BRAZING PROCEDURE SPECIFICATIONS

PROCEDURE QUALIFICATION RECORDS

and

BRAZING PERFORMANCE QUALIFICATION RECORDS

As required by


According to

Section IX, ASME Boiler & Pressure Vessel Code, Welding & Brazing Qualifications

and

ANSI/AWS B2.2 Standard for Brazing Procedure & Performance Qualification

by

COPPER DEVELOPMENT ASSOCIATION INC.
260 Madison Avenue
New York, NY 10016
212/251-7200

March 18, 1994
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SUMMARY

Copper Development Association Inc. (CDA) regularly receives inquiries regarding the methods and procedures required to qualify brazers for installation of nonflammable medical gas systems. The attached documentation has been prepared in response to these questions and satisfies the requirements of the National Fire Protection Association Standard for Health Care Facilities - NFPA 99, 1993 Edition. Chapter 4 of this standard, Gas and Vacuum Systems, Section 4-4.1.4.2, requires brazing procedures and brazer performance to be qualified. These qualifications must comply with either Section IX, Welding and Brazing Qualifications of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code or American Welding Society (AWS) B2.2, Standard for Brazing Procedures and Performance Qualification. Section 4-4.1.4.2 of NFPA 99-93 lists modifications to these standards that must also be considered.

This document contains two Brazing Procedure Specification formats. One complies with ASME and the other with AWS requirements. 1½" Type L, OXY/ACR copper tube was used in both procedures and the necessary qualification documentation and records required to qualify these procedures are enclosed. The enclosed brazing documentation was developed by CDA and tested by PRL Industries, Inc., an ASME recognized test laboratory.

The installing contractor has the option to use either the ASME or AWS requirements to qualify brazers and should choose the appropriate documentation. To accept these specifications for use and to meet the requirements of NFPA, the contractor shall sign and date the Brazing Procedure Specification and its supporting qualifications prior to use.

It is the responsibility of each contractor that decides to use either of these Brazing Procedure Specifications and the supporting qualification records to have the required tests conducted to qualify each brazer accordingly. It is also the contractor's responsibility to assure that these specifications meet any additional requirements of the referencing document. Suggested forms for nonflammable medical gas applications in both the ASME and AWS formats are included in the appendices for this purpose. The contractor shall maintain a signed and dated record of the Brazing Procedure Specifications, Procedure Qualification Records and the resulting Brazer Performance Qualifications and shall assume responsibility for representation of any liabilities or warranties implied. CDA assumes no responsibility or liability of any kind in connection with the use of this document and makes no representations or warranties of any kind hereby.

The documentation consists of the following:

- Brazing Procedure Specifications (BPS) - the document that specifies the required brazing variables for a specific application.
- Procedure Qualification Record (PQR) - a record of brazing variables and conditions used to produce an acceptable test brazement and the results of tests conducted on the brazement to qualify a brazing procedure specification.
- Brazing Performance Qualification Record (BPQR or BQR) - a record of the brazing conditions used to produce an acceptable test brazement and the results of the tests conducted on the brazement to qualify a brazer.

For information regarding CDA's brazing procedures, contact a CDA Regional Manager through Copper Development Association Inc., 260 Madison Avenue, New York, NY 10016 or phone 212/251-7200.

---

1PRL Industries, Inc., 64 Rexmont Road P.O. Box 142, Cornwall, PA 17016
ASME
BRAZING DOCUMENTS

Brazing Procedure Specification
BPS No. CDA-003

~

Procedure Qualification Record
PQR No. CDA-003-HV

~

Brazer Performance Qualification
BPQ
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PROCEDURE SPECIFICATION (BPS)
See QB-200.1, Section IX, ASME Boiler & Pressure Vessel Code & NFPA 99-1993

<table>
<thead>
<tr>
<th>Company Name</th>
<th>COPPER DEVELOPMENT ASSOCIATION INC.</th>
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<tbody>
<tr>
<td>BPS No.</td>
<td>CDA-003</td>
</tr>
<tr>
<td>Date</td>
<td>2/9/1994</td>
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<tr>
<td>Supporting PQR</td>
<td>CDA-003-HV</td>
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<td>Revision No.</td>
<td></td>
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<tr>
<td>Date</td>
<td></td>
</tr>
<tr>
<td>Supporting PQR</td>
<td></td>
</tr>
</tbody>
</table>

**BASE METALS**

- P-No. 107 to P-No. 107
- Spec. type and grade SB-75 Copper No. C12200 (See Attachment #1)
- Chemical analysis 99.9 Cu + 0.015-0.040 P
- Thickness range 0.054" - 0.066"
- Tube/Pipe diameter range 0.375" - 5.125" O.D.

**FILLER METALS**

- Specification No. SFA-5.8
- AWS Classification BCuP
- F-No. 103 Size or shape 0.125" x 0.050" Rod

**BRAZING TEMPERATURE**

- Temperature range (not applicable for torch brazing) N/A

**BRAZING PROCESS**

- H-No. 101 Process Torch Brazing (TB)
- Type Manual

**BRAZING FLUX**

- AWS designation Flux not required

**PURGE**

- Requirements Continuous flow of 99.99% pure Nitrogen

**FLOW POSITION**

- Flow position Flat (horizontal) and Vertical-up
- Method of applying filler metal Manual feed from face of joint

**JOINT DESIGN & TOLERANCES**

- Joint type Socket (lap) - Tube/fitting Clearance Range 0.002" - 0.010"
- Lap length range per ANSI B16.22
- Minimum overlap 4 times the thickness of the thinner member
- Sketch See Attachment #2 Figure #1

**TECHNIQUE**

- Joint Preparation See Attachment #2 & Attachment #3
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PROCEDURE SPECIFICATION (BPS)
See QB-200.1, Section IX, ASME Boiler & Pressure Vessel Code & NFPA 99-1993

BPS No. CDA-003

TITLE

BRAZING PROCEDURE SPECIFICATION CDA-003 FOR THE BRAZING OF COPPER TUBE AND
WROUGHT COPPER FITTINGS UTILIZING A MANUAL TORCH BRAZING PROCESS IN ACCORDANCE
WITH QB-200.1, SECTION IX, ASME BOILER & PRESSURE VESSEL CODE.

SCOPE

This procedure is applicable for the brazing of copper tube and wrought copper fittings in the range of
0.375" O.D. to 5.125" O.D. The wall thickness range shall be 0.027" to 0.132". A test brazement shall be
performed in the vertical-up and flat (horizontal) positions, thus qualifying the brazer in all positions.

BASE METAL (QB-402)

Base metals shall conform to the requirements of P-No. 107 and Base Metal Specification SB-75, Copper
Number C12200. ASTM B-75, seamless copper tube, was used for testing and certification purposes.
Seamless copper tube with the same O.D. and wall thickness listed in this BPS and that complies with
ASTM B-75, B-88, B-280 or B-819 may be used for brazer performance qualification. However, installation
shall be limited to seamless copper tube types listed in NFPA 99.

FILLER METAL (QB-403)

Filler metal shall meet the requirements of SFA 5.8 and F-Number 103. Filler metal shall be of the AWS
BCuP series for the test brazement. Filler metal shall be stored in accordance with the manufacturers’
recommendations and shall be 0.125” x 0.050” rod.

BRAZING PROCESS (QB-405)

The brazing process shall meet the requirements of H-Number 101, Manual Torch Brazing (TB).

BRAZING FLUX (QB-406)

No brazing flux shall be used in the fabrication of the test brazement.

PURGE

Purge gas shall be Nitrogen, 99.99% pure. Purge gas flow rate shall be in the range of 5 to 20 SCFH and
flow continuously during the brazing process. The purge gas shall flow until the brazement is cool to the
touch so that no oxidation forms on the I.D. of the tube and fitting.

FLOW POSITION (QB-407)

The brazements shall be configured so that flow positions are vertical-up and flat (horizontal). Filler metal
shall be applied manually.

JOINT DESIGN and TOLERANCES (QB-408)

Joint type shall be socket/lap (see Attachment #2, Figure #1). The minimum and maximum joint tolerances
shall be 0.002” to 0.010”. Lap (overlap) shall meet the requirements of ANSI B16.22 Wrought Copper and
Copper Alloy Solder Joint Pressure Fittings.
JOINT PREPARATION, ASSEMBLY & SUPPORT

CUTTING

Cut tube ends square with a tube cutter. The cutter wheel shall be sharp and the cutter rollers free rolling to prevent tube ends from being deformed. Tube cutter shall be free of all oil, dirt, lint and other debris.

REAMING

Ream all cut tube ends to the full I.D. of the tube to remove the small burr created by the cutting operation. Special care shall be exercised to insure that no shavings are left in the tube.

CLEANING

Removal of surface oxidation on the I.D. of the fitting socket shall not be necessary if the fittings have been cleaned according to Compressed Gas Association Pamphlet G-4.1 and kept clean until ready for use.

Surface particles and dirt shall be removed from the O.D. of the tube ends, for a distance slightly more than the fitting cup, using a clean lint free cloth.

Surface oxidation on the O.D. of the tube shall be removed with the use of a nylon abrasive cloth for a distance slightly more than the depth of the fitting socket. Care must be exercised to insure that dust or particles are not allowed to be deposited on the I.D. of the tube.

When the tube ends are cleaned and the surface oxidation is removed the brazer shall perform a visual inspection of the tube I.D.

ASSEMBLY AND SUPPORT

Insert tube ends into fitting cup, making sure that the tube is seated against the base of the fitting cup.

Support the tube and fitting assembly to insure a uniform capillary space around the entire circumference of the joint.

POSTBRAZE CLEANING (QB-410)

When the joint is cool to the touch, the outside shall be cleaned using a wet cloth to remove loose surface oxidation and allow a clear visual inspection of the joint.
# TABLE 1
SUGGESTED TORCH TIP SELECTION GUIDE for BRAZING COPPER TUBE and FITTINGS

<table>
<thead>
<tr>
<th>*SCFH ACETYLENE</th>
<th>*BTUH</th>
<th>**TUBE SIZE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>2940</td>
<td>1/8&quot; - 3/8&quot;</td>
</tr>
<tr>
<td>3.6</td>
<td>5292</td>
<td>1/8&quot; - 1/2&quot;</td>
</tr>
<tr>
<td>5.7</td>
<td>8379</td>
<td>3/8&quot; - 7/8&quot;</td>
</tr>
<tr>
<td>8.3</td>
<td>12201</td>
<td>5/8&quot; - 1-1/8&quot;</td>
</tr>
<tr>
<td>11</td>
<td>16170</td>
<td>7/8&quot; - 1-5/8&quot;</td>
</tr>
<tr>
<td>14.5</td>
<td>21315</td>
<td>1-1/8&quot; - 2-1/8&quot;</td>
</tr>
<tr>
<td>33.2</td>
<td>48804</td>
<td>2 1/8&quot; - 4-1/8&quot;</td>
</tr>
</tbody>
</table>

* BTUH = SCFH × 1470
(Acetylene gas has a heat content of 1470 btuh / cubic foot)

** Size ranges are given as an average. Actual sizes to be brazed shall be determined by the individual brazer’s abilities.

NOTE The BTUH output of each type of torch shall be determined from the manufacturer’s literature for the torch used.

EXAMPLE A Victor® #2 multi-flame tip has an acetylene consumption of 3 to 9 SCFH. Multiplied by 1470 BTUH/cu ft would equal 4410 to 13,230 BTUH. This tip will braze a 1/8" through 1-1/8" copper to copper joint.
COPPER DEVELOPMENT ASSOCIATION INC.
PROCEDURE QUALIFICATION RECORD (PQR)
See QS-200.2, Section IX, ASME Boiler & Pressure Vessel Code & NFPA 99-1993
Record of Actual Conditions Used to Braze Test Coupon

Company Name                   COPPER DEVELOPMENT ASSOCIATION INC.
PQR No.       CDA-003-HV     Date       2/22/94     Supporting BPS     CDA-003

BASE METALS
F-No. 107          to F-No. 107
Spec. type and grade  SB-75  Copper No. C12200
Chemical analysis     99.9 Cu + 0.015-0.040 P
Thickness range 0.054” - 0.066”  Tube/ Pipe diameter 1.5” (1.625” O.D.)

FILLER METALS
Specification No. SFA-5.8     AWS Classification BCuP
F-No. 103          Size or shape 0.125” x 0.050” Rod

BRAZING TEMPERATURE
Temperature range (not applicable for torch brazing)  N/A

BRAZING PROCESS
H-No. 101          Process  Torch Brazing (TB)
Type Manual

BRAZING FLUX
AWS designation Flux not required     Trade name  N/A

PURGE
Requirements  Continuous flow of 99.99% pure Nitrogen (see Note #1 attached)

FLOW POSITION
Flow position  Flat (horizontal) and Vertical-up (see Figure #1)
Method of applying filler metal  Manual feed from face of joint

JOINT DESIGN & TOLERANCES
Joint type  Socket (lap) - Tube/fitting    Clearance Range 0.002” - 0.010”
Lap length range  per ANSI B16.22  (1.09” - full socket insertion per NFPA 99-93)
Minimum overlap  0.216” (4 times the thickness of the thinner member)
Sketch  See Figure #1 Sheet 2 of 2

TECHNIQUE
Joint Preparation  See Note#2 Attachment #1 and Table #1 Attachment #2
**Figure #1 Joint Sketch**

**Tensile Tests (QB-150)**

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Dimensions</th>
<th>Ultimate Total Load (lbs)</th>
<th>Ultimate Stress (ps)</th>
<th>Failure Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width (in)</td>
<td>Thickness (in)</td>
<td>O.D. (in)</td>
<td>Area (sq. in.)</td>
</tr>
<tr>
<td>(1) 003-Horz</td>
<td>1.15</td>
<td>.060</td>
<td>1.625</td>
<td>.069</td>
</tr>
<tr>
<td>(2) 003-Horz</td>
<td>1.12</td>
<td>.060</td>
<td>1.625</td>
<td>.0672</td>
</tr>
<tr>
<td>(1) 003-Vert</td>
<td>1.14</td>
<td>.060</td>
<td>1.625</td>
<td>.0654</td>
</tr>
<tr>
<td>(2) 003-Vert</td>
<td>1.01</td>
<td>.060</td>
<td>1.625</td>
<td>.0606</td>
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</tbody>
</table>

**Peel or Section Tests (QB-170 & QB-180)**

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>(1) 003-Horizontal</td>
<td>Acceptable (0%, 0% unbrazed)</td>
</tr>
<tr>
<td>(2) 003-Horizontal</td>
<td>Acceptable (0%, 0% unbrazed)</td>
</tr>
<tr>
<td>(1) 003-Vertical</td>
<td>Acceptable (0%, 0% unbrazed)</td>
</tr>
<tr>
<td>(2) 003-Vertical</td>
<td>Acceptable (0%, 0% unbrazed)</td>
</tr>
</tbody>
</table>

Brazer's Name: A.G. "Andy" Kireta  
Brazer Identification: 1-A  
Brazing Witnessed by: Dale R. Powell  
Tests Conducted by: Scott Smith  
Laboratory Test Number: 2148  

We certify that the statements in this record are correct and that the test brazements were prepared, brazed and tested in accordance with the requirements of Section IX of the ASME Code.

Contractor: COPPER DEVELOPMENT ASSOCIATION INC  
By: [Signature]  
Date: 2/22/94
NOTE #1 PURGE (Requirements)

PURGE GAS

Purge gas shall conform to the following composition and purity: Nitrogen 99.99% pure. The purge gas shall have a flow range of 5 to 20 SCFH and flow continuously during the brazing process. Purge gas shall be permitted to flow after the completion of the brazing process, for a sufficient time period, to insure that no oxidation is permitted to form on the I.D. of the tube and fitting.

NOTE #2 TECHNIQUE (Joint Preparation)

CUTTING

Cut tube ends square with a tube cutter. The cutter wheel shall be sharp and the cutter rollers free rolling to prevent tube ends from being deformed. Tube cutter shall be free of all oil, dirt, lint and other debris.

REAMING

Ream all cut tube ends to the full I.D. of the tube to remove the small burr created by the cutting operation. Special care shall be exercised to insure that no shavings are left in the tube.

CLEANING

Removal of surface oxidation on the I.D. of the fitting socket shall not be necessary if the fittings have been cleaned according to Compressed Gas Association Pamphlet G-4.1 and kept clean until ready for use.

Surface particles and dirt shall be removed from the O.D. of the tube ends, for a distance slightly more than the fitting cup, using a clean lint free cloth.

Surface oxidation on the O.D. of the tube shall be removed with the use of a nylon abrasive cloth for a distance slightly more than the depth of the fitting socket. Care must be exercised to insure that dust or particles are not allowed to be deposited on the I.D. of the tube.

When the tube ends are cleaned and the surface oxidation is removed the brazer shall perform a visual inspection of the tube I.D.

ASSEMBLY AND SUPPORT

Insert tube ends into fitting cup, making sure that the tube is seated against the base of the fitting cup.

Support the tube and fitting assembly to insure a uniform capillary space around the entire circumference of the joint.

POSTBRAZE CLEANING

When the joint is cool to the touch, the outside shall be cleaned using a wet cloth to remove loose surface oxidation and permit a clear visual inspection of the joint.
VISUAL EXAMINATION

Following sectioning of the brazements, the joints shall be visually examined. The following conditions shall be considered unacceptable according to NFPA 99-93, Section 4-4.1.4.3 (j):

1. Flux or flux residue (not applicable to this BPS & PQR)
2. Excessive oxidation of the joint
3. Presence of unmelted filler metal
4. Failure of the filler metal to be clearly visible all the way around the exterior of the joint at the interface between the socket and the tube
5. Cracks in the tube or component
6. Cracks in the braze filler metal
7. Failure of the joint to hold the required test pressure (not applicable to this BPS & PQR)

TABLE 1

SUGGESTED TORCH TIP SELECTION GUIDE for BRAZING COPPER TUBE and FITTINGS

<table>
<thead>
<tr>
<th>*SCFH ACETYLENE</th>
<th>*BTUH</th>
<th>**TUBE SIZE RANGE</th>
</tr>
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<tr>
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<td>48904</td>
<td>2-1/8&quot; - 4-1/8&quot;</td>
</tr>
</tbody>
</table>

* BTUH = SCFH X 1470
(Acetylene gas has a heat content of 1470 btuh / cubic foot)

** Size ranges are given as an average. Actual sizes to be brazed shall be determined by the individual brazer's abilities.

NOTE The BTUH output of each type of torch shall be determined from the manufacturer's literature for the torch used.

EXAMPLE A Victor® #2 multi-flame tip has an acetylene consumption of 3 to 9 SCFH. Multiplied by 1470 BTUH/cu ft, would equal 4410 to 13,230 BTUH. This tip will braze a 1/8" through 1-1/8" copper to copper joint.
COPPER DEVELOPMENT ASSOCIATION INC.
CONTRACTOR'S RECORD OF BRAZER PERFORMANCE
QUALIFICATION (BPQ)
BPQ# CDA-003/93

<table>
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<tr>
<th>Variables</th>
<th>Record Actual Values Used in Qualification</th>
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<td>1-1/2&quot; OXY/ACR Copper Tube</td>
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<td>Thickness</td>
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<td>103</td>
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<td>Brazing Temp. Range (QB-404)</td>
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<td>Brazing Process (QB-405)</td>
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<td>101</td>
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<td>H-Number</td>
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<tr>
<td>Flow Position(s) (QB-407)</td>
<td>Flat (Horizontal) &amp; Vertical Up</td>
<td>All Positions</td>
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<tr>
<td>Method of applying filler metal</td>
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<tr>
<td>Joint Types(s) (QB-408)</td>
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<td>Length Overlap</td>
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TEST RESULTS - Section (QB-180) - Tensile (QB-150)

<table>
<thead>
<tr>
<th>Flow Position</th>
<th>Section</th>
<th>Tensile</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Flat (horizontal)</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>(2) Flat (horizontal)</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>(1) Vertical-up</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>(2) Vertical-up</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
</tr>
</tbody>
</table>

Tests Conducted by Scott Smith, Laboratory Test No. 2148

We certify that the statements made in this record are correct and that the test brazes were prepared, brazed and tested in accordance with the requirements of Section IX of the ASME Code.

Contractor: COPPER DEVELOPMENT ASSOCIATION INC.

Date: February 22, 1994

Note: Any essential variables in addition to those above shall be recorded.
AWS
BRAZING DOCUMENTS
(Horizontal Joint)

Brazing Procedure Specification
BPS No. CDA-001

Procedure Qualification Record
PQR

Brazer Performance Qualification Record
BPQR No. CDA-001-H
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PROCEDURE SPECIFICATION (BPS)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPS No. CDA-001 Date 2/8/94 BPQR No. CDA-001-H
Company COPPER DEVELOPMENT ASSOCIATION INC.
Brazing Process Oxy-Fuel Torch Manual X Mechanized Automatic
Brazing Equipment Oxy-Fuel Gas Torch

BRAZING CONDITIONS

BASE METAL:
Identification Copper Number C12200 Tube & Fitting BM No. 300
Thickness 0.054" - 0.066" Preparation See Note #1 attached
Other

FILLER METAL:
FM No. 150 AWS Classification AWS A5.8 BCuP
Form Rod or Wire Method of Application Manual Face Feed

FLUX:
AWS Type Flux not required Other

ATMOSPHERE:
AWS Type N/A Other

BRAZING PROCESS:
Temperature 1275°F - 1550°F Test position Horizontal
Time As required Current N/A
Fuel gas Acetylene Tip size See Table #1 attached
Postbraze cleaning See Note #2 attached
Postbraze heat treatment N/A
Other See Note #3 attached

JOINT:
Type Lap (Socket) Joint - Tube/fitting
Clearance 0.002" - 0.010"
UTS 30,000 psi
Other

JOINT SKETCH

Approved for production

Employer
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PROCEDURE SPECIFICATION (BPS)
in Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPS No. CDA-001

TITLE


SCOPE

This procedure is applicable for the brazing of copper tube and wrought copper fittings in the range of 0.375" O.D. to 2.525" O.D. The wall thickness range shall be 0.014" to 0.079". A test brazement shall be performed in the horizontal position.

BASE METAL

Base metals shall conform to the requirements of Group BM No. 300 as listed in Table B1 of ANSI/AWS B2.2-91.

FILLER METAL

Filler metal shall meet the requirements of Group FM No. 150 as listed in Table C1 of ANSI/AWS B2.2-91. Filler metal shall be of the AWS BCuP series for the test brazement. Filler metal shall be stored in accordance with the manufacturers’ recommendations and shall be 0.125” x 0.050” rod.

BRAZING PROCESS

The brazing process shall be Manual Torch Brazing (TB). The brazement shall be configured so that flow position is horizontal. Filler metal shall be applied manually.

BRAZING FLUX

No brazing flux shall be used in the fabrication of the test brazement.

PURGE

Purge gas shall be Nitrogen, 99.99% pure. Purge gas flow rate shall be in the range of 5 to 20 SCFH and flow continuously during the brazing process. The purge gas shall flow until the brazement is cool to the touch so that no oxidation forms on the I.D. of the tube and fitting.

JOINT DESIGN and TOLERANCES

Joint type shall be socket/lap (see Figure #1). The minimum and maximum joint tolerances shall be 0.002” to 0.010”. Lap (overlap) shall meet the requirements of ANSI B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PROCEDURE SPECIFICATION (BPS)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPS No. CDA-001

NOTE #1 BASE METAL (Preparation)

CUTTING

Cut tube ends square with a tube cutter. The cutter wheel shall be sharp and the cutter rollers free rolling to prevent tube ends from being deformed. Tube cutter shall be free of all oil, dirt, lint and other debris.

REAMING

Rearm all cut tube ends to the full I.D. of the tube to remove the small burr created by the cutting operation. Special care shall be exercised to insure that no shavings are left in the tube.

CLEANING

Removal of surface oxidation on the I.D. of the fitting socket shall not be necessary if the fittings have been cleaned according to Compressed Gas Association Pamphlet G-4.1 and kept clean until ready for use.

Surface particles and dirt shall be removed from the O.D. of the tube ends, for a distance slightly more than the fitting cup, using a clean lint free cloth.

Surface oxidation on the O.D. of the tube shall be removed with the use of a nylon abrasive cloth for a distance slightly more than the depth of the fitting socket. Care must be exercised to insure that dust or particles are not allowed to be deposited on the I.D. of the tube.

When the tube ends are cleaned and the surface oxidation is removed the brazer shall perform a visual inspection of the tube I.D.

ASSEMBLY AND SUPPORT

Insert tube ends into fitting cup, making sure that the tube is seated against the base of the fitting cup.

Support the tube and fitting assembly to insure a uniform capillary space around the entire circumference of the joint.

NOTE #2 BRAZING PROCESS (Postbraze Cleaning)

POSTBRAZE CLEANING

When the joint is cool to the touch, the outside shall be cleaned using a wet cloth to remove loose surface oxidation and allow a clear visual inspection of the joint.

NOTE #3 BRAZING PROCESS (Other)

PURGE GAS

Purge gas shall conform to the following composition and purity: Nitrogen 99.99% pure. The purge gas shall have a flow range of 5 to 20 SCFH and flow continuously during the brazing process. Purge gas shall be permitted to flow after the completion of the brazing process, for a sufficient time period, to insure that no oxidation is permitted to form on the I.D. of the tube and fitting.
TABLE 1
SUGGESTED TORCH TIP SELECTION GUIDE for BRAZING COPPER TUBE and FITTINGS

<table>
<thead>
<tr>
<th>*SCFH ACETYLENE</th>
<th>*BTUH</th>
<th>**TUBE SIZE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>2940</td>
<td>1/8&quot; - 3/8&quot;</td>
</tr>
<tr>
<td>3.6</td>
<td>5292</td>
<td>1/8&quot; - 1/2&quot;</td>
</tr>
<tr>
<td>5.7</td>
<td>8379</td>
<td>3/8&quot; - 7/8&quot;</td>
</tr>
<tr>
<td>8.3</td>
<td>12201</td>
<td>5/8&quot; - 1-1/8&quot;</td>
</tr>
<tr>
<td>11</td>
<td>16170</td>
<td>7/8&quot; - 1-5/8&quot;</td>
</tr>
<tr>
<td>14.5</td>
<td>21315</td>
<td>1 1/8&quot; - 2-1/8&quot;</td>
</tr>
<tr>
<td>33.2</td>
<td>48804</td>
<td>2-1/8&quot; - 4-1/8&quot;</td>
</tr>
</tbody>
</table>

* BTUH = SCFH X 1470
( Acetylene gas has a heat content of 1470 btuh / cubic foot )

** Size ranges are given as an average, actual sizes to be brazed shall be determined by the individual brazer's abilities.

NOTE The BTUH output of each type of torch shall be determined from the manufacturer's literature for the torch used.

EXAMPLE A Victor® #2 multi-flame tip has an acetylene consumption of 3 to 9 SCFH. Multiplied by 1470 BTUH/cu ft would equal 4410 to 13,230 BTUH. This tip will braze a 1/8" through 1-1/8" copper to copper joint.
COPPER DEVELOPMENT ASSOCIATION INC.
PROCEDURE QUALIFICATION RECORD (PQR)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPQR No. CDA-001-H Date 2/9/1994 BPS No. CDA-001
Company COPPER DEVELOPMENT ASSOCIATION INC.
Brazer's Name and Id. A.G. "Andy" Kireta (1-A)
Brazing Process Oxy-Fuel Torch Manual X Mechanized Automatic
Brazing Equipment Oxy-Fuel Gas Torch

BRAZING CONDITIONS

BASE METAL:
Identification Copper Number C12200 Tube & Fitting BM No. 300
Thickness 0.054" - 0.066" Preparation See Note #1 attached
Other

FILLER METAL:
FM No. 150 AWS Classification AWS A5.8 BCuP
Form Rod or Wire Method of Application Manual Face Feed

FLUX:
AWS Type Flux not required Other

ATMOSPHERE:
AWS Type N/A Other

BRAZING PROCESS:
Temperature 1275°F - 1550°F Test position Horizontal
Time As required Current N/A
Fuel gas Acetylene Tip size See Table #1 attached
Postbraise cleaning See Note #2 attached
Postbraise heat treatment N/A
Other See Note #3 attached

JOINT:
Type Lap (socket) Joint - Tube/fitting
Clearance 0.002" - 0.010"
Other

[Diagram: Joint Sketch]
# TEST RESULTS

**BPQR No.** CDA-001-H  
**Date** 2/22/1994

## VISUAL

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Horiz.</td>
<td>According to NFPA 99-93, Section 4.4.1.4.3 (j)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(2) Horiz.</td>
<td>According to NFPA 99-93, Section 4.4.1.4.3 (j)</td>
<td>X</td>
<td></td>
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</tbody>
</table>

## TENSION

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>UTS psi</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Horiz.</td>
<td>31343</td>
<td>Failed in base metal (Tube)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(2) Horiz.</td>
<td>28571</td>
<td>Failed in base metal (Tube)</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

## BEND

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

## MACROETCH

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Horiz.</td>
<td>0%, 0% unbrazed</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(2) Horiz.</td>
<td>0%, 0% unbrazed</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

## PEEL

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We certify that the information in this record is correct and that the test brazements were prepared, brazed and tested in accordance with the requirements of the American Welding Society Standard for Brazing Procedure Qualification, ANSI/AWS B-2.2-81.

Approved by [Signature]

Qualifier
CUTTING

Cut tube ends square with a tube cutter. The cutter wheel shall be sharp and the cutter rollers free rolling to prevent tube ends from being deformed. Tube cutter shall be free of all oil, dirt, lint and other debris.

REAMING

Ream all cut tube ends to the full I.D. of the tube to remove the small burr created by the cutting operation. Special care shall be exercised to insure that no shavings are left in the tube.

CLEANING

Removal of surface oxidation on the I.D. of the fitting socket shall not be necessary if the fittings have been cleaned according to Compressed Gas Association Pamphlet G-4.1 and kept clean until ready for use.

Surface particles and dirt shall be removed from the O.D. of the tube ends, for a distance slightly more than the fitting cup, using a clean lint free cloth.

Surface oxidation on the O.D. of the tube shall be removed with the use of a nylon abrasive cloth for a distance slightly more than the depth of the fitting socket. Care must be exercised to insure that dust or particles are not allowed to be deposited on the I.D. of the tube.

When the tube ends are cleaned and the surface oxidation is removed, the brazer shall perform a visual inspection of the tube I.D.

ASSEMBLY AND SUPPORT

Insert tube ends into fitting cup, making sure that the tube is sealed against the base of the fitting cup.

Support the tube and fitting assembly to insure a uniform capillary space around the entire circumference of the joint.

NOTE #2 BRAZING PROCESS (Postbraze Cleaning)

POSTBRAZE CLEANING

When the joint is cool to the touch, the outside shall be cleaned using a wet cloth to remove loose surface oxidation and permit a clear visual inspection of the joint.

NOTE #3 BRAZING PROCESS (Other)

PURGE GAS

Purge gas shall conform to the following composition and purity: Nitrogen 99.99% pure. The purge gas shall have a flow range of 5 to 20 SCFH and flow continuously during the brazing process. Purge gas shall be permitted to flow after the completion of the brazing process, for a sufficient time period, to insure that no oxidation is permitted to form on the I.D. of the tube and fitting.
VISUAL EXAMINATION

Following sectioning of the brazements, the joints shall be visually examined. The following conditions shall be considered unacceptable according to NFPA 99-93, Section 4-4.1.4.3 (f):

1. Flux or flux residue (not applicable to this BPS & PQR)
2. Excessive oxidation of the joint
3. Presence of unmelted filler metal
4. Failure of the filler metal to be clearly visible all the way around the exterior of the joint at the interface between the socket and the tube
5. Cracks in the tube or component
6. Cracks in the braze filler metal
7. Failure of the joint to hold the required test pressure (not applicable to this BPS & PQR)

TABLE 1
SUGGESTED TORCH TIP SELECTION GUIDE for BRAZING COPPER TUBE and FITTINGS

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<td>48604</td>
<td>2-1/8&quot; - 4-1/8&quot;</td>
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* BTUH = SCFH X 1470
(Acetylene gas has a heat content of 1470 btuh / cubic foot)

** Size ranges are given as an average. Actual sizes to be brazed shall be determined by the individual brazer’s abilities.

NOTE The BTUH output of each type of torch shall be determined from the manufacturer's literature for the torch used.

EXAMPLE A Victor® #2 multi-flame tip has an acetylene consumption of 3 to 9 SCFH. Multiplied by 1470 BTUH/cu ft, would equal 4410 to 13,230 BTUH. This tip will braze a 1/8" through 1-1/8" copper to copper joint.
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PERFORMANCE QUALIFICATION RECORD (BPQR)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BQR No. CDA-001-H

Name A.G. "Andy" Kireta
Id. 1-A

Date February 22, 1994
BPS No. CDA-001

Brazing Process Oxy-Fuel Torch
Brazer X Operator _

TEST BRAZEMENT

Base Metal Id. C12200 Copper
BM No. 300
BM T 30,000 psi

Filler Metal Id. AWS A5.8 BCuP
FM No. 150
FM Feed Manual

Test Position Horizontal Joint Type Lap (Socket) - Tube/fitting

TEST RESULTS

VISUAL

Specimen No. Remarks Pass Fail
(1) Horiz. According to NFPA 99-93, Section 4.4.1.4.3 (j) X
(2) Horiz. According to NFPA 99-93, Section 4.4.1.4.3 (j) X

TENSION

Specimen No. UTS psi Remarks Pass Fail
(1) Horiz. 31343 Failed in base metal (tube) X
(2) Horiz. 28571 Failed in base metal (tube) X

MACROETCH

Specimen No. Remarks Pass Fail
(1) Horiz. 0% 0% unbrazed X
(2) Horiz. 0% 0% unbrazed X

QUALIFIED FOR

Brazing Process Oxy-Fuel Torch Position Horizontal
BM No. 300 BM T 30,000 psi
FM No. 150 FM Feed Manual
Joint Type Lap (Socket) - Tube/fitting

The above named individual is qualified in accordance with the American Welding Society Standard for Brazing Procedure and Performance Qualification, ANSI/AWS B2.2-91.

Date 2/22/1994
Signed Scott Smith
Qualifier
AWS
BRAZING DOCUMENTS
(Vertical-up Joint)

Brazing Procedure Specification
BPS No. CDA-002

~

Procedure Qualification Record
PQR

~

Brazer Performance Qualification Record
BPQR No. CDA-002-V
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PROCEDURE SPECIFICATION (BPS)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPS No. CDA-002 Date 2/6/94 BPQR No. CDA-002-V
Company COPPER DEVELOPMENT ASSOCIATION INC.
Brazing Process Oxy-Fuel Torch Manual X Mechanized ____ Automatic ____
Brazing Equipment Oxy-Fuel Gas Torch

BRAZING CONDITIONS

BASE METAL:
Identification Copper Number C12200 Tube & Fitting BM No. 300
Thickness 0.054" - 0.066" Preparation See Note #1 attached
Other

FILLER METAL:
FM No. 150 AWS Classification AWS A5.8 BCuP
Form Rod or Wire Method of Application Manual Face Feed

FLUX:
AWS Type Flux not required Other

ATMOSPHERE:
AWS Type N/A Other

BRAZING PROCESS:
Temperature 1275° F - 1550° F Test position Vertical Up
Time As required Current N/A
Fuel gas Acetylene Tip size See Table #1 attached
Postbraze cleaning See Note #2 attached
Postbraze heat treatment N/A
Other See Note #3 attached

JOINT:
Type Lap (Socket) Joint - Tube/fitting
Clearance 0.002" - 0.010"
UTS 30,000 psi
Other

Approved for production

JOINT SKETCH

Employer
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PROCEDURE SPECIFICATION (BPS)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPS No. CDA-002

TITLE


SCOPE

This procedure is applicable for the brazing of copper tube and wrought copper fittings in the range of 0.375" O.D. to 2.625" O.D. The wall thickness range shall be 0.014" to 0.079". A test brazement shall be performed in the vertical-up position.

BASE METAL

Base metals shall conform to the requirements of Group BM No. 300 as listed in Table B1 of ANSI/AWS B2.2-91.

FILLER METAL

Filler metal shall meet the requirements of Group FM No. 150 as listed in Table C1 of ANSI/AWS B2.2-91. Filler metal shall be of the AWS BCuP series for the test brazement. Filler metal shall be stored in accordance with the manufacturers' recommendations and shall be 0.125" x 0.050" rod.

BRAZING PROCESS

The brazing process shall be Manual Torch Brazing (TB). The brazement shall be configured that flow position is vertical-up. Filler metal shall be applied manually.

BRAZING FLUX

No brazing flux shall be used in the fabrication of the test brazement.

PURGE

Purge gas shall be Nitrogen, 99.99% pure. Purge gas flow rate shall be in the range of 5 to 20 SCFH and flow continuously during the brazing process. The purge gas shall flow until the brazement is cool to the touch so that no oxidation forms on the I.D. of the tube and fitting.

JOINT DESIGN and TOLERANCES

Joint type shall be socket/lap (see Sketch). The minimum and maximum joint tolerances shall be 0.002" to 0.010". Lap (overlap) shall meet the requirements of ANSI B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
CUTTING

Cut tube ends square with a tube cutter. The cutter wheel shall be sharp and the cutter rollers free rolling to prevent tube ends from being deformed. Tube cutter shall be free of all oil, dirt, lint and other debris.

REAMING

Ream all cut tube ends to the full I.D. of the tube to remove the small burr created by the cutting operation. Special care shall be exercised to insure that no shavings are left in the tube.

CLEANING

Removal of surface oxidation on the I.D. of the fitting socket shall not be necessary if the fittings have been cleaned according to Compressed Gas Association Pamphlet 7-4.1 and kept clean until ready for use.

Surface particles and dirt shall be removed from the O.D. of the tube ends, for a distance slightly more than the fitting cup, using a clean lint free cloth.

Surface oxidation on the O.D. of the tube shall be removed with the use of a nylon abrasive cloth for a distance slightly more than the depth of the fitting socket. Care must be exercised to insure that dust or particles are not allowed to be deposited on the I.D. of the tube.

When the tube ends are cleaned and the surface oxidation is removed the brazer shall perform a visual inspection of the tube I.D.

ASSEMBLY AND SUPPORT

Insert tube ends into fitting cup, making sure that the tube is seated against the base of the fitting cup.

Support the tube and fitting assembly to insure a uniform capillary space around the entire circumference of the joint.

NOTE #2 BRAZING PROCESS (Postbrazing Cleaning)

POSTBRAZE CLEANING

When the joint is cool to the touch, the outside shall be cleaned using a wet cloth to remove loose surface oxidation and allow a clear visual inspection of the joint.

NOTE #3 BRAZING PROCESS (Other)

PURGE GAS

Purge gas shall conform to the following composition and purity: Nitrogen 99.99% pure. The purge gas shall have a flow range of 5 to 20 SCFH and flow continuously during the brazing process. Purge gas shall be permitted to flow after the completion of the brazing process, for a sufficient time period, to insure that no oxidation is permitted to form on the I.D. of the tube and fitting.
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SUGGESTED TORCH TIP SELECTION GUIDE for BRAZING COPPER TUBE and FITTINGS

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<tr>
<td>33.2</td>
<td>48804</td>
<td>2-1/8&quot; - 4-1/8&quot;</td>
</tr>
</tbody>
</table>

* BTUH = SCFH X 1470  
(Acetylene gas has a heat content of 1470 btuh / cubic foot)

** Size ranges are given as an average, actual sizes to be brazed shall be determined by the individual brazer's abilities.

NOTE The BTUH output of each type of torch shall be determined from the manufacturer's literature for the torch used.

EXAMPLE A Victor® #2 multi-flame tip has an acetylene consumption of 3 to 9 SCFH. Multiplied by 1470 BTUH/cu ft would equal 4410 to 13,230 BTUH. This tip will braze a 1/8" through 1-1/8" copper to copper joint.
COPPER DEVELOPMENT ASSOCIATION INC.
PROCEDURE QUALIFICATION RECORD (PQR)
in Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPQR No. CDA-002-V Date 2/9/1994 BPS No. CDA-002

Company COPPER DEVELOPMENT ASSOCIATION INC.
Brazer's Name and Id. A.G."Andy" Kireta (1-A)
Brazing Process Oxy-Fuel Torch Manual X Mechanized Automatic
Brazing Equipment Oxy-Fuel Gas Torch

### BRAZING CONDITIONS

**BASE METAL:**
- Identification: Copper Number C12200 Tube & Fitting
- BM No.: 300
- Thickness: 0.054" - 0.066"
- Preparation: See Note #1 attached

**FILLER METAL:**
- FM No.: 150
- AWS Classification: AWS A5.8 BCuP
- Form: Rod or Wire
- Method of Application: Manual Face Feed

**FLUX:**
- AWS Type: Flux not required
- Other

**ATMOSPHERE:**
- AWS Type: N/A
- Other

**BRAZING PROCESS:**
- Temperature: 1275° F - 1550° F
- Test position: Vertical Up
- Time: As required
- Current: N/A
- Fuel gas: Acetylene
- Tip size: See Table #1 attached
- Postbraise cleaning: See Note #2 attached
- Postbraise heat treatment: N/A
- Other: See Note #3 attached

**JOINT:**
- Type: Lap (socket) Joint - Tube/fitting
- Clearance: 0.002" - 0.010"
- Other

![JOINT SKETCH](image-url)
## TEST RESULTS

**BPQR No.**: CDA-002-V

**Date**: 2/22/1994

### VISUAL

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Vert.</td>
<td>According to NFPA 99-93, Section 4-4.1.4.3 (i)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(2) Vert.</td>
<td>According to NFPA 99-93, Section 4-4.1.4.3 (i)</td>
<td>X</td>
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### TENSION

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>UTS psi</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
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<tr>
<td>(1) Vert.</td>
<td>32463</td>
<td>Failed in base metal</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(2) Vert.</td>
<td>34.98</td>
<td>Failed in base metal</td>
<td>X</td>
<td></td>
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</table>

### BEND

<table>
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<tr>
<th>Specimen No.</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
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</table>

### MACROETCH

<table>
<thead>
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<th>Specimen No.</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Vert.</td>
<td>0%, 0% unbrazed</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(2) Vert.</td>
<td>0%, 0% unbrazed</td>
<td>X</td>
<td></td>
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### PEEL

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Remarks</th>
<th>Pass</th>
<th>Fail</th>
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We certify that the information in this record is correct and that the test brazements were prepared, brazed and tested in accordance with the requirements of the American Welding Society Standard for Brazing Procedure Qualification, ANSI/AWS B-2.2-91.

Approved by [Signature]

Qualifier
CUTTING

Cut tube ends square with a tube cutter. The cutter wheel shall be sharp and the cutter rollers free rolling to prevent tube ends from being deformed. Tube cutter shall be free of all oil, dirt, lint and other debris.

REAMING

Ream all cut tube ends to the full I.D. of the tube to remove the small burr created by the cutting operation. Special care shall be exercised to insure that no shavings are left in the tube.

CLEANING

Removal of surface oxidation on the I.D. of the fitting socket shall not be necessary if the fittings have been cleaned according to Compressed Gas Association Pamphlet G-4.1 and kept clean until ready for use.

Surface particles and dirt shall be removed from the O.D. of the tube ends, for a distance slightly more than the fitting cup, using a clean lint free cloth.

Surface oxidation on the O.D. of the tube shall be removed with the use of a nylon abrasive cloth for a distance slightly more than the depth of the fitting socket. Care must be exercised to insure that dust or particles are not allowed to be deposited on the I.D. of the tube.

When the tube ends are cleaned and the surface oxidation is removed the brazer shall perform a visual inspection of the tube I.D.

ASSEMBLY AND SUPPORT

Insert tube ends into fitting cup, making sure that the tube is seated against the base of the fitting cup.

Support the tube and fitting assembly to insure a uniform capillary space around the entire circumference of the joint.

NOTE #2 BRAZING PROCESS (Postbraise Cleaning)

POSTBRAZE CLEANING

When the joint is cool to the touch, the outside shall be cleaned using a wet cloth to remove loose surface oxidation and permit a clear visual inspection of the joint.

NOTE #3 BRAZING PROCESS (Other)

PURGE GAS

Purge gas shall conform to the following composition and purity: Nitrogen 99.99% pure. The purge gas shall have a flow range of 5 to 20 SCFH and flow continuously during the brazing process. Purge gas shall be permitted to flow after the completion of the brazing process, for a sufficient time period, to insure that no oxidation is permitted to form on the I.D. of the tube and fitting.
VISUAL EXAMINATION

Following sectioning of the brazements, the joints shall be visually examined. The following conditions shall be considered unacceptable according to NFPA 99-93, Section 4-4.1.4.3 (j):

1. Flux or flux residue (not applicable to this BPS & PQR)
2. Excessive oxidation of the joint
3. Presence of unmelted filler metal
4. Failure of the filler metal to be clearly visible all the way around the exterior of the joint at the interface between the socket and the tube
5. Cracks in the tube or component
6. Cracks in the braze filler metal
7. Failure of the joint to hold the required test pressure (not applicable to this BPS & PQR)

TABLE 1
SUGGESTED TORCH TIP SELECTION GUIDE for BRAZING COPPER TUBE and FITTINGS

<table>
<thead>
<tr>
<th>*SCFH ACETYLENE</th>
<th>*BTUH</th>
<th>**TUBE SIZE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>2940</td>
<td>1/8&quot; - 3/8&quot;</td>
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<tr>
<td>3.6</td>
<td>5292</td>
<td>1/8&quot; - 1/2&quot;</td>
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<tr>
<td>5.7</td>
<td>8379</td>
<td>3/8&quot; - 7/8&quot;</td>
</tr>
<tr>
<td>8.3</td>
<td>12201</td>
<td>5/8&quot; - 1-1/8&quot;</td>
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<tr>
<td>11</td>
<td>16170</td>
<td>7/8&quot; - 1-5/8&quot;</td>
</tr>
<tr>
<td>14.5</td>
<td>21315</td>
<td>1 1/8&quot; - 2-1/8&quot;</td>
</tr>
<tr>
<td>33.2</td>
<td>48804</td>
<td>2-1/8&quot; - 4-1/8&quot;</td>
</tr>
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</table>

* BTUH = SCFH X 1470
(Acetylene gas has a heat content of 1470 btuh/ cubic foot)

** Size ranges are given as an average. Actual sizes to be brazed shall be determined by the individual brazor's abilities.

NOTE The BTUH output of each type of torch shall be determined from the manufacturer's literature for the torch used.

EXAMPLE A Victor® #2 multi-flame tip has an acetylene consumption of 3 to 9 SCFH. Multiplied by 1470 BTUH/cu ft would equal 4410 to 13,230 BTUH. This tip will braze a 1/8" through 1-1/8" copper to copper joint.
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PERFORMANCE QUALIFICATION RECORD (BPQR)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPQR No. CDA-002-V

Name A.G. "Andy" Kireta

Id. 1-A

Date February 22, 1994

BPS No. CDA-002

Brazing Process Oxy-Fuel Torch

Brazer Operator

TEST BRAZEMENT

Base Metal Id. C12200 Copper

BM No. 300

BM T 30,000 psi

Filler Metal Id. AWS A5.8 BCuP

FM No. 150

FM Feed Manual

Test Position Vertical-up

Joint Type Lap (Socket) - Tube/fitting

TEST RESULTS

VISUAL

Specimen No. Remarks Pass Fail

| (1) Vert. | According to NFPA 99-93, Section 4-4.1.4.3 (i) | X |
| (2) Vert. | According to NFPA 99-93, Section 4-4.1.4.3 (i) | X |

TENSION

Specimen No. UTS psi Remarks Pass Fail

| (1) Vert. | 32463 | Failed in base metal (tube) | X |
| (2) Vert. | 34198 | Failed in base metal (tube) | X |

MACROETCH

Specimen No. Remarks Pass Fail

| (1) Vert. | 0%, 0% unbrazed | X |
| (2) Vert. | 0%, 0% unbrazed | X |

QUALIFIED FOR

Brazing Process Oxy-Fuel Torch Position Horizontal/Vertical Up & Down

| BM No. | 300 | BM T 30,000 psi |
| FM No. | 150 | FM Feed Manual |

Joint Type Lap (Socket) - Tube/fitting

The above named individual is qualified in accordance with the American Welding Society Standard for Brazing Procedure and Performance Qualification, ANSI/AWS B2.2-91.

Date 2/22/1994

Signed Scott Smith

Qualifier
APPENDIX A

SAMPLE CDA/ASME BRAZING FORMS

Brazing Procedure Specification

Procedure Qualification Record

Brazer Performance Qualification
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PROCEDURE SPECIFICATION (BPS)
See QB-200.1, Section IX, ASME Boiler & Pressure Vessel Code & NFPA 99-1993

<table>
<thead>
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<th>Company Name</th>
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<tbody>
<tr>
<td>BPS No. _________________________ Date ___________ Supporting PQR _________________________</td>
</tr>
<tr>
<td>Revision No. _____________________ Date ___________ Supporting PQR _________________________</td>
</tr>
</tbody>
</table>

**BASE METALS**

| P-No. __________________________ to P-No. __________________________ |
| Spec. type and grade ____________________________ |
| Chemical analysis ____________________________ |
| Thickness range ______________ Tube/pipe diameter range ______________ |

**FILLER METALS**

| Specification No. __________________ AWS Classification __________________ |
| F-No. __________________________ Size or shape __________________ |

**BRAZING TEMPERATURE**

Temperature range (not applicable for torch brazing) ____________________________

**BRAZING PROCESS**

| H-No. __________________________ Process __________________ |
| Type __________________________ |

**BRAZING FLUX**

AWS designation ____________________________

**PURGE**

Requirements ____________________________

**FLOW POSITION**

Flow position ____________________________

| Method of applying filler metal ____________________________ |

**JOINT DESIGN & TOLERANCES**

| Joint type __________________________ Clearance Range __________________________ |
| Lap length range __________________________ |
| Minimum overlap __________________________ |
| Sketch __________________________ |

**TECHNIQUE**

| Joint Preparation __________________________ |

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COPPER DEVELOPMENT ASSOCIATION INC.
PROCEDURE QUALIFICATION RECORD (PQR)
Record of Actual Conditions Used to Braze Test Coupon

Company Name  

PQR No.  Date  Supporting BPS  

BASE METALS
P-No.  to P-No.  
Spec. type and grade  
Chemical analysis  
Thickness range  Tube/ Pipe diameter  

FILLER METALS
Specification No.  AWS Classification  
F-No.  Size or shape  

BRAZING TEMPERATURE
Temperature range (not applicable for torch brazing)  

BRAZING PROCESS
H-No.  Process  
Type  

BRAZING FLUX
AWS designation  Trade name  

PURGE
Requirements  

FLOW POSITION
Flow position  
Method of applying filler metal  

JOINT DESIGN & TOLERANCES
Joint type  Clearance Range  
Lap length range  
Minimum overlap  
Sketch (Figure #1 Sheet 2)  

TECHNIQUE
Joint Preparation  

36
TENSILE TESTS (QB-150)

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Dimensions</th>
<th>Ultimate Total Load (lbs.)</th>
<th>Ultimate stress (psi)</th>
<th>Failure Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width (in.)</td>
<td>Thickness (in.)</td>
<td>O.D. (in.)</td>
<td>Area (sq.in.)</td>
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PEEL OR SECTION TESTS (QB-170 & QB-180)

<table>
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<tr>
<th>Specimen</th>
<th>Results</th>
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<tbody>
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<td></td>
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Brazer's Name: ___________________  Brazer Identification: ___________________
Brazing Witnessed by: ___________________
Tests Conducted by: ___________________  Laboratory Test Number: ___________________

We certify that the statements in this record are correct and that the test brazements were prepared, brazed and tested in accordance with the requirements of Section IX of the ASME Code.

Contractor: ___________________  By ___________________  Date: ___________________
COPPER DEVELOPMENT ASSOCIATION INC.
CONTRACTOR'S RECORD OF BRAZER PERFORMANCE
QUALIFICATION (BPQ)
BPQ#

Brazer's Name ______________________ Brazer Identification ______________________
Using BPS No. ______________________ Revision ______________________

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<th>Variables</th>
<th>Record Actual Values Used in Qualification</th>
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<td>Material Spec. (QB-402)</td>
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<tr>
<td>Thickness</td>
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<tr>
<td>Filler Metal (QB-403)</td>
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<tr>
<td>F-Number</td>
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<tr>
<td>Brazing Temp. Range (QB-404)</td>
<td>(Not applicable to torch brazing)</td>
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<tr>
<td>Brazing Process (QB-405)</td>
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<tr>
<td>H-Number</td>
<td></td>
<td></td>
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<tr>
<td>Flow Position(s) (QB-407)</td>
<td>Method of applying filler metal</td>
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</tr>
<tr>
<td>Joint Types(s) (QB-408)</td>
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<tr>
<td>Joint Clearance</td>
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<tr>
<td>Length Overlap</td>
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<td>Other</td>
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<td>Technique</td>
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<td>Torch Brazing</td>
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TEST RESULTS - Section (QB-180) - Tensile (QB-150)

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<th>Section</th>
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</tbody>
</table>

Tests Conducted by ______________________ Laboratory Test No. ______________________

We certify that the statements made in this record are correct and that the test brazements were prepared, brazed and tested in accordance with the requirements of Section IX of the ASME Code.

Contractor ______________________
Date ______________________ By ______________________

Note: Any essential variables in addition to those above shall be recorded.
APPENDIX B

SAMPLE CDA/AWS BRAZING FORMS

Brazing Procedure Specification

Procedure Qualification Record

Brazer Performance Qualification Record
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PROCEDURE SPECIFICATION (BPS)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPS No. __________________ Date ______________ BPQR No. ____________

Company ________________________________________________________________

Brazing Process Manual _____ Mechanized _____ Automatic _____

Brazing Equipment _______________________________________________________

BRAZING CONDITIONS

BASE METAL:
Identification __________________________ BM No. _______________________
Thickness ____________________________ Preparation ______________________
Other ________________________________

FILLER METAL:
FM No. ______________________________ AWS Classification ___________________
Form __________________________ Method of Application __________________

FLUX:
AWS Type ___________________________ Other ____________________________

ATMOSPHERE:
AWS Type ___________________________ Other ____________________________

BRAZING PROCESS:
Temperature __________________________ Test position ______________________
Time ________________________________ Current __________________________
Fuel gas ____________________________ Tip size ____________________________
Postbraze cleaning __________________
Postbraze heat treatment
Other ______________________________

JOINT:
Type ________________________________
Clearance __________________________
UTS ______________________________
Other ______________________________

JOINT SKETCH

Approved for production ________________________________

Employer ____________________________________________
COPPER DEVELOPMENT ASSOCIATION INC.
PROCEDURE QUALIFICATION RECORD (PQR)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

BPQR No. _______________ Date _______________ BPS No. ____________
Company
Brazer’s Name and Id.
Brazing Process ___________ Manual _____ Mechanized _____ Automatic _____
Brazing Equipment

BRAZING CONDITIONS

BASE METAL:
Identification ________________________________ BM No. _______________
Thickness ________________________________ Preparation __________________________
Other

FILLER METAL:
FM No. ________________________________ AWS Classification __________________________
Form ________________________________ Method of Application __________________________

FLUX:
AWS Type ________________________________ Other __________________________

ATMOSPHERE:
AWS Type ________________________________ Other __________________________

BRAZING PROCESS:
Temperature ________________________________ Test position __________________________
Time ________________________________ Current __________________________
Fuel gas ________________________________ Tip size __________________________
Postbraze cleaning ________________________________
Postbraze heat treatment ________________________________
Other

JOINT:
Type ________________________________
Clearance ________________________________
Other

JOINT SKETCH
TEST RESULTS

BPQR No. ___________________________ Date ___________________________

VISUAL

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

TENSION

Specimen No. ___________________________ UTS psi ___________________________ Remarks ___________________________ Pass ________ Fail ________

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

BEND

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

MACROETCH

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

PEEL

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

Specimen No. ___________________________ Remarks ___________________________ Pass ________ Fail ________

We certify that the information in this record is correct and that the test brazements were prepared, brazed and tested in accordance with the requirements of the American Welding Society Standard for Brazing Procedure Qualification, ANSI/AWS B-2.2-91.

Approved by ___________________________ Qualifier ___________________________
COPPER DEVELOPMENT ASSOCIATION INC.
BRAZING PERFORMANCE QUALIFICATION RECORD (BPQR)
In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

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<th>Brazer</th>
<th>Operator</th>
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**TEST BRAZEMENT**

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<th>BM No.</th>
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<th>Joint Type</th>
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**TEST RESULTS**

**VISUAL**

<table>
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<th>Specimen No.</th>
<th>Remarks</th>
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**TENSION**

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**MACROETCH**

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<tr>
<th>Specimen No.</th>
<th>Remarks</th>
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**QUALIFIED FOR**

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<th>Position</th>
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<tr>
<th>Joint Type</th>
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The above named individual is qualified in accordance with the American Welding Society Standard for Brazing Procedure and Performance Qualification, ANSI/AWS B2.2-91.

Date

Signed

Qualifier