INTERNATIONAL STANDARD

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Specification and approval of welding procedures for metallic materials —

Part 1: General rules for fusion welding

Descriptif et qualification d'un mode opératoire de soudage pour les matériaux métalliques —
Partie 1: Règles générales pour le soudage par fusion

Reference number
ISO 9956-1:1995(E)

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.

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.

International Standard ISO 9956-1 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*.

This part of ISO 9956 is the equivalent of European Standard EN 288-1.

ISO 9956 consists of the following parts, under the general title *Specification and approval of welding procedures for metallic materials*:

— *Part 1: General rules for fusion welding*

— *Part 2: Welding procedure specification for arc welding*

— *Part 3: Welding procedure tests for the arc welding of steels*

— *Part 4: Welding procedure tests for the arc welding of aluminium and its alloys*

— *Part 5: Approval by using approved welding consumables for arc welding*

— *Part 6: Approval related to previous experience*

— *Part 7: Approval by a standard welding procedure for arc welding*

— *Part 8: Approval by a pre-production welding test*

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— *Part 10: Welding procedure specification for electron beam welding*

— *Part 11: Welding procedure specification for laser beam welding*

— *Part 12: Welding procedure test for arc welding of cast steels*

Annex A of this part of ISO 9956 is for information only.

Introduction

Welding procedure specifications are needed in order to provide a well-defined basis for planning of the welding operations and for quality control during welding. Welding is considered a special process in the terminology of standards for quality systems. Standards for quality systems usually require that special processes be carried out in accordance with written procedure specifications.

ISO 9956-2 defines a format for the welding procedure specifications for arc welding of metallic materials, which is considered to fulfill the requirements in current standards for quality systems as regards procedure specifications.

Preparation of a welding procedure specification provides the necessary basis for, but does not in itself ensure that the welds fulfill the requirements. Some deviations, notably imperfections and distortions, can be evaluated by nondestructive methods on the finished product.

Metallurgical deviations constitute a special problem, however, because nondestructive evaluation of the mechanical properties is impossible at the present level of nondestructive technology. This has resulted in the establishment of a set of rules for approval of the welding procedure prior to the release of the specification to actual production. This part of ISO 9956 defines these rules.

Specification and approval of welding procedures for metallic materials —

Part 1:
General rules for fusion welding

1 Scope

This part of ISO 9956 defines general rules for the specification and approval of welding procedures for metallic materials. This standard also refers to several other standards as regards detailed rules for specific applications.

It is assumed that the welding procedure specifications are used in production by competent welders approved in accordance with the relevant part of ISO 9606.

This part of ISO 9956 is applicable to production by conventional welding equipment under direct control of the welder. It may not be sufficient for fully automatic or robotic welding, without direct human control ("intelligent welding system").

This standard applies when approval of the welding procedure is required, e.g. by either contract, standards, rules or legal requirements.

The use of a particular method of approval of a welding procedure is often a mandatory requirement of an application standard. In the absence of such a requirement, the method of approval shall be agreed between the contracting parties at the enquiry or at the order stage.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9956. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9956 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 857:1990, *Welding, brazing and soldering processes — Vocabulary.*

ISO 4063:1990, *Welding, brazing, soldering and braze welding of metals — Nomenclature of processes and reference numbers for symbolic representation on drawings.*

ISO 6520:1982, *Classification of imperfections in metallic fusion welds, with explanations.*

ISO 9606-1:1994, *Approval testing of welders — Fusion welding — Part 1: Steels.*

ISO 9606-2:1994, *Approval testing of welders — Fusion welding — Part 2: Aluminium and aluminium alloys.*

ISO 9956-2:1995, *Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding.*

ISO 9956-3:1995, *Specification and approval of welding procedures for metallic materials — Part 3: Welding procedure tests for the arc welding of steels.*

ISO 9956-4:1995, *Specification and approval of welding procedures for metallic materials — Part 4: Welding procedure tests for the arc welding of aluminium and its alloys.*

3 Definitions

For the purposes of this part of ISO 9956 the following definitions apply.

3.1 welding procedure: Specified course of action to be followed in making a weld, including reference to materials, preparation, preheating (if necessary), method and control of welding and post-weld heat treatment (if relevant), and necessary equipment to be used.

3.2 welding processes: For nomenclature and definitions see ISO 857 and for the numbering system see ISO 4063.

3.3 preliminary welding procedure specification; pWPS: Tentative welding procedure specification, which is assumed to be adequate by the manufacturer, but which has not been approved.

NOTE 1 Welding of test pieces needed for approval of a welding procedure specification has to be carried out on the basis of a preliminary welding procedure specification.

3.4 welding procedure specification; WPS: A document providing in detail the required variables for a specific application to assure repeatability.

3.5 work instruction: Simplified specification of the welding procedure, suitable for direct application in the workshop.

3.6 approved welding procedure specification: Specification for which the welding procedure has been approved in accordance with ISO 9956.

3.7 welding procedure approval record; WPAR: Record comprising all relevant data from the welding of a test piece needed for approval of a welding procedure specification as well as all results from the testing of the test weld.

NOTES

2 One or more welding procedure approval records may be needed in order to approve one welding procedure specification, and one welding procedure approval record may, in certain cases, provide approval for more than one welding procedure specification.

3 WPAR was formerly designated as WPQR.

3.8 previous welding experience: When it can be shown by authenticated test data that the manufacturer's established production welding procedures have been capable of consistently producing welds of acceptable quality over a period of time.

3.9 approved welding consumable: Welding consumable or consumable combination tested and certified by an independent examiner or test body.

3.10 welding procedure test: Making and testing of a welded joint, representative of the one to be used in production, in order to prove the feasibility of a welding procedure.

3.11 standard welding procedure: Welding procedure tested and certified by an independent examiner or test body which may then be made available to any manufacturer.

3.12 pre-production welding test: Welding test having the same function as a welding procedure test, but based on a non-standard test piece, simulating the production conditions.

3.13 welding consumables: Materials consumed in the making of a weld, including filler metals, fluxes and gases.

3.14 Welding variables

3.14.1 essential variable: Variable which influences the mechanical and/or metallurgical properties of the welded joint.

3.14.2 additional variable: Variable which does not influence the mechanical and/or metallurgical properties of the welded joint.

3.15 range of approval: Extent of approval for an essential variable.

3.16 Parent metals

3.16.1 standard material: Parent metal of a defined chemical composition, mechanical properties, heat treatment, etc., produced and delivered according to a standard or similar comprehensive specification.

3.16.2 group of standard materials: Defined number of similar standard materials.

3.16.3 batch of standard materials: Parent metals of the same chemical composition, mechanical properties, heat treatment, etc., delivered as a unit from a single manufacturer (e.g. steel mill); the batch is limited to a single charge.

3.17 test piece: Welded assembly which is used in the approval test.

3.18 test specimen: Part or portion cut from the test piece in order to perform a specified destructive test.

3.19 test: Series of operations which will include the making of a welded test piece and subsequent non-destructive and/or destructive testing and reporting of results.

3.20 homogeneous assembly: Assembly in which the weld metal and parent metal have no significant differences in mechanical properties and/or chemical composition.

NOTE 4 An assembly made of similar parent metals without filler metal is considered homogeneous.

3.21 heterogeneous assembly: Assembly in which the weld metal and parent metal have significant differences in mechanical properties and/or chemical composition.

3.22 dissimilar metal joint: Assembly in which the parent metals have significant differences in mechanical properties and/or chemical composition.

3.23 imperfection: Discontinuity in the weld or a deviation from the intended geometry; imperfections include, for example, cracks, lack of penetration, porosity, slag inclusions.

NOTE 5 ISO 6520 contains a comprehensive list of imperfections.

3.24 metallurgical deviation: Changes in the mechanical properties and/or metallurgical structure of the weld metal or heat affected zones compared to the properties of the parent metal.

NOTE 6 Metallurgical changes include reduced strength, reduced ductility, reduced fracture toughness, etc., in the weld metal and heat affected zones. The metallurgical changes are caused by the temperature variations during welding combined with the resulting chemical composition and structure of the weld metal.

3.25 manufacturer: Person or organization which is responsible for the welding production (welding workshop).

3.26 welder: Person who performs the welding.

NOTE 7 A collective term used for both manual welders and welding operators.

3.27 manual welder: Welder who holds and manipulates the electrode holder, welding gun, torch or blowpipe by hand.

3.28 welding operator: Welder who operates welding equipment with partly mechanized relative movement between the electrode holder, welding gun, torch or blowpipe and the workpiece.

3.29 examiner or test body: Person or organization appointed by the contracting parties to verify compliance with the applicable standard.

3.30 supplier of consumables: Company which manufactures or supplies the consumables.

4 Specification of welding procedures

All welding operations shall be adequately planned prior to production; the planning shall provide WPS's for all welded joints. The WPS shall comply with ISO 9956-2. The specification level shall be compatible with the chosen method of approval.

A WPS shall be classified as pWPS until approved in accordance with this part of ISO 9956.

The manufacturer may, in addition to the WPS, prepare detailed work instructions, etc., to be used during the actual production. Work instructions are not mandatory, unless required by the manufacturer. If prepared, the work instructions shall:

— be prepared on the basis of an approved WPS;

— define values for the welding process to be used by the welder for all essential variables under direct control by the welder. The values may be given as machine settings, provided there is a well-defined correspondence between machine settings and the values of the essential and additional variables defined in the WPS.

5 Approval of welding procedures

5.1 General

5.1.1 Methods for approval

This part of ISO 9956 defines a number of methods for approval of welding procedures. Each method of approval has certain limits of application as regards welding process, parent metal and consumables (if used). Limitations for the application of the various methods of approval are stated in all parts of ISO 9956.

Each WPS shall be approved by only one method. The use of a particular method of approval of a welding procedure is often a mandatory requirement of an application standard. In the absence of such a re-

quirement the method of approval shall be agreed between the contracting parties at the enquiry or at the order stage.

Annex A provides some guidelines for the application of each method of approval. Approval shall be obtained by one of the following types of documentation:

— previous welding experience (see 5.2);

— approved welding consumables (see 5.3);

— welding procedure tests (see 5.4);

— standard welding procedure (see 5.5);

— pre-production welding test (see 5.6).

5.1.2 Application

The manufacturer shall prepare a pWPS in accordance with clause 4. The workshop shall ensure that the pWPS is applicable for the actual production, using experience from previous productions and the general fund of knowledge of welding technology. Subsequently, the pWPS shall be approved by one of the methods stated in 5.1.1.

If the approval involves welding of test pieces, then the test pieces shall be welded in accordance with the pWPS.

All welding procedures shall be approved prior to actual production welding.

5.1.3 Supervision

When approval is obtained by a welding procedure test or pre-production welding test, all activities including preparation and assembly related to welding, inspection and testing of the test pieces shall be verified by the examiner or test body.

5.2 Approval by previous welding experience

A manufacturer may have a WPS approved by referring to previous experience on condition that he can prove by appropriate authentic documentation of an independent nature that he has previously satisfactorily welded the type of joint and materials in question.

The permissible range for a WPS, approved by reference to previous experience, shall be limited to the standard material(s), welding process(es), consumable(s) and ranges of essential variables, for which adequate previous experience can be documented.

NOTE 8 Further information and technical details which specify the requirements for approval testing using previous welding experience will be identified in a subsequent part of ISO 9956.

5.3 Approval by use of approved welding consumables

Some materials do not deteriorate significantly in the heat affected zones, provided heat inputs are kept within specified limits. For such materials, a WPS shall be considered approved on the condition that the welding consumables are approved and that all essential variables are within the range for which the approval is valid.

Approval by the use of approved welding consumables shall be restricted to arc welding processes, using filler metals.

All activities related to welding, testing and inspection of test pieces shall be the responsibility of an independent examiner or test body. The examiner or test body shall state the permitted range of approval with regards to essential variables for the approved welding consumables.

NOTE 9 Further information and technical details which specify the requirements for approval testing using approved welding consumables will be identified in a subsequent part of ISO 9956.

5.4 Approval by welding procedure tests

Welding procedure tests shall be carried out in accordance with appropriate parts of ISO 9956 (see, for example, ISO 9956-3 and ISO 9956-4).

5.5 Approval by a standard welding procedure

A WPS prepared by a manufacturer is approved, if the ranges for all variables are within the range permitted by a standard welding procedure.

A standard welding procedure shall be prepared and approved by an independent examiner or test body. The independent examiner or test body shall verify the preparation of a pWPS, welding of test pieces, testing and inspection, and preparation of a final WPS in accordance with this part of ISO 9956 for procedure testing.

However, special attention shall be paid to proper specification of essential welding variables so as to

make the approved WPS independent of any particular make of welding machine or any particular conditions during welding of the test pieces. When approved by the examiner or test body, the final WPS becomes a standard welding procedure which may then be made available to any manufacturer.

NOTE 10 Further information and technical details which specify the requirements for approval testing using a standard welding procedure will be identified in a subsequent part of ISO 9956.

5.6 Approval by a pre-production welding test

Approval by a pre-production welding test may be used where the shape and dimensions of required test pieces (e.g. those in ISO 9956-3, 6.2) do not adequately represent the joint to be welded, e.g. attachment weld to thin pipe.

In such cases, one or more special test pieces shall be made to simulate the production joint in all essential features, e.g. dimensions, restraint, heat sink effects. The test shall be carried out prior to production and under the conditions to be used in production.

Inspection and testing of the test piece shall be carried out as far as possible within the requirements of appropriate parts of ISO 9956, for example ISO 9956-3 and ISO 9956-4, but this testing may need to be supplemented or replaced by special tests according to the nature of the joint in question and shall be agreed by the examiner or test body.

A satisfactory pre-production welding test approves any WPS essentially similar to that used in the test.

NOTE 11 Further information and technical details which specify the requirements for approval testing using a standard welding procedure will be identified in a subsequent part of ISO 9956.