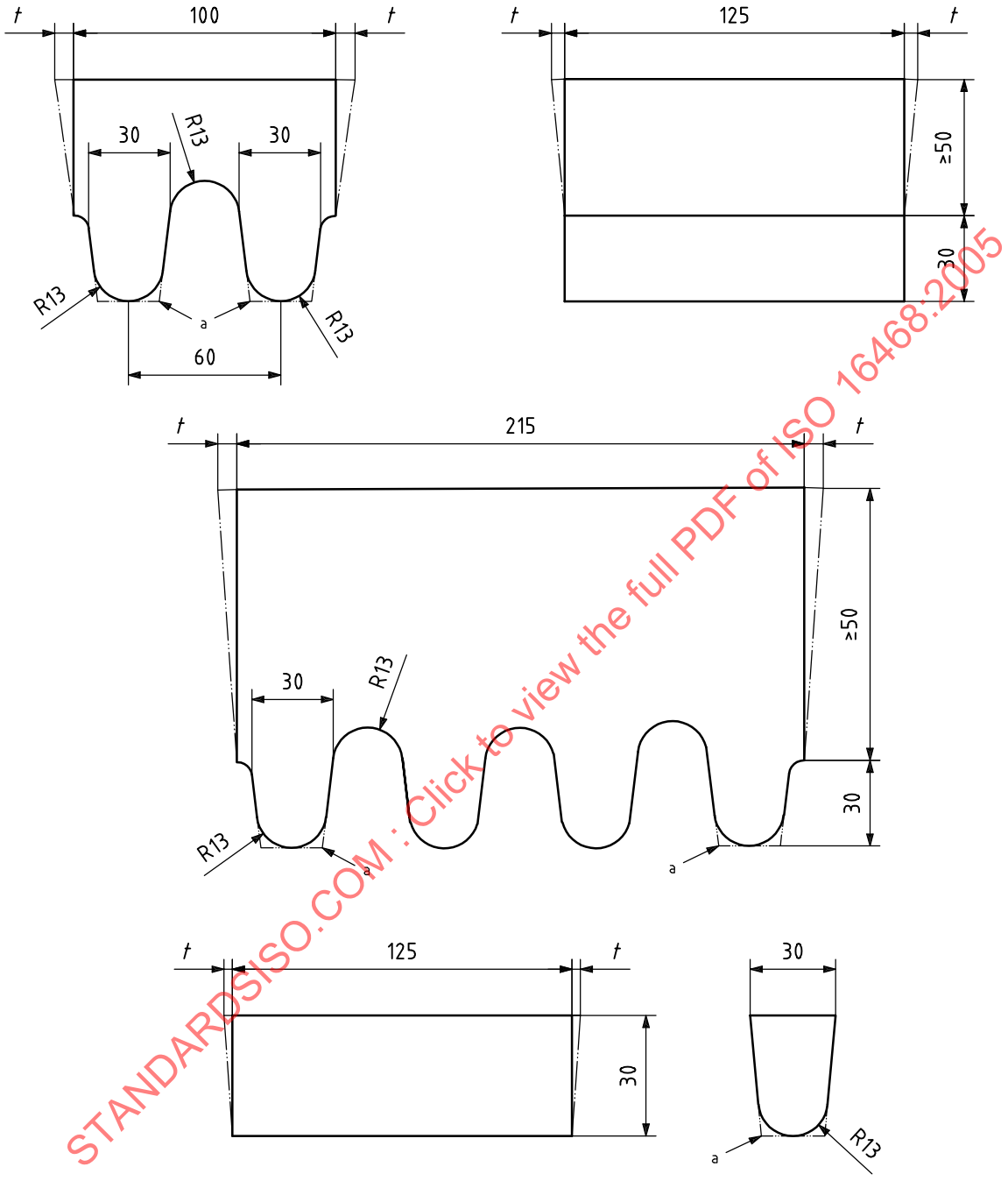
5.2.1 If castings are poured directly from one or more primary heats, then the samples for chemical and other required testing shall also be poured directly from each of the primary heats.

5.2.2 Unless otherwise specified by the purchaser, test coupons may be taken from castings, may be cast integrally with the castings, or may be cast in separate moulds of the same type and materials as those used for the castings. Chemical-composition analysis samples may be cast in other types of mould.

5.2.3 If castings are poured from a sub-heat, then the samples for chemical and other required testing shall also be poured from a sub-heat of the same primary melt, but not necessarily from the same sub-melt as the castings. The sub-melt used for the test samples shall be produced using the same practices and additions as used for the castings.

5.2.4 Examples of test coupons which may be used for mechanical testing are shown in Figure 1, except when 10.14 is specified. The test coupon in Figure 1 d) may be employed only for austenitic alloy castings with a ruling thickness less than 65 mm.

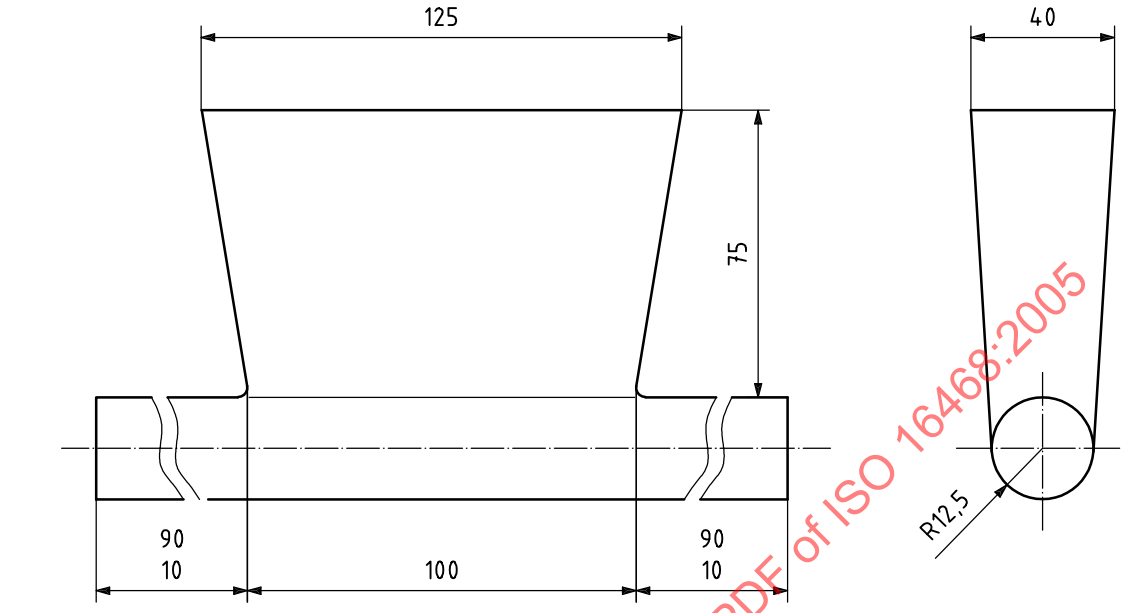
Dimensions in millimetres



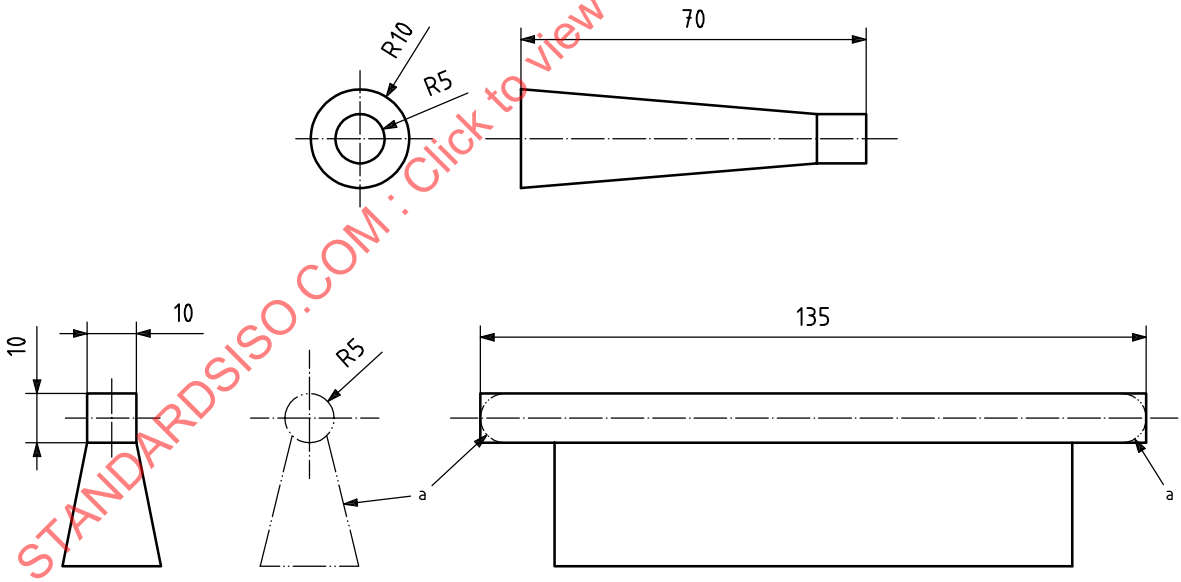
a)

Figure 1 — Test coupons

Dimensions in millimetres



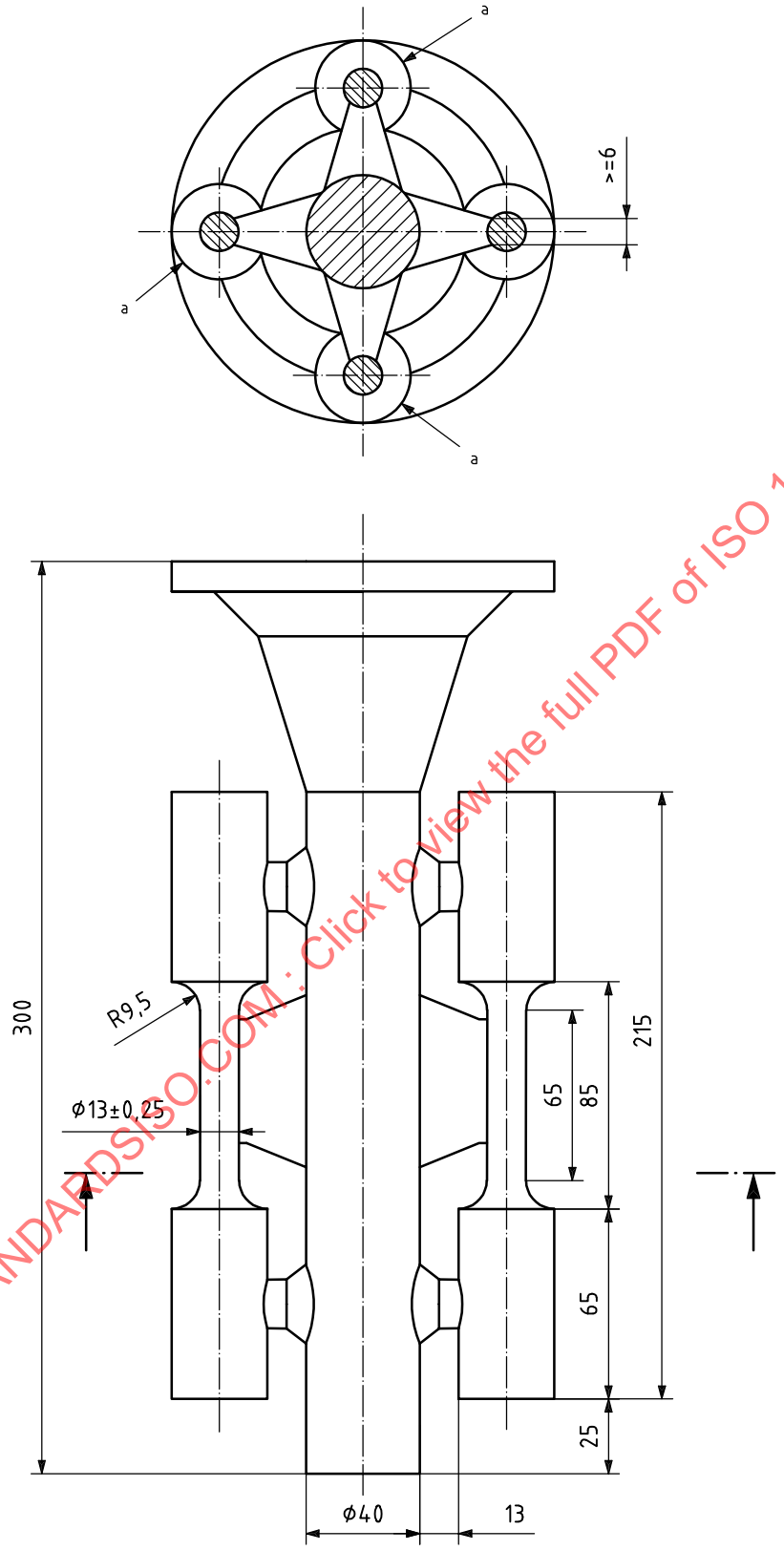
b)



c)

Figure 1 (*continued*)

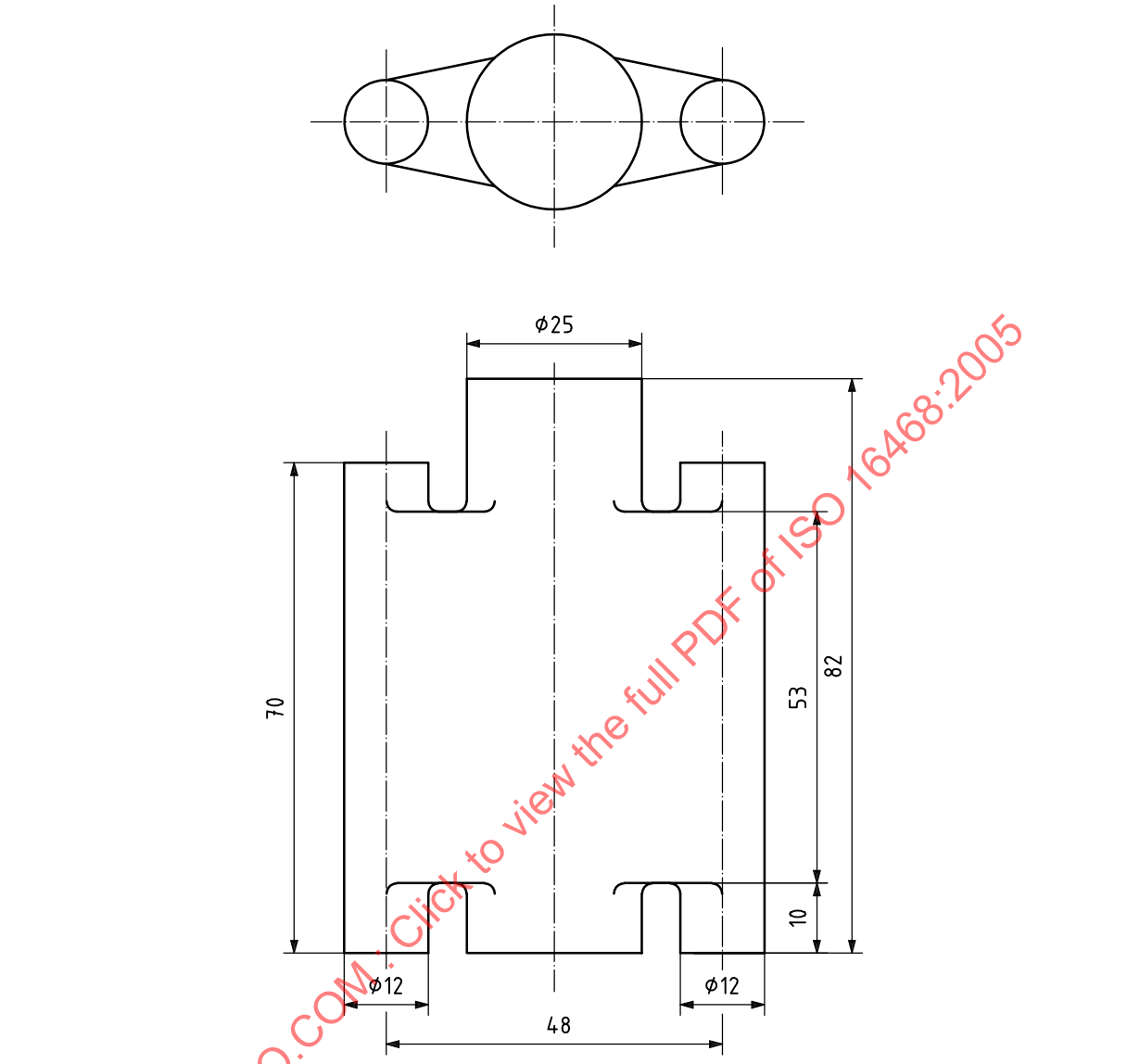
Dimensions in millimetres



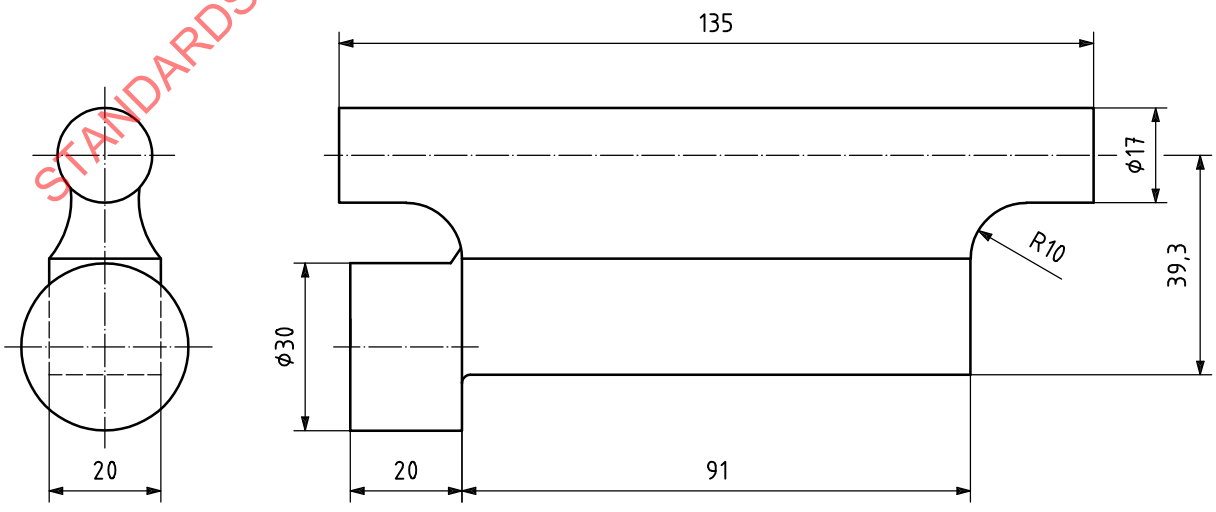
d)

Figure 1 (*continued*)

Dimensions in millimetres



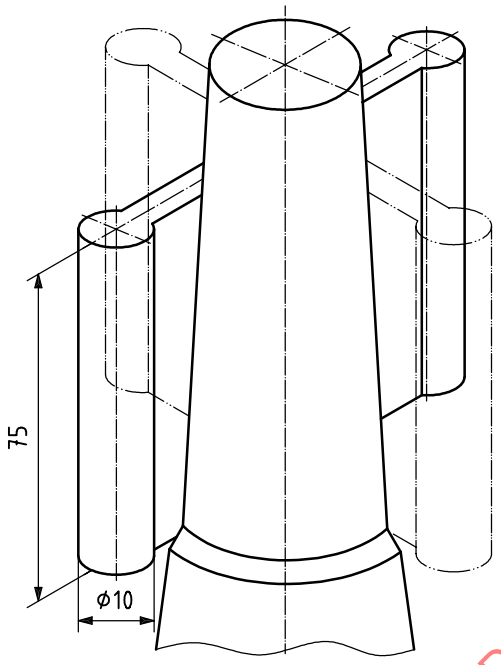
e)



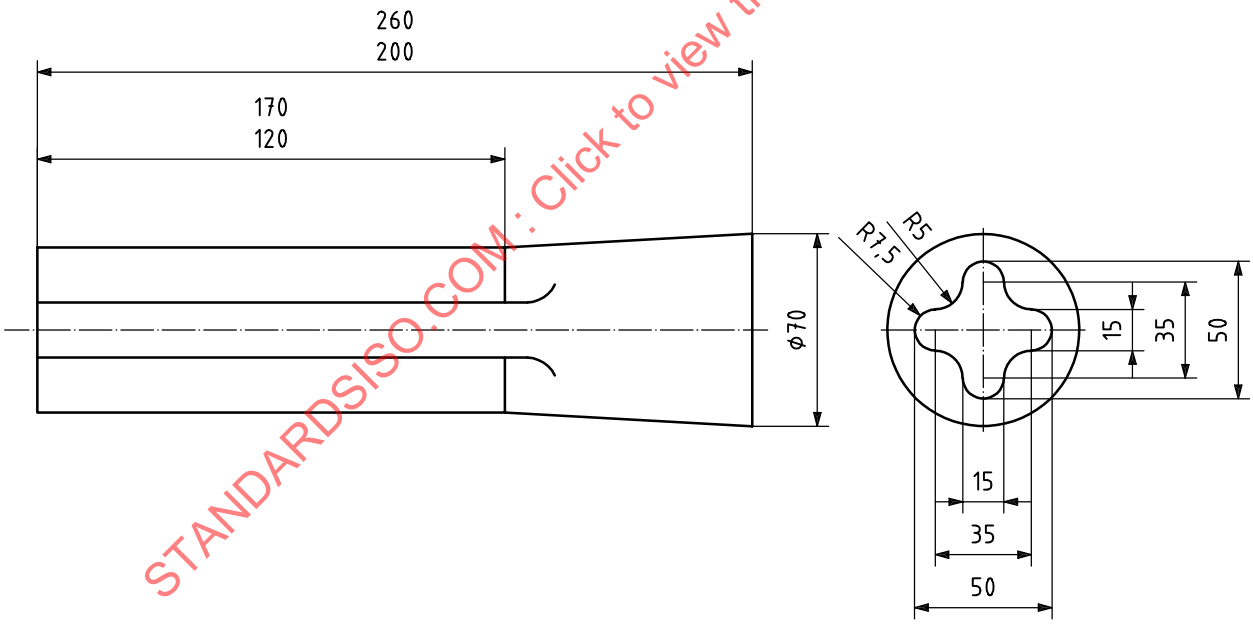
f)

Figure 1 (*continued*)

Dimensions in millimetres



g)



h)

Key

t taper

a alternative

Figure 1 (*continued*)

6 Retests

In addition to the requirements of ISO 4990, if any specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted from the same primary heat.

7 Cleaning and dressing

All the castings shall be cleaned and dressed sufficiently to determine compliance with the requirements of Clause 8. Additional dressing may be agreed at the time of the enquiry and order.

If the pattern is supplied by the purchaser, or is produced using a die supplied by the purchaser, the dimensions of the casting shall be as produced by the pattern or die.

8 Quality

8.1 Visual standards for acceptance shall be agreed between the purchaser and manufacturer. ISO 11971 may be used to specify visual surface standards. Other surface conditions shall meet the visual acceptance standards specified in the order. Unacceptable visual surface discontinuities shall be removed and their removal verified by visual examination.

8.2 When additional inspection is desired, 10.3, 10.4, 10.5, 10.6 or 10.7 may be specified.

9 Production welds

Production welding shall be in accordance with the requirements of ISO 11970.

10 Supplementary requirements

10.1 General

One or more of the following supplementary requirements may be applied when specified in the enquiry and order. Additional supplementary requirements may also be found in ISO 4990. Details of these supplementary requirements shall be agreed upon by the manufacturer and purchaser at the time of the enquiry and order. The specified tests shall be carried out before delivery of the castings.

10.2 Agreed manufacturing procedure

At the time of enquiry and order, the purchaser may require prior approval of the manufacturing process.

10.3 Magnetic particle inspection

Castings shall be inspected for surface and near-surface discontinuities by magnetic particle inspection. The inspection shall be in accordance with ISO 4986. The extent of inspection and the basis for acceptance shall be agreed upon between the manufacturer and the purchaser.

10.4 Radiographic inspection

Castings shall be inspected for internal defects by means of X-rays or gamma rays. The procedure shall be in accordance with ISO 4993. The extent of inspection and the basis for acceptance shall be agreed upon between the manufacturer and purchaser.

10.5 Liquid penetrant inspection

Castings shall be inspected for surface discontinuities by means of liquid penetrant inspection. The inspection shall be in accordance with ISO 4987. Areas to be inspected, methods and types of liquid penetrants to be used, developing procedure, and the basis for acceptance shall be agreed upon between the manufacturer and purchaser.

10.6 Ultrasonic inspection

Castings shall be inspected for internal defects by means of ultrasonic inspection. The extent of inspection, methods of inspection, and the basis for acceptance shall be agreed upon between the manufacturer and purchaser.

10.7 Inspection of weld preparation

10.7.1 Magnetic particle or liquid penetrant inspection

Surfaces prepared for welding shall be inspected, using the same methods and acceptance criteria as specified for the casting, to verify removal of discontinuities.

10.7.2 Radiographic inspection

Unless other degrees of shrinkage or types of discontinuities found in the cavities are specified, Type II (internal shrinkage) reference photographs referenced in ISO 4993:1987, of Degree 2 in sections up to 50 mm thick, and of Degree 3 in sections over 50 mm thick, shall be acceptable.

10.8 Prior agreement relating to major finishing welds

The requirements related to major finishing welds shall be in accordance with ISO 4990.

10.9 Impact test at low temperatures

The requirements related to the impact test at low temperatures shall be in accordance with ISO 4990.

10.10 Hardness test

10.10.1 Brinell

Brinell hardness tests at specified locations of the castings shall be carried out in accordance with ISO 6506-1, and shall be reported.

10.10.2 Rockwell

Rockwell hardness tests at specified locations of the castings shall be carried out in accordance with ISO 6508-1, and shall be reported.

10.10.3 Vickers

Vickers hardness tests at specified locations of the castings shall be carried out in accordance with ISO 6507-1, and shall be reported.

10.11 Specified ferrite range in austenitic and austenitic ferritic stainless steels

10.11.1 The chemical composition of the melt shall be controlled such that the ferrite content, as determined by the chemical composition procedure of ISO 13520, shall be in conformance with the specified ferrite content range.