Designation: ~~B828 – 02 (Reapproved 2010)~~ B828 – 16

Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings[1]

This standard is issued under the fixed designation B828; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice describes a procedure for making capillary joints by soldering of copper and copper alloy tube and fittings.

1.2 This procedure is applicable to pressurized systems such as plumbing, heating, air conditioning, refrigeration, mechanical, fire sprinkler, and other similar systems. ASME B31.5 and B31.9 reference the techniques used for satisfactory joint preparation. It is also used in the assembly of nonpressurized systems such as drainage, waste, and vent.

1.3 It is not applicable to the assembly of electrical or electronic systems.

1.4 Tube and fittings are manufactured within certain tolerances to provide for the small variations in dimensions associated with manufacturing practice. Applicable specifications are listed in Appendix X1.

1.5 A variety of solders are available that will produce sound, leak-tight joints. Choice of solder will depend upon the type of application and on local codes. For potable water systems, only lead-free solders shall be used, some of which are described in Specification B32.

1.6 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For hazard statements, see the warning statements in 6.4.1, 6.6.1, and 6.6.3.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B32 Specification for Solder Metal
~~B68~~B68/B68M Specification for Seamless Copper Tube, Bright Annealed
~~B68M Specification for Seamless Copper Tube, Bright Annealed (Metric) (Withdrawn 2011)~~[3]
~~B75~~B75/B75M Specification for Seamless Copper Tube
~~B75M Specification for Seamless Copper Tube (Metric)~~
B88 Specification for Seamless Copper Water Tube
B88M Specification for Seamless Copper Water Tube (Metric)
B280 Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
B306 Specification for Copper Drainage Tube (DWV)
B447 Specification for Welded Copper Tube
B640 Specification for Welded Copper Tube for Air Conditioning and Refrigeration Service
B641 Specification for Seamless and Welded Copper Distribution Tube (Type D) (Withdrawn 1996)[3]
B716 Specification for Welded Copper Water Tube (Withdrawn 1994)[3]
B716M Specification for Welded Copper Water Tube (Metric) (Withdrawn 1994)[3]
B813 Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
B846 Terminology for Copper and Copper Alloys

[1] This practice is under the jurisdiction of ASTM Committee B05 on Copper and Copper Alloys and is the direct responsibility of Subcommittee B05.04 on Pipe and Tube.
Current edition approved ~~Oct. 1, 2010~~June 1, 2016. Published ~~December 2010~~June 2016. Originally approved ~~as~~in ~~B828 – 92.~~1992. Last previous edition approved in 2010 as ~~B828 – 02.~~B828 – 02 (2010). DOI: ~~10.1520/B0828-02R10.~~10.1520/B0828-16.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

***A Summary of Changes section appears at the end of this standard**

2.2 ~~Other~~*ASME Documents:*[4]
ASME B31.5 Refrigeration Piping
ASME B31.9 Building Services Piping
ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings—DWV
ASME B16.29 Wrought Copper and Copper Alloy Solder Joint Drainage Fittings—DWV
~~ANSI/ASC Z49.1 Safety in Welding and Cutting~~[5]
2.3 *ANSI Document:*[5]
ANSI Z49.1 Safety in Welding and Cutting

3. Terminology

3.1 For definitions of terms related to copper and copper alloys, refer to Terminology B846 ~~for terms specific to this practice.~~.

3.2 ~~*Definitions:*~~*Definitions of Terms Specific to This Standard:*

3.2.1 *soldering*—a group of joining processes that produce coalescence of materials by heating them to the soldering temperature and by using a filler metal (solder) having a liquidus not exceeding 840°F (450°C) and below the solidus of the base metals.[6]

[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, ~~Three~~Two Park Ave., New York, NY 10016-5990, http://www.asme.org.
[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[6] *American Welding Society Welding Handbook, Welding Processes*, 8th ed., Vol 2, American Welding Society, ~~550 N.W. LeJeune Rd.,~~ 8669 NW 36 Street, #130, Miami, FL ~~33126.~~33166-6672.

3.2.1.1 *Discussion*—

In actual practice, most soldering is done at temperatures from about 350 to 660°F (177 to 349°C).

4. Summary of Practice

4.1 To consistently make satisfactory joints, the following sequence of joint preparation and operations shall be followed:
~~*(1)* measuring and cutting,~~
(1) measuring and cutting,
(2) reaming,
(3) cleaning,
(4) fluxing,
(5) assembly and support,
(6) heating,
(7) applying the solder, and
(8) cooling and cleaning.
~~*(2)* reaming,~~
~~*(3)* cleaning,~~
~~*(4)* fluxing,~~
~~*(5)* assembly and support,~~
~~*(6)* heating,~~
~~*(7)* applying the solder, and~~
~~*(8)* cooling and cleaning.~~

5. Significance and Use

5.1 The techniques described herein are used to produce leak-tight soldered joints between copper and copper alloy tube and fittings, either in shop operations or in the field. Skill and knowledge on the part of the operator or mechanic are required to obtain a satisfactorily soldered joint.

6. Procedure

6.1 *Measuring and Cutting:*

6.1.1 Accurately measure the length of each tube segment (Fig. 1) to ensure joint quality. If the tube is too short, it will not reach all the way into the cup of the fitting and a proper joint cannot be made. If the tube segment is too long, the possibility exists that system strain that negatively affects service life will be introduced.

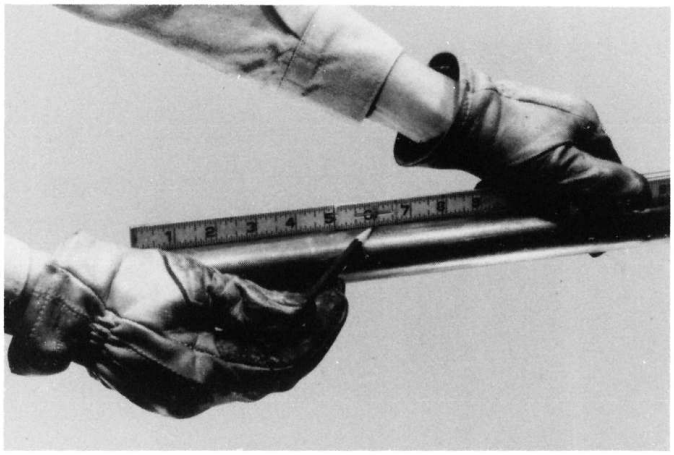

FIG. 1 Measuring

6.1.2 Cut the tube to the measured lengths using tools that provide a square cut, for example, a disk-type tube cutter (Fig. 2), a hacksaw, an abrasive wheel, or with a stationary or portable band saw. Avoid deforming the tube during cutting. Regardless of method, the cut shall be made square with the run of the tube, so that the tube will seat properly in the fitting cup.

6.2 *Reaming:*

6.2.1 Ream all cut tube ends to the full inside diameter of the tube to remove the small burr created by the cutting operation. Failure to remove this rough edge by reaming is a leading cause of erosion-corrosion that occurs as a result of local turbulence and increased local flow velocity in the tube. A properly reamed piece of tube provides a smooth surface for better flow.

6.2.2 Remove any burrs on the outside of the tube ends created by the cutting operation to ensure proper entrance of the tube into the fitting cup.

6.2.3 Tools used to ream tube ends include the reaming blade on the tube cutter, half-round or round files (Fig. 3), a pocket knife (Fig. 4), and a suitable deburring tool (Fig. 5). With soft (annealed) tube, care must be taken not to deform the tube end by applying too much pressure.

6.2.4 Soft temper tube, if deformed, shall be brought back to its proper roundness and dimensions with a sizing tool. This tool consists of a plug and sizing ring.

6.3 *Cleaning:*

6.3.1 Clean all oxides and surface soil from the tube ends and fitting cups. The removal of all oxides and surface soil is crucial to proper flow of solder metal into the joint. Unremoved oxides, surface soil, and oils will interfere with capillary action, lessen the strength of the joint, and cause failure.

6.3.2 Lightly abrade the tube ends using sand cloth (Fig. 6) or nylon abrasive pads (Fig. 7) for a distance slightly more than the depth of the fitting cups.

6.3.3 Clean the fitting cups by using abrasive cloth, abrasive pads (Fig. 8), or a properly sized fitting brush (Fig. 9).

FIG. 2 Cutting

FIG. 3 Reaming: File

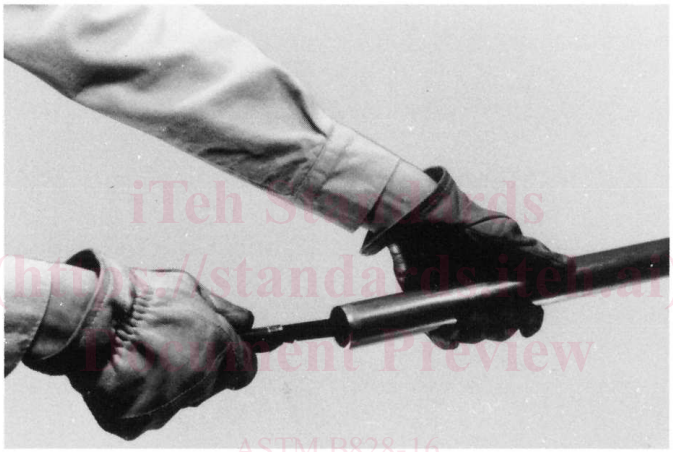

FIG. 4 Reaming: Pocket Knife

FIG. 5 Reaming: Deburring Tool

6.3.4 The capillary space between tube and fitting is approximately 0.004 in. (0.1 mm). Solder metal fills this gap by capillary action. This spacing is critical for the solder metal to flow into the gap and form a strong joint. Copper is a relatively soft metal. Removal of too much material from the tube end or fitting cup will result in a loose fit and interfere with satisfactory capillary action in making the joint.

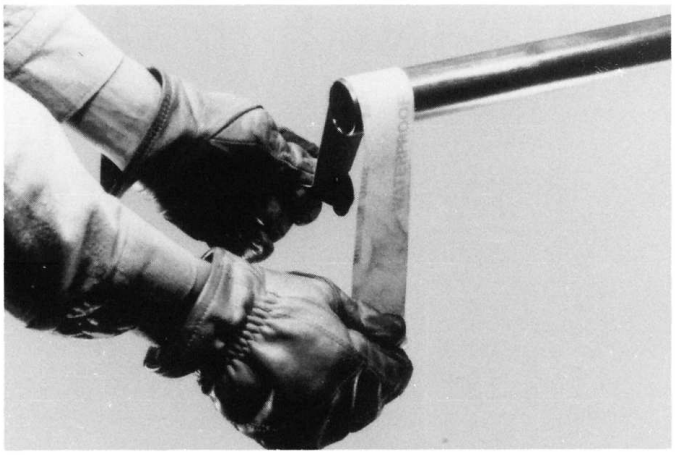

FIG. 6 Cleaning: Sand Cloth

FIG. 7 Cleaning: Abrasive Pad

FIG. 8 Cleaning: Abrasive Pad

6.3.5 If chemical cleaning is used, the tube ends and fittings shall be thoroughly rinsed after cleaning in accordance with the recommended procedure furnished by the manufacturer of the cleaner. Do not touch the cleaned surface with bare hands or oily gloves. Skin oils, lubricating oils, and grease impair solder metal.

6.4 *Applying Flux:*

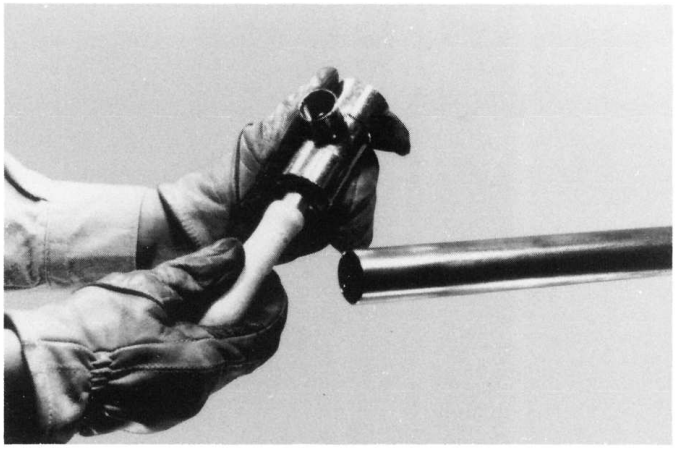

FIG. 9 Cleaning: Fitting Brush

6.4.1 Use a flux ~~that will~~ meeting the requirements of Specification B813. Soldering fluxes are necessary to dissolve and remove traces of oxide from the cleaned surfaces to be joined, protect the cleaned surfaces from reoxidation during heating, and promote wetting of the surfaces by the solder ~~metal, as recommended in the general requirements of Specification~~ metal. ~~B813.~~ Apply a thin even coating of flux with a brush to both tube and fitting as soon as possible after cleaning (Figs. 10 and 11). (**Warning—**Do not apply with fingers. Chemicals in the flux are potentially harmful if carried to the eyes or open ~~cuts.)~~ cuts.)

6.4.2 Use care in applying flux. Flux residue inside the tube has been known to cause corrosion and perforation of the tube and/or fitting wall long after the system has been installed.

6.5 *Assembly and Support:*

6.5.1 Insert tube end into fitting cup, making sure that the tube seats against the base of the fitting cup (Fig. 12). A slight twisting motion ensures even coverage by the flux. Remove excess flux from the exterior of the joint with a cotton rag (Fig. 13).

6.5.2 Support the tube and fitting assembly to ensure a uniform capillary space around the entire circumference of the joint. Uniformity of capillary space will ensure good molten solder metal capillary flow (Fig. 14). Susceptibility to solder metal cracking under conditions of stress or vibration is increased in joints with excessive joint clearance.

6.5.3 The joint is now ready for soldering. Joints prepared and ready for soldering shall be completed the same day and not left unfinished or unsoldered overnight.

6.6 *Heating:*

6.6.1 (**Warning—**When dealing with an open flame, high temperatures and flammable gases, safety precautions must be observed as described in ~~ANSI/AWS~~ANSI Z49.1.) Begin heating with the flame perpendicular to the tube (Fig. 15). The copper tube conducts the initial heat into the fitting cup for even distribution of heat in the joint area. The extent of this preheating depends upon the size of the joint. Experience will indicate the amount of time needed.

6.6.2 Next, move the flame onto the fitting cup (Fig. 16).

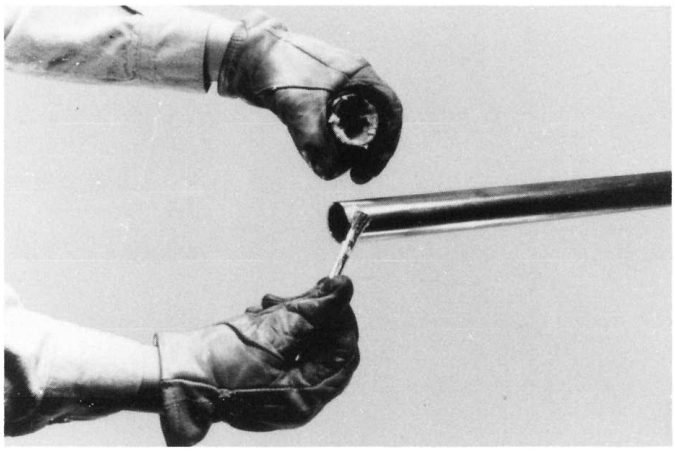

FIG. 10 Fluxing: Tube