General Brazing Guidelines

NCPWB
National Certified Pipe Welding Bureau

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The National Certified Pipe Welding Bureau (NCPWB) gratefully acknowledges the permission from ASTM to use their data on copper tube sizes in this publication.

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FOREWORD

These General Brazing Guidelines are intended to provide background information and supplementary instructions to contractors and their brazers who are using National Certified Pipe Welding Bureau Welding (NCPWB) Brazing Procedure Specifications (BPSs).

This document is divided into three parts: Mandatory Practices, Recommended Practices and General Information.

The Mandatory Practices presents requirements that shall be followed during the process of making brazed joints.

Recommended Practices part presents additional guidelines, recommendations and information beyond that specified by the BPS and the Mandatory Practices part which should be followed during brazing unless the brazer is directed otherwise by his immediate supervisor.

The Contractor may elect to add more stringent requirements to those given by this document and the BPS since the Contractor has final responsibility for the quality of work which is done.

General Information part presents tables of copper tube and fitting sizes and other information of general interest for those doing brazing.

MANDATORY PRACTICES

Safety Practices

The workplace in which brazing is to be done shall be free of materials which can catch on fire during brazing, such as rags, paper, paint and solvents.

Be sure that you know what the materials are that you are going to braze and that they will not generate toxic fumes. Do not braze metals that have paint, galvanized coating, cadmium coatings, organic or inorganic coatings without removing those coatings first.

Do not handle flux or flux-coated rods with bare hands; wear gloves or protective cream. Do not expose bare skin to flux fumes. Do not breathe flux fumes.

When flux is required by the Brazing Procedure Specification (BPS), use enough flux. Proper fluxing is not only necessary to obtain a quality brazed joint, but the flux also helps prevent oxidation of the base metal which is difficult to remove.

Wear safety glasses or goggles that are made for cutting and brazing. A number 4 or 5 shade is recommended. Do not expose your eyes to metal spatter or heat.

Do not braze in confined spaces without proper ventilation. If necessary, use an air-supplied breathing system.

Do not braze alone. Be sure someone is nearby to provide assistance in the event of an accident or emergency.

Brazing Procedure Specifications

The Brazing Procedure Specification (BPS) provides the basic and mandatory requirements that shall be followed during brazing. Care shall be taken that the base metal, base metal specification, type and grade, base metal thickness, overlap of the socket joint and all other variables specified by the BPS are followed in making a brazed joint. In addition to the requirements of the BPS, the requirements of this Mandatory Practices portion of the General Brazing Guidelines shall be followed.

All NCPWB BPSs have been qualified in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section IX *Welding and Brazing Qualifications*. This Code requires that sample brazed joints which were made following the BPS successfully demonstrate that the resulting joint is at least as strong as the base metals which will be joined, and that the braze metal was able to flow into the overlapped joint to an adequate depth to obtain this strength. The Brazer does not need access to the procedure qualification records, since all the detailed instructions for making the brazed joint are covered in the BPS.

Repair of Brazed Joints

Joints which fail to meet the requirements listed below shall be repaired:

1. Filler metal not clearly visible all the way around the joint at the interface of the socket and the tube. A small fillet of braze metal at this location is preferred.

2. Cracks in the tube or the component.
3. Cracks in the braze metal.
4. Excessive oxidation of the joint.
5. Failure of the joint to hold during pressure testing.

Repairs shall be made by replacement of the parts making up the joint or by reheating and disassembling the joint. After disassembly, sand, grind or machine the socket and tube ends of the components sufficiently to allow the joints to be reassembled with the proper amount of gap. Reclean the tube and components following the requirements of the BPS and rebraze the joint. Where the joint was rejected due to cracking of the base metal, the defective material shall be cut off and discarded or replaced. When the joint has been rejected by criteria 2 through 5 above, repair of joints is prohibited by simply adding braze metal to the joint.

RECOMMENDED PRACTICES

General

Strong, leak-tight brazed connections using copper and steel pipe, tube and fittings are usually made using filler metal which melts in the temperature range of 1100 to 1500°F. This is below the melting point of either of the base metals. The filler metal is distributed between the closely-fitting surfaces of the parts being joined by capillary attraction. The most important part of brazing is to make sure that the surfaces which are being joined together are clean and tightly fitting so that the filler metal can be distributed between the parts evenly, filling the entire gap.
Where the term tube is used in this document or in an NCPWB BPS, it shall also mean pipe, and *vice-versa*.

Measuring and Fit-up

The Brazing Procedure Specification (BPS) will specify the minimum length of overlap of the tube in the socket. See Figure 1. The tube must always be inserted into the socket at lease to the depth of the minimum overlap specified in the BPS. See Figure 1, item F. The maximum overlap which may be used in production brazing is the maximum overlap for which the brazer is qualified. The BPS does not specify a maximum overlap.

The minimum overlap depends on the strength of the materials being joined and the thickness of the socket wall or the tube wall. Typically, the BPS will specify that the tube end be inserted into the socket to a depth equal to at least four times the wall thickness (4t) of either the tube or the socket, whichever is less, or four times the thickness of the weaker of the two if materials of different strengths are being used. Inserting the tube into the socket more than the minimum distance required by the Brazing Procedure Specification (BPS) does not increase to the strength of the joint. Inserting the tube into the socket more than the minimum distance required by the Brazing Procedure Specification (BPS) only makes getting a sound joint more difficult.

To determine whether or not special measuring and control over the depth of insertion is required when using fittings which are designed for soldering, look up the maximum overlap for which the brazer is qualified. Scan the depth-of-socket column in Table 1 until you find the largest value which is less than or equal to the maximum overlap for which the brazer is qualified. The corresponding tube size is the largest tube size which may be fully inserted into the socket without making special measurements to limit the depth of insertion.

EXAMPLE

1. The joint to be brazed is Type L, 2 inch tube, 0.080 wall. BPS 107-1 has a minimum overlap of the greater of 1/4 inch or 3 times the thickness of the thinner member. Since 0.080 X 3 = 0.240, the tube must be inserted into the socket at least 1/4 inch 0.25 in).
2. The brazer was qualified following BPQT-40, which limits him/her to a maximum overlap of 1.36 inches.
3. When the brazer assembles the joint, the tube must be inserted into the socket at least 1/4 inch (to meet the requirements of the BPS) but not more than

1.36 inches (to say within the barzer's maximum insertion depth limit).

4. Scanning the depth-of-socket column in Table 1, the largest tube size that has a depth that is equal to or less than the maximum permitted is a 2 inch size tube. The joint to be brazed is 2 inch and may be brazed using full insertion. If the tube sizes to be brazed are larger than 2 inch, then special attention has to be given to keeping the overlap less than the maximum overlap for which the brazer is qualified (1.36 in.),
5. The tube shall fit inside the socket and exhibit Joint Clearance that is within the range specified by the BPS. See Joint Clearance shown in Figure 1.

The tube shall be measured for cutting so that at least the minimum overlap length but not more than the maximum overlap length is obtained after the tube and the socket are assembled. A shallow scribe mark or other marking should be placed a measured distance from the tube end prior to assembly so that overlap can be verified after brazing. Alternatively, the end of the socket may be deformed to limit the insertion depth or the excess depth of socket may be mechanically removed provided the clearance gap limits between the tube and the socket are maintained.

Cutting

Copper tube should be cut using a tubing cutter. The use of hack saw or an abrasive saw is acceptable provided the tube is not deformed by the process and any residual chips or dust from the cutting process are removed.

The cut should be square to the axis of the tube.

After cutting, the tube end shall be deburred by reaming or use of other suitable device followed by inspection and removal of any metal chips or slivers.

If the tube end has deformed during cutting, it shall be made round by using a sizing tool.

Cleaning

The proper sequence of cleaning is important. Solvent cleaning is appropriate prior to mechanical cleaning since wire brushing or other aggressive methods can create shallow scratches that may protect hydrocarbons from being removed by solvents. Their presence will interfere with wetting of the surface by the braze metal. Overly aggressive mechanical cleaning can groove the tube making the gap between the tube and the component irregular. This will interfere with the capillary forces needed to achieve proper distribution of the braze metal in the joint.

The outside surface of the tube and the inside surface of the socket should be cleaned of any oil, grease, drawing compound or other hydrocarbon contamination using suitable solvents such as acetone, MEK, or other solvent which leaves no residue. Special cleaning solutions may be specified on the BPS when the piping system will be used for oxygen or other special service; in such cases, the solutions specified by the BPS shall be used to remove hydrocarbon contamination. After removal of hydrocarbon contamination, the surfaces to be brazed shall be mechanically cleaned using a clean stainless steel wire brush, fine (00) sandpaper or ScotchBrite®

pad or equivalent. The use of emery cloth or steel wool is discouraged due to the frequent presence of oils in these abrasives.

Mechanical cleaning should not result in grooving of the surfaces to be joined.

1. Press hard enough to remove any surface oxide or other film, but not hard enough to remove or deform the metal.
2. Do not remove any more metal than necessary, since a close fit, usually 0.001 to 0.004" clearance, is necessary in order to have capillary attraction draw the braze metal into the joint properly.
3. The clearance between the tube and the inside of the socket shall be within the range specified in the BPS. Usually, if the tube and socket fit snugly together, the clearance is correct. The only exception is that when dissimilar metals are jointed (e.g., copper and steel), a press fit or a loose fit may be specified to compensate for dissimilar expansion of the metals when they are heated.

During mechanical cleaning, care shall be taken to avoid contamination of the internal surfaces of the tube and components. After mechanical cleaning, the surfaces shall be wiped using a clean, lint-free white rag.

Joints should be recleaned if they are contaminated prior to brazing. Avoid handling of the cleaned surfaces with bare hands or dirty gloves, since any oils which are transferred to the surfaces will interfere with proper cleaning action of the flux and wetting of the filler metal.

Joints should be brazed within one hour of being cleaned.

Application of Flux

Flux shall be used when required by the Brazing Procedure Specification (BPS). If the BPS does not require or permit the use of flux, flux shall be used.

Flux shall be used either as supplied by the manufacturer, or it may be diluted following the manufacturer's recommendations. Dilution should be minimized, since the concentration of the flux on the surfaces to be brazed determines how long it will be effective during brazing.

Flux shall be applied carefully to minimize contamination of the inside of the tube with flux. The flux shall be applied and worked into the surfaces to be brazed using a stiff bristle brush to ensure adequate coverage and wetting of the surfaces by the flux. Heating the flux to 120 to 140°F will make it flow and wet the surface better. Heating the flux also promotes better coverage, since warm flux is more active than cold flux. Avoid getting flux inside the tube.

Use enough flux. Flux prevents oxidation of the tube and the fitting. Flux has to last throughout the entire brazing cycle, so larger and deeper joints require application of more flux than smaller joints. Also, flux which is not entirely saturated with oxides after brazing is complete is easier to remove than flux which is fully saturated.

Flux may also be applied to the outside surfaces of the tube and fitting; this will aid in preventing oxidation of these surfaces, greatly improving their finished appearance.

Flux-coated brazing rods are acceptable, but may not be used in lieu of application of flux to the surfaces to be brazed.

When a flux has to be used on a system in which internal cleanliness is critical, such as for oxygen service, consideration should be given to brazing short sections or copper tube to the non-copper component as a subassembly, followed by cleaning of that subassembly before installing it in a copper piping system.

At the option of the Contractor, brazers who have qualified to braze using a flux may braze following another Brazing Procedure Specification (BPS) which does not specify use of a flux, or vice-versa, without requalification. The Contractor may elect to requalify brazers when the BPS is changed to add or delete flux since the Contractor has final responsibility for the quality of work that is done by the brazer.

Assembly

Tube end shall be inserted into the socket to a depth equal to at least the minimum overlap specified on the BPS, but not more than the maximum overlap for which the brazer is qualified.
When flux is used, the tube and the socket should be rotated slightly relative to each other after assembly; this ensures full distribution of the flux inside the joint.

The joint should be supported firmly during the brazing so that it does not move during heating, brazing or cooling.

Purging

Purging shall be performed when required by the Brazing Procedure Specification or other fabrication documents. When installing medical gas piping, use of "NF nitrogen" will be specified and is readily available from larger welding equipment and gas suppliers. All openings in the piping system shall be plugged or capped during the purging process, except for a discharge opening located on the opposite side of the joint from where the purge gas is being introduced. During brazing, the purge gas flow rate shall be reduced to a rate that will not produce a positive pressure inside the tube. After brazing is complete, all openings shall be plugged or capped to prevent contamination of the inside of the tube. Refer to Table 5 for purge times.

Heating

Brazing can be done using oxygen and the fuel gas specified by the BPS or using an air-fuel gas "Turbotorch.". The fuel gas may include acetylene, MAPP, propane or natural gas. The flame shall be set to be slightly reducing when acetylene and oxygen are used.

For one inch and larger sockets, preheating of the entire fitting and connection tube to 500°F or higher is recommended before heating the joint directly. The use of multiple-tip torches is also recommended to assist in uniformly bringing these larger joints up to temperature. The more uniformly the joint is heated before filler metal is added, the more uniformly the joint will be filled with braze metal.

When a flux is used, the joint shall be heated slowly until the flux has liquefied. Once this has occurred, or if no flux is used, the joint should be heated quickly to the brazing temperature, taking care not to overheat the joint.

Heat the tube first, beginning about one inch from the edge of the fitting. Move the flame across and around the tube in short strokes perpendicular to the axis of the tube, keeping the flame in constant motion and taking care not to overheat the tube locally. When a flux is used, it can be used to monitor the tube temperature:

Temp(°F)	Flux Activity
212	Water boils off
600	Flux becomes white and fluffy, begins to melt and bubble
800	Flux is milky liquid and bubbles
1100	Flux is clear and quiet, bright metal is visible underneath. Metal glows deep red
1200	Metal glows dark cherry red.
1400	Metal glows full cherry red.
>1600	Flux no longer protective. Metal glows light cherry red.

Once the tube has been heated, switch to heating the fitting, again using a side-to-side motion and directing the flame towards the base of the socket cup. Cast fittings must be carefully heated in order to avoid melting of the fitting due to grain boundary liquation.

After the tube and fitting are heated, sweep the flame across both the tube and the fitting (parallel to the axis of the tube), dwelling slightly at the base of the socket.

Brazing tip sizes for various tube sizes are shown in Table 1.

Application of Brazing Metal

Apply the brazing rod, wire or strip at the point where the tube enters the socket of the fitting. When the joint is at the proper temperature, the filler metal will melt rapidly and be instantly drawn into the space between the tube and the socket by capillary action.
Keep the flame away from the filler metal while feeding it into the joint, otherwise oxides will form on the filler metal. Melting of the filler metal should occur by conduction from the joint rather than heating by the flame; that is, the joint should be hot enough to melt the filler metal without using the flame. If the filler metal fails to flow or balls up when it is placed in contact with the joint, the joint is not hot enough or it has oxidized because there is not sufficient flux on the surface.

Keep both the fitting the tube heated by moving the flame back and forth from one to the other as the filler metal is drawn into the joint.

Stop feeding the filler metal when a continuous fillet of filler metal is visible all around the joint.

For larger joints, it may not be possible to braze the entire joint at one time unless a multiple-tip torch is available. In this case, a portion of the joint can be brazed at a time, and the balance brazed in progressive segments around the joint.

When making large diameter joints where the pipe is horizontal, it is preferable to first apply the filler metal at the bottom of the joint, then the two sides and finally the top, being sure that each section overlaps the other sections. An alternative method is to preheat the joint, apply brazed metal at the top of the joint and proceed down one side of the joint to the bottom, return to the top and apply braze metal to the other side, then return to the top and reheat and apply filler metal if necessary to bring the filler metal flush to the surface.

When making joints in which the pipe axis is vertical, it does not matter where brazing is started. For joints where the socket faces downward, the filler metal will tend to flow downward onto the tube. To avoid this, apply more heat to the socket than to the tube. If the filler metal does run down the tube, allow the joint to cool, then reheat the socket to draw the filler metal up into the joint.

If the work starts to oxidize while being heated, there is too little flux. Dipping the end of the filler metal into the flux before it is fed into the joint, or using flux-coated wire helps protect both the filler metal and the joint from oxidation.

If the filler metal flows over one member of a joint but not over the other, the members are unequally heated. The braze metal always flows towards the hotter metal.

Postbraze Cleaning

Allow cast fittings to cool naturally until they are below 600°F, then quench them with water or a sopping wet rag. Wrought tube and fittings may be quenched with a wet rag immediately after the braze metal has solidified. The quenching action helps to fracture the flux oxides, making them easier to remove.

Clean the joint with a wet brush or swab, removing all traces of flux and flux residue. It is important to remove all traces of flux, since the flux continues to react with the base metal, and will eventually weaken the joint or corrode through it. If the residues are stubborn, brush them with a wire brush, or tap the assembly lightly with a hammer, and then soak the joint again with a wet rag.

When the flux is green or black, it has been saturated with metal oxides, and it will be very difficult to remove. In this case, removal can be done with a pickling solution consisting of 25% sulfuric acid and 10% potassium dichromate or by very careful abrasive cleaning. The presence of such difficult-to-remove flux indicates that insufficient flux was used during brazing.

Inspection

Each brazed joint shall be visually examined after completion of brazing and cleaning of the outside of the joint. The following conditions are unacceptable:

1. Presence of flux or flux residue.
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 joint at the interface of the socket and the tube.
5. Cracks in the tube or the component.

6. Cracks in the braze metal.
7. Failure of the joint to hold during pressure testing.

Identification of Copper Tube

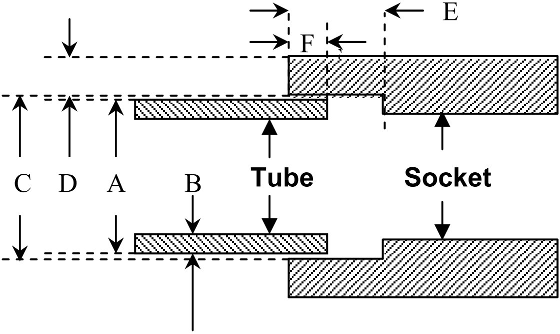
Hard copper tube is identified in accordance with the applicable specification requirements. This identification is applied directly to the tube, including the manufacturer, type, size and country of origin. the type is further identified by the marking coloring:

Color	**Type**
Green	K
Blue	L or ACR
Red	M
Yellow	DWV

The inside diameter, outside diameter and wall thickness of types K, L, M, DWV and ACR tube are given in Tables 2, 3, 4, 5 and 6, respectively.

FIGURE 1

Typical Pipe Braze Joint Nomenclature



A is the outside diameter of the tube.
B is the wall thickness of the tube.
C is the inside diameter of the socket.
D is the wall thickness of the socket.
E is the depth of the socket.
F is the Overlap (depth of insertion of the tube into the socket).

The **Joint Clearance** is one-half to the difference between the outside diameter of the tube (A) and the inside diameter of the socket (C):

Joint Clearance = (C - A)/2

The Overlap (F) shall not be greater than nor less than that specified on the Brazing Procedure Specification. Note that the Overlap does not have to be the same as the depth of the socket (E).

TABLE 1

Depth of Sockets for Solder Joint Fittings

(See Figure 1, Item E, for Description of Socket Depth)

Tube Size	Socket Depth (in.)
1/8	0.31
1/4	0.31
3/8	0.38
1/2	0.50
5/8	0.62
3/4	0.75
1	0.91
1-1/4	0.98
1-1/2	1.09
2	1.34
2-1/2	1.47
3	1.66
3-1/2	1.91
4	2.16
5	2.66
6	3.09
8	3.97

TABLE 2
Typical brazing parameters for Copper Tube to Wrought Fittings

Tube Size (in)	Torch Tip Drill Size No.	Acetylene Flow (CFH)	Oxygen & Fuel Gas Pressure (psi)
1/4	54	15.9	4
3/8	54	15.9	4
1/2	51	24.8	5
3/4	51	24.8	5
1	48	31.6	6
1-1/4	48	31.6	6
1-1/2	44	38.7	7
2	40	60.0	7
2-1/2	40	60.0	7
3	35	70.0	7-1/2
3-1/2	35	70.0	7-1/2
4	30	88.5	9
5	30	88.5	9
6	30	88.5	9

TABLE 3
Type K Copper Tube Sizes
(Nominal Dimensions, Inches)

Size In.	Outside Diameter	Inside Diameter	Wall Thick-ness	Weight Pounds Per Lin Ft.
1/4	.375	.305	.035	0.145
3/8	.500	.402	.049	0.269
1/2	.625	.527	.049	0.344
5/8	.750	.652	.049	0.418
3/4	.875	.745	.065	0.641
1	1.125	.995	.065	0.839
1-1/4	1.375	1.245	.065	1.04
1-1/2	1.625	1.481	.072	1.36
2	2.125	1.959	.083	2.06
2-1/2	2.625	2.435	.095	2.93
3	3.125	2.907	.109	4.00
3-1/2	3.625	3.385	.120	5.12
4	4.125	3.857	.134	6.51
5	5.125	4.805	.160	9.67
6	6.125	5.741	.192	13.9
8	8.125	7.583	.271	25.9
10	10.125	9.449	.338	40.3
12	12.125	11.315	.405	57.8

TABLE 4

Type L Copper Tube Sizes
(Nominal Dimensions, Inches)

Size In.	Outside Diameter	Inside Diameter	Wall Thick-ness	Weight, Pounds Per Lin Ft.
1/4	.375	.315	.030	0.126
3/8	.500	.430	.035	0.190
1/2	.625	.545	.040	0.285
5/8	.750	.668	.042	.036
3/4	.875	.785	.045	0.455
1	1.125	1.025	.050	0.656
1-1/4	1.375	1.265	.055	0.884
1-1/2	1.625	1.506	.060	1.14
2	2.125	1.985	.070	1.75
2-1/2	2.625	2.465	.080	2.48
3	3.125	2.945	.090	3.33
3-1/2	3.625	3.425	.100	4.29
4	4.125	3.905	.110	5.38
5	5.125	4.875	.125	7.61
6	6.125	5.845	.140	10.2
8	8.125	7.725	.200	19.3
10	10.125	9.625	.250	30.1
12	12.125	11.565	.280	40.4

TABLE 5

Type M Copper Tube Sizes

(Nominal Dimensions, Inches)

Size In.	Outside Diameter	Inside Diameter	Wall Thick-ness	Weight, Pounds Per Lin Ft.
3/8	.500	.450	.025	0.145
1/2	.625	.569	.028	0.204
3/4	.875	.811	.032	0.328
1	1.125	1.055	.032	0.465
1-1/4	1.375	1.291	.042	0.682
1-1/2	1.625	1.527	.049	0.940
2	2.125	2.009	.058	1.46
2-1/2	2.625	2.495	.065	2.03
3	3.125	2.981	.072	2.68
3-1/2	3.625	3.450	.083	3.58
4	4.125	3.935	.095	4.68
5	5.125	4.907	.109	6.66
6	6.125	5.881	.122	8.92
8	8.125	7.785	.170	16.5
10	10.125	9.701	.212	25.6
12	12.125	11.617	.254	36.7

TABLE 6
Type DWV Copper Tube Sizes
(Nominal Dimensions, Inches)

Size In.	Outside Diameter	Inside Diameter	Wall Thick-ness	Weight, Pounds Per Lin Ft.
1-1/4	1.375	1.295	.040	.65
1-1/2	1.625	1.541	.042	.81
2	2.125	2.041	.042	1.07
3	3.125	3.030	.045	1.69
4	4.125	4.009	.058	2.8
5	5.125	4.981	.072	4.43
6	6.125	5.959	.083	6.10
8	8.125	7.907	.109	10.6

TABLE 7
Type ACR Copper Tube
Sizes (Nominal Dimensions, Inches)

Size In.	Outside Diameter	Inside Diameter	Wall Thick-ness	Weight, Pounds Per Lin Ft.
1/8	.125	.065	.030	.0347
3/16	.188	.128	.030	.0577
1/4	.250	.190	.030	.0804
5/16	.312	.248	.032	.109
3/8*	.375	.311	.032	.126
1/2*	.500	.436	.032	.182
5/8*	.625	.555	.035	.251
3/4*	.750	.680	.035	.362
7/8	.875	.785	.045	.455
1-1/8	1.125	1.025	.050	.655
1-3/8	1.375	1.265	.055	.884
1-5/8	1.625	1.505	.060	1.14
2-1/8	2.125	1.985	.070	1.75
2-5/8	2.625	2.465	.080	2.48
3-1/8	3.125	2.945	.090	3.33
3-5/8	3.625	3.425	.100	4.29
4-1/8	4.125	3.905	.110	5.38

*may also be supplied as slightly heavier drawn temper

TABLE 8
Purge Time Tables

Flow Rate 50 Cubic Feet Per Hour
(24 liters Per Minute)
Producing 6 Volume Changes

Tube Size	Purge Time Per 10 Feet of Length
1/2 or smaller	5 sec.
3/4	9 sec.
1	11 sec.
1-1/4	16 sec.
1-1/2	20 sec.
2	45 sec.
2-1/2	75 sec.
3	2 min.
4	4 min.
5	6 min.
6	12 min.

To calculate the prepurge time for any length of tube, multiply the value obtained from the Table by the length of tube.

Example: Find time required for prepurging of 200 ft. of 2 in. tube. From Table for 2 inch tube size, the purge time is 45 seconds. per 1 ft. of tube. 45 seconds per foot times 200 ft. = 9,000 seconds or 150 minutes or 2.5 hours.

Caution: Inert gases, including nitrogen, displace air. They can cause death by oxygen deprivation.

TABLE 9

ASME P- and S-Numbers for Brazing

The ASME P-number system groups metals according to comparable base metal characteristics such as composition, brazeability and mechanical properties. The reason for grouping base metals in this manner is to reduce the number of brazing procedure and performance qualifications that would otherwise be required. The following is a listing of materials by base metal P/S-Number. Materials that are not listed here can be found in QW/QB-422 of ASME Section IX and in the tables of allowable stress found in the B31 Code Sections.

FERROUS ALLOY WITH CHROMIUM CONTENT LESS THAN 0.90%

P/S Numbers	Spec. Numbers	Type or Grade	Product Type
101	A-36		Structural Shapes, Plate
	A-53	All	Seamless Pipe
	A-105		Forgings
	A-106	All	Seamless Pipe
	A-108	1015,1020	Bar, Tube
	A-181	C1.60,70	Pipe Flanges
	A-209	All	Seamless Tube
	A-213	T2	Seamless Tube
	A-216	WPA,B,C	Castings
	A-234	WPB, WBC	Pipe Fittings
	A-285	All	Plate
	A-333	1,6	Seamless and Welded Pipe

A-334	1,6	Seamless and Welded Pipe
A-350	LF1,2	Forgings
A-352	LCA, B,C	Castings
A-387	Gr2	Plate
A-515	All	Plate
A-519	1018, 1026	Bar, Tube
A-671	CA,CB,CC	Fusion Welded Pipe
A-672	A,B,C,E	Fusion Welded Pipe
A-691	CM65/75	Fusion Welded Pipe
A-714	Gr. V (Alloy)	Seamless and welded Pipe
API-5L	All	Seamless and Welded Pipe

FERROUS ALLOYS WITH CHROMIUM CONTENT ABOVE 0.90%

P/S Numbers	**Spec. Numbers**	**Type or Grade**	**Product Type**
102	A-182	F5,7,9,11,12 21,22, 91	Pipe Flanges
	A-213	T11,22,5,91	Seamless Tube
	A-213	TP3XX	Seamless Tube
	A-234	WP11,22,5,7,9	Pipe Fittings
	A-240	Type 3XX	Plate
	A-312	TP3XX	Seamless or Welded Pipe
	A-335	P11,12,21,22	Seamless Pipe
	A-387	Gr.11,12,21,22	Plate
	A-671	CF65,66,70,71	Fusion Welded Pipe
	A-691	1 1/4Cr.	Fusion Welded Pipe

	A-691	2 1/4Cr.	Fusion Welded Pipe
	A-691	5,7,9, 91Cr.	Fusion Welded Pipe
	A-789		All Seamless and Welded Pipe
	A-790	All	Seamless and Welded Pipe

ALUMINUM AND ALUMINUM BASE ALLOYS

P/S Numbers	**Spec. Numbers**	**Type or Grade**	**Product Type**
104	B-209	1100,3003	Sheet, Plate
	B-210	3003	Tube
	B-221	1100,3003	Bar, Rod, Shape, Tube
	B-234	3003	Tube
	B-241	1100,3003	Bar, Rod Shape, Tube
105	B-209	6061	Sheet, Plate
	B-210	6061,6063	Tube
	B-211	6061	Bar, Rod
	B-221	6061,6063	Bar, Rod, Shape, Tube
	B-234	6061	Tube
	B-241	6061,6063	Bar, Rod, Shape, Tube

COPPER ALLOYS WITH LESS THAN .50% ALUMINUM

P/S Numbers	Spec. Numbers	Type or Grade	Product Type
107	B-62	Alloy 836	Fittings, Castings
	B-68	Copper	Seamless Tube
	B-88	Copper	Seamless Tube
	B-111	Brass	Seamless Pipe
	B-111	Copper	Seamless Pipe
	B-111	Cu-Ni	Seamless Pipe
	B-171	443,444,445	Seamless Tube
	B-359	443,444,445	Seamless Tube
	B-819	Copper	Medical Gas Cleaned Seamless tube
	B16.18	836,838,844	Leaded Brass Castings
	B16.22	Copper	Solder Joint Fittings
	B16.22	230 (Brass)	Solder Joint Fittings

NICKEL ALLOYS WITH LESS THAN 1% CHROMIUM

P/S Numbers	Spec. Numbers	Type or Grade	Product Type
110	B-161	NO 2200,1	Pipe, Tube
	B-165	NO 4400	Seamless Pipe and Tube

NICKEL ALLOYS WITH MORE THAN 1% CHROMIUM

P/S Numbers	Spec. Numbers	Type or Grade	Product Type
111	B-163	600,800,825	Seamless Pipe and Tube
	B-167	600	Seamless and Welded Pipe
	B-464	N08020	Seamless and Welded Pipe
	B-407	800	Seamless Pipe and Tube
	B-423	825	Seamless Pipe and Tube
	B-446	625	Seamless Tube and Tube
	B-464	Alloy 20	Seamless Pipe and Tube
112	B-619	Alloy 276	Seamless Pipe and Tube
	B-622	Alloy 276	Seamless Pipe and Tube

Item PW2

NCPWB National Certified Pipe Welding Bureau

MCAA Mechanical Contractors Association of America

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