INTERNATIONAL STANDARD

ISO 19828

First edition
2017-04

Welding for aerospace applications — Visual inspection of welds

Soudage pour applications aérospatiales — Inspection visuelle des soudures

Reference number
ISO 19828:2017(E)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 14, *Welding and brazing in aerospace*.

Requests for official interpretations of any aspect of this document should be directed to the Secretariat of ISO/TC 44/SC 14 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Welding for aerospace applications — Visual inspection of welds

1 Scope

This document specifies the requirements for visual inspection of welds in metallic materials and requirements for qualification and certification of personnel for visual weld inspection.

This document is also applicable to the visual inspection of the joint prior to or between welding sequences, and of brazed joints. In this case, the contents of theoretical and practical training will need to be adapted accordingly.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 18490, *Non-destructive testing — Evaluation of vision acuity of NDT personnel*

EN 4179[1)], *Aerospace series — Qualification and approval of personnel for non-destructive testing*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
authorization
written statement by an employer that an individual is entitled to perform visual weld inspection within the organization

3.2
examiner
person who is designated by the employer to certify and recertify visual weld inspectors

Note 1 to entry: The examiner can be at the employer's or an external organization.

3.3
employer
organization employing or contracting the services of one or more individuals who perform visual weld inspection, including self-employed individuals

1) Under a Memorandum of Understanding, this is identical to NAS 410[10].

3.4
inspection plan
document providing an overview of the sequence of inspections and tests, including appropriate resources and procedures to be referenced by the manufacturing plan

[SOURCE: ISO 13880:1999, 3.7]

3.5
weld zone
zone containing the weld metal and the heat-affected zones

[SOURCE: ISO/TR 25901-1:2016, 2.1.2.3]

4 General

Weld zones shall meet all specified requirements, as defined in the applicable engineering documents and as detailed in an inspection plan.

As a minimum, the following aspects shall be included in the visual inspection process of weld zones:

a) presence and location of joints as specified in drawings;

b) appearance (e.g. colouration, oxidation, contamination);

c) visible discontinuities (e.g. surface cracks, lack of fusion, overlaps, undercut, spatter);

d) joint dimension (e.g. fillet weld size, weld reinforcement, weld width);

e) joint geometry (e.g. mismatch, concavity);

f) welds shall be correctly located according to drawing or engineering definition.

5 Documentation of visual weld inspection result

The result of visual weld inspection shall be documented. This can be done by a personalized inspector stamp and/or signature in the manufacturing documentation.

If a comprehensive inspection report is requested, the recommended minimum requirements are given in Annex C.

6 Inspection conditions and equipment

6.1 Post weld inspection condition

Unless otherwise specified, weld zones shall be inspected in the as-welded condition.

In case of a mechanical weld zone rework (dressing) or re-welding, the weld zone shall be re-inspected after rework or re-welding.

If, as an aid to manufacture, any attachment that is temporarily welded to the component to facilitate production or assembly is removed, it shall be removed in a way that the component is not damaged. The area where the attachment was fixed shall be inspected for defects.

Where there is doubt as to the result of visual inspection, the engineering/design authority shall be consulted.

6.2 Lighting conditions

The lighting conditions for inspection are best achieved by oblique dominant illumination combined with subdued background lighting. The minimum white light illumination of a 1 000 lx shall be available within the inspection area.

6.3 Inspection equipment

Examples of equipment applicable to visual inspection are given in Annex D.

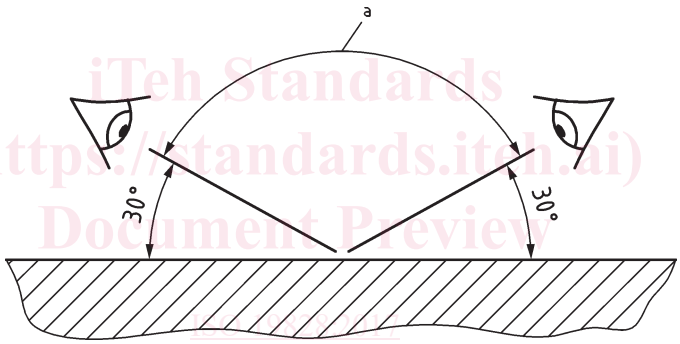
6.4 Direct inspection

For direct inspection, there shall be a direct line of sight to the surface being inspected.

Direct inspection may be performed with the aid of magnification up to maximum 10×.

For direct inspection, the access shall be sufficient to view the surface to be inspected within a maximum of 400 mm. The angle of inspection should not be less than 30° (see Figure 1), unless required by specific lighting and surface texture condition. Indirect inspection may be used to supplement direct inspection.

NOTE The optimum angle of inspection depends on surface textures and lighting conditions.



a Range of angles for direct inspection.

Figure 1 — Access for direct inspection

6.5 Indirect inspection

Indirect inspection using visual aids (for example, mirrors, borescopes, fibre optics or cameras) shall be applied when the access for inspection in accordance with Figure 1 is not possible or as specified by the engineering/design authority.

Equipment used shall be suitable for inspecting all features to enable assessment of discontinuities defined within the relevant quality acceptance standards.

The lighting may be adjusted to improve the contrast between surface features and background.

Lighting conditions of 6.2 may not apply to indirect inspection.

6.6 Limitations of visual inspection

When a weld zone cannot be completely visually inspected, the engineering/design authority shall be informed.

7 Personnel qualification

7.1 General

Visual inspection of weld zones and the evaluation of results for acceptance shall be performed by certified visual weld inspectors.

7.2 Eye sight requirements

Visual weld inspectors and visual weld inspector candidates shall fulfil the eye sight requirements of EN 4179 or ISO 18490.

Retesting of near vision shall be performed at a maximum period of two years.

NOTE Maximum period for retesting the near vision is harmonized with vision test requirements for fusion welding personnel.

Retesting of colour perception shall be performed at a maximum period of five years. Any limitations in colour perception shall be evaluated by the examiner prior to certification and shall be approved in writing.

Eye sight tests shall be administered by competent personnel.

Eye sight test results (pass/fail), including any limitations (e.g. visual aids when required to pass the eye sight test), shall be documented in a report.

7.3 Education and experience

The following requirements shall be fulfilled by each candidate for visual weld inspector.

a) A minimum of one year of experience in an occupational function that has direct relationship to weldments being fabricated to written specifications or standards. This experience can be based on the following activities:

— design: preparation of plans and drawings for weldment construction;

— production: planning and control of welding operations such as procedures, equipment, materials, or personnel involved in weldment fabrication, for example;

— fabrication: performance as a welder, fitter, or other function in the fabrication or erection of weldments;

— inspection: detection and measurement of weld discontinuities or verification of fabrication requirements;

— repair: weld repair of castings.

b) Capable of understanding applicable weld inspection instruction and documentation.

At the discretion of the examiner, requirements under a) may be replaced in part or fully by relevant welding education.

8 Employer and examiner

The employer is responsible for the authorization of visual weld inspectors. The authorization shall be based on training, testing and certification in accordance with this document.

The examiner shall be designated in writing by the quality organization or the responsible welding coordinator of the employer to certify and recertify visual weld inspectors.

The examiner is responsible for assuring that the training and qualification comply with this document.

The examiner shall fulfil the same eye sight requirements as the candidates for visual weld inspectors according to 7.2.

The examiner shall have the skills and knowledge to plan, organize, and present classroom training and practical exercises in accordance with the documented training program.

9 Training

Candidates shall receive training to understand the principles of weld inspection applicable to the inspection of the product. Additional training may be necessary when inspection requirements change.

Training shall include applicable safety considerations and the proper care and use of inspection tools and equipment.

A documented training program shall detail contents and timeframe. A content of recommended training is provided in Annex A and Annex B.

10 Examination requirements

An examination program for new candidates and recertification shall be established by the examiner and approved by the employer. The examination program shall incorporate proficiency checks to verify that the individual has the ability to perform specific inspection and interpret the results.

The examination shall consist of

a) an open-book section on industry standards or contracts applicable to the employer,

b) a closed-book section on welding fundamentals (including health and safety), and

c) a section on practical applications of weld inspection on a minimum of five components/test pieces representative of the material(s), joint type(s) and welding process(es) to be inspected in production. At least two welds shall have nonconforming features.

Sections a) and b) shall consist of a minimum of 30 questions in total. Section c) may be performed on test pieces or actual production parts.

To pass the examination, the candidates shall

— achieve 80 % in sections a) and b),

— correctly assess and record 80 % of all features (dimensional and non-dimensional) to the specified visual weld inspection criteria, and

— detect all (100 %) unacceptable surface and geometric features (defects).

NOTE Visual weld inspection criteria are specified in either a visual weld inspection plan and/or a weld specification/standard, subject to the organizational needs.

Examination results shall be documented as evidence that the candidate meets the requirements of this document.

The maximum period of validity of the certification shall not exceed five years. The requirements on eyesight testing shall be fulfilled according to 7.2.

11 Re-examination

A candidate who fails to obtain the pass grade for any examination section may be re-examined. Re-examinations shall be considered as repeat examination of the failed section(s). The candidate may take one re-examination within six months of the original examination date without further training. Any additional re-examinations will require documented re-training in accordance with Clause 9.

The maximum number of re-examinations taken in any three-year period is three.

12 Certification

At the discretion of the examiner, an external agency may be engaged to provide training and qualification services. In such instances, the examiner is responsible for assuring that training, qualification, and certification are in accordance with this document.

The examiner is responsible for assuring that the external training and qualification services comply with this document by conducting periodic reviews. The examiner shall maintain a written record of the review(s).

The certificate shall contain, as a minimum, the following:

a) name of certified individual and employee identification number;

b) statement indicating experience and completion of training in accordance with the established training program;

c) name of the employer;

d) applicable welding process(es);

e) inspection methods (direct and/or indirect);

f) date of certification;

g) expiration date for period of validity;

h) signature of examiner.

Certification records shall be maintained on file by the employer and shall contain qualification records for the certified individuals. These records shall be maintained during the time the visual weld inspectors are certified and according to applicable document retention rules.

These records shall contain, as a minimum, the following:

— certificate;

— visual acuity report;

— training records;

— examination records including actual results.

13 Recertification

Visual weld inspectors certified to this document shall be recertified at intervals not to exceed five years.

14 Loss of certification

14.1 Expiration

Certification shall expire when the certification exceeds the validity period with no recertification issued. Certification is considered to expire at the end of the corresponding month in which the certification had been issued.

Expired certification requires a new examination in accordance with Clause 10.

