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Brazing — Qualification test of brazers and brazing operators

Brasage fort — Essais de qualification des braseurs et des opérateurs braseurs en brasage fort

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Foreword

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

Introduction

The purpose of this International Standard is to provide a general set of rules for qualification, independent of product or application.

Brazing — Qualification test of brazers and brazing operators

1 Scope

This International Standard specifies basic requirements for the qualification testing of brazers and brazing operators providing conditions for brazing, testing, examination, acceptance criteria and range of qualification for certificates.

NOTE 1 Annex D gives guidelines on general quality requirements for brazing.

NOTE 2 This International Standard does not apply to brazing for aerospace applications covered by ISO 11745[2].

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 857-2, *Welding and allied processes — Vocabulary — Part 2: Soldering and brazing processes and related terms*

ISO 17672, *Brazing — Filler metals*

ISO 18279, *Brazing — Imperfections in brazed joints*

ISO/TR 25901, *Welding and related processes — Vocabulary*

EN 12797, *Brazing — Destructive tests of brazed joints*

EN 12799, *Brazing — Non-destructive examination of brazed joints*

EN 13134, *Brazing — Procedure approval*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 857-2, ISO/TR 25901 and the following apply.

3.1
brazer
person who holds and manipulates the device for heating the brazing area by hand

3.2
brazing operator
person who prepares the joint and sets up brazing equipment and thereby has direct influence on the brazed joint quality

NOTE Examples of brazing equipment are mechanized torch holders, furnaces, salt baths, and induction equipment.

3.3
brazing
joining process in which a molten filler material is used that has a liquidus temperature above 450 °C but lower than the solidus temperature of the parent material(s)

NOTE Adapted from ISO 857-2:2005, 3.1.2.

3.4
brazing procedure specification
BPS
document that has been qualified and provides the required variables of the brazing procedure to ensure repeatability during production brazing

3.5
preliminary brazing procedure specification
pBPS
document containing the required variables of the brazing procedure which is not yet qualified

3.6
manufacturer
workshop or site (or both) which is (are) under the same technical and quality management

3.7
examiner
person appointed to verify compliance with the applicable standard

NOTE In certain cases, an external independent examiner can be required.

[ISO/TR 25901:2007, 2.119]

3.8
examining body
organization appointed to verify compliance with the applicable standard

NOTE In certain cases, an external independent examining body can be required.

[ISO/TR 25901:2007, 2.120]

3.9
filler metal
filler metals
added metal required for soldered or brazed joints, which can be in the form of wire, inserts, powder, pastes, etc.

NOTE Adapted from ISO 857-2:2005, 3.2.1.

3.10
flux
non-metallic material which, when molten, promotes wetting by removing existing oxide or other detrimental films from the surfaces to be joined and prevents their re-formation during the joining operation

[ISO 857-2:2005, 3.2.2]

3.11
test piece
brazed assembly which is used for testing purposes

NOTE Adapted from ISO/TR 25901:2007, 2.373.

3.12
test specimen
part or portion cut from the test piece in order to perform a specified destructive test

[ISO/TR 25901:2007, 2.374]

4 Symbols, definitions and reference numbers

4.1 General

Where the full wording is not used, the symbols in 4.2 and reference numbers in 4.3 shall be used when completing the qualification test certificate (see Annexes A and B).

4.2 Symbols

t material thickness of the work piece

L overlap length

D outside pipe diameter

4.3 Reference numbers

For applicable brazing process reference numbers, see 5.2.

5 Essential variables and range of qualification

5.1 General

The qualification of brazers and brazing operators is based on essential variables. For each essential variable, a range of qualification is defined and brazing outside that range of qualification requires a new qualification test. The essential variables are:

— brazing process;

— product type;

— type of joint;

— parent material group(s);

— brazing filler metal type;

— brazing filler application;

— dimension (material thickness, outside pipe diameter and overlap length);

— filler metal flow direction;

— degree of mechanization.

NOTE There can be other variables that the manufacturer deems to be essential in certain applications, e.g. constraint on access for the torch, which need separate qualification (see Annex E).

The variables listed in the first paragraph are essential only to ISO 4063[1] processes 912 and 916, see 5.2. For the other processes in 5.2, the range of qualification is unlimited for the listed variables (except the brazing process).

5.2 Brazing process

Brazing processes are defined in ISO 857-2 and listed in the following, preceded by their ISO 4063[1] process numbers.

Each qualification test normally qualifies only one brazing process. A change of brazing process requires a new qualification test.

— 911 Infrared brazing

— 912 Flame brazing, torch brazing

— 913 Laser beam brazing

— 914 Electron beam brazing

— 916 Induction brazing

— 918 Resistance brazing

— 919 Diffusion brazing

— 921 Furnace brazing

— 922 Vacuum brazing

— 923 Dip-bath brazing

— 924 Salt-bath brazing

— 925 Flux bath brazing

— 926 Immersion brazing

NOTE The principle of this International Standard can be applied to other brazing processes.

5.3 Product type

The brazing of one product type qualifies for other product types according to Table 1.

Table 1 — Range of qualification for product type

Product type for test piece	Range of qualification
Plate	Plate
Pipe	Pipe

5.4 Type of joint

Range of qualification for type of joint is given by Table 2.

Table 2 — Range of qualification for type of joint

Type of joint in test piece	Range of qualification
Butt joint	Butt joint
Overlap joint	Overlap joint

5.5 Parent material group(s)

To simplify the presentation of the range of qualification, the materials are indexed into A to F, according to Table 3, using the material grouping of ISO/TR 15608[3].

The parent material group used in the qualification test qualifies the brazer or brazing operator for the brazing of all other metals within the same material group as well as other material groups according to Table 3.

When brazing parent materials outside the grouping system, a separate qualification test is required and the qualification is limited to the materials used.

Table 3 — Range of qualification for parent material

ISO/TR 15608[3] material group	Index	Test piece	Range of qualification
1, 2, 3, 4, 5, 6, 9, 11	A	A – A	A – A
7, 8, 10	B	B – B	A – A, B – B, A – B
21, 22, 23	C	C – C	C – C
31-34, 37, 38	D	D – D	D – D
41-45	E	E – E	E – E
51-54	F	F – F	F – F
Dissimilar metal joints		A – B	A – A, A – B
		D – A	D – A
		D – B	D – A, D – B
		D – E	D – E
		E – A	E – A
		E – B	E – A, E – B

5.6 Filler metals and brazing filler application

The brazing filler metal type based on its class, as specified in ISO 17672, is a qualification criterion for other filler metal types within the same class.

The brazing filler metal application qualifies for other filler metal application according to Table 4.

Table 4 — Range of qualification for brazing filler application

Test piece brazing filler application	Range of qualification
Face fed	Face fed, Pre-placed
Pre-placed	Pre-placed
NOTE “Face fed” is also known as “applied to the mouth of the joint”, which can be manually or mechanically fed.	

5.7 Dimensions

The brazer qualification test of brazed joints is based on the material thickness, outside pipe diameters and overlap length. The ranges of qualification are specified in Table 5.

For dissimilar material thicknesses of test pieces, the range of qualification is based on the thickness of each plate (or pipe).

It is not intended that material thicknesses or outside pipe diameters should be measured precisely, but rather the general philosophy behind the values given in Table 5 should be applied.

For test pieces of different outside pipe diameters and parent material thicknesses, the brazer is qualified for:

— the smallest to the largest diameter (see Table 5);

— the thinnest to the thickest parent material thickness (see Table 5).

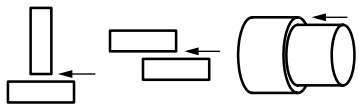
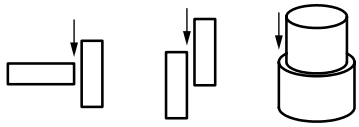
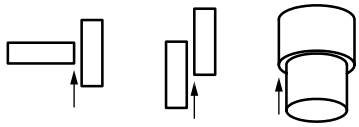
Table 5 — Range of qualification for dimensions

Dimensions	Test piece	Range of qualification
Material thickness, t (mm)	<3	0,5t to 2t
	3 to 10	1,5 to 2t
	>10	5 to 2t
Outside pipe diameter, D (mm)[a]	D	$\leq D$
Overlap length, L (mm)[a]	L	$\leq L$
NOTE If material thicknesses differ (see Figure C.5), the lower limit is based on the thinnest and the upper limit is based on the thickest thickness.		
[a] if applicable.		

5.8 Filler metal flow direction

The brazing of one filler metal flow direction qualifies for other flow directions according to Table 6.

Table 6 — Range of qualification for filler metal flow direction

Illustrations	Filler metal flow direction of the test piece	Range of qualification
	Horizontal flow	Horizontal flow and vertical down-flow
	Vertical down-flow	Vertical down-flow
	Vertical up-flow	All flow directions

5.9 Degree of mechanization

The brazing with one degree of mechanization qualifies for other degrees according to Table 7.

Table 7 — Range of qualification for degree of mechanization

Degree of mechanization of the test piece	Range of qualification
Manual	Manual and mechanized
Mechanized	Mechanized

If mechanized brazing is used for the test, the range of qualification is limited to the process and type of equipment only (6.2 applies).

6 Examination and testing

6.1 Supervision

The brazing of test pieces shall be witnessed by the examiner or examining body. The testing shall be verified by the examiner or examining body.

The test pieces shall be marked with the identification of the examiner and the brazer before brazing starts.

The examiner or examining body may stop the test if the brazing conditions are not correct or if it appears that the brazer or brazing operator does not have the skill to fulfil the requirements.

6.2 Brazing conditions

The qualification test of brazers and brazing operators shall follow a pBPS or BPS prepared in accordance with EN 13134. The brazing time for the test piece shall correspond to the working time under usual production conditions.

The brazer or brazing operator shall prepare the parts (e.g. mechanical preparation, cleaning) or accept the preparation, set up the heating means and conduct the necessary verification to carry out the test according to the pBPS or BPS.

NOTE It can be of value to otherwise imitate production conditions for the qualification test as far as possible.

6.3 Test piece

The test piece may be any design of joint which is relevant to the end work. Typically, this is a basic lap or butt joint in sheet material or a sleeve joint in tube (for examples of applicable joint configurations, see Annex C).

NOTE It is possible that requirements concerning test piece design are given in the applicable product standard.

6.4 Assessment of work pieces

When assembling the test piece, the brazer or brazing operator shall assess the work pieces for:

a) joint fit up;

b) joint gap;

c) degree or absence of local deformation;

and is permitted to refuse the test piece components if the brazer or brazing operator considers that these are not in accordance with the written pBPS or BPS.

6.5 Extent of testing

Each test piece shall be tested by visual testing and one or more of the following tests:

a) ultrasonic test;

b) radiographic test;

c) peel test;

d) macroscopic examination;

e) bend test.

6.6 Visual testing

All joints shall be visually examined [see D.1 i)] in accordance with EN 12799; the brazed assembly may need to be cut open to offer an internal examination and the test may therefore be destructive.

6.7 Non-destructive testing

Any non-destructive testing performed shall be carried out in accordance with EN 12799.

6.8 Destructive testing

Any destructive testing performed shall be carried out in accordance with EN 12797.

6.9 Additional examination and testing

Additional testing may be carried out as appropriate or agreed with non-destructive test methods, e.g.

a) penetrant testing;

b) leak testing;

c) proof testing;

d) thermography;

or destructive test methods e.g.

e) shear tests;

f) tensile tests;

g) metallographic examination;

h) hardness testing.

NOTE Additional testing can be required in the product standard or by contract.

7 Acceptance requirements for test pieces

The acceptance requirements for imperfections found by test methods specified in this International Standard shall, unless otherwise specified, be assessed in accordance with ISO 18279. A brazer or brazing operator is qualified, if the imperfections are within quality level B of ISO 18279 and no imperfections pass through the joint length.

8 Re-tests

If any test fails to comply with the requirements of this International Standard, the brazer or brazing operator shall be given the opportunity to repeat the qualification test once without further training.

If it is established that failure is due to metallurgical or other extraneous causes that cannot be directly attributed to the lack of skill of the brazer or brazing operator, an additional test is required in order to assess the quality and integrity of the new test material and/or new test conditions.

9 Period of validity

9.1 Initial qualification

The period of validity of the brazer qualification starts at the date of brazing, or the date of prolongation, see 9.2. However, the brazer qualification is not valid until all required tests are completed and accepted.

The period of validity of the brazer qualification is 3 years. This is providing that all the following conditions are fulfilled which shall be confirmed every 6 months by a responsible person of the employer signing the certificate.

a) The brazer or brazing operator shall be engaged with reasonable continuity in brazing work within the range of qualification. An interruption for a period of no longer than 6 months is permitted.

b) The work of the brazer or brazing operator shall be in general accordance with the technical conditions under which the qualification test is carried out.

c) There shall be no specific reason to question the skill and knowledge of the brazer or brazing operator (if applicable).

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

9.2 Prolongation

The validity of the qualification on the certificate may be prolonged for further periods of 3 years provided that each of the following conditions, in addition to those specified in 9.1, are fulfilled.

a) The production brazed joints made by the brazer or brazing operator are continuously of the required quality.

b) Records of tests, e.g. documentation of volumetric non-destructive or destructive tests, from brazing within the original range of qualification during the immediately previous 6 month period shall be filed together with the qualification certificate of the brazer. Acceptance criteria for the production test piece are according to Clause 7.

The examiner or examining body shall verify compliance with conditions a) and b), and sign or issue the prolongation of the qualification test certificate for the brazer.

10 Certificate

A certificate shall be issued to detail that the brazer or brazing operator has passed the performance qualification test. The relevant test conditions shall be recorded on the certificate.

If the brazer or brazing operator 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. The brazer qualification certificate shall contain all the information specified in Annex A. The brazing operator qualification certificate, issued when mechanized brazing is tested, shall contain all the information specified in Annex B. The format of Annex A or B is recommended to be used as the certificate.

The pBPS or BPS of the manufacturer shall give information about materials, brazing processes, range of qualification, etc., in accordance with this International Standard.

11 Designation

The designation of a brazer qualification test shall comprise the following items in the order given (the system is arranged so that it can be used for computerization):

a) number of this International Standard;

b) the essential variables:

   1) brazing process code number in accordance with ISO 4063[1],

   2) product type, pipe (T) or plate (P),

   3) type of joint, butt joint (B), overlap joint (O) or T-joint (T),

   4) parent material group(s) according to Table 3,

5) brazing filler metal type according to ISO 17672,

6) brazing filler application, face fed (FF) or pre-placed (PP),

7) dimension (material thickness, outside pipe diameter and overlap length),

8) filler metal flow direction, horizontal flow (H), vertical up flow (VU) or vertical down flow (VD).

EXAMPLE 1

Qualification test for manual torch brazing (912) of pipe, overlap joint, steel material group 8 (ISO/TR 15608[3]), face-fed Ni600 filler metal, 1,5 mm material thickness, 20 mm outside pipe diameter, 3 mm overlap length, horizontal flow direction:

ISO 13585 - 912 T O B Ni600 FF t1,5 D20 L3 H

EXAMPLE 2

Qualification test for induction brazing (912) of plate, overlap joint, copper material group 31 (ISO/TR 15608[3]), face-fed Cu511 filler metal, 4 mm material thickness, 5 mm overlap length, vertical down flow direction:

ISO 13585 - 916 P O D Cu511 FF t4 L5 VD

EXAMPLE 3

Qualification test for brazing operator, furnace brazing (921):

ISO 13585 - 921

Annex A
(informative)

Brazer qualification test certificate

Designation(s):

Manufacturer's name and address:

Certificate reference No:

BPS reference No:

Brazer's name:

Identification/Method of identification:

Date and place of birth:

Employer:

Testing standard:

Job knowledge: Acceptable/Not tested (delete as necessary)

Photograph (if required)

Variables	Test piece	Range of qualification
Brazing process		
Material thickness(es) (mm)		
Outside pipe diameter (mm)		
Overlap length (mm)		
Parent material(s)		
Brazing filler type, work temperature		
Brazing filler application		
Product type		
Filler metal flow direction		
Degree of mechanization		
Other		

Further information is stated in the attached document or in the specification for brazing procedure No:

Type of testing	Performed and accepted	Not tested
Visual testing		
Radiographic testing		
Ultrasonic testing		
Peel testing		
Other test method:		

Name of examiner or examining body:

Place, date and signature of examiner or examining body:

Date of brazing:

Qualification valid until:

Confirmation of qualification by employer or other responsible person (every six months), required for the validity of the certificate.			Prolongation of qualification by examiner or examining body (every three years).		
Date	Signature	Position or title	Date	Signature	Position or title

Annex B
(informative)

Brazer operator qualification test certificate

Designation(s):

Manufacturer's name and address:

Certificate reference No:

BPS reference No:

Brazer's name:

Identification/Method of identification:

Date and place of birth:

Employer:

Testing standard:

Job knowledge: Acceptable/Not tested (delete as necessary)

Photograph (if required)

Variables	Test piece	Range of qualification
Brazing process Type of brazing equipment		

Further information is stated in the attached document or in the specification for brazing procedure No:

Type of testing	Performed and accepted	Not tested
Visual testing Radiographic testing Ultrasonic testing Peel testing Other test method:		

Name of examiner or examining body:

Place, date and signature of examiner or examining body:

Date of brazing:

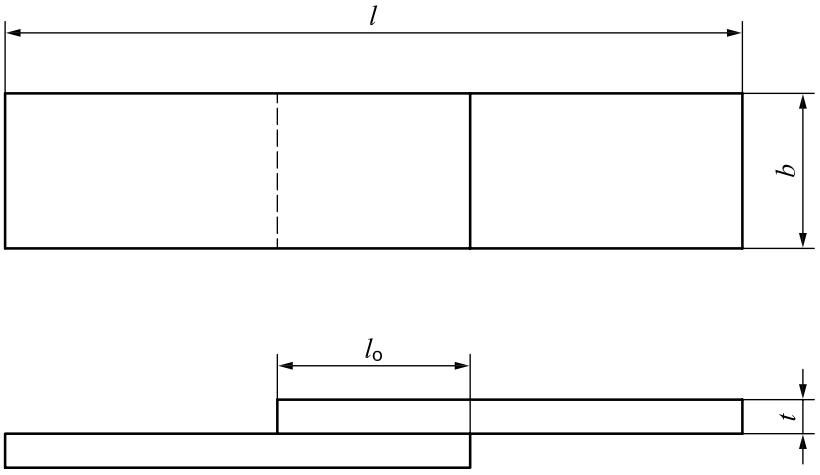
Qualification valid until:

Confirmation of qualification by employer or other responsible person (every six months), required for the validity of the certificate.			Prolongation of qualification by examiner or examining body (every three years).		
Date	Signature	Position or title	Date	Signature	Position or title

Annex C
(informative)

Examples of test pieces

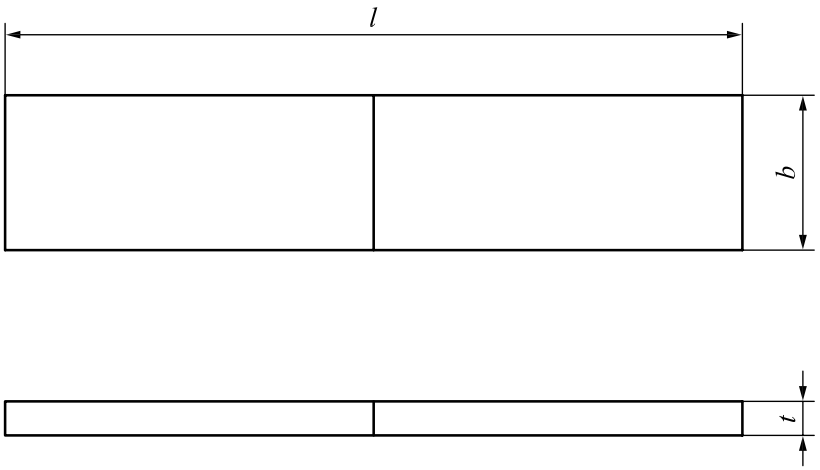
Examples of test pieces are shown in Figures C.1 to C.4



Key

b width
l total length
t thickness
l_o overlap length

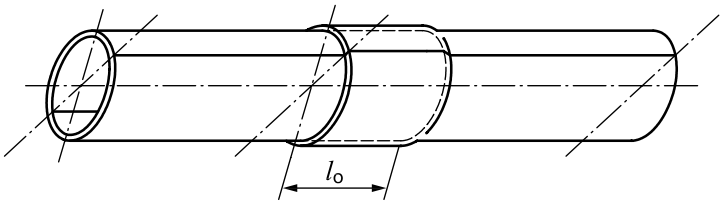
Figure C.1 — Test piece — Lap joint



Key

b width
l total length
t thickness

Figure C.2 — Test piece — Butt joint



Key

l_o overlap

Figure C.3 — Test piece — Simple lap joint

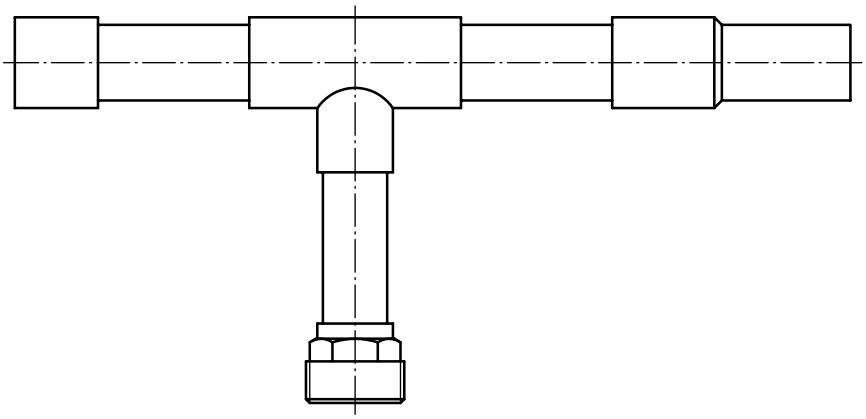
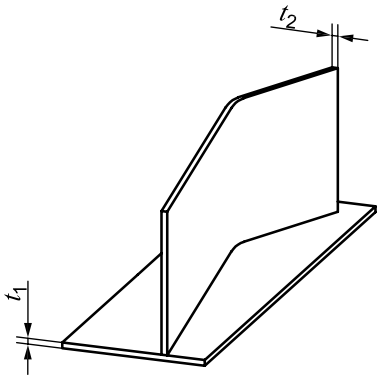


Figure C.4 — Test piece — Multiple joints



Key

t_1 thickness of first component

t_2 thickness of second component

Figure C.5 — Test piece — T-joint

Annex D
(informative)

Quality requirements for brazing

D.1 Information and requirements for the workshop

The following information and requirements should be agreed and documented prior to the contract, when applicable:

a) the application standards to be used, if any, together with any supplementary requirements;

b) the BPS, including the brazing process and the brazing variables;

c) the joint design for the test pieces together with relevant tolerances and the number of test pieces required;

d) the specifications of the parent materials;

e) the specifications of the brazing consumables;

f) the handling of parent materials and brazing consumables;

g) the design and method of preparation of the test specimens and, where appropriate, the number to be taken from any test piece;

h) the acceptance criteria;

i) the principle of and procedure for retesting of a series of test pieces, including any additional requirements with regard to the number of test pieces/test specimens and any retraining and time delay conditions prior to reassessment;

j) the extent of visual testing and additional testing requirements for the non-destructive and/or destructive tests;

k) records and documentation.

Annex E
(informative)

Other non-essential variables

E.1 Fuel/gases

Fuel/gases shall be selected to be relevant to the heating requirement. Typical examples include:

a) natural gas/air;

b) natural gas/oxygen;

c) propane/air,

d) propane/oxygen;

e) acetylene/air;

f) acetylene/oxygen.

E.2 Brazing torch

A torch similar to that used in production shall be used.

E.3 Joint location

On-site brazing may require a brazer to make joints in close proximity to walls, etc. Joints may be horizontal or vertical. Similar constraints on access for torches may also be encountered in mass production. Qualification tests shall be designed to reproduce these conditions.

E.4 Jigs and fixtures

If necessary, jigs and fixtures shall be used to position the components of a test piece.

E.5 Test location

The qualification test shall take place in a workshop but simulate the on-site limitations. It enables the ability of the brazer to perform on-site and workshop brazing operations in the selected jointing technique to be judged.

Bibliography

[1] ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers*

[2] ISO 11745, *Brazing for aerospace applications — Qualification test for brazers and brazing operators — Brazing of metallic components*

[3] ISO/TR 15608, *Welding — Guidelines for a metallic materials grouping system*

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