FSW-Tech

Friction Stir Welding European Qualifications

EUROPEAN FRICTION STIR WELDING SPECIALIST (EFSW-S) AND ENGINEER (EFSW-E)

Co-funded by the Erasmus+ Programme of the European Union

INSTITUT ZA VARILSTVO
Welding Institute

ISQ

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8. Coordination

Scope:

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8.1 Certification/qualification of welding personnel and limitations

Because the majority of the commercial applications of FSW involve aluminium and aluminium alloys, existing standards for certification and qualification of welding personnel (operators) deals only with this metal:

- ISO 25239-3:2011 Friction stir welding – Aluminium – Qualification of welding operators
- AWS D17.3/D17.3M:2016 Specification for Friction Stir Welding of Aluminum Alloys for Aerospace Applications

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Requirements of ISO 25239-3 for FSW welding operators

➢ Welding operator qualification: shall be qualified by one of the following tests:

- standard welding test
- welding procedure test
- production welding sample test

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➢ Essential variables and ranges of qualification:

The qualification of welding operators is based on essential variables. For each essential variable, a range of qualification is defined. If a welding operator is required to weld outside the range of qualification, then a new qualification test is required. FSW is a mechanized process.

a.) FSW methods:

A successful welding operator qualification test made with any type of FSW method qualifies an operator only for that welding method.

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b.) Welding equipment: The following changes require a new qualification:

- A change from welding with a joint sensor to welding without, although welding without a joint sensor also qualifies an operator to weld with a joint sensor.
- A change from one type of welding machine to another type of welding machine that requires additional training to operate - a test made with any type of machine qualifies only that type of machine.
- Addition, removal or change of control system.

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c.) Parent materials:

A successful test weld made in any aluminium alloy qualifies an operator for all aluminium alloys. A successful test weld of any parent material thickness qualifies an operator for all parent material thicknesses. A successful test weld of any parent material form (sheet, plate, tube, castings, forgings or extrusions) qualifies an operator for all parent material forms and for all tube diameters.

d.) Weld joint geometry:

A successful test weld made in any weld joint geometry qualifies an operator for all weld joint geometries.

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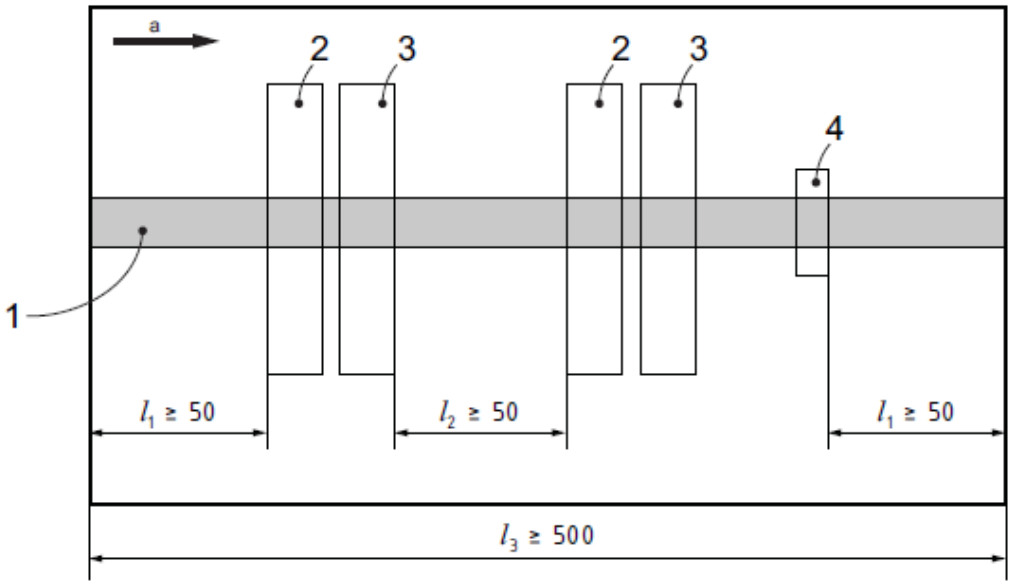
- Qualification methods:

a.) Qualification based on standard welding test: The following test piece shall be used for the standard welding test.



Key

1 weld
2 root bend test piece
3 face bend test piece
4 macroscopic examination test specimen
l_1 minimum length of weld from the edge of the test piece to a test specimen
l_2 minimum length of weld between face bend and root bend test specimens
l_3 minimum total length of weld

[a] Weld direction.

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b.) Qualification based on welding procedure test: A welding operator shall have successfully completed a welding procedure test in accordance with ISO 25239-4, Clause 6, to be considered qualified for the method and type of welding machine used.

c.) Qualification based on production welding sample test: A production part shall be considered qualified if representative samples of the items that are produced are approved by the examiner or the examining body. This testing of production samples shall be in accordance with the requirements of ISO 25239-3 or the requirements of the contracting parties, whichever is more stringent.

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- Test welds: Test welds shall be made in accordance with a WPS, except when qualification based on welding procedure test or on pre-production/production welding test applies.
- Testing and acceptance levels of test welds:

- VT testing: shall be carried out in accordance with ISO 25239-4. The weld shall have an as-welded surface and shall be free of cracks or cavities. If a full penetration weld is specified, then there shall be no incomplete penetration.
- NDT and destructive testing:
  - NDT: 100 % tested with an appropriate non-destructive, volumetric testing method (RT or UT) or with bend test.

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- Macroscopic examination (MA): One test specimen for shall be taken from the test weld. The acceptance levels shall be as specified in ISO 25239-5, Annex A.
- Bend test: Shall be performed in accordance with ISO 25239-4. Two face and two root bend test specimens shall be taken from the test weld. During testing, the test specimens shall not reveal any single crack > 3 mm in any direction.

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- Certificate: It shall be verified that the welding operator passed the qualification test. All essential variables shall be recorded on the certificate. The certificate shall be issued under the sole responsibility of the examiner or examining body and shall contain all the information detailed in ISO 25239-3, Annex C.

- Period of validity:

a.) Initial qualification: The welding operator's qualification test certificate is valid for a period of 2 years, the period of validity ending on the last day of the month.

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b.) Confirmation of the validity: The welding coordinator or the person responsible from the employer shall confirm that the welding operator has been working within the initial range of qualification. This shall be confirmed every 6 months.

c.) Prolongation of the qualification: The welding operator's qualification test certificates can be prolonged every 2 years by an examiner or examining body. Before prolongation of the certification takes place, the specifications of confirmation of validity shall be satisfied and the following conditions shall be confirmed:

- all records and evidence used to support prolongation shall be traceable to the welding operator and shall identify the WPS(s) used in production;

- evidence used to support prolongation shall be of a volumetric nature (RT or UT) or, for destructive testing (bend or fracture), shall have been made on two welds during the previous 6 months

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8.2 Contract requirements

- Engineering authority: Contracting agency or corporate organization that acts for and on behalf of the Customer on all matters within the scope of this specification. The Engineering Authority has the responsibility for the structural integrity of the hardware and compliance with all contract documents.
- Weld joint design data: The Engineering Authority shall develop or obtain appropriate material property data to support the weldment design. In addition, the Engineering Authority shall either account for the residual stresses resulting from the welding process or provide a method for controlling or minimizing those residual stresses (e.g., annealing, ageing after welding).

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- Drawing information requirements: The engineering drawing shall show the form, shape and dimensions of a weld joint. Welding symbols shall be in accordance with ISO 2553. Special conditions shall be fully explained by adding notes or details on the engineering drawing.

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8.3 Subcontracting activities

➢ Rules for subcontracting:

When a manufacturer (fabricator) intends to use subcontracted services or activities (e.g. welding, inspection, NDT inspection, heat treatment), information necessary to meet applicable requirements shall be supplied by the manufacturer to the subcontractor.

The information to be provided by the manufacturer to the subcontractor shall include all relevant data from the review of requirements and the technical review. Additional requirements may be specified as necessary to assure sub-contractor compliance with technical requirements.

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➢ Review of requirements:

a) the product standard to be used, together with any supplementary requirements
b) statutory and regulatory requirements
c) any additional requirement determined by the manufacturer
d) the capability of the manufacturer to meet the prescribed requirements/contract.

➢ Technical review:

a) parent material specification and weld joint properties
b) quality and acceptance criteria for welds
c) location, accessibility and sequence of welds, including accessibility for inspection and for NDT
d) welding procedure specifications (WPS), NDT procedures and heat treatment procedures

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e) the approach to be used for the qualification of welding procedures (WPQR)
f) the qualification of welding operators
g) selection, identification and/or traceability (e.g. for parent materials, welds)
h) quality-control arrangements, including any involvement of an independent inspection body
i) inspection and testing plans (ITP)
j) post-weld heat treatment (PWHT)
k) dimensions and details of joint preparation and completed weld
l) handling of non-conformances.

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8.4 Work management principles

These principles are based on ISO 9001:2015.

- Communication: The manufacturer/fabricator shall determine the internal and external communications relevant to the quality management system, including:
  - on what it will communicate,
  - when to communicate,
  - with whom to communicate,
  - how to cummunicate,
  - who communicates.

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- Risk management: A risks is a positive or negative deviation from the expected. Addressing a risk could mean pursuing a new opportunity. Organizations are required during planning of their Quality Management Systems (QMS) to address both risks and opportunities. Opportunities can include the adoption of new customers, products, technology or practices.

The ISO 9001:2015 around risks and opportunities do not require a formal risk management system. When evaluating risk, it is helpful to use two metrics or parameters:

- severity (If the risk occurs, how serious is it?)
- probability (What is the probability of the risk occurring?)

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8.5 Manufacturing and inspection plan

- Production planning: The manufacturer (fabricator) shall carry out adequate production planning. Items to be considered shall include at least:

- specification of the sequence by which the construction shall be manufactured (e.g. as single parts or sub-assemblies, and the order of subsequent final assembly);
- identification of the individual processes required to manufacture the construction;
- reference to the appropriate procedure specifications for welding and allied processes;
- sequence in which the welds are to be made;

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- order and timing in which the individual processes are to be performed;
- specification for inspection and testing, including the involvement of any independent inspection body;
- identification by batches, components or parts, as appropriate;
- allocation of qualified welding personnel;

➢ Inspection and testing plan (ITP): Comprises the minimum requirements related to the activities in the field of quality control and supervision in the execution of projects. Applicable inspections and tests shall be implemented at appropriate points in the manufacturing process to assure conformity with contract requirements.

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Indicative Content of the Inspection and Testing Plan (ITP):

- name and number of the document (ITP) and the name of production;
- name of the manufacturer/fabricator and the purchaser;
- name and signature of the QA/QC staff who made ITP (manufacturer and purchaser);
- history of ITP audits (audit number, date, change description);
- reference documents for manufacturer testing procedures (WPQR);
- reference standards (ISO, AWS, national ...).

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➢ Inspection and testing in manufacturing of welded parts with FSW:

a.) Inspection and testing before welding:

- suitability of the WPS;
- parent material alloy and temper;
- joint preparation (e.g. shape and dimensions);
- joint fit-up, jigging, and tacking;
- welding parameters set in accordance with the WPS;

b.) Inspection and testing during welding: The welding sequence shall be checked at suitable intervals or by continuous monitoring.

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c.) Inspection and testing after welding: After welding, compliance with the relevant application standards or relevant requirements shall be verified for:

-visual testing (VT);

-non-destructive testing (PT, RT, UT, ET);

-destructive testing (tesnile, bend, fracture, hardness, macrographic);

-proof testing (pressure test) may be used in conjunction with, or in instead of, the NDT testing methods when specified by the design specification or relevant requirements.

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