# BRAZING PROCEDURE SPECIFICATIONS

# PROCEDURE QUALIFICATION RECORDS

and

# BRAZING PERFORMANCE QUALIFICATION RECORDS

As required by

NFPA 99, *Standard for Health Care Facilities*, 1993 Edition

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

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A4014-00/94

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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 a 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.,[1] 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.

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[1]PRL Industries, Inc., 64 Rexmont Road P O. Box 142, Cornwall, PA 17016

# ASME
# BRAZING DOCUMENTS

Brazing Procedure Specification
BPS No. CDA-003

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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

Company Name: COPPER DEVELOPMENT ASSOCIATION INC.

BPS No.: CDA-003 Date: 2/9/1994 Supporting PQR: CDA-003-HV

Revision No.: Date: Supporting PQR:

## 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.

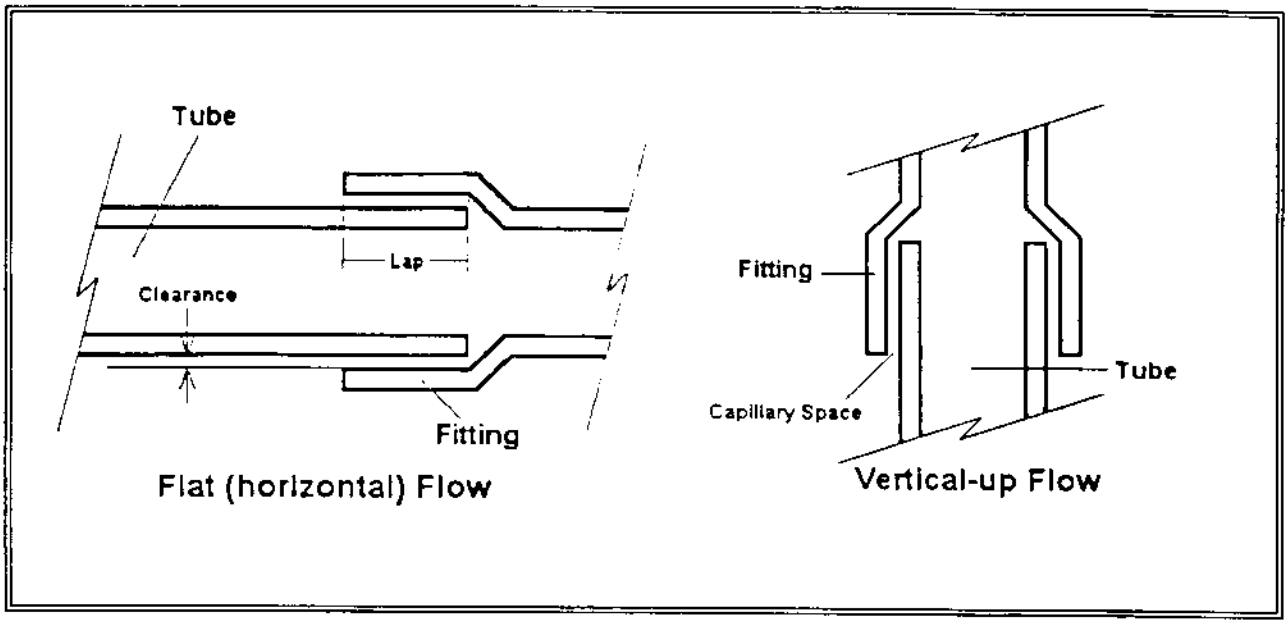
## FLOW POSITION (QB-407)

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.*

FIGURE #1 JOINT SKETCH




## 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

| *SCFH ACETYLENE | *BTUH | **TUBE SIZE RANGE |
|---|---|---|
| 2.0 | 2940 | 1/8" - 3/8" |
| 3.6 | 5292 | 1/8" - 1/2" |
| 5.7 | 8379 | 3/8" - 7/8" |
| 8.3 | 12201 | 5/8" - 1-1/8" |
| 11 | 16170 | 7/8" - 1-5/8" |
| 14.5 | 21315 | 1-1/8" - 2-1/8" |
| 33.2 | 48804 | 2 1/8" - 4-1/8" |

* 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)

See QB-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

P-No.: 107  to P-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)

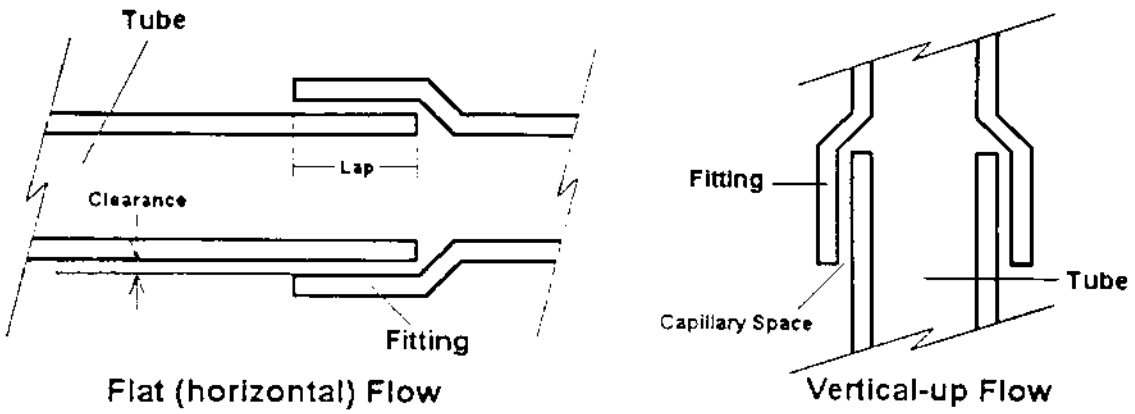
Minimum overlap: 0.216" (4 times the thickness of the thinner member)

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) [X] Reduced Section [ ] Full Section

| Specimen No. | Dimensions | | | | Ultimate Total Load (lbs.) | Ultimate Stress (psi) | Failure Location |
|---|---|---|---|---|---|---|---|
| | Width (in.) | Thickness (in.) | O.D (in.) | Area (sq. in.) | | | |
| (1) 003-Horz. | 1.15 | .060 | 1.625 | 069 | 2130 | 30870 | Tube |
| (2) 003-Horz. | 1.12 | .060 | 1.625 | .0672 | 2250 | 33482 | Tube |
| (1) 003-Vert. | 1.14 | .060 | 1.625 | 0684 | 2190 | 32018 | Tube |
| (2) 003-Vert. | 1.01 | .060 | 1.625 | 0606 | 2100 | 34653 | Tube |

PEEL OR SECTION TESTS (QB-170 & QB-180) [ ] Peel [X] Section

| Specimen | Results |
|---|---|
| (1) 003-Horizontal | Acceptable (0%, 0% unbrazed) |
| (2) 003-Horizontal | Acceptable (0%, 0% unbrazed) |
| (1) 003-Vertical | Acceptable (0%, 0% unbrazed) |
| (2) 003-Vertical | Acceptable (0%, 0% unbrazed) |

Brazer's Name: A.G."Andy" Kireta Brazer Identification: 1-A

Brazing Witnessed by: Dale L. 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

# COPPER DEVELOPMENT ASSOCIATION INC.
# PROCEDURE QUALIFICATION RECORD (PQR)

See QB-200.2, Section IX, ASME Boiler & Pressure Vessel Code & NFPA 99-1993

**BPS No. CDA-003**

## 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**

| *SCFH ACETYLENE | *BTUH | **TUBE SIZE RANGE |
|---|---|---|
| 2.0 | 2940 | 1/8" - 3/8" |
| 3.6 | 5292 | 1/8" - 1/2" |
| 5.7 | 8379 | 3/8" - 7/8" |
| 8.3 | 12201 | 5/8" - 1-1/8" |
| 11 | 16170 | 7/8" - 1-5/8" |
| 14.5 | 21315 | 1 1/8" - 2-1/8" |
| 33.2 | 48804 | 2-1/8" - 4-1/8" |

* 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

| | | | |
|---|---|---|---|
| Brazer's Name | A.G. "Andy" Kireta | Brazer Identification | 1-A |
| Using BPS No. | CDA-003 | Revision | |

| Variables | Record Actual Values Used in Qualification | Qualification Range |
|---|---|---|
| Material Spec. (QB-402) | 1-1/2" OXY/ACR Copper Tube | 0.375" - 5.125" O.D. |
| Thickness | 0.054" - 0.066" | 0.027" -0.132" |
| Filler Metal (QB-403) | | |
| Specification No. | SFA 5.8 | SFA 5.8 |
| Class | N/A | N/A |
| F-Number | 103 | 103 |
| Brazing Temp. Range (QB-404) (Not applicable to torch brazing) | N/A | N/A |
| Brazing Process (QB-405) H-Number | 101 | 101 |
| Flow Position(s) (QB-407) Method of applying filler metal | Flat (Horizontal) & Vertical Up | All Positions |
| Joint Types(s) (QB-408) | | |
| Joint Clearance | 0.002" - 0.010" | 0.002" - 0.010" |
| Length Overlap | 1.09" (per ANSI B-16.22) | 2.18" |
| Other | N/A | N/A |
| Technique | | |
| Torch Brazing | Manual Torch | Manual Torch |

**TEST RESULTS - Section (QB-180) - Tensile (QB-150)**

| Flow Position | Section | Tensile |
|---|---|---|
| (1) Flat (horizontal) | Satisfactory | Satisfactory |
| (2) Flat (horizontal) | Satisfactory | Satisfactory |
| (1) Vertical-up | Satisfactory | Satisfactory |
| (2) Vertical-up | Satisfactory | Satisfactory |

Tests Conducted by Scott Smith Laboratory Test No. 2148

*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 COPPER DEVELOPMENT ASSOCIATION INC.

Date February 22, 1994 By

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

# AWS
# BRAZING DOCUMENTS
## (Horizontal Joint)

Brazing Procedure Specification
BPS No. CDA-001

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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

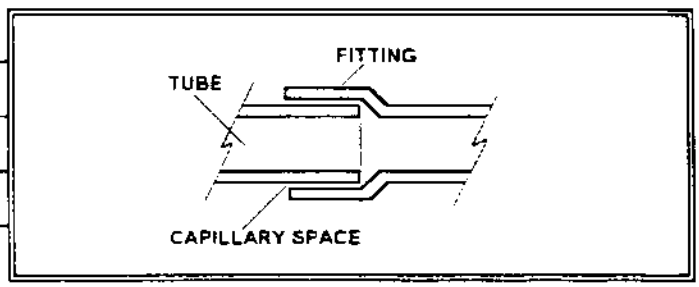
**JOINT:**

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

BRAZING PROCEDURE SPECIFICATION CDA-001 FOR THE BRAZING OF COPPER TUBE AND WROUGHT COPPER FITTINGS UTILIZING A MANUAL TORCH BRAZING PROCESS IN ACCORDANCE WITH ANSI/AWS B2.2-91 and NFPA 99-1993.

## 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 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

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 (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

| *SCFH ACETYLENE | *BTUH | **TUBE SIZE RANGE |
|---|---|---|
| 2.0 | 2940 | 1/8" - 3/8" |
| 3.6 | 5292 | 1/8" - 1/2" |
| 5.7 | 8379 | 3/8" - 7/8" |
| 8.3 | 12201 | 5/8" - 1-1/8" |
| 11 | 16170 | 7/8" - 1-5/8" |
| 14.5 | 21315 | 1 1/8" - 2-1/8" |
| 33.2 | 48804 | 2-1/8" - 4-1/8" |

* 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-OO1

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

Postbraze cleaning See Note #2 attached

Postbraze heat treatment N/A

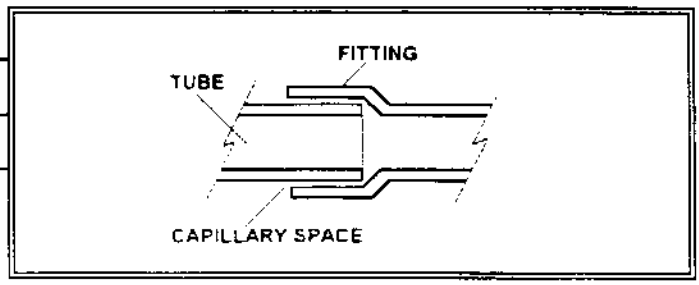
Other See Note #3 attached

**JOINT:**

Type Lap (socket) Joint - Tube/fitting

Clearance 0.002" - 0.010"

Other




JOINT SKETCH

## TEST RESULTS

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

### 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 | |

### BEND

| Specimen No. | Remarks | Pass | Fail |
|---|---|---|---|
| | | | |
| | | | |

### MACROETCH

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

### PEEL

| 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 Scott Smith

Qualifier

# COPPER DEVELOPMENT ASSOCIATION INC.
# PROCEDURE QUALIFICATION RECORD (PQR)

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

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 (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 (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

| *SCFH ACETYLENE | *BTUH | **TUBE SIZE RANGE |
|---|---|---|
| 2.0 | 2940 | 1/8" - 3/8" |
| 3.6 | 5292 | 1/8" - 1/2" |
| 5.7 | 8379 | 3/8" - 7/8" |
| 8.3 | 12201 | 5/8" - 1-1/8" |
| 11 | 16170 | 7/8" - 1-5/8" |
| 14.5 | 21315 | 1 1/8" - 2-1/8" |
| 33.2 | 48804 | 2-1/8" - 4-1/8" |

* 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

BPQR 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 2/8/94 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

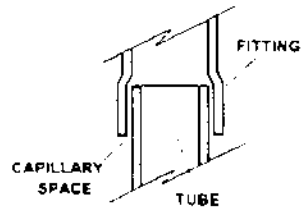
**JOINT:**

Type Lap (Socket) Joint - Tube/fitting

Clearance 0.002" - 0.010"

UTS 30,000 psi

Other




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-002**

## TITLE

BRAZING PROCEDURE SPECIFICATION CDA-002 FOR THE BRAZING OF COPPER TUBE AND WROUGHT COPPER FITTINGS UTILIZING A MANUAL TORCH BRAZING PROCESS IN ACCORDANCE WITH ANSI/AWS B2.2-91 and NFPA 99-1993.

## 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*.

# COPPER DEVELOPMENT ASSOCIATION INC.
# BRAZING PROCEDURE SPECIFICATION (BPS)

In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

**BPS No. CDA-002**

## 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

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 (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

| *SCFH ACETYLENE | *BTUH | **TUBE SIZE RANGE |
|---|---|---|
| 2.0 | 2940 | 1/8" - 3/8" |
| 3.6 | 5292 | 1/8" - 1/2" |
| 5.7 | 8379 | 3/8" - 7/8" |
| 8.3 | 12201 | 5/8" - 1-1/8" |
| 11 | 16170 | 7/8" - 1-5/8" |
| 14.5 | 21315 | 1 1/8" - 2-1/8" |
| 33.2 | 48804 | 2-1/8" - 4-1/8" |

* 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-OO2

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 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

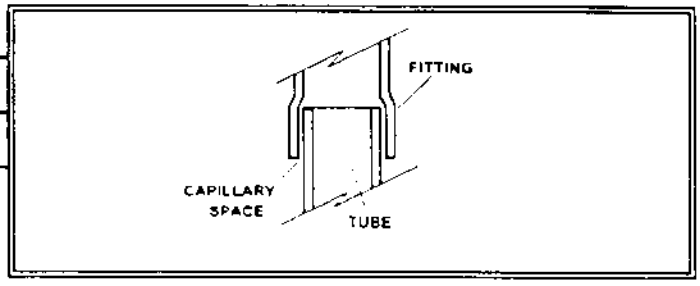
Other See Note #3 attached

**JOINT:**

Type Lap (socket) Joint - Tube/fitting

Clearance 0.002" - 0.010"

Other




JOINT SKETCH

## TEST RESULTS

BPQR No. CDA-002-V Date 2/22/1994

### VISUAL

| Specimen No. | Remarks | Pass | Fail |
|---|---|---|---|
| (1) Vert. | According to NFPA 99-93, Section 4-4.1.4.3 (j) | X | |
| (2) Vert. | According to NFPA 99-93, Section 4-4.1.4.3 (j) | X | |

### TENSION

| Specimen No. | UTS psi | Remarks | Pass | Fail |
|---|---|---|---|---|
| (1) Vert. | 32463 | Failed in base metal | X | |
| (2) Vert. | 34[illegible]98 | Failed in base metal | X | |

### BEND

| Specimen No. | Remarks | Pass | Fail |
|---|---|---|---|
| | | | |
| | | | |

### MACROETCH

| Specimen No. | Remarks | Pass | Fail |
|---|---|---|---|
| (1) Vert. | 0%, 0% unbrazed | X | |
| (2) Vert. | 0%, 0% unbrazed | X | |

### PEEL

| 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 Scott Smith
Qualifier

# COPPER DEVELOPMENT ASSOCIATION INC.
# PROCEDURE QUALIFICATION RECORD (PQR)

In Accordance with ANSI/AWS B2.2-91 & NFPA 99-1993

**BPS No. CDA-002**

## 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

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 (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 (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

| *SCFH ACETYLENE | *BTUH | **TUBE SIZE RANGE |
|---|---|---|
| 2.0 | 2940 | 1/8" - 3/8" |
| 3.6 | 5292 | 1/8" - 1/2" |
| 5.7 | 8379 | 3/8" - 7/8" |
| 8.3 | 12201 | 5/8" - 1-1/8" |
| 11 | 16170 | 7/8" - 1-5/8" |
| 14.5 | 21315 | 1 1/8" - 2-1/8" |
| 33.2 | 48804 | 2-1/8" - 4-1/8" |

* 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

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

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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

Company Name _____

BPS No. _____ Date _____ Supporting PQR _____

Revision No. _____ Date _____ Supporting PQR _____

**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 _____

# COPPER DEVELOPMENT ASSOCIATION INC.
# PROCEDURE QUALIFICATION RECORD (PQR)

See QB-200.2, Section IX, ASME Boiler & Pressure Vessel Code & NFPA 99-1993
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 _____

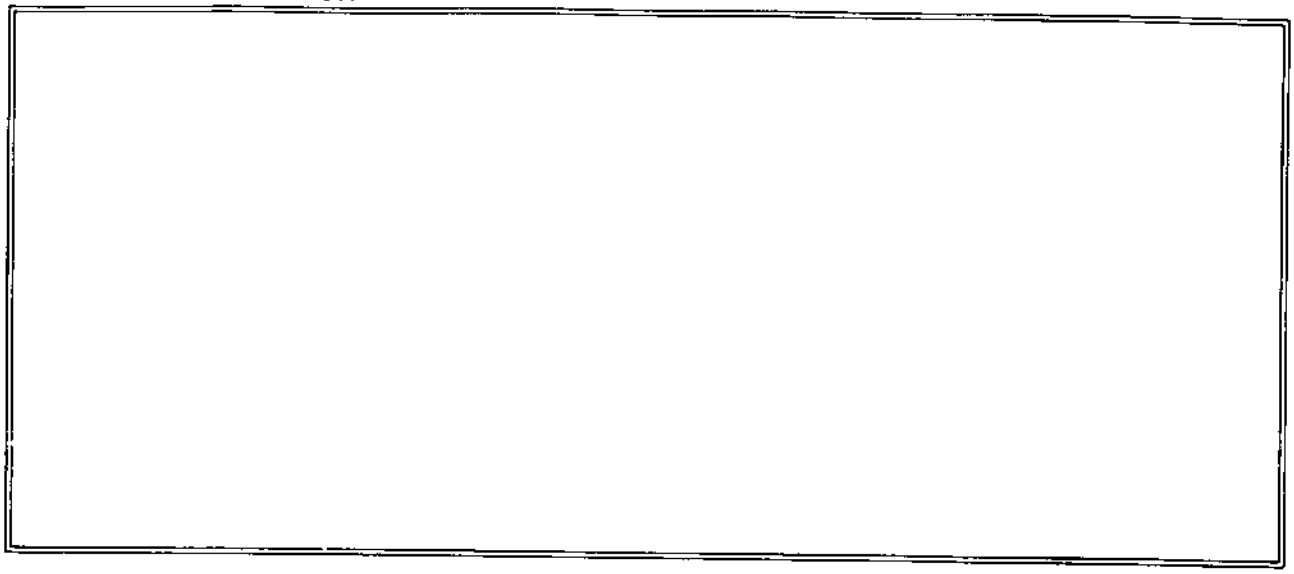
Minimum overlap _____

Sketch (Figure #1 Sheet 2) _____

**TECHNIQUE**

Joint Preparation _____

FIGURE #1 JOINT SKETCH



**TENSILE TESTS (QB-150)** ☐ Reduced Section ☐ Full Section

| Specimen No. | Dimensions | | | | Ultimate Total Load (lbs.) | Ultimate stress (psi) | Failure Location |
|---|---|---|---|---|---|---|---|
| | Width (in.) | Thickness (in.) | O.D. (in.) | Area (sq. in.) | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**PEEL OR SECTION TESTS (QB-170 & QB-180)** ☐ Peel ☐ Section

| Specimen | Results |
|---|---|
| | |
| | |
| | |
| | |

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 _____

| Variables | Record Actual Values Used in Qualification | Qualification Range |
|---|---|---|
| Material Spec. (QB-402) | | |
| Thickness | | |
| Filler Metal (QB-403) | | |
| Specification No. | | |
| Class | | |
| F-Number | | |
| Brazing Temp. Range (QB-404) (Not applicable to torch brazing) | | |
| Brazing Process (QB-405) H-Number | | |
| Flow Position(s) (QB-407) Method of applying filler metal | | |
| Joint Types(s) (QB-408) | | |
| Joint Clearance | | |
| Length Overlap | | |
| Other | | |
| Technique | | |
| Torch Brazing | | |

TEST RESULTS - Section (QB-180) - Tensile (QB-150)

| Flow Position | Section | Tensile |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

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 _____

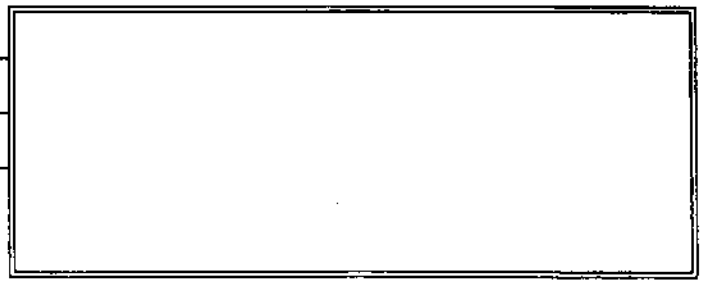
Other _____

**JOINT:**

Type _____

Clearance _____

Other _____



**JOINT SKETCH**

## TEST RESULTS

BPQR No. _____ Date _____

**VISUAL**

| Specimen No. | Remarks | Pass | Fail |
|---|---|---|---|
| | | | |
| | | | |

**TENSION**

| Specimen No. | UTS psi | Remarks | Pass | Fail |
|---|---|---|---|---|
| | | | | |
| | | | | |

**BEND**

| Specimen No. | Remarks | Pass | Fail |
|---|---|---|---|
| | | | |
| | | | |

**MACROETCH**

| Specimen No. | Remarks | Pass | Fail |
|---|---|---|---|
| | | | |
| | | | |

**PEEL**

| 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

BPQR No. _____

Name _____ Id. _____

Date _____ BPS No. _____

Brazing Process _____ Brazer ___ Operator ___

## TEST BRAZEMENT

Base Metal Id. _____ BM No. _____ BM T _____

Filler Metal Id. _____ FM No. _____ FM Feed _____

Test Position _____ Joint Type _____

## TEST RESULTS

### VISUAL

| Specimen No. | Remarks | Pass | Fail |
|---|---|---|---|
| | | | |
| | | | |

### TENSION

| Specimen No. | UTS psi | Remarks | Pass | Fail |
|---|---|---|---|---|
| | | | | |
| | | | | |

### MACROETCH

| Specimen No. | Remarks | Pass | Fail |
|---|---|---|---|
| | | | |
| | | | |

## QUALIFIED FOR

Brazing Process _____ Position _____

BM No. _____ BM T _____

FM No. _____ FM Feed _____

Joint Type _____

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