
Brazing — Specification and qualification of brazing procedures for metallic materials

*Brasage fort — Descriptif et qualification d'un mode opératoire de
brasage fort pour les 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.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of 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 www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: <https://committee.iso.org/sites/tc44/home/interpretation.html>.

Introduction

The purpose of this document is to provide a general set of rules for brazing procedure qualification independent of product or application.

All new brazing procedure tests are to be carried out in accordance with this document from the date of its issue. However, this document does not invalidate previous brazing procedure tests made to former standards or specifications.

Where additional tests need to be carried out to make the qualification technically equivalent, it is only necessary to perform the additional tests on a test piece which should be made in accordance with this document.

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Brazing — Specification and qualification of brazing procedures for metallic materials

1 Scope

This document specifies requirements for the specification and qualification of brazing procedures for brazing of metallic materials.

This document specifies requirements for brazing of the test piece, testing of the test specimen, essential variables and their range of qualification, acceptance criteria, brazing procedure qualification record (BPQR) and brazing procedure specification (BPS).

This document gives general provisions on quality requirements for brazing (see [Annex A](#)).

This document does not cover testing of residual stresses, corrosion resistance and impact properties.

This document applies to the following brazing processes according to ISO 857-2 and ISO 4063:2009 with local and global heating:

- 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;
- 972 Arc weld brazing.

The principles of this document can be applied to other brazing processes and brazing of materials not listed.

This document does not apply to brazing for aerospace applications covered by ISO 11745.

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

ISO 4063:2009, *Welding and allied processes — Nomenclature of processes and reference numbers*

ISO 13585, *Brazing — Qualification testing of brazers and brazing operators*

ISO 17672, *Brazing — Filler metals*

ISO 18279:2003, *Brazing — Imperfections in brazed joints*

ISO 18496, *Brazing — Fluxes for brazing — Classification and technical delivery conditions*

ISO/TR 25901-1, *Welding and allied processes — Vocabulary — Part 1: General terms*

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 857-2, ISO/TR 25901-1 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

brazing

joining process using filler metal with a liquidus temperature above 450 °C

[SOURCE: ISO 857-2:2005, 3.1.2.]

3.2

brazing procedure specification

BPS

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

3.3

preliminary brazing procedure specification

pBPS

document containing the required variables of the brazing procedure which is not yet qualified

3.4

brazing procedure qualification record

BPQR

record comprising all necessary data from qualification of a *preliminary brazing procedure specification* (3.3).

3.5

manufacturer

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

3.6

examiner

person who has been appointed to verify compliance with the applicable standard

Note 1 to entry: In certain cases, an external independent examiner can be required.

[SOURCE: ISO/TR 25901-1:2016, 2.5.29]

3.7

examining body

organization that has been appointed to verify compliance with the applicable standard

Note 1 to entry: In certain cases, an external independent examining body can be required.

[SOURCE: ISO/TR 25901-1:2016, 2.5.30]

3.8

filler metal

added metal applied to brazed joints

Note 1 to entry: Filler metal can be in the form of wire, inserts, powder, pastes, foil, etc.

3.9

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

[SOURCE: ISO 857-2:2005, 3.2.2]

3.10

test piece

brazed assembly which is used for testing purposes

3.11

test specimen

part or portion cut from the test piece in order to perform specified destructive testing

[SOURCE: ISO/TR 25901-1:2016, 2.2.1.6]

4 Preliminary brazing procedure specification (pBPS)

A preliminary brazing procedure specification shall be prepared. An example pBPS form is shown in [Annex B](#).

5 Brazing procedure test

The brazing and testing of test pieces shall be in accordance with [Clause 6](#) and [Clause 7](#).

A brazer or brazing operator who undertakes the brazing procedure test satisfactorily in accordance with this document shall be considered qualified for the appropriate range of qualification in accordance with ISO 13585, provided that the relevant testing requirements are met.

6 Test piece

6.1 General

The test piece or pieces shall be brazed using a type of joint design proposed in the pBPS and be representative for the intended production.

6.2 Shape and dimensions of test pieces

If not specified in application standard, the shape and dimension of the test piece shall be agreed by the contracting parties.

The test piece is typically a basic lap or butt joint in sheet material or a sleeve joint in tube (for examples of applicable joint configurations, see [Annex C](#)).

The size of the test piece shall be sufficient to allow all required tests to be carried out. Additional test pieces may be prepared in order to allow for additional tests and/or for re-testing specimens.

6.3 Brazing of test pieces

Preparation and brazing of test pieces shall be carried out in accordance with the pBPS, and under the general conditions of brazing in production, which they shall represent.

Brazing and testing of the test pieces shall be witnessed by an examiner or an examining body.

7 Examination and testing

7.1 Extent of testing

As a minimum, testing shall be carried out in accordance with [Table 1](#), EN 12797 and EN 12799.

Table 1 — Examination and testing of the test pieces

Test piece	Type of test	Extent of testing
T-joint	Visual, and Metallographic, or Bend	100 % 2 sections ^a 2 specimens ^b
Lap joint	Visual, and Metallographic, and Shear, or Peel	100 % 2 sections ^a 2 specimens 2 specimens
Butt joint	Visual, and Metallographic, and Tensile, or Bend	100 % 2 sections ^a 2 specimens 2 specimens ^b
^a Normally, macro sections are sufficient. However, micro sections can be required.		
^b One first surface and one second surface test.		

Application standards can specify additional tests, e.g.:

- longitudinal tensile test;
- volumetric testing (RT or UT);
- corrosion tests;
- chemical analysis;
- cruciform test.

NOTE Specific service, material or manufacturing conditions can require more comprehensive testing than is specified by this document in order to gain more information and to avoid repeating the brazing procedure test at a later date just to obtain additional test data.

7.2 Test specimens

The shape and dimensions of test specimens shall be in accordance with EN 12797, EN 12799, an application standard or technically equivalent standards. For other test specimens where the shape and dimensions are not specified, they shall be agreed by the contracting parties.

7.3 Non-destructive testing

The extent of non-destructive testing shall be in accordance with [7.1](#) and [Table 1](#) and be carried out on the test pieces prior to cutting of the test specimens. Visual testing shall be performed in accordance with EN 12799 or technically equivalent standards. Radiographic testing, where specified, shall also be carried out in accordance with EN 12799 or technically equivalent standards.

7.4 Destructive testing

7.4.1 General

The extent of destructive testing shall be in accordance with [7.1](#) and [Table 1](#).

7.4.2 Bend testing

The testing and test specimens shall be in accordance with EN 12797 or technically equivalent standards and [Table 1](#).

One first surface bend test specimen and one second surface bend test specimens shall be tested. The first surface is defined as the surface from which the filler metal is applied. The second surface is defined as the opposite surface from which the filler metal is applied.

For testing of T-joints, the configuration of the test piece shall be in accordance with [Figure 1](#).

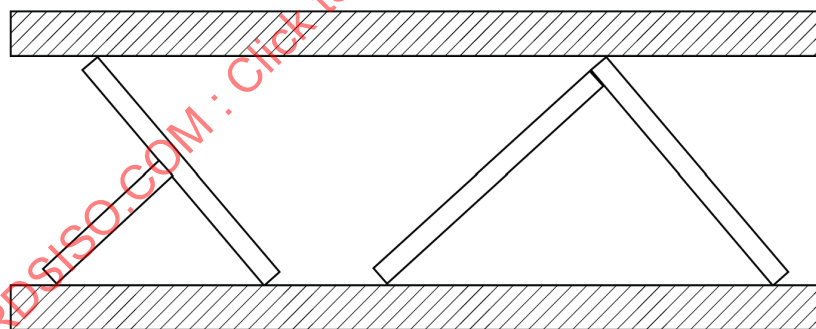


Figure 1 — Types of configuration of transverse bend testing of T-joint

7.4.3 Peel testing

The test specimens and the testing shall be performed in accordance with EN 12797 or technically equivalent standards.

7.4.4 Shear testing

The test specimens shall be in accordance with one of the types defined in EN 12797 or technically equivalent standards. The test specimen shall fracture in the weakest parent material, unless otherwise specified.

If the specimen fractures in the braze metal although the requirements in [7.5](#) are met, the overlap length is considered to be too small and the joint should be re-designed.

7.4.5 Transverse tensile testing

The test specimens shall be in accordance with one of the types defined in EN 12797 or technically equivalent standards. The details of testing procedure and test specimen shall be established before any testing is undertaken. The tensile strength shall not be less than the specified minimum tensile strength of the weaker parent material in the annealed condition or, 95 % thereof if the test specimen fractures in the parent material.

7.5 Acceptance levels

Unless otherwise specified, the acceptance requirements for imperfections found by all test methods in accordance with this document shall be assessed in accordance with ISO 18279:2003.

A brazing procedure is qualified if the imperfections in the test piece are within quality level B in ISO 18279:2003 except for excess braze metal (6BAAA) where quality level C applies and no imperfection pass through the joint length.

7.6 Re-testing

If the test piece fails to comply with any of the requirements for visual testing or NDT specified in [7.5](#), one further test piece shall be brazed and subjected to the same testing. If this additional test piece does not comply with the requirements, the brazing procedure test has failed.

If any test specimens fail to comply with the requirements for destructive testing in accordance with [7.4](#) but only due to braze imperfections, two further test specimens shall be tested for each one that failed. The additional test specimens can be taken from the same test piece if there is sufficient material or from a new test piece. Each additional test specimen shall be subjected to the same tests as the initial test specimen that failed. If either of the additional test specimens does not comply with the requirements, the brazing procedure test has failed.

8 Essential variables and range of qualification

8.1 General

Each of the conditions given in [Clause 8](#) shall be met in order to comply with this document.

Changes outside of the ranges specified shall require a new brazing procedure test.

8.2 Brazing process

Each qualification test qualifies only one brazing process (see [Clause 1](#)). A change of brazing process requires a new qualification test.

For processes where global heating is applied (process 92 in accordance with ISO 4063:2009), a change in brazing temperature shall not exceed outside the range specified in the BPS.

When applicable, the furnace atmosphere is limited to the same type of atmosphere, e.g. reducing or inert, carburizing or decarburizing, and hydrogen or disassociated ammonia.

For brazing processes where fuel gases apply, the qualification is limited to the same type of fuel gas and flame.

8.3 Product type

The brazing of one product type qualifies for other product types in accordance with [Table 2](#).

Table 2 — Range of qualification for product type

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

8.4 Type of joint

The range of qualification for type of joint is given by [Table 3](#).

Table 3 — Range of qualification for type of joint

Type of joint in test piece	Range of qualification
T-joint	T-joint
Lap joint	Lap joint
Butt joint	Butt joint

8.5 Branch connection

A test with any branch angle, α , covers all branch angles, α .

8.6 Parent material group(s)

In order to minimize the number of brazing procedure qualification tests, parent materials are assigned to M-number groupings (see [Annex E](#)).

The parent material used in the brazing procedure qualification test qualifies the brazing procedure for brazing of all other parent materials within the same M-number grouping (see [Table 4](#)).

Parent materials that do not appear in [Annex E](#), require separate qualification and only qualify that material.

Table 4 — Range of qualification for parent material

Test piece material (see Annex E)	Range of qualification ^{a,b}
100, 110, 120, 170	100, 110, 120, 170
130, 140, 150, 160, 180	130, 140, 150, 160, 180
200, 210, 220	200, 210, 220
300, 310, 320, 330, 340, 350, 360	300, 310, 320, 330, 340, 350, 360
400, 410, 420, 430	400, 410, 420, 430
500	500
600	600
700	700
800	800
^a For a test piece material used for brazing procedure qualification, the brazing procedure is qualified to braze all materials and all combinations of materials given in the same row. ^b When test piece material from two rows are used for brazing procedure qualification, the brazing procedure is qualified to braze all material combinations in each row and combinations between those rows.	

Qualification testing using two different M-number groupings in a single test piece also qualifies, using the same brazing filler metal, flux, atmosphere, and process, for combinations of materials from:

- each M-number material groupings to material in the other grouping;
- one M-number material groupings to others in the same grouping.

8.7 Filler metals, flux and brazing filler application

The brazing filler metal type shall be classified in accordance with ISO 17672, or other standards that provide equivalent technical conditions. Each class in accordance with ISO 17672 qualifies other filler metal types within the same class. One filler metal form (for example, from preformed ring to paste) only qualifies for the same form.

A test with a flux classified in accordance with ISO 18496, or other standards that provide equivalent technical conditions, only qualifies for brazing within that same classification.

The brazing filler metal application qualifies for other filler metal application in accordance with [Table 5](#).

Table 5 — Range of qualification for brazing filler application

Test piece brazing filler application	Range of qualification
Face fed	Face fed
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.	

8.8 Dimensions

Ranges of qualification for parent material thickness are given by [Table 6](#). For dissimilar parent material thicknesses, the range of qualification based on each part separately and given by [Table 6](#).

For lap joints, the overlap used on the test piece is the minimum overlap qualified.

The joint gap shall not deviate from the interval recommended by the filler metal manufacturer.

Table 6 — Range of qualification for parent material thickness

Dimensions in millimetres

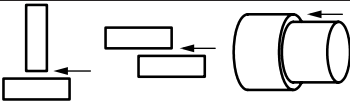
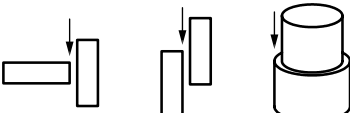
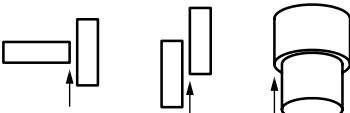
Thickness of test piece t	Range of qualification
$t < 3$	0,5t to 2t
$3 \leq t < 10$	1,5 to 2t
$10 \leq t \leq 25$	5 to 2t

NOTE Diameter is not considered as an essential variable.

8.9 Filler metal flow direction

Ranges of qualification for the filler metal flow direction are given by [Table 7](#). Any other flow direction shall be qualified separately. For procedure qualification, an angular deviation of maximum $\pm 15^\circ$ from filler metal flow positions applies.

Table 7 — 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

8.10 Post braze heat treatment

Addition or deletion of post-braze heat-treatment requires requalification of the BPS.

8.11 Related to the manufacturer

A qualification of a pBPS in accordance with this document obtained by a manufacturer is valid for brazing in workshops or sites under the same technical and quality control of the manufacturer.

Brazing is under the same technical and quality control when the manufacturer who performed the brazing procedure qualification retains complete responsibility for all brazing carried out to it.

9 Brazing procedure qualification record (BPQR)

The brazing procedure qualification record (BPQR) is a statement of the results of assessing each test piece including re-tests. The relevant items listed for the BPS shall be included, together with details of any features that would be rejectable based on the requirements of [Clause 7](#). If no rejectable features or unacceptable test results are found, a BPQR detailing the brazing procedure test piece results is qualified and shall be signed and dated by the examiner or the examining body.

A BPQR format shall be used to record details for the brazing procedure and the test results, in order to facilitate uniform presentation and assessment of the data.

An example of BPQR format is shown in [Annex D](#).

10 Brazing procedure specification (BPS)

A brazing procedure specification (BPS) shall provide all necessary information required to make a braze joint. The brazing procedure specification shall be designed as an instruction for the brazer or brazing operator to apply. Therefore, the tolerances given for each essential variable may not be the full ranges of qualification given in the BPQR. However, it is practical that tolerances are given in relevant cases, e.g. for gap or overlap length.

A brazing procedure specification is considered preliminary (pBPS) until it is qualified documented by a BPQR.

When applicable, the brazing procedure specification (BPS or pBPS) shall contain, at least, the following information (including applicable tolerances for variables):

- identification of the manufacturer;
- identification of the BPS;

- reference to the brazing procedure qualification record (BPQR) or other documents as required;
- parent material designation and reference standard(s), and material group in accordance with [Annex E](#);
- dimensions of the parent material (thickness and pipe outside diameter);
- joint design/configuration sketch containing all relevant dimensions, e.g. overlap length and gap;
- brazing process;
- brazing filler material flow direction;
- brazing filler material designation and reference standard(s);
- brazing filler material type;
- brazing filler material application;
- brazing flux designation and reference standard(s), and trade name;
- brazing flux type;
- fuel gas designation or composition, and gas flow;
- brazing temperature;
- furnace atmosphere;
- post-braze heat treatment relation to transformation temperature;
- method of preparation and cleaning of the joint before and after brazing;
- degree of mechanisation (manual, mechanized, automatic).

An example of BPS format is shown in [Annex B](#).

Annex A

(informative)

Quality requirements for brazing

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 B (informative)

Brazing procedure specification (BPS)

BPS reference No.:	
Manufacturer's name and address:	
Manufacturer's brazing procedure (BPQR No.):	

Brazing process:		Method of joint preparation:	
Joint type:		Material thickness (mm):	
Parent material(s) and specification(s):		Outside diameter (mm):	
Degree of mechanization: (manual/mechanized/automatic)		Brazing position:	
Gap (mm):		Overlap, L (mm):	

Joint design and preparation details (sketch):

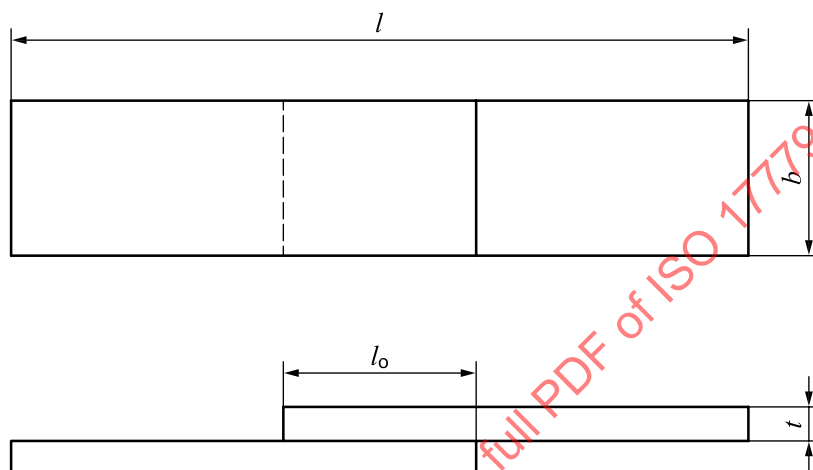
Brazing filler metal type and specification:		Method of pre-braze cleaning:	
Brazing filler metal form:		Method of post-braze cleaning:	
Method of filler metal supply:		Nozzle size and number:	
Flux type and specification:		Heating gas type:	
Flux form:		Heating gas pressure:	
Method of flux supply:		Preheat temperature:	
Jig/fixture details:		Post-braze heat treatment:	

Manufacturer's representative Name, date and signature:	Examiner/Examining body Name, date and signature:

Annex C (informative)

Examples of test pieces

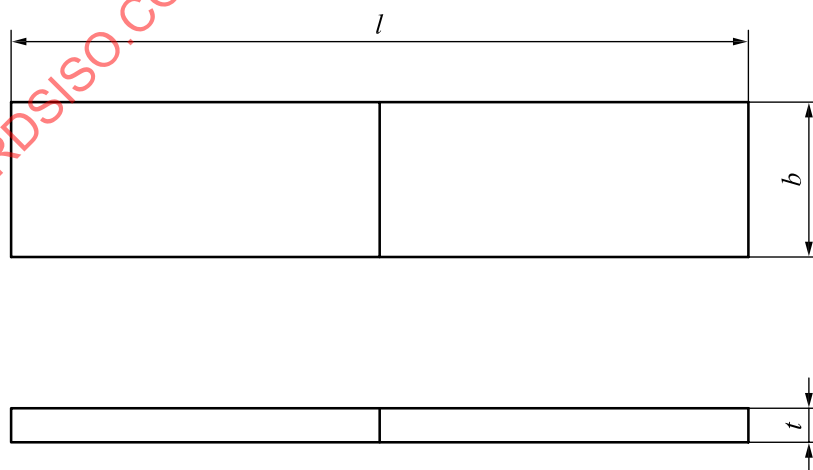
Examples of test pieces are shown in [Figures C.1 to C.5](#).



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