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Welding personnel — Approval testing of welding operators for fusion welding and of resistance weld setters for fully mechanized and automatic welding of metallic materials

*Personnel en soudage — Épreuve de qualification des opérateurs soudeurs
pour le soudage par fusion et des réglleurs en soudage par résistance pour
le soudage automatique et entièrement automatique des matériaux
métalliques*

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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 14732 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 11, *Approval requirements for welding and allied processes personnel*.

Annexe A forms an integral part of this International Standard, annexes B to D are for information only.

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Introduction

This International Standard is intended to provide the basis for the mutual recognition by examining bodies for approval related to the competence of welding operators and resistance weld setters in the various fields of application. Tests shall be carried out in accordance with this International Standard unless more severe test are specified by the relevant application standard when these shall be applied.

In order to make this International Standard applicable for fusion and resistance welding the terminology, especially for welding operators in the field of fusion welding and for resistance weld setters in the field of resistance welding, was clarified.

The welding operator's/resistance weld setter's ability and job knowledge continue to be approved only if the welding operators/resistance weld setters are working with reasonable continuity on welding work within the extent of approval.

All new approvals are to be in accordance with this International Standard from the date of issue.

However, this International Standard does not invalidate previous approvals made to former national standards or specifications, provided that the intent of the technical requirements be satisfied and the previous approvals be relevant to the application and production work on which they are to be employed.

Also, where additional tests have to be carried out to make the approval technically equivalent it is only necessary to do those additional tests that should be made in accordance with this International Standard.

Considerations of previous approvals to former national standards or specifications should be made at the time of the enquiry or contract stage and be agreed between the contracting parties.

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1 Scope

This International Standard specifies requirements for approval of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding processes of metallic materials. Only welding operators/resistance weld setters responsible for the setting up and/or adjustment during welding have to be approved. Personnel exclusively performing the programming of the welding unit or operation of the welding unit do not need any particular approval.

This International Standard is applicable when approval testing of operators/resistance weld setters is required by the contract or by the application standard.

This International Standard does not apply to welding operators in resistance welding (see 3.10) or under hyperbaric conditions.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 857-1:—¹⁾, *Welding and allied processes — Part 1: Welding processes — Vocabulary*.

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 arc welding of aluminium and its alloys*.

ISO 9956-8:1995, *Specification and approval of welding procedures for metallic materials — Part 8: Approval by a pre-production welding test*.

ISO 9956-10:1996, *Specification and approval of welding procedures for metallic materials — Part 10: Welding procedure specification for electron beam welding*.

ISO 9956-11:1996, *Specification and approval of welding procedures for metallic materials — Part 11: Welding procedure specification for laser beam welding*.

1) To be published. (Revision of ISO 857:1990)

ISO 10447:1991, *Welding — Peel and chisel testing of resistance spot, projection and seam welds*.

ISO 14731:1997, *Welding coordination — Tasks and responsibilities*.

3 Definitions

For the purpose of this International Standard, the classification of manual welding and partly mechanized welding according to table 1 of ISO 857: —, and the following definitions apply.

3.1 automatic welding:

Welding where all operations are performed automatically and manual adjustment of welding variables during welding is not possible.

3.2 function test:

Test of a welding unit set-up in accordance with a Welding Procedure Specification (WPS).

3.3 fully mechanized welding:

Welding where all main operations (excluding the handling of the work piece) are performed automatically but manual adjustment of welding variables during welding is possible.

3.4 pre-production welding test:

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

3.5 production test:

Welding test carried out in the production environment on the welding unit, on actual products or on simplified test pieces, the main characteristic of such a test being that normal production is interrupted during this test.

3.6 production sample testing:

Sample testing of actual welding products sampled from a continuous production using the welding unit, no interruption of normal production during sampling being necessary.

3.7 programming:

Incorporation of the approved welding procedure specification and/or the specified movements of the welding unit into a programme.

3.8 robotic welding:

Automatic welding using a manipulator that can be pre-programmed to different welding directions and fabrication geometries.

3.9 setting-up:

Correct adjustment of the welding unit before welding, if required by entering the robot programme.

3.10 welding operator:

3.10.1 In fusion welding a person who performs fully mechanized or automatic welding.

3.10.2 In resistance welding a person who uses equipment with mechanized or fully mechanized relative movement between the welding gun and the workpiece and who has followed a training course covering such tasks (see also clause 1).

3.11 resistance weld setter:

In resistance welding a person who sets up mechanized or automatic welding.

3.12 welding unit:

Totality of equipment used to perform welding consisting of jigs and fixtures, one or more robots, feeding units and other ancillary equipment including equipment which can perform loading and unloading of the work pieces.

3.13 welding unit operation:

The starting and, if necessary, the stopping of the production cycle including loading and unloading the work pieces.

3.14 examiner or examining body:

Person or organization who verifies compliance with the application standard and who shall be acceptable to any contracting parties.

4 Approval

4.1 General

Welding operators/resistance weld setters shall be approved by one of the following methods, as detailed in 4.2:

- approval based on welding procedure test, see 4.2.1;
- approval based on pre-production welding test or production test, see 4.2.2;
- approval based on production sample testing, see 4.2.3;
- approval based on function test, see 4.2.4.

Any of the approval methods may be supplemented by a test of knowledge related to welding technology. Such a test is recommended, but not mandatory. Annex B includes a recommendation for such an examination.

The methods shall be supplemented by a test of the functional knowledge appropriate to the welding unit, see annex A.

The essential variables and the range of approval are specified in the appropriate subclauses of 4.2 and the validity in 4.3.

4.2 Essential variables and the range of approval

4.2.1 Approval based on welding procedure test

A welding operator/resistance weld setter having successfully completed a welding procedure test in accordance with ISO 9956-3 or ISO 9956-4, shall be considered approved for that type of unit used.

Provided that the welding operator/resistance weld setter works according to an approved Welding Procedure Specification (WPS), there is no limitation for the range of approval provided that the type of welding unit and the welding process are not changed.

A suggested form for the certificate is shown in annex C.

4.2.2 Approval based on pre-production welding test or production test

A welding operator/resistance weld setter having successfully completed a pre-production welding test in accordance with ISO 9956-8 or a production test shall be considered approved for that type of welding unit used.

Provided that the welding operator/resistance weld setter work according to an approved Welding Procedure Specification (WPS), there is no limitation for the range of approval provided that the type of welding unit and the welding process are not changed.

A suggested form for the certificate is shown in annex C

4.2.3 Approval based on production sample testing

A welding operator/resistance weld setter having successfully set up the production shall be considered approved if representative samples of the items produced are approved. This testing of production samples is to be in accordance with the requirements of the contracting parties.

Provided that the welding operator/resistance weld setter work according to an approved Welding Procedure Specification (WPS), there is no limitation for the range of approval provided that the type of welding unit and the welding process are not changed.

A suggested form for the certificate is shown in annex C.

4.2.4 Approval based on function test

A welding operator/resistance weld setter having successfully performed a function test shall be considered approved for that type of welding unit. A function test shall include the following:

- to know the correlation between parameter deviations and the welding results;
- to control parameter setting at the welding unit according to WPS;
- to test the operational items of the welding unit according to WPS;
- to report of any malfunction of the welding unit, which influenced the weld.

Provided the welding operator/resistance weld setter work according to an approved Welding Procedure Specification (WPS), there is no limitation for the range of approval provided that the type of welding unit and the welding process are not changed.

A suggested form for the certificate is shown in annex C.

4.2.5 Automatic and robotic welding

The following changes require fresh approval:

- welding with or without arc and/or joint sensor;
- change from single-run to multi-run technique;
- change of robotic type and system including numerical control unit;
- other essential variables specific to the processes used.

Welding without joint sensor also covers welding with joint sensor, but not vice versa. Welding with multi-run technique also covers single-run technique, but not vice versa.

4.3 Period of validity

The validity of the welding operator's/resistance weld setter's approval starts from the date of welding of the test piece, provided that the required tests are satisfactory.

A welding operator's/resistance weld setter's approval shall remain valid for a period of two years provided that the employer/welding coordinator, in accordance with ISO 14731, confirm that both following conditions are fulfilled:

- a) The welding operator/resistance weld setter shall be engaged with reasonable continuity on welding work within the current range of approval. An interruption for a period no longer than six months is permitted.
- b) There shall be no specific reason to question the welding operator's/resistance weld setter's knowledge.

If any of these conditions is not fulfilled, the approval shall be cancelled.

The employer/welding coordinator may sign the relevant certificate at six-month intervals in respect of the foregoing.

5 Prolongation

The validity of the approval on the certificate may be prolonged for further periods of two years, within the original range of approval, provided each of the following conditions according to 4.3 are fulfilled:

- the production welds are of the required quality;
- records of tests, e.g. half-yearly documentation about radiographic or ultrasonic inspections or test reports about fracture test or peel and chisel test according to ISO 10447 shall be maintained on file with the operator's/resistance weld setter's approval certificate.

The examiner or examining body shall verify compliance with the above conditions and sign the prolongation of the welding operator's/resistance weld setter's approval test certificate.

6 Certificate

The examiner or examining body shall certify that the welding operator/resistance weld setter has successfully passed the approval test. All relevant test conditions shall be recorded on the certificate. If the welding operator/resistance weld setter fails any of the prescribed tests, no certificate shall be issued.

The certificate shall be issued under the sole responsibility of the examiner or examining body and shall contain all the information detailed in annex C. The format of annex C is recommended to be used as the welding operator's/resistance weld setter's approval test certificate.

If any other form of welding operator's/resistance weld setter's approval test certificate is used, it shall contain the information required in annex C. The manufacturer's WPS as shown in ISO 9956-2:1995, ISO 9956-10:1996 or ISO 9956-11:1996 shall give information about materials, welding positions, welding processes and range of welding parameters etc., in accordance with this International Standard.

The welding operator's/resistance weld setter's approval test certificate shall be issued at least in one of the official ISO languages (English, French).

Each change of the essential variables for the approval testing beyond the permitted ranges requires a new test and a new approval certificate.

7 Documentation

Certificates and test reports/records of welding tests and prolongations shall be kept on file.

Annex A (normative)

Functional knowledge appropriate to the welding unit

This annex outlines the functional knowledge appropriate to the welding unit that a welding operator/resistance weld setter should have to ensure that procedures are followed and common practices are complied with.

A.1 Welding sequences/procedures in the relevant process

Appreciation of welding procedure requirements and the influence of welding parameters.

A.2 Joint preparation and weld representation in the relevant process

- a) Conformance of joint preparation to Welding Procedure Specification (WPS).
- b) Cleanliness of fusion faces.

A.3 Weld imperfection in the relevant process

- a) Identification of weld imperfection.
- b) Causes.
- c) Prevention and remedial action.

A.4 Welding operator's/resistance weld setter's approval

The welding operator/resistance weld setter shall be aware of the range of the approval.

A.5 Process operation

- a) Knowledge of programming (if relevant).
- b) Knowledge of the control system and signals given by this system.
- c) Moving system.
- d) Auxiliary equipment.
- e) Jigs and fixtures and set-up.
- f) Parameters and adjustment within the given procedures.
- g) Safety regulations and precautions.
- h) Start-stop procedures.

Annex B (informative)

Knowledge on welding technology

B.1 General

The test of job knowledge is recommended, but is not mandatory. However, some countries may require that the welding operator/resistance weld setter undergoes a test of job knowledge. If the job knowledge test is carried out, it should be recorded on the welding operator's/resistance weld setter's certificate.

This annex outlines the job knowledge that a welding operator/resistance weld setter should have to ensure that procedures are followed and common practices are complied with. The job knowledge indicated in this annex is only pitched at the most basic level.

Owing to different training programmes in various countries, it is only proposed to standardize general objectives or categories of job knowledge. The actual questions used should be drawn up by the individual country, but should include questions on areas covered in B.2, relevant to the welding operator's/resistance weld setter's approval test.

The actual tests of a welding operator's/resistance weld setter's job knowledge can be given by any of the following methods or combinations of these methods:

- a) written objective tests (multiple choice);
- b) oral questioning following a set of written questions;
- c) computer testing;
- d) demonstration/observation testing following a written set of criteria.

The test of job knowledge is limited to the matters related to the welding process used in the test.

B.2 Requirements

B.2.1 Welding equipment

B.2.1.1 Arc welding

- a) Identification of gas cylinders.
- b) Identification and assembly of essential components.
- c) Selection of correct nozzles and welding torches.
- d) Wire feed control method.

B.2.1.2 Beam welding

- a) Electron beam welding equipment.
- b) Laser beam welding equipment.

B.2.1.3 Pressure welding

- a) Types and equipment.
- b) Identification and assembly of essential components.

B.2.1.4 Resistance welding

- a) Identification and assembly of essential components.
- b) Selection of correct electrodes.
- c) Cooling system.
- d) Maintenance of the equipment.

B.2.2 Welding processes**B.2.2.1 Shielded metal-arc welding (114, 131, 135, 136, 137, 141, 15 of ISO 4063:—)**

- a) Procedures.
- b) Type and size of electrodes.
- c) Identification of shielding gas and flow rate (without 114).
- d) Type, size and maintenance of nozzles/contact tip.
- e) Selection and limitation of mode of metal transfer.
- f) Protection of the welding arc from draughts.

B.2.2.2 Submerged arc welding (121, 122 of ISO 4063:—)

- a) Procedures.
- b) Drying, feeding and correct recovery of flux.
- c) Correct alignment and travel of welding head.
- d) Single-wire or multi-wire process.
- e) Influence of welding current and voltage.

B.2.2.3 Electron beam welding (76 of ISO 4063:—)

- a) Procedures.
- b) Parameters and their influence to the welding process.
- c) Focussing system.
- d) Parameter controlling.
- e) Preparation of parent material.
- f) Vacuum system including leak test.

B.2.2.4 Laser beam welding (51 of ISO 4063:—)

- a) Procedures.
- b) Parameters and their influence on the welding process.
- c) Focussing system.
- d) Parameter controlling.
- e) Preparation of parent material.
- f) Choice of relevant gases.
- g) Processing in/on different types of laser.
- h) Type of mode for operation.

B.2.2.5 Pressure welding (41, 42, 44, 45 of ISO 4063:—)

- a) Procedures.
- b) Type of equipment.
- c) Surface preparation.
- d) Control system.

B.2.2.6 Resistance welding (21, 22, 23, 24, 25, 29 of ISO 4063:—)

- a) Procedures.
- b) Surface preparation.
- c) Parameters.
- d) Material and shape of electrodes, contact area and fixing of electrodes.
- e) Method of welding.
- f) Control and surveillance system.
- g) Causes of defect.
- h) Test methods.

B.2.3 Parent metals

- a) Identification of material.
- b) Methods and control of pre-heating.
- c) Control of interpass temperature.

B.2.4 Consumables

- a) Identification of consumables.
- b) Storage, handling and conditioning of consumables.

- c) Selection of correct size.
- d) Cleanliness of wire electrodes and flux-cored electrodes.
- e) Control of wire spooling.
- f) Control and monitoring of gas flow rates and quality.
- g) Principles of welding without consumables.

B.2.5 Safety and accident prevention

B.2.5.1 General

- a) Electrical risk.
- b) Mechanical risk.
- c) Risk of welding fumes and gases.
- d) Noise risk.
- e) Risk by radiographic application (if relevant).

B.2.5.2 All arc processes

- a) Environment of increased hazard of electric shock.
- b) Radiation from the arc.
- c) Effects of stray arcing.
- d) Effects of poor earthing.

B.2.6 Visual examination of welds

Knowledge of visual examination.