

BOILERS, PRESSURE VESSELS, AND REFRIGÉRATION



Brazing Program Implementation Guide

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Safety Notice

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Also, the references in this outline are not an exhaustive list of all examples that may apply to a particular situation.

Users should exercise their best judgement and expertise to assess whether these references are current and applicable to their specific situation.

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This guideline does not supersede the requirements of the Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation or any adopted codes and standards.

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1. Scope of this Guideline

This guideline is designed to assist licensed contractors in integrating brazing programs within their organization's quality control program (“**QCP**”) to ensure the activity is appropriately controlled and employees performing brazing under the QCP are adequately qualified. This guideline does not apply to new construction of boilers or pressure vessels performed under a Class MA contractor licence or by organizations holding an ASME Certificate of Authorization.

This guideline should be used in conjunction with the appropriate class of [Contractor License Guidelines](#) for QCP development.

2. What is Brazing?

Brazing is a metal joining process in which two or more metal parts are joined by melting and flowing a filler metal into the joint by capillary action. When used as a joining process on a regulated product (e.g., pressure piping system, refrigeration system and equipment, etc.), brazing meets the definition of “regulated work” for the purposes of the *Safety Standards Act*, SBC 2003, c.39 and its associated regulations.

The CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code (“**CSA B51**”) and ASME Section IX Welding, Brazing, and Fusing Qualifications Code (“**ASME Section IX**”) define brazing as follows:

Brazing: “a group of metal-joining processes that produce a coalescence of materials by heating them to a suitable temperature and by using a filler metal having a liquidus above 450 °C (840 °F) and below the solidus of the base materials. The filler metal is distributed between the closely fitted surfaces of the joint by capillary action.”

Individuals performing brazing are referred to as “brazers” or “brazing operators,” depending on the type of brazing process being used (i.e. manual, semi-automatic, or automatic). The term “brazer” in this document refers to both brazers and brazing operators.

Brazer: one who performs a manual or semi-automatic brazing operation.

Brazing operator: one who operates machine or automatic brazing equipment.

The above definitions align with terminology used in ASME Section IX, Article XIV.

3. Requirements Applicable to Brazing

The regulatory and code requirements applicable to brazing activities in British Columbia include, but are not limited to, the following:

- Power Engineers, Boiler, Pressure Vessel, and Refrigeration Safety Regulation establishes the broad requirements applicable to brazing activities, including procedure registration (s. 78), and brazer qualification requirements (s. 5(4)); in accordance with CSA B51).
- CSA B51 establishes general and administrative requirements for procedure, registration, and testing of equipment manufactured within and outside of Canada.
- ASME Section IX establishes the detailed technical requirements for brazing procedures, procedure qualifications, and performance tests. ASME Section IX is incorporated by reference in CSA B51 section 6.2.2.3.
- ASME B31.3: Process Piping, and ASME B31.5: Refrigeration Piping and Heat Transfer Components establish further technical and administrative requirements for brazing procedure qualification, and performance qualification. ASME B31.3 and B31.5 are incorporated by reference in CSA B51 at section 5.3.1, and apply towards the design and fabrication of pressure piping.

4. Elements to be Addressed within a Quality Control Program Manual

Quality control programs must address an organization's internal processes and procedures for implementing the above brazing requirements, including, but not limited to:

- brazing procedure specification development and qualification
- brazing procedure registration requirements
- brazer performance qualification and continuity record(s)
- essential variables and portability of qualifications
- control and distribution of brazing procedure specifications (“**BPS**”)

Appendix A of this guideline expands upon each of these elements, including the associated regulation(s) or code requirement(s), and provides guidance on acceptable practices for addressing same within an organization's QCP.

Depending on the scope of the regulated work to be performed and any applicable code requirements, additional information beyond the content specified in this guideline may be necessary to include in an organization's QCP.

5. Review of Brazing Program Implementation

Quality Control Programs are subject to inspection, including investigation, monitoring, and audit, by Technical Safety BC at any time. We inspect a licensee's QCP and associated regulated work to confirm that a contractor is meeting the requirements under their licence, including, but not limited to, the application of brazing processes as specified in the QCP.

Appendix A. Brazing Requirements

The following provides guidance respecting the applicable code requirements relevant to brazing. Detailed requirements can be found within the Power Engineers, Boiler, Pressure Vessel, and Refrigeration Safety Regulation, CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code, ASME Section IX Welding, Brazing, and Fusing Qualifications, and applicable code of construction (i.e. ASME B31.3, ASME B31.5, etc.).

Depending on the complexity of the regulated work to be performed and the applicable code requirements, additional information that is beyond the contents of this guideline may be required in the QCP.

A.1. Brazing Procedure Development and Qualification Testing

A Brazing Procedure Specification (“**BPS**”) is a written document that defines how a brazed joint will be produced.

A BPS must follow the technical requirements of ASME Section IX. At a minimum, a BPS shall include the following:

- Procedure name or number and revision number (if applicable)
- Organization (procedure developer) name
- Brazing process (torch brazing, furnace brazing, induction brazing, resistance brazing, drip brazing-salt or flux bath, and/or dip brazing-molten metal bath)
- Brazing variables listed for each brazing process. See section A.2. for details on essential variables and non-essential variables.

[FORM QB-482](#) of ASME Section IX represents a suggested form for BPS that can be used by organizations when developing their own BPS’.

Once a BPS has been developed, the developing organization must qualify and test it to ensure it is suitable for the intended application. Brazing procedure qualification testing is achieved by brazing a test coupon in strict accordance with the new procedure and having it destructively or non-destructively tested in accordance with the requirements of ASME Section IX, to evaluate the integrity of the joint. The outcome of the qualification testing determines if the procedure meets the technical requirements of ASME Section IX. Brazing performed for the purposes of procedure qualification may also be considered satisfactory for issuance of a performance qualification if all the relevant regulatory and code requirements specified under section 3 of this guide and Article XIII of ASME Section IX have been met.

Required testing can include:

- Tension tests: used to determine the ultimate strength of brazed butt, scarf, lap, and rabbet joints.
- Guided bend tests: used to determine the degree of soundness and ductility of butt and scarf joints.
- Peel tests: used to determine the quality of the bond and the quantity of defects in lap joints
- Sectioning tests: used to determine the soundness of workmanship coupons or test specimens. This test also substitutes for peel test when peel test is impractical to perform.
- Visual examination: used to determine the soundness of the joint by inspecting the external surface for continuity of brazing filler metal, size, contour, and wetting of fillet along the joint.

ASME Section IX QB-202 provides details on the testing required for brazing procedure qualification.

[FORM QB-483](#) of ASME Section IX is a suggested form of a brazing procedure qualification record (“**PQR**”) that should be used by organizations to keep the record of the tests.

A.2. Brazing Variables (Essential and Non-Essential)

Brazing variables used in a BPS are subdivided into “essential” and “non-essential” variables:

Essential variables are those in which a change is considered to affect the mechanical properties of the brazement and such change shall require requalification and re-registration of the brazing procedure specification. Essential variables include, but are not limited to:

- Base Metal (ASME Section IX, Paragraph QB-402)
- Brazing Filler Metal (ASME Section IX, Paragraph QB-403)
- Brazing Temperature (ASME Section IX, Paragraph QB-404)
- Brazing Flux, Gas, or Atmosphere (ASME Section IX, Paragraph QB-406)
- Flow Position (ASME Section IX, Paragraph QB-407)
- Joint Design (ASME Section IX, Paragraph QB-408)
- Post-Braze Heat Treatment (ASME Section IX, Paragraph QB-409)

Non-essential variables are those in which a change may be made in the brazing procedure specification without requalification. Nonessential variables include, but are not limited to:

- Technique (ASME Section IX, Paragraph QB-410):
 - Method of preparing base metal
 - Method of post-braze cleaning
 - Change in the nature of the flame
 - Change in brazing tip size
 - Change from manual to machine/semi-automatic torch brazing or vice versa
- Brazing Time (ASME Section IX, Paragraph QB-411)

Types and the extent of brazing variables depend on the brazing process itself, which are listed in the ASME Section IX at tables QB-252 through QB-257.

An individual who is qualified to a BPS may perform brazing activities in accordance with any other BPS containing the same essential variables.

A.3. Brazing Procedure Registration and Use

Once a brazing procedure has been developed, tested, and qualified it must be [registered with Technical Safety BC](#) in accordance with section 78 of the Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation prior to use in connection with any regulated pressure equipment.

Procedures may be registered individually by a licensed contractor, or they may be registered by a larger representative group, such as an industry association, educational institution, cooperative, etc., for use by members, program participants, or registrants.

When a BPS is developed, qualified, and registered by a larger representative group, it can be shared with other contractors/organizations provided that the following conditions are met:

- **Compliance with ASME Section IX:** The BPS must fully meet the applicable requirements of ASME Section IX.
- **Registration with Technical Safety BC:** The BPS must be registered with Technical Safety BC.
- **Verification of Compatibility:** A contractor adopting a registered BPS must verify that the procedure is compatible with the brazing work to be performed by them.
- **Quality Control Program Documentation:** A contractor adopting a registered BPS must address adoption within their QCP and must include a copy or reference to the registered BPS and associated documents within their QCP.

Documentation must be established between the organization that originally developed and registered a BPS and a contractor adopting it. At a minimum, the following items must be noted within a contractor's QCP or associated reference documentation:

- Name and address of the original BPS developer/registrant
- Name and address of the contractor adopting the BPS
- BPS identification number
- Technical Safety BC registration (Admin #) number
- Date of the agreement
- Expiry date, where applicable
- Signatures from both parties

Members of certain associations with pre-registered procedures may have access to brazing procedure resources. These resources may be used by association members provided they follow the requirements for documentation as noted above. To learn more about what resources may be available to you, check with your membership association.

Regardless of the method chosen, a QCP must describe how procedure registration or access to registered procedures will be managed. For registered procedures accessed by virtue of association membership or alternative, a QCP must also detail how those procedures will be “adopted” into the program in accordance with this manual and ASME requirements.

Contractors are responsible for reviewing any registered procedure(s) they intend to use in any brazing activity to ensure such procedures are compatible with the brazing process(es) being performed and to ensure they meet the requirements of any applicable codes of construction.

Contractors may adopt BPS’ developed and registered in other Canadian jurisdictions provided such procedures are accepted through reciprocal registration with Technical Safety BC.

A.4. Brazer Performance Qualification Testing and Performance Qualification Records

Brazer qualification testing is used to demonstrate that an individual performing brazing activities has the ability to produce a sound joint. Similar to the qualification of brazing procedures, brazer qualification testing is achieved by brazing a test coupon in strict accordance with a developed or adopted procedure and having it destructively or non-destructively tested in accordance with the requirements of Article XIII of ASME Section IX, to evaluate the integrity of the joint. Anyone can obtain a brazer performance qualification following the requirements of ASME section IX; however, only a qualified individual working under an appropriate class of contractor license may perform brazing of regulated pressure equipment .

Testing may be performed by a licensed contractor for their own brazers or at a Recognized Test Administrator facility. At a minimum, QCPs must detail the following with respect to testing activities:

- processes;
- material controls;
- test methods;
- qualification or declaration of competency for individual(s) administering testing;
- documentation controls; and
- record keeping associated with the activity.

Licensed contractors must describe within their QCPs how performance qualification test records will be maintained and made available to a safety officer during inspection.

ASME Section IX QB-302 provides details on testing required for brazer performance qualification testing.

[FORM QB-484](#) of ASME Section IX is a suggested form of a brazer performance qualification (“**BPQ**”) that should be used by organizations to keep record of brazer performance tests.

Portability of performance qualifications from one employer to another:

Performance qualifications of brazers respecting a specific BPS may be accepted by a new employer/contractor provided that:

- the new employer obtains a copy of the performance qualification test (BPQ) of the brazer (such as Form QB-484) that shows the name of the employer under which the brazer or brazing operator was qualified and the date of such qualification;
- the new employer obtains a copy of the continuity record showing use of each relevant BPS at no more than 6-month intervals from the date of qualification of such BPS to the date that the qualification record is transferred to the new employer;
- the new employer verifies that the essential variables associated with the brazers existing BPQ are within the limits of the essential variables of the new employers BPS; and
- the new employer shall indicate acceptance of the brazers existing performance qualification record in accordance with their QCP.

A.5. Continuity of Brazer Performance Qualifications

Performance qualification tests remain valid so long as continuity is maintained in accordance with ASME Section IX QB-320. Brazers must retain evidence of brazing process(es) having been used at least once every 6 months since the completion of a relevant performance qualification test. At a minimum, a continuity record must clearly identify the brazing process(es) used, the date(s) of use, and details of the individual performing the brazing activities. Evidence of usage of (a) brazing process(es) can include, among other things, field use of a process during installation, repair, alteration, etc., or, shop-based brazing completed for the purpose of maintaining continuity.

A QCP must describe how activities will be tracked to ensure brazers are always appropriately qualified to complete certain brazing activities. If continuity ceases, a performance qualification expires, and retesting will be required to renew or re-qualify for an associated process. Renewal and/or requalification of performance qualification(s) must occur in accordance with ASME Section. IX, Paragraph QB-322.