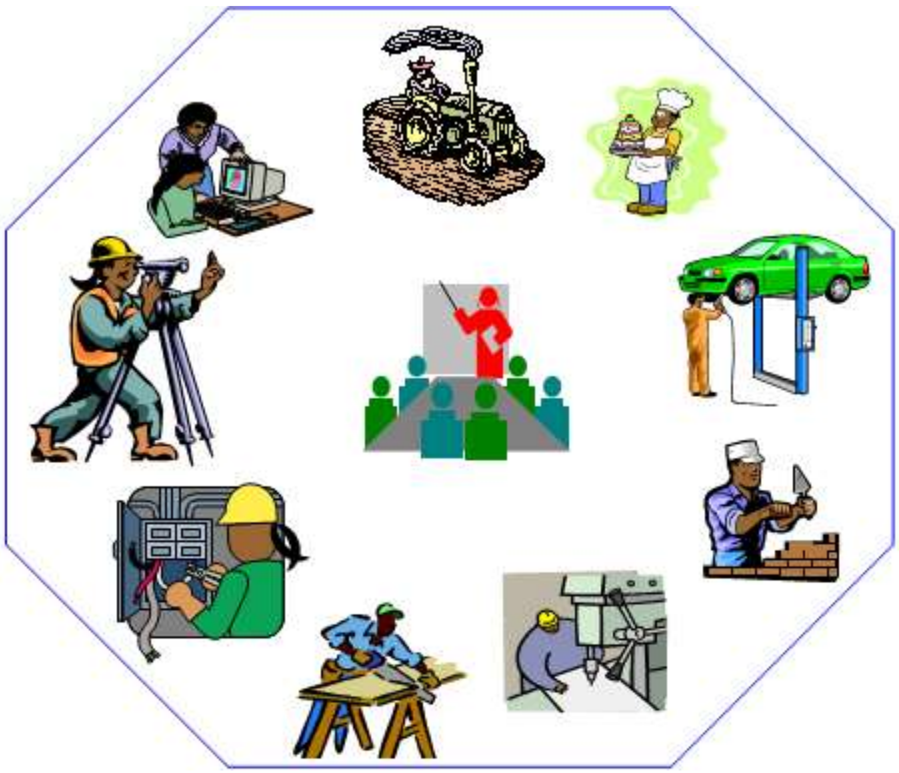
WELDING

Level-IV

Based on Feb 2021, Version 1 Occupational standard



Module Title: - Performing Brazing And /or Silver Soldering

LG Code: IND WLD4 M10 LO (1-3) LG (34-36)

TTLM Code: IND WLD4 M TTLM 7 0121v1

Feb, 2021
Adama/ Ethiopia

LG #34	LO #1- Prepare materials and equipment.

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content:

- Determining Job requirements.
- Preparing materials.
- Assembling/aligning materials.
- Identifying distortion prevention measures and taking action.
- Assembling and setting up heating equipment.

This guide will also assist you to attain the learning outcome stated on the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Scope of work is determined from specifications and/ or instructions
- Materials are correctly prepared using appropriate tools and techniques
- Materials are correctly assembled/aligned to meet specifications as required
- Distortion prevention measures are identified and appropriate action is taken as required
- Heating equipment is assembled and set up safely and correctly in accordance with standard operating procedures
- Correct and appropriate consumables are selected and prepared due to operational procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your

trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to "Operation sheets".

Information Sheet 1	Determining Job requirements.

1.1 Welding

WELDING AND JOINING processes are essential for the development of virtually every manufactured product. However, these processes often appear to consume greater fractions of the product cost and to create more of the production difficulties than might be expected. There are a number of reasons that explain this situation.

First, welding and joining are multifaceted, both in terms of process variations (such as fastening, adhesive bonding, soldering, brazing, arc welding, diffusion bonding, and resistance welding) and in the disciplines needed for problem solving (such as mechanics, materials science, physics, chemistry, and electronics). An engineer with unusually broad and deep training is required to bring these disciplines together and to apply them effectively to a variety of processes.

Second, welding or joining difficulties usually occur far into the manufacturing process, where the relative value of scrapped parts is high.

Third, a very large percentage of product failures occur at joints because they are usually located at the highest stress points of an assembly and are therefore the weakest parts of that assembly. Care full attention to the joining processes can produce great rewards in manufacturing economy and product reliability.

BRAZING AND SOLDERING require the application of a number of scientific and engineering skills to produce joints of satisfactory quality and reliability. Brazing employs higher temperatures than soldering, but the fundamental concepts are similar, particularly with respect to metallurgy and surface chemistry (Table 1). However, joint design, materials to be joined, filler metal and flux selection, heating methods, and joint preparation can vary widely between the two processes. Economic considerations involving filler metal and process technology are also varied, particularly in relation to automated techniques and inspection and testing.

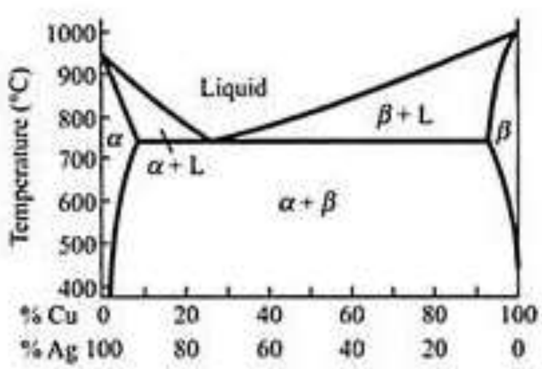
Brazing and soldering are performed in many industries, from exotic applications in the electronics and aerospace field to everyday plumbing applications.

1.2 Principles of joining processes

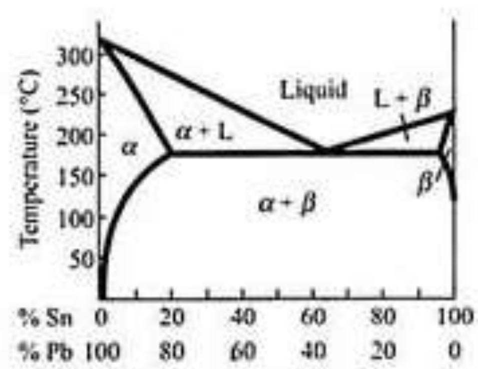
1.2.1 Brazing and Soldering

The soldering and brazing processes are carried out by allowing molten filler material to flow in the gap between the parent bodies. Obviously, the filler material has to have a melting point much lower than that of the parent bodies. When the filler material is a copper alloy (e.g., copper-zinc and copper-silver), the process is called brazing. A similar process with a lead-tin alloy as the filler material is called soldering. The most common heat source for these processes is electrical resistance heating.

The copper-silver phase diagram is shown in Fig. Here, we see that by varying the composition of the alloy the flow temperature can be controlled in the range 750-980°C. Similarly, the lead-tin phase diagram (Fig.) indicates a flow temperature in the range 160-300°C.



Equilibrium phase diagram of Cu – Ag Alloy



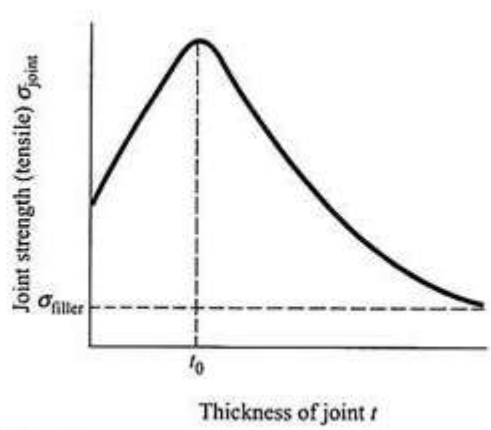
Equilibrium phase diagram of Pb – Sn Alloy.

Two distinct advantages of this class of joining processes are obvious. First, the heating of the parent materials is negligible to cause any change in their structure or properties. Second, these processes can join two materials which are insoluble in each other.

To produce a perfect joint, the entire gap between the parent bodies must be filled up by the filler material. This is achieved essentially through a capillary action. Thus, the spreading and the wetting capacities of the filler liquid play a predominant role towards producing a satisfactory joint. In some cases, these properties even dictate the composition of the alloy to be used. In what follows, we shall briefly discuss the adhesion between a liquid and a solid surface.

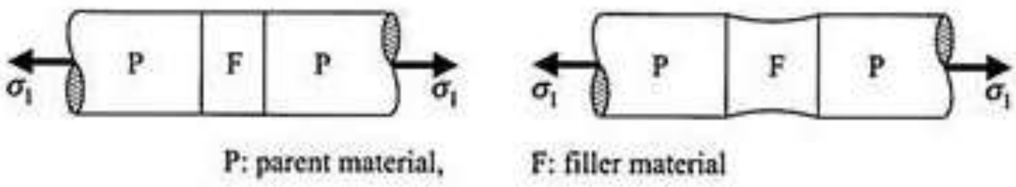
The strength of a typically brazed joint varies with the thickness of the joint in a manner shown in Fig. Here, we note that an optimum joint thickness (t0) exists at which the strength is maximum. For a very large thickness of the joint, the strength of the joint approaches that of the brazing alloy (σ filler). Below the optimum thickness, the entire joint is not filled up due to the strong resistance against the capillary flow. Hence, the strength is low due to the lack of a perfect fit.

It can be seen that the maximum joint strength is higher than the strength of the filler material; this can be explained as follows. Usually, the yield stress of the filler material is lower than that of the parent materials. Let the joint be subjected to a tensile loading of stress σ1 (Fig.). With increasing value of σ1, the filler material tends to yield and the P (parent material)-F (filler material) interfaces tend to resist the yielding (because the parent material does not yield at this loading).

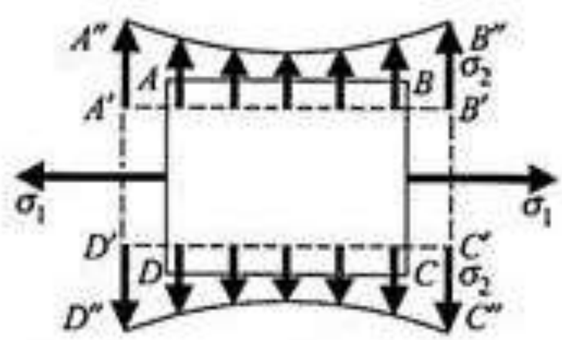


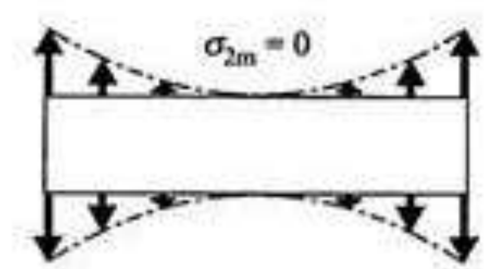
Variation of strength of brazed joint with joint thickness

The resulting deformation takes the shape shown in Fig. b. The yield strength of the filler alloy (σ filler) is determined, by a uniaxial test, when the deformed shape of a rectangular specimen ABCD takes the shape A'B'CD' (shown by the dashed lines in Fig. c). If AD and BC are considered as the P-F interfaces (indicated in Fig. a), then, in the presence of the parent materials, the deformed shape of the same specimen takes the shape A"B"C''D'' (Fig. c) as in Fig. b.



Joint before deformation deformed shape of filler material





Stress system in filler material case when joint strength is equal to filler material

Strength.

Fig Deformation characteristics of brazed joint under tension

1.3 Advantage of soldering and brazing

Low temperature. Since the base metal does not have to melt, a low-temp heat source can be used. This minimized distortion and creates a smaller heat-affected zone (HAZ).

Joints can be made be permanently or temporarily. Since the base metal is not damaged, parts can be dis-assembled at a any time by simply supplying heat. The parts then can be reused. The joint made by soldering or brazing process is solid enough to be permanent.

Metals of dissimilar can be joined. By using soldering and brazing process dissimilar metals can be easily joined, such as aluminum to brass, copper to steel and cast iron to stainless steel. It is also possible to join nonmetals, i.e. ceramics can be easily brazed to each other or to metals.

Speed of joining. Parts can be pre-assembled and furnace soldered or brazed in large quantities. A lower temperature means less time in heating.

Less chance of damaging parts. A heat source can be used that has a maximum temperature below that which may cause damage to the base material.

Parts of varying thickness can be joined. Very thin parts or a thick part and a thin part can be easily joined without burning through or overheating them.

Easy realignment. Parts can be easily realigned by reheating the joint, re-positioning the parts and allowing the filler metal to solidify.

Determining Job requirements

In manufacturing workshop in order to produce the required work (as customer need). Worker or soldering and brazing operator has to perform some operations. It is important that the sequence of operations be carefully planned in order to produce a part quickly and accurately. Following a wrong sequence of operation can often result in spoiled work. The best methods of job planning is first interpret the instruction of the given job sheet or verbal instructions correctly, and arrange the sequence of soldering and brazing operation to plan technically to obtain the given components to the required properties.

Interpretation

Interpretation means reading and understanding the information given points engineering drawing, job sheet or verbal instructions; Reading, interpreting and following information on written job instructions, specifications, standard operating procedures, manufacturers manual and instructions, chart, list, drawings and applicable reference documents as organizational / company rule and regulation.

Operational sequences line

It is a sequence of soldering and brazing operation plan. Which is prepared based on the information provided on the job sheet or verbal instructions of the component to be heat treated has to ready for producing expected parts / components / with required properties of metals.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (4Pts)

1. The first activities to do works, job sheet or verbal instructions to heat treatment workshop (2Pts)

A. Read and understand work requirements

B. Apply sequence of heat treating operation

2. To make a product of desired properties on heat treatment operation operator has to (2Pts)

A. Interpret work as needed

B. Prepare sequence of heat treating techniques

Note: Satisfactory rating - 4 points **Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

1.____

2.____

Information Sheet 2	**Preparing materials.**

2.1 Introduction to soldering and brazing

Welding is "a material joining process which produces coalescence of materials by heating them to suitable temperatures, with or without the application of pressure or by the application of pressure alone, and with or without the use of filler material" (Ref. (1)). From this definition for welding, it is understandable why many people refer to brazing and soldering as welding. However, people intimately associated with the brazing industry will argue that brazing and welding are not the same because when brazing, no thermal melting of the base metals being joined occurs.

With both brazing and soldering, a filler metal is used that has a melting point lower than the solidus point of the metal parts being joined (this is the primary difference between welding and brazing). After reaching a certain temperature, generally, about 50° to 100°F higher than the melting temperature of the filler depending on the heating rate, the surface of the base metal reacts with the filler alloy to form a metallic bond. According to the American Welding Society (AWS) the only thing that differentiates soldering from brazing is temperature. If the metal bonding process uses a filler metal that melts below 450°C (842°F) the bonding process is defined as soldering. However, if the filler metal melts above 450°C (842°F) then the bonding process is defined as brazing (Ref. (2)). Other sources differentiate brazing from soldering in that for brazing there is a metallurgic bond created by the diffusion of the parent and filler material across the joint boundaries whereas this is not normally achieved in soldering.

Ferrous and nonferrous metal

All materials have physical and working properties. Physical properties are the traits a material has before it is used, whereas working properties are how the material behaves when it is manipulated.

Metals are found naturally and are mined from the earth. Metals used in products are extracted from the natural ore using large heat furnaces. They are sold as sheets, bars, rods, tubes and angles. Most metals can be recycled, saving natural resources.

Ferrous metals

Ferrous metals contain iron and are magnetic. They are prone to rust and therefore require a protective finish, which is sometimes used to improve the aesthetics of the product it is used for as well.

Ferrous metal	Properties	Uses
Cast iron	Brittle if thin, can be cast in a mold , strong compression strength, good electrical and thermal conductivity but poor resistance to corrosion	Manhole covers, pans and gates, vices
High-carbon steel (tool steel)	Hard but brittle, less malleable than mild steel, good electrical and thermal conductivity	Taps and tools, eg screwdrivers and chisels
Low-carbon steel (mild steel)	Ductile and tough, easy to form, braze and weld, good electrical and thermal conductivity but poor resistance to corrosion	Nuts, bolts, screws, bike frames and car bodies

Non-ferrous metals

Non-ferrous metals do not contain iron and are not magnetic. They do not rust.

Non-ferrous metal	Properties	Uses
Aluminum	Light in weight and malleable but strong, a good conductor of heat and corrosion resistant	Drink cans, saucepans, bike frames
Copper	An excellent electrical conductor of heat	Plumbing fittings and

	and electricity, extremely malleable and can be polished, oxidizes to a green color	electrical wires, professional chef's saucepans
Silver	A precious metal that is soft and malleable when heated, highly resistant to corrosion and an excellent electrical conductor of heat	Jew Ellery

Copper oxidized to green color

Alloys

Alloys are mixtures of metal with an element to improve its properties or aesthetic. For example brass is a mixture of copper and zinc. Alloys can also be classified as ferrous or non-ferrous. Non-ferrous metal may require a protective finish. This finish is sometimes used to improve the aesthetics of the product it is used for.

Alloy	Properties	Uses
Brass (alloy of copper and zinc)	Non-ferrous metal that is strong and ductile, casts well and is gold colored but darkens when oxidized with age, a good conductor of heat	Taps, screws, castings, locks and doorknobs
Bronze (alloy of copper, aluminum	Non-ferrous alloy, harder than brass and corrosion resistant, reddish/yellow in color	Castings, bearings

and/or nickel)		
Stainless steel (alloy of steel also with chromium, nickel and magnesium)	Ferrous metal that is silver when polished, hard and tough with excellent resistance to corrosion	Cutlery, sinks, saucepans, surgical equipment

Stainless steel spatula

Type of soldering

There are three types of soldering which use increasingly higher temperatures, which in turn produce progressively stronger joints:

Soft soldering (90 °C - 450 °C) - This process has the lowest filler metal melting point of all the soldering types at less than around 400°C these filler metals are usually alloys, often containing lead with liquids temperatures under 350°C. Because of the low temperatures used in soft soldering it thermally stresses components the least but does not make strong joints and is then therefore unsuitable for mechanical load-bearing applications. It is also not suited for high temperature use as this type of solder loses strength and melts.

Hard (silver) soldering (>450 °C) – Brass or silver is the bonding metal used in this process, and requires a blowtorch to achieve the temperatures at which the solder metals.

Brazing (>450 °C) – This type of soldering uses a metal with a much higher melting point than those used in hard and soft soldering. However, similarly to hard soldering, the metal being bonded is heated as opposed to being melted. Once both the materials are heated sufficiently, you can then place the soldering metal between them which melts and acts as a bonding agent.

Uses of a Soldering Iron

A soldering iron is a hand tool used to heat solder, usually from an electrical supply at high temperatures above the melting point of the metal alloy. This allows for the solder to flow between the workpieces needing to be joined.

This soldering tool is made up of an insulated handle and a heated pointed metal iron tip. Good soldering is influenced by how clean the tip of your soldering iron is. To maintain cleanliness, a user will hold the soldering iron and use a wet sponge to clean the soldering iron tip prior to soldering components or making soldered connections.

In addition to the soldering iron, solder suckers are an important part of the soldering setup. If excessive solder is applied, these small tools are used to remove the solder, leaving only that desired.

2.2 Soldering Materials & Equipment

EIS offers a complete range of lead-free and leaded solder products, as well as masking and cleaning compounds. Solder Materials include lead-free solder pastes for both no-clean and water-soluble assembly; wave solder fluxes, both alcohol and VOC-free, formulated for lead-free soldering; and rework and hand assembly compatible lead-free solders. Additional materials include solder bar, solder preforms, tacky soldering fluxes, solder spheres and bumping pastes, all designed to enable lead-free assembly.

Deformers, Cleaners & Flux Concentration Test Kits

Deformers, Cleaners, and Flux Concentration Test Kits are all necessary components for the total soldering process for printed circuit boards.

Deformers – deformers are designed to eliminate excessive foam in aqueous cleaning systems using tap, filtered or DI water.

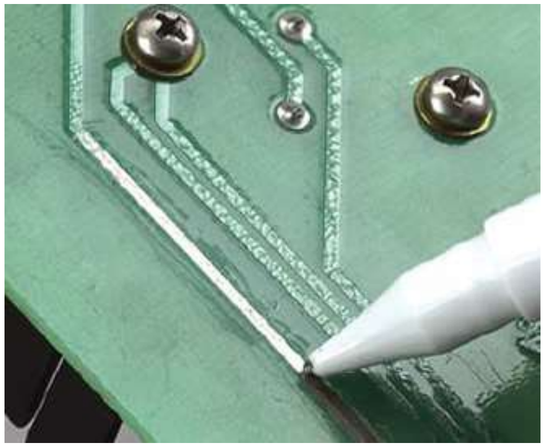
Cleaners – Cleaners remove oxides, sulfides, carbonates and/or other contamination to facilitate soldering. It cleans by dissolving or solubilizing the contaminates for easy removal by water rinsing.

Flux Concentration Test Kits – These kits are used to determine the acid number of the flux or to determine the relative flux concentration.

Flux Pens & Flux Remover Pens

Flux Pens, sometimes referred to as Rework Pens, are a must have soldering tool. A Flux Pen is essentially a small pen-shaped container with a spring loaded felt tip at one end. Flux Pen application allows you to have precise, uniform control in your flux application while being easy and convenient. Using a slight amount of pressure, the tips allow flux to wick through the felt and onto the area were the flux is needed. Flux pens come in 3 different types:

- Mildly Activated Flux Pen
- No-Clean Flux Pen
- Water Soluble Flux Pen



Flux Thinner

Flux Thinners are used for reducing solids or replacing evaporated solvent, resulting in maximum efficiency of the flux in an open vessel application. Flux thinners should be used if the Specific Gravity or Titration test results indicate that the solvent needs to be increased. Depending on your foaming, dipping or spray application, there are an array of flux thinners that will thin your Water Soluble, No Clean, and RMA (rosin mildly activated) fluxes.

Bar Solder

Bar Solder is used in various applications including high tech electronics and printed circuit boards. Tin/Lead solder alloy are the traditional bar solder that have a very low melting temperature, which is important since most electronic components are heat sensitive. Tin/lead alloys are often referred by their alloy ratio such as 60/40 or 63/37. Whereas tin/lead/silver alloys have a small percent of silver in the solder which prevents the silver on the leads from migrating into the solder resulting in a weak or brittle solder connection. The variety of lead-free bar solders are designed to meet the Reduction of Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) standards making them safer to use than lead based solders.

Solder Flux

Solder Flux is a critical element in many soldering applications. Flux is designed to spread out across the metal, keep the metal surface clean until the solder reaches it, and promote the spreading of the soldering across the surface of the metal. In some cases, the flux included in the core of the solder wire is sufficient to prevent oxides from forming and allows a strong bond. But for several applications, such as circuit boards assemblies and multilayered boards, additional flux is extremely beneficial.

Solder Wire

Solder Wires have either a solid core or an inside core containing flux. The flux promotes wetting and flow of the solder into the joint by removing any oxidation on the metal surfaces. EIS offers flux-cored solder wire with rosin, mildly activated rosin, no-clean, water soluble, and inorganic flux. The two main types of solder wire alloys are classified as leaded and Lead-free. Leaded solder wire is typically a 63/37 or 60/40 mix of tin/lead. Lead-free solder wire has become very prevalent in use and often requires a higher temperature due to the higher melting point of the alloys. Different flux types and alloy combinations have been developed to offset many of the early difficulties of soldering with lead-free alloys.

Soldering Iron

Soldering Iron is also called as solder gun. To facilitate soldering, most important tool is soldering iron. The main parts of soldering iron are handle, element and bit. The element of soldering iron is just like that of electric heater. When electricity passes through the element, it generates heat. This in turn heats the bit of iron which then transfers the heat to the joint to be soldered.

A step-by-step guide soldering operation

Preparation before soldering

The first step in any case is to create a clean, dust-free work environment. Make sure that the soldering tip and the item you are going to solder are completely clean and that there is no residue on them.

If any excess material is found on the component, gently grind it with abrasive paper and then thoroughly clean it with compressed Air 67 or alcohol.

Place a small vice in position so that the part to be soldered is held securely and does not slip during heating or cooling.

In order to be able to solder very small parts precisely, a soldering aid with a magnifying glass can help you out a lot.

Reheat your appliance and bring it to an appropriate operating temperature for your solder (see below).

It is best to ensure suitable ventilation for your workplace. The fluid contains acids which, upon heating, can cause harmful vapors and should not be inhaled.

Extraction units with integrated filters are available in a range of sizes to provide optimum protection against toxins in the air.

Using a soldering station instead of a soldering iron

A soldering station is much more comfortable than using a soldering iron. Soldering stations can keep an exact temperature pre-setting, ensuring it doesn’t change during the whole soldering process.

The stations usually have clear displays and offer numerous other helpful functions.

Soldering stations are available with different settings and price points, depending on the application area and your preference.

Using the right tool

Helpful soldering tools should be ready and within reach at all times to avoid unnecessary interruptions. Important tools include a stripping tool, a high quality tweezer set, a side cutter, a board assistant with a magnifying glass, a circuit board and a dry sponge for cleaning.

This type of cleaning (also referred to as “dry clean“) puts less strain on the soldering tip as it doesn’t experience a temperature shock. For high-quality soldering stations, such as the WT1010H from Weller, a dry sponge is already integrated.

Once you’re up and running with soldering

The cable ends which are to be connected, should first be stripped and twisted into one another. The work to be carried out depends on whether the cables are thin cables of up to 1.5 square meters or thicker cables.

For thin cables, it is sufficient to apply a little solder to the soldering tip and hold it to the soldering point. The strands will be sucked in together by capillary forces.

In the case of thicker cables, the larger amount of copper leads to cooling of the soldered joint – do not hold the soldering tip any longer. Since copper is very conductive, the insulation could melt – use a larger amount of solder to avoid this.

Although most varieties of solder already contain flux, a thicker solder joint may be helpful. However, you should pay attention to the ventilation of your workplace; the flux which bonds the materials together generates toxic fumes.

Solder wires are available in various alloys, depending on the application area. Although lead-bearing solder is still available, from environmental and health points of view, the heavy metal should be avoided.

Soldering through plug-in power

Since connectors require a stable connection to the circuit board, wired versions are usually used due to their stability.

Due to the through-hole technology (THT), they are so rigidly connected to the component that both plugging and pulling forces have no influence on them.

For this purpose, the wired components are inserted through the existing contact holes of the circuit board and then soldered. To make sure you are not using any damaged parts, make sure you test them with an LCR component tester beforehand.

Soldering of components

Clean the circuit board first with a suitable cleaning agent then wet both pads with flux. For such small parts, a flux pen is particularly helpful.

Align the two parts correctly and fix them with two diagonally set soldering points.

If the parts are not perfectly aligned, re-adjust them after heating the two soldering points, now the pins are soldered.

In order to be able to remove the excess tin from a soldering wire, pull the soldering tip to one side. Be careful not to overheat the part during the entire process, and try not to apply too much pressure to it.

In this case, superfluous solder, so-called solder bridges, is most easily removed by means of a de-soldering strand. You can find out how to do this under the heading 'De-soldering'.

The optimal temperature

There is a difference between soft and hard soldering.

Soft solder melts at less than 450 degrees Celsius, whereas the liquid temperature of Hart ten is between 450 and 900 degrees Celsius.

Since electronic components are very sensitive, only soft soldering can be used here.

The temperature your work depends on the components you are using. Check the melting temperature of your soldering tin, as well as the working temperature of your flux. It should in any case be above the two minimum values, but it must not exceed the maximum operating temperature of the flux, as this will then evaporate.

The soldering temperature for electronic components is 300 to 320 degrees Celsius. When fine wires are used, a temperature of less than 300 degrees and a thin soldering tip is used.

If the temperature is too low, the solder will not be shiny and will be drop-shaped. In this case, you should adjust the temperature, and then continue to work.

2.2.1 Checking over your solder work

To ensure that all components have been soldered correctly, the soldering work should be checked before commissioning. First of all, examine the component. Are there any defective soldered joints, bent IC legs or even incorrectly used components? If all looks good here, a test should then be carried out with a multi meter.

This allows you to measure the throughput, voltage, current consumption and resistance of each individual connection, thus identifying short circuits and disruptions.

All accessories are supplied with Atlas models. Through the oscilloscope function and Bluetooth capability, the data from the Atlas Multi meter can be transferred to a smartphone or tablet.

Only when you‘ve made sure there is no fault in your soldering work should the component be installed and subjected to a functional test.

Distortion is the alteration of the original shape (or other characteristic) of something. In communications and electronics it means the alteration of the waveform of an information-bearing signal, such as an audio signal representing sound or a video signal representing images, in an electronic device or communication channel.

Distortion is usually unwanted, and so engineers strive to eliminate or minimize it. In some situations, however, distortion may be desirable. For example, in noise reduction systems like the Dolby system, an audio signal is deliberately distorted in ways that emphasize aspects of the signal that are subject to electrical noise, then it is symmetrically "undistorted" after passing through a noisy communication channel, reducing the noise in the received signal. Distortion is also used as a musical effect, particularly with electric guitars.

The addition of noise or other outside signals (hum, interference) is not considered distortion, though the effects of quantization distortion are sometimes included in noise. Quality measures that reflect both noise and distortion include the signal-to-noise and distortion (SINAD) ratio and total harmonic distortion plus noise (THD+N).

Type of distortion

Amplitude distortion

Amplitude distortion is distortion occurring in a system, subsystem, or device when the output amplitude is not a linear function of the input amplitude under specified conditions.

Harmonic distortion

Harmonic distortion adds overtones that are whole number multiples of a sound wave's frequencies. Nonlinearities that give rise to amplitude distortion in audio systems are most often measured in terms of the harmonics (overtones) added to a pure sinewave fed to the system. Harmonic distortion may be expressed in terms of the relative strength of individual components, in decibels, or the root mean square of all harmonic components: Total harmonic distortion (THD), as a percentage. The level at which harmonic distortion becomes audible depends on the exact nature of the distortion. Different types of distortion (like crossover distortion) are more audible than others (like soft clipping) even if the THD measurements are identical. Harmonic distortion in radio frequency applications is rarely expressed as THD.

Frequency response distortion

Non-flat frequency response is a form of distortion that occurs when different frequencies are amplified by different amounts in a filter. For example, the non-uniform frequency response curve of AC-coupled cascade amplifier is an example of frequency distortion. In the audio case, this is mainly caused by room acoustics, poor loudspeakers and microphones, long loudspeaker cables in combination with frequency dependent loudspeaker impedance, etc.

Phase distortion

This form of distortion mostly occurs due to electrical reactance. Here, all the components of the input signal are not amplified with the same phase shift, hence making some parts of the output signal out of phase with the rest of the output.

Group delay distortion

Can be found only in dispersive media. In a waveguide, phase velocity varies with frequency. In a filter, group delay tends to peak near the cut-off frequency, resulting in pulse distortion. When analog long distance trunks were commonplace, for example in 12 channel carrier, group delay distortion had to be corrected in repeaters.

The elimination of distortion during soldering

A method of preventing distortion from soldering operations has been described. The uniform preheating in a porcelain furnace of the invested parts of a fixed restoration has been shown to eliminate the errors which result from uneven blowpipe or Bunsen burner preheating.

What is Weld Distortion?

Distortion in a weld results from the expansion and contraction of the weld metal and adjacent base metal during the heating and cooling cycle of the welding process. Doing all welding on one side of a part will cause much more distortion than if the welds are alternated from one side to the other. During this heating and cooling cycle, many factors affect shrinkage of the metal and lead to distortion, such as physical and mechanical properties that change as heat is applied. For example, as the temperature of the weld area increases, yield strength, elasticity, and thermal conductivity of the steel plate decrease, while thermal expansion and specific heat increase (Fig.). These changes, in turn, affect heat flow and uniformity of heat distribution.

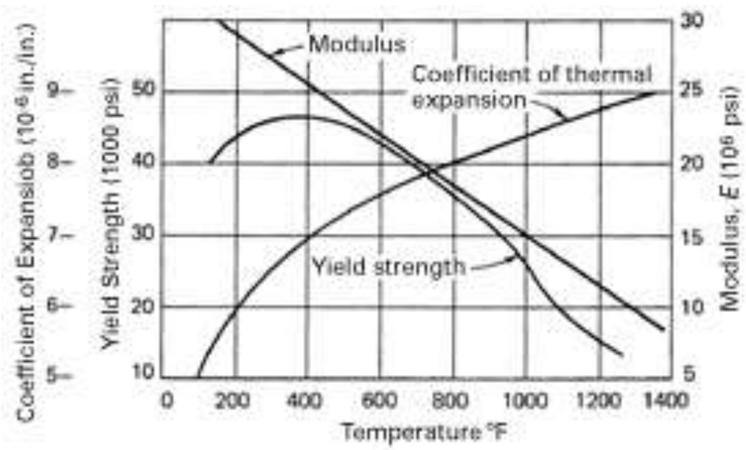


Fig Changes in the properties of steel with increases in temperature complicate analysis of what happens during the welding cycle - and, thus, understanding of the factors contributing to weldment distortion.

2.3 DISTORTION - CORRECTIVE TECHNIQUES

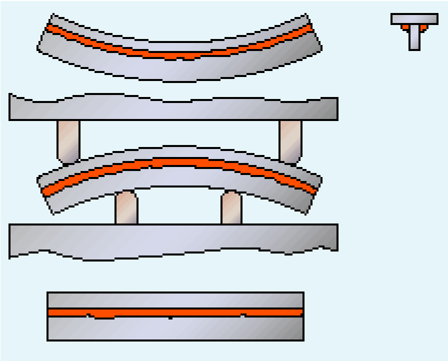
Every effort should be made to avoid distortion at the design stage and by using suitable fabrication procedures. As it is not always possible to avoid distortion during fabrication, several well-established corrective techniques can be employed. However, reworking to correct distortion should not be undertaken lightly as it is costly and needs considerable skill to avoid damaging the component.

In this issue, general guidelines are provided on 'best practice' for correcting distortion using mechanical or thermal techniques.

Mechanical techniques

The principal mechanical techniques are hammering and pressing. Hammering may cause surface damage and work hardening.

In cases of bowing or angular distortion, the complete component can often be straightened on a press without the disadvantages of hammering. Packing pieces are inserted between the component and the platens of the press. It is important to impose sufficient deformation to give over-correction so that the normal elastic spring-back will allow the component to assume its correct shape.



Use of press to correct bowing in T butt joint

Pressing to correct bowing in a flanged plate is illustrated in Fig. In long components, distortion is removed progressively in a series of incremental pressings; each one acting over a short length. In the case of the flanged plate, the load should act on the flange to prevent local damage to the web at the load points. As incremental point loading will only produce an approximately straight component, it is better to use a former to achieve a straight component or to produce a smooth curvature.

Best practice for mechanical straightening

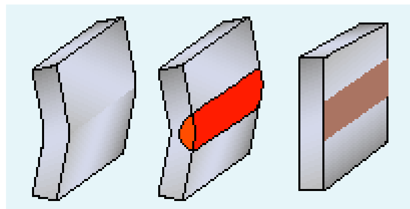
The following should be adopted when using pressing techniques to remove distortion:

- Use packing pieces which will over correct the distortion so that spring-back will return the component to the correct shape
- Check that the component is adequately supported during pressing to prevent buckling
- Use a former (or rolling) to achieve a straight component or produce a curvature
- As unsecured packing pieces may fly out from the press, the following safe practice must be adopted:
    - ✓ bolt the packing pieces to the platen

- ✓ place a metal plate of adequate thickness to intercept the 'missile'
- ✓ clear personnel from the hazard area

Thermal techniques

The basic principle behind thermal techniques is to create sufficiently high local stresses so that, on cooling, the component is pulled back into shape.



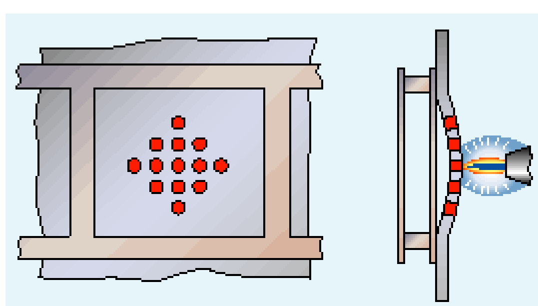
Localized heating to correct distortion

This is achieved by locally heating the material to a temperature where plastic deformation will occur as the hot, low yield strength material tries to expand against the surrounding cold, higher yield strength material. On cooling to room temperature the heated area will attempt to shrink to a smaller size than before heating. The stresses generated thereby will pull the component into the required shape. (See Fig.)

Local heating is, therefore, a relatively simple but effective means of correcting welding distortion. Shrinkage level is determined by size, number, location and temperature of the heated zones. Thickness and plate size determines the area of the heated zone. Number and placement of heating zones are largely a question of experience. For new jobs, tests will often be needed to quantify the level of shrinkage.

Spot, line or wedge-shaped heating techniques can all be used in thermal correction of distortion.

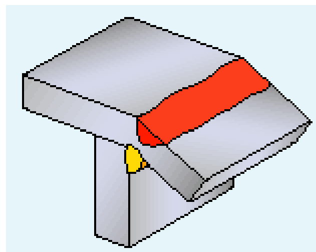
Spot heating



Spot heating for correcting buckling

Spot heating (Fig.), is used to remove buckling, for example when a relatively thin sheet has been welded to a stiff frame. Distortion is corrected by spot heating on the convex side. If the buckling is regular, the spots can be arranged symmetrically, starting at the center of the buckle and working outwards.

Line heating

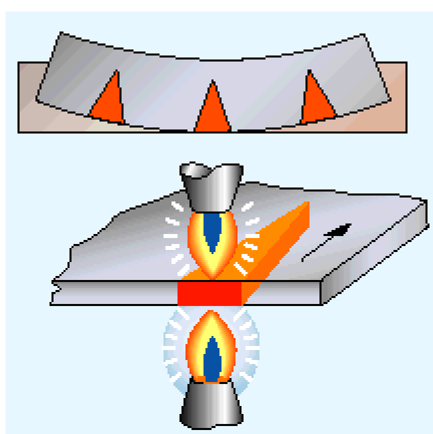


Line heating to correct angular distortion in a fillet weld

Heating in straight lines is often used to correct angular distortion, for example, in fillet welds (Fig.). The component is heated along the line of the welded joint but on the opposite side to the weld so the induced stresses will pull the flange flat.

Wedge-shaped heating

To correct distortion in larger complex fabrications it may be necessary to heat whole areas in addition to employing line heating. The pattern aims at shrinking one part of the fabrication to pull the material back into shape.



Use of wedge shaped heating to straighten plate

Apart from spot heating of thin panels, a wedge-shaped heating zone should be used, (Fig.) from base to apex and the temperature profile should be uniform through the plate thickness. For thicker section material, it may be necessary to use two torches, one on each side of the plate.

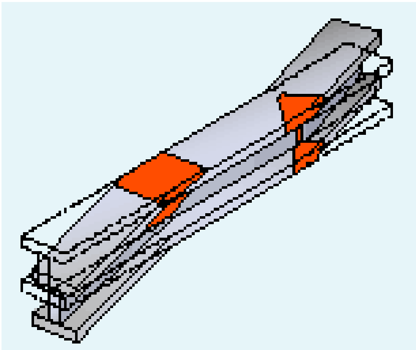
As a general guideline, to straighten a curved plate (Fig.) wedge dimensions should be:

1. Length of wedge - two-thirds of the plate width
2. Width of wedge (base) - one sixth of its length (base to apex)

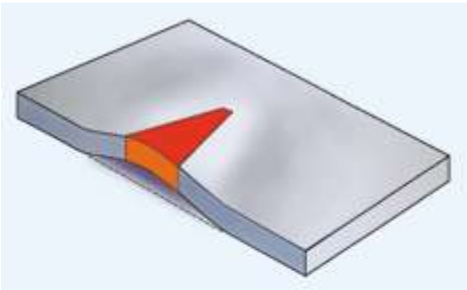
The degree of straightening will typically be 5mm in a 3m length of plate.

Wedge-shaped heating can be used to correct distortion in a variety of situations, (Fig. 6):

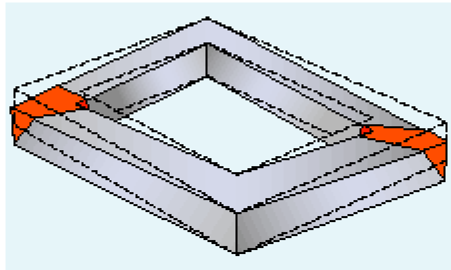
1. Standard rolled section which needs correction in two planes (Fig. 6a)
2. Buckle at edge of plate as an alternative to rolling (Fig. 6b)
3. Box section fabrication which is distorted out of plane (Fig. 6c)



Wedge shaped heating to correct distortion a) standard rolled steel section



b) Buckled edge of plate



c) Box fabrication

General precautions

The dangers of using thermal straightening techniques are the risk of over-shrinking too large an area or causing metallurgical changes by heating to too high a temperature. As a general rule, when correcting distortion in steels the temperature of the area should be restricted to approximately 60° - 650°C - dull red heat.

If the heating is interrupted, or the heat lost, the operator must allow the metal to cool and then begin again.

Best practice for distortion correction by thermal heating

The following should be adopted when using thermal techniques to remove distortion:

- use spot heating to remove buckling in thin sheet structures
- other than in spot heating of thin panels, use a wedge-shaped heating technique
- use line heating to correct angular distortion in plate
- restrict the area of heating to avoid over-shrinking the component
- limit the temperature to 60° to 650°C (dull red heat) in steels to prevent metallurgical damage
- in wedge heating, heat from the base to the apex of the wedge, penetrate evenly through the plate thickness and maintain an even temperature

PREVENT OR MINIMIZEDISTORTION

A major concern for you, when joining, is the susceptibility to cracking and deformation. Cracks can occur in various regions of the joint with different orientations, such as center line cracks, transverse cracks, and micro cracks in the underlying weld metal or adjacent heat-affected zone (HAZ). These cracks are primarily due, to low-melting liquid phases, which allow boundaries to separate under the thermal and shrinkage stresses during weld solidification and cooling. Types of distortion are listed below:

Longitudinal shrinkage

- Transverse shrinkage
- Angular distortion
- Bowing
- Buckling
- Twisting

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (5Pts)

1) All materials have physical and working properties.(1Pts)
A) True B) False
2) _________contain iron and are magnetic. (1Pts)
A) Ferrous metal
B) Non Ferrous metal
C) Metallic alloy
D) All of the above
3) _________do not contain iron and are not magnetic(1Pts)
A) Metallic alloy
B) Ferrous metal
C) Non Ferrous metal
D) None of the above
4) This process has the lowest filler metal melting point of all the soldering types at less than around 400°C. (1Pts)
A) Soft soldering
B) Hard soldering
C) Brazing
D) All
5) Brass or silver is the bonding metal used in this process(1Pts)
A) Brazing
B) Hard soldering
C) Iron soldering
D) Soft soldering

Note: Satisfactory rating - 5 points Unsatisfactory - below 5 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

1.____

2.____

3.____

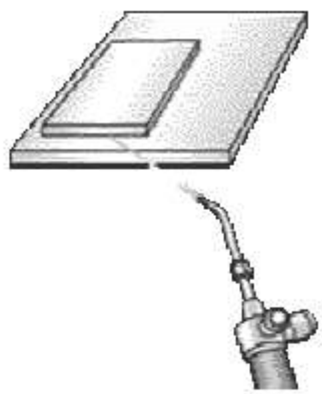
4.____

5.____

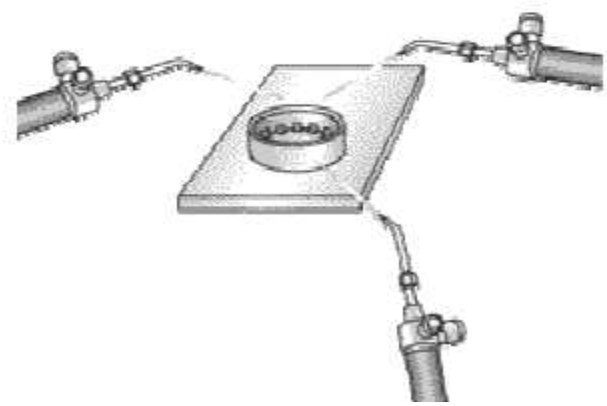
Information Sheet 3	Assembling/aligning materials.

3.1 Soldering

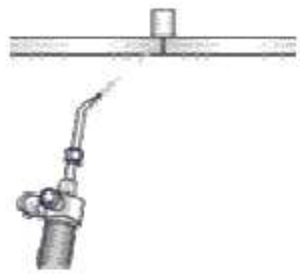
There are three basic types of solder joints that you should know: sweat, which is sur face to surface (joining two flat sheets of metal, one on top of the other); strip, or edge to surface (joining a bezel to its base); and butt, or edge to edge (joining two sheets abutting, or side by side, as in marriage of metals or as in two wires end to end). This simple fact dictates where the solder is placed and how the heat is applied in any solder joint. Disregarding this principle causes more frustration and disasters than anything else except a poor fit.



Sweat-solder joint, surface-to-surface



Strip solder joint. Edge-to-edge surface



Butt solder joint. Edge-to-edge surface

- Plates should be properly squared up and free from burrs.
- Plates must be aligned according to work sheet specifications.

Brazing

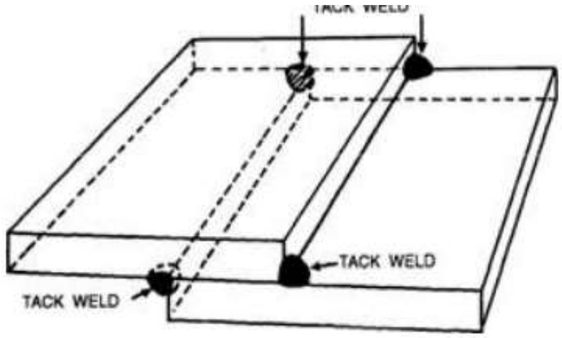
Brazing is usually used to join both similar and dissimilar metals. These include:

- Steel
- Wrought and Cast Iron
- Brass
- Bronze
- Copper Alloy
- Aluminum
- Silver

The following processes are usually followed by brazing:

- Cleaning
- Filing

Joint Preparation (for brazing, the base materials must be very clean and the joint must be perfectly fit with each other. Thus, more time has to be spent on joint preparation.) Below is a joint properly aligned.



Lap joint

Brazing processes on progress

Many less critical structures, such as electronic housings, sensor housings, sensor packages, wave guides, tubes, thermal management packages, heat pipes, cold plates, electrical feedthroughs and electrical contacts, are conventionally soldered.

Soldering can bond many metals, including copper, brass, nickel and nickel alloys, steel and stainless steel and even aluminum. Metals, with the exception of copper and brass, are often plated with copper, gold or nickel to permit these soft solders to wet (spread evenly onto the surface when molten) and adhere.

The advantage of soldering over brazes joining (> 450ºC) are:

- Lower joining temperatures
- Less discoloration or distortion of structural parts
- Joints are more easily disassembled and reassembled

The most common attribute of soldering is the use of fluxes that chemically clean surfaces while the part is heated, allowing the molten solder filler metals to flow onto the surfaces or into the joints being bonded. In conventional flux soldering, the flux and molten solder filler metals flow via capillary action into joints to bond structures together.

3.2 Soldering Procedures

Soldering is a joining process wherein coalescence is produced by heating below 800°F, using a non-ferrous filler metal with a melting point below that of the base metal. The metals to be joined dictate the flux, solder, and heating methods to be used. Base metals are selected for specific properties such as electrical conductivity, weight, and corrosion resistance.

To achieve a sound soldered joint, the following should be considered:

- **Joint design**: They should be designed with the requirements of soldiers and their limitations in mind.

- **Pre-cleaning**: The surfaces must be thoroughly cleaned to allow the solder to wet the base metal.
- **Fluxing**: A flux must be provided to remove traces of surface film or oxides and to prevent formation of oxides during the soldering operation.
- **Proper fixtures** or alignment of parts must be maintained to insure a sound soldered joint.
- **Heating** of the base metals should be uniform or even on base metals, to insure good penetration of the filler alloy into the joint. If a noncorrosive flux is used no further cleaning is necessary. The use of a corrosive flux makes flux residue removal imperative.

Basic Steps of Soldering

1. **Joint fitting**: A clearance of 0.005" is suitable for most soldering. When soldering pre coated metals, a clearance of 0.001" is recommended for maximum mechanical strength.
2. **Types of cleaning include**:
   - Mechanical - Scotch Brite pad, emery cloth
   - Chemical - cleaning using acids to remove rust, scale or sulfides. Most commonly used acids are hydrochloric and sulfuric.
3. **Application of flux**
   - Flux should be capable of removing oxides and stop them from reforming.
   - Flux should permit displacement by the solder.
   - Flux should promote wetting of the surface by the solder.
4. **Application of heat**: Heating the joints evenly or uniformly is of utmost importance to insure a sound joint.
   - Types of soldering equipment:
     1. Soldering irons - electric
     2. Plumbers torch - propane low heat
     3. Dip soldering - large tank with molten solder to solder multiple joints

4. Oven heating - only used in production where other heating methods are impractical

5. **Applying the Solder takes place in two steps**:
    1. Wetting the metal surfaces
    2. Filling the gap between the wetted surfaces with solder depending upon conditions dictated by the application, each step can be done separately. This allows for more easily controlled conditions.
6. **Cooling the Joint**:

    - As soon as possible after soldering the joint may be cooled using water spray or air blast. Slow cooling could cause excessive alloying, resulting in a brittle joint.

- **Flux Residue Treatment**:
    - Non-corrosive fluxes are ones which are rosin base and do not require removal. Corrosive fluxes are fluxes containing zinc chloride. Removal is a must to prevent corrosion.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (9Pts)

1) What is soldering? (3Pts)
2) Brazing usually used to joint(3Pts)
3) Write soldering procedures(3Pts)

Note: Satisfactory rating - 9 points **Unsatisfactory - below 9 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

1.____

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2.____

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3.____

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Information Sheet 4	Identifying distortion prevention measures and taking action.

4.1 PREVENT OR MINIMIZEDISTORTION

A major concern for you, when joining, is the susceptibility to cracking and deformation. Cracks can occur in various regions of the joint with different orientations, such as center line cracks, transverse cracks, and micro cracks in the underlying weld metal or adjacent heat-affected zone (HAZ). These cracks are primarily due, to low-melting liquid phases, which allow boundaries to separate under the thermal and shrinkage stresses during weld solidification and cooling. Types of distortion are listed below:

- Longitudinal shrinkage
- Transverse shrinkage
- Angular distortion
- Bowing
- Buckling
- Twisting

You should ensure that distortion is prevented by:

- using a sequence of welding known as wandering that provides for making welds at different points of the braze or solder.
- Tacking welding both ends prior to completing the weld.
- Supporting work piece during the soldering/brazing process.
- Pre-setting parts so that welding distortion will achieve overall alignment and dimensional control with the minimum of residual stress.
- Pre-bending edges to counteract distortion and achieve alignment and dimensional control with minimum residual stress.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (4Pts)

1) Write list of distortion (4Pts)

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

1.____

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5.1 Heating equipment

Heating systems are required to ensure comfort winter, especially in colder climates. An NZEB must be designed to harness the power of sun through correct orientation, glass area, and insulation so as to reduce the need for heating. In residential application portable electric space heaters are common in India, although they are inefficient and should only be used, where no other options are possible. Small heat-pumps are getting popular in new residential buildings; these are often 3-4 times more efficient than electric space heaters.

Central Furnace - A central furnace is a self-contained, indirect-fired or electrically heated furnace supplying heated air through ducts to spaces. A central furnace can be a stand-alone unit, but is typically integral to a rooftop-DX (direct expansion) system or split DX system air conditioner. Though less common, a central furnace may also contain a hydronic coil that would be used for air conditioning.

Duct Furnace - A duct furnace is a furnace normally installed in distribution ducts of air-conditioning systems to supply warm air. A duct furnace usually does not have its own supply fan and uses air supplied through the ducts by other supply fans such as a fan for a central air conditioner.

Hydronic or Steam Coil - A hydronic coil is an array of tubing, placed in a supply air stream, through which hot or cold water passes, heating or cooling the supply air stream to provide heating or air conditioning to a space. Hydronic coils, central furnaces, and DX coils are used in various configurations of heating and air- conditioning systems. A steam coil is an array of tubing, placed in a supply air stream, through which steam passes to provide heat to a space.

Heat Pump - A heat pump is a DX air conditioner with a reversing valve, allowing it to operate in two refrigeration modes. When the refrigeration system is reversed, the heat pump absorbs heat from the outdoor air and rejects it to the indoor environment, providing heat to the space. Heat pumps are manufactured in several configurations, including packaged terminal, rooftop package, split system, water loop, and ground coupled.

5.2 Power Supply Unit

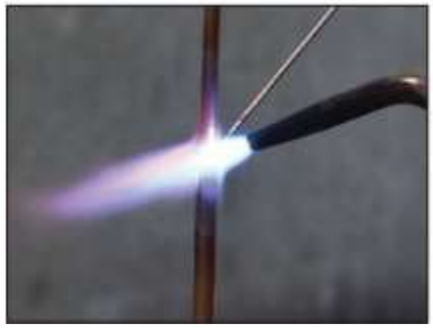
Laboratory power suppliers have a practical application in both repairs and diagnostics of modern electronic devices. They can be used to supply the power to the motherboards of electronic devices, for example, smartphones, without using the battery. Moreover, you can adjust the current and the voltage, which is extremely helpful when repairing any type of electronic devices.

The power supply units with the wattage of up to 30 W and the current of up to 3 A, for example, UNI-T UTP3315TFL, can be used for almost any type of soldering and repair works.

5.3 HEAT SOURCES FOR BRAZING

The heat for brazing is typically provided by a hand-held torch, a furnace or an induction heating system. Other techniques include dip brazing and resistance brazing. Torch brazing is often used for small assemblies and low-volume applications. A “neutral” flame with a bluish to orange tip, a well-defined bluish white inner cone and no acetylene feather works the best; a flame with a colorless tip can cause oxidation. Although the quality of the joint is largely dependent on operator skill and consistency is sometimes an issue, torch brazing requires only a small investment and is very popular.

Furnace brazing does not require a skilled operator, and is often used to braze many assemblies at once. This method is only practical if the filler metal can be pre-positioned. Furnaces normally must be left on 24/7 to eliminate long start up and cool down delays, and are not particularly energy-efficient.



Torch brazing is often used for small assemblies

5.4 OXY-ACETYLENE APPARATUS

Oxy-fuel apparatus consists of two cylinders (one oxygen and one acetylene) equipped with two regulators, pressure gauges, two lengths of hose, and a blow torch. The regulators are attached to cylinders and are used to reduce and maintain a uniform pressure of gases at the torch. The gases at reduced pressure are conveyed to the torch by the hoses. The regulators include high pressure and low pressure gauges to indicate the contents of the cylinder and the working-pressure on each hose. When the gases reach the torch they are there mixed and combustion takes place at the welding tip fitted to the torch.

- **The basic equipment used to carry out gas welding** is:
  - ✓ Acetylene gas cylinder (maroon/red)
  - ✓ Oxygen gas cylinder (green)
  - ✓ Oxygen and Acetylene pressure regulator
  - ✓ Oxygen gas hose (Blue) and Acetylene gas hose (Red)
  - ✓ Welding torch or blow pipe with a set of nozzles and gas lighter
  - ✓ Protective equipment for the welder (e.g., asbestos apron, gloves, goggles, etc.)
  - ✓ Trolleys for the transportation of oxygen and acetylene cylinders

ACETYLENE GAS CYLINDER

An acetylene cylinder is also a solid drawn steel cylinder and the common sizes are 300, 120 and 75 cubic feet. Cylinder pressure is 250 PSI when filled. An acetylene cylinder is painted maroon and the valves are screwed left handed (with grooved hex on nut or shank).

Acetylene is extremely unstable in its pure form at pressure above 15 PSI. This instability places special requirements on the storage of acetylene. Acetylene cylinders are packed with porous material (balsa wood, charcoal, corn pith, or Portland cement) that is saturated with acetone to allow the safe storage of acetylene. These porous filler materials aid in the prevention of high-pressure gas pockets forming in the cylinder.

Acetone, a colorless, flammable liquid, is than added to the cylinder until about 40 percent of the porous material is saturated. Acetone is a liquid chemical that dissolves large portions of acetylene under pressure without changing the nature of the gas and is a liquid capable of absorbing 25 times its own volume of acetylene gas at normal pressure. Being a liquid, acetone can be drawn from an acetylene cylinder when it is not upright.

Oxygen Cylinder Valves

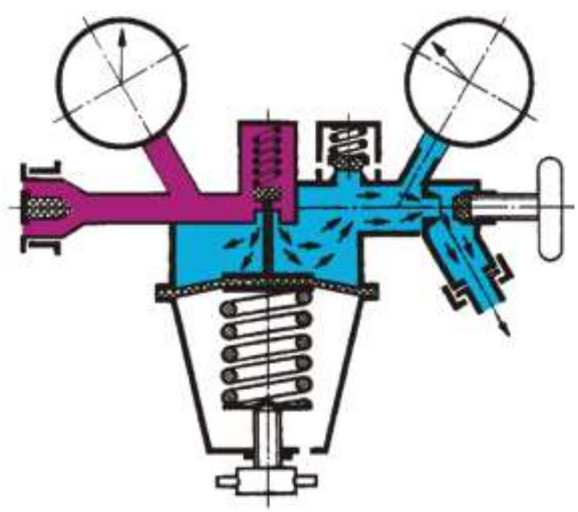
The oxygen cylinder valve is made largely of brass with **right hand** threads. Its outlet is threaded and machined. Every oxygen cylinder valve is also equipped with *a bursting disk* which will rupture and release the contents of the cylinder if cylinder pressure should approach cylinder test pressure (as it might in case of a fire). In order to protect cylinder valve from getting damaged, a removable steel cap is screwed on the cylinder at all times when the cylinder is not in use. The cylinder valve is kept closed when the cylinder is not in use and even when cylinder is empty.

PRESSURE REGULATOR

- Pressure regulator performs two functions.
  - ✓ Reduce high storage pressure from the cylinder to the suitable working pressure
  - ✓ Help in maintaining constant gas pressure at the blowpipe.
- Two types of pressure regulator are used to set up oxyacetylene welding unit:
  - ✓ Acetylene pressure regulator and
  - ✓ Oxygen pressure regulator

Most regulators have two gauges. The right gauge measures the pressure of gas in the cylinder (supply pressure) and the left one measure the gas coming in to the blowpipe (working pressure)

Gas Regulator

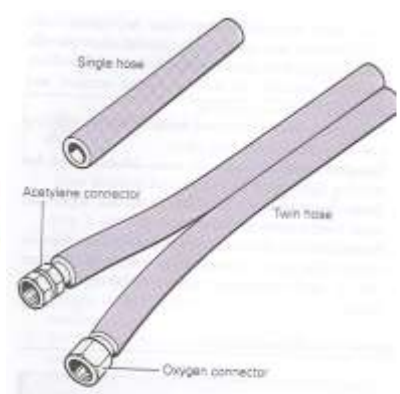


Difference between Oxygen and Acetylene Pressure Regulators

Acetylene Regulator	Oxygen Regulator
The cylinder and hose connections have left handed threads on the acetylene regulator	There are right hand threads in this case
Acetylene connection nuts have chamfers or grooves cut in them.	Nuts are plain, i.e., with no chamfer or grooves.
Color band on acetylene regulator in maroon or red.	It is either blue or black on the oxygen regulator.
The inlet or high pressure gauge on the regulator reads up to 8bar.	The inlet or high pressure gauge on the regulator reads up to 100bar.
The outlet or low pressure gauge on the regulator reads up to 1bar.	The outlet or low pressure gauge on the regulator reads up to 4.8bar.

GAS HOSES & CLAMPS

The hoses used to make the connections between the torch and the regulators must be strong, nonporous, light, and flexible enough to make torch movements easy. The most common type of cutting and welding hose is the twin or double hose that consists of the fuel hose and the oxygen hose joined together side by side.



Welding hoses and connectors.

Oxygen hoses are **green** in color and have right hand thread. **Acetylene hoses** are **red** in color with left hand thread. The nut on the acetylene connection has a notch that runs around the center, distinguishing it from the nut on the oxygen connection. This is a safety precaution to prevent hoses from being hooked up the wrong way.

- Some precautions are to be taken when using reinforced rubber hoses:
  - ✓ Only one gas should be used in a hose. For example, using an oxygen hose to carry acetylene could cause a serious accident.
  - ✓ The hose should never be patched or repaired.
  - ✓ Hot metal (job) should never be placed on the hose.

HOSE CLAMPS

A metal clamp is used to attach the welding hose to a nipple. There are basically two types of connections that can be used. The first is using a jubilee clip. The second option is using a crimped connector. The second option is probably safer as it is harder for this type of connection to come loose. The hoses should also be clipped together at intervals approximately 3 feet apart.

Figure 9 Hose clamps

WELDING TORCH & BLOW PIPE

A welding torch mixes oxygen and acetylene in the desired proportions, burns the mixture at the end of the tip, and provides a means for moving and directing the flame.

- There are two types of welding torches, namely:

✓ High pressure (or equal pressure) type

✓ Low pressure (or injector) type

High pressure blowpipes or torches are used with (dissolved) acetylene stored in cylinders at a pressure of 117 psi. Low pressure blowpipes are used with acetylene obtained from an acetylene generator at a pressure of 8 inch - head of water (approximately 0.3 psi).

In high pressure blow torch, both the oxygen and acetylene are fed at equal pressures and the gases are mixed in a mixing chamber prior to being fed to the nozzle tip.

- The high pressure torch also called the equal pressure torch is most commonly used because:
    - ✓ It is lighter and simpler;
    - ✓ It does not need an injector;
    - ✓ In operation, it is less troublesome since it does not suffer from backfires to the same extent.
- **There are two types of blowpipe or torch**: -
    - ✓ **Welding blowpipe**
    - ✓ **Cutting blowpipe**

The difference is an extra oxygen control valve, which is used to produce an oxygen jet, which does the cutting. Welding blowpipe have the ejector or law pressure types that will be the mixing chamber I the nozzle tube and balance types which used with high pressure cylinder.

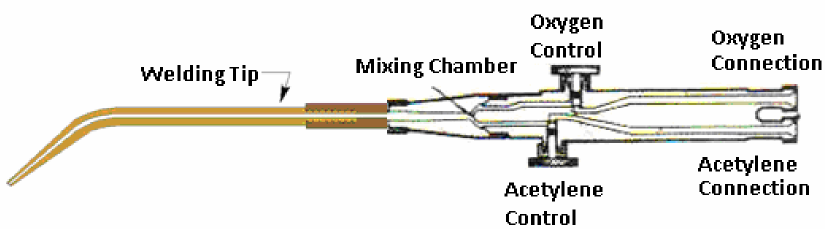


Figure 10 High pressure (equal Pressure) type of welding torch

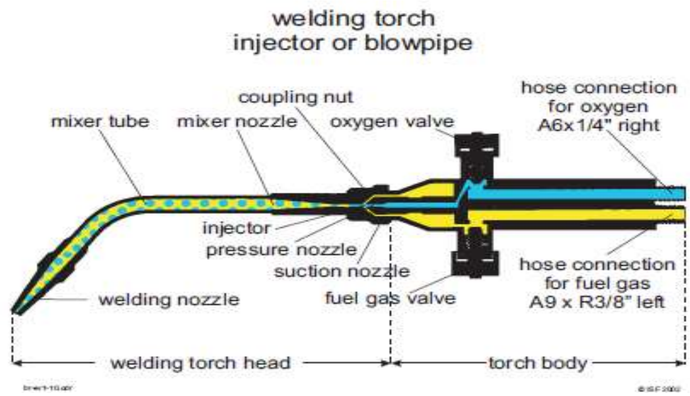


Figure 11 Injector Type of welding tor

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (4Pts)

4) _________is a self-contained, indirect-fired or electrically heated furnace supplying heated air through ducts to spaces. (1Pts)

A) Central furnace

B) Duct furnace

C) Heat pump

D) All

5) The heat for brazing is typically provided by a hand-held torch, a furnace or an induction heating system. (1Pts)

A) True B) False

6) ________cylinder valve is made largely of brass with right hand threads. (1Pts)

A) Oxygen cylinder

B) Acetyl cylinder

C) Argon cylinder

D) None of the above

7) A metal clamp is used to attach the welding hose to a nipple. (1Pts)

A) True B) False

Note: Satisfactory rating - 4 points Unsatisfactory - below 4 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

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6.1 Introduction

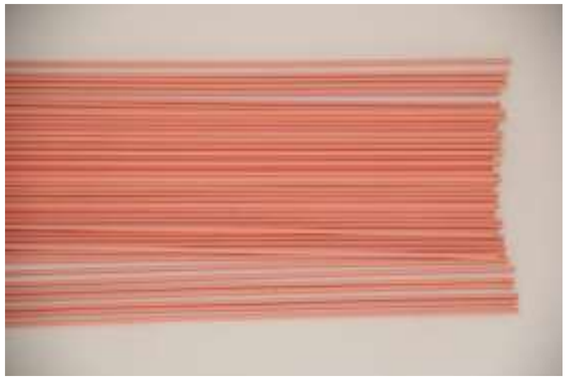
Materials that are used in a production process although, unlike direct materials, they do not form part of the direct cost of sales. Examples are cooling fluid for production machinery, lubricating oil, and sanding discs. In circumstances in which direct materials of small value are used, such as cotton or nylon thread or nails and screws, they are sometimes treated in the same way as consumable materials.

6.1.1 ALLOYS, MATERIALS AND TOOLS FOR BRAZING AND SOLDERING

Silver alloys with different silver content and copper-phosphorous can be widely applicable in installing of all kinds of industry as well as home refrigeration and air conditioning equipment, electronics and different constructions.

Soldering alloys are low-temperature, free-flowing filler metals for joining similar and dissimilar metals (i.e. copper to steel). The joints are safe because they are cadmium-free.

FLUX COATED SILVER ALLOY 40%



Form: round rods 2x500 mm

Chemical compositional 40%-cu 30%-zn 28%-sn 2%

Melting range: 650°-710° c

Working temperature: 690°c

Recommended for brazing steel, copper, copper alloys and nickel alloys. not recommended for aluminum and magnesium.

FLUX COATED SILVER ALLOY 30% AG

Form: round rods 2x500 mm

Chemical compositional 30%-cu 36%-zn 32%-sn 2%

Chemical composition of flux: boric acid 20-30%-potassium difluoride 20-30%-potassium tetra fluoroborate 10-20%

Melting range: 665°-755°c

Working temperature: 740°c

Particularly suitable for massive brass welding with low capillarity.

COOPER-PHOSPHOROUS ALLOY WITH 5% OF SILVER WITHOUT FLUX

Form: square rods 2x2x500 mm

Chemical compositional 5%-cu 89%-p 6%

Melting range: 645°-815°c

Working temperature: 710°c

Has been developed primarily for use in copper, however, its application has been extended to other non-ferrous copper alloys.

This alloy is commonly used in refrigeration, air conditioning, electrical conductors, pipes for hot and cold water and pre-fabricated houses.

It's a copper-phosphorus alloy with intermediate percentage of silver with good flow properties, ductility and self-fluxing in copper. it is not advisable its use in nickel alloys and iron-based alloys, under penalty of having formation of brittle compounds at the interface of the joint, giving less good properties. Similar, it is not advisable to use this alloy in sulfurous environments.

Silver alloys with different composition of 0%, 2%, and 15% of silver without flux. For different soldering and brazing.

6.2 Silver Solder & Braze

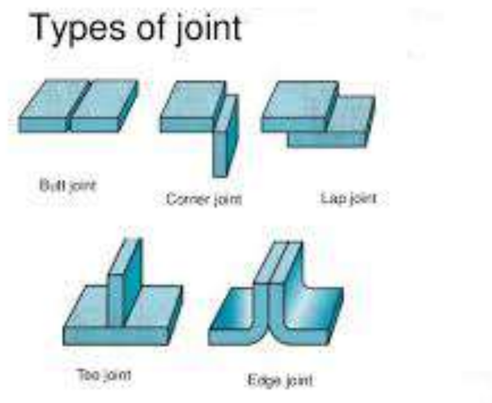
Silver Solder

Silver Solder is more fluid than Braze and works by being drawn into the joint by a capillary action. So if, for example, you want to join two pieces of thin sheet metal together, you would need to overlap them. The Silver Solder will be drawn through the joint, filling the minute crack between the two pieces of metal, bonding with the surfaces to join them. If you tried to butt the two pieces of metal together, there simply wouldn't be enough surface area touching to achieve a strong joint.

Silver Solder is used with a Flux, which chemically cleans the metal and keeps it clean during the Silver Soldering process. Silver Solder is also known as Silver Brazing.

Braze

Braze on the other hand, does not get drawn into the joint, but is built up on the surface of the metal being joined, so it looks more like a weld. Like Silver Solder, the Braze material bonds with the surface of the metal being joined. Braze is used with a Flux, which chemically cleans the metal and keeps it clean during the Brazing process. Brazing is also known as Bronze Welding. What Silver Solder & Braze have in common is that neither involves melting the metal that's being joined, that would be welding! In the joint examples shown, I would use Silver Solder on the Edge & Lap Joint and Braze for the Butt, Corner & Tee Joint.



Types of Silver Solder & Braze

Whilst there are a number of Brazing Alloys on the market, for this article we'll keep it simple and just cover the most common, C2.

C2 is a multi-purpose, Silicon Bronze brazing rod that's suited to most general purpose brazing on metals including Steel, Copper, Cast Iron and dissimilar metals.

C2 Braze is Brass Colored and typically melts at around 875ºC.

Most Silver Solders can be categorized by their Silver content. The Silver content will determine the fluidity and melting temperature, the more silver, the more fluid and the lower the melting temperature.

Most common are 33% Silver (around 720ºC), 40% Silver (around 675ºC) and 55% Silver (around 650ºC).

Also available are Silver bearing Copper Phosphorus Alloys (CoPhos). These are available with either 2% or 5% Silver and are used primarily for joining Copper to Copper, where, if the metal is clean, no Flux need be used.

Silver Solder can be used to join most common metals, including Mild Steel, Stainless Steel, Copper, Brass, Cast Iron and Dissimilar Metals.

Silver Solder & Braze is usually available in 2 or 3 forms:

1. Bare Wire – (Silver Solder & Braze). This is my preferred type. With this wire you use a powder flux. This can be coated onto the wire as necessary by gently warming the end of the wire in your flame, then dipping in the powder. This can be repeated as necessary.

2. Flux Coated – (Silver Solder & Braze). This may seem like a good idea, but there are, for me, three flaws. Flux coated wires are more expensive than bare wire. If you need additional flux, you'll still need a pot of powder. If the wires are bent, the flux tends to fall off!
3. Flux Impregnated – (Braze Only). Here the flux is in little nicks on the wire. This works very well and the wires can be bent. The downside is that flux impregnated wires are the most expensive.

Tin lead alloy

A tin-Lead solder is the largest single group and the most widely used of the soldering alloys. Tin-Lead solders are compatible for use with all types of base metal cleaners, fluxes, and heating methods. 60/40 Tin Lead solder, almost the eutectic is particularly adaptable to delicate work or when soldering temperature may be critical. This particular item is a soldering bar weighing approx. 1 Lb. with dimensions of approx. 3/4″ wide x 1/4″ thick x 14″ long.

Brass alloy

Brass is an alloy. In this case a mixture of copper and zinc. The zinc gives brass a tougher surface and more rigidity than copper, but also makes it less malleable, more brittle. Brass rod is strong enough to maintain its shape and straightness well, but soft enough to be easily cut with hand-tools. For these reasons it is one of the most available metals in a wide variety of fine-scale forms. Copper is softer and can be worked even more easily, but rods of around 1mm thickness would deform too easily and have much less structural rigidity. In addition, copper is an excellent conductor, which means that standard soldering irons would struggle to keep up with the constant heat loss from the joint area.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (9Pts)

1) What is silver alloy? (3Pts)
2) What is silver solder? (3Pts)
3) What is brazing? (3Pts)

Note: Satisfactory rating - 9 points **Unsatisfactory - below 9 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: __________________________ Date: _______________

Test I

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LG #35	LO #2- Braze and/or silver solder

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content:

- Selecting process.
- Performing brazing, braze welding, silver soldering
- Preheating materials.
- Appling consumables using correct techniques.
- Appling jointing material.
- Annealing material.

This guide will also assist you to attain the learning outcome stated on the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- The correct process is selected to meet specifications.
- Materials are preheated as required
- Consumables are applied using correct techniques
- Jointing material is applied correctly and in appropriate quantities to meet job/specifications
- Material temperature is annealed using correct and appropriate techniques

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your

trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1	**Selecting process**

1.1 Performing brazing, braze welding, silver soldering

Brazing and soldering, in essence, are the same in that they both melt the filler metal (braze or solder) only, not the base materials. The liquid filler metal wets the base materials through capillary action. When the liquid filler metal solidifies, it is bonded to the base materials, creating a joint. What differentiates soldering and brazing is the melting temperature of the filler metal; brazing is hotter.

Each process has its advantages and disadvantages, from a processing and application perspective.

1.2 Brazing procedure

CUT TUBE SQUARE Cut to the exact length required using a tube cutter or hacksaw. If a hacksaw is used, a sawing fixture should also be used to ensure square cuts. Remove all inside and outside burrs with a reamer, file, or other sharp edge scraping tool. If tube is out of round, it should be brought to true dimension and roundness with a sizing tool.

CLEAN TUBE END AND INSIDE SURFACE OF FITTING The joint surface areas should be clean and free from oil, grease, or oxide contamination. Surfaces may be properly cleaned for brazing by brushing with a stainless steel wire brush or by a stiff rubbing with emery cloth. If oil or grease is present, clean with a commercial solvent. Remember to remove small foreign particles such as emery dust, by wiping with a clean dry cloth. The joint surface MUST be clean.

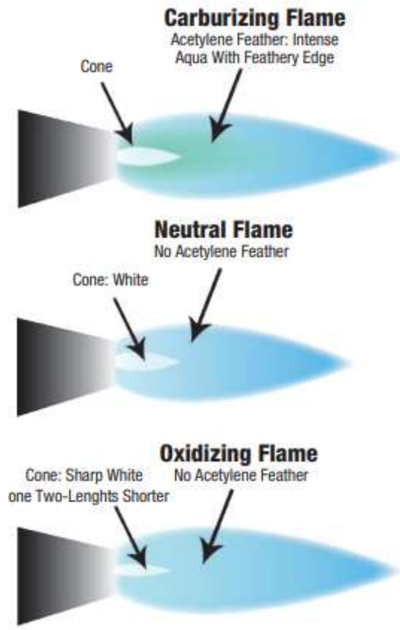
SELECT BRAZING ALLOY Refer to the Alloys Selection Tables for recommended brazing filler metal selection. When brazing copper to copper, alloys such as DynaflowTM, Stay-SilvTM 5, or Stay-SilvTM 15 are recommended. These alloys contain phosphorus and are self-fluxing on copper. When brazing brass or bronze fittings, Stay-SilvTM white is required with these alloys. When brazing iron, steel or other ferrous metals, select one of the Safety-Silv TM brazing alloys such as Safety-SilvTM 45 or Safety-SilvTM 56 with Stay-Silv TM white or Eco Smart® flux. Do not use phosphorus bearing alloys as the joint may be brittle.

PERFORM PROPER FLUXING Proper fluxing is important because the flux absorbs oxides formed during heating and promotes the flow of the filler metal. Stir paste flux before use. If flux is dried out add a small amount of water until flux reaches a paste consistency. When using Stay-SilvTM white flux, apply it only with a brush. To prevent excess flux residue inside refrigeration lines, apply a thin layer of flux to only the male tubing. Insert the tube into the fitting and, if possible, rotate the fitting once or twice on the tube to ensure uniform coverage.

FLUX APPLICATION White flux is used for most applications. Black flux is helpful for long heating cycles or localized heating with induction. It is also used when brazing stainless steel. Flux goes through physical changes during heating and turns clear at about 593°C. This is an indication that parts are close to brazing temperature.

TORCH FLAME ADJUSTING

OXYGEN / FUEL Alternate fuel gases such as propane, propylene, butane, and natural gas / methane mixed with oxygen is the most common method used for production brazing globally. This is due to these gases higher Kcal content, increased safety, and reduced cost when compared to acetylene. For most brazing jobs using oxy-acetylene gases, a slightly carburizing or neutral flame should be used. The neutral flame has a well-defined inner cone. Avoid an oxidizing flame.

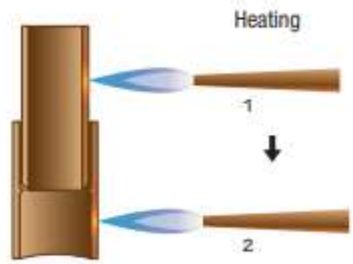


AIR / ACETYLENE TORCHES Brazing with air/acetylene torches is a popular alternative to oxygen mixed fuel gas. The fuel gas flow aspirates air into a mixer that contains an internal vane that spins the gas to improve combustion and increase flame temperature. If the tank has a delivery pressure gauge, set the delivery pressure at 0,97 – 1,03 bar. If the tank has only a contents gauge delivery pressure is preset at the factory. Open the regulator adjusting screw all the way by turning it clockwise until it bottoms.

OPEN THE TORCH VALVE Opening the torch valve about 3/4 of a turn will provide sufficient fuel gas delivery. Do not try to meter pressure (reducing the flame) by using the torch handle valve. If a higher or lower flame is required, change to a different tip size.

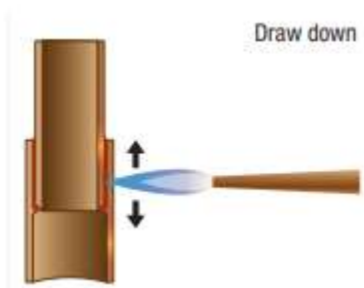
Always keep the torch in short motion.

- Start heating the tube, by first applying the flame to a point just adjacent to the fitting. Work the flame alternately around the tube and fitting until both reach brazing temperature, before applying the brazing filler metal.



- When a flux is used, it will be a good temperature guide. Continue heating the tube until the flux passes the “bubbling” temperature range and becomes quiet, completely fluid and transparent. Watch for this on both sides of the joint to ensure even heating.
- Direct the flame from the tube to the fitting. When alloy is applied it should quickly melt and flow into the joint.

- Sweep the flame back and forth along the axis of the assembled joint, tube, and fitting to reach and then maintain uniform heat in both parts.



APPLY THE BRAZING ALLOY feed the alloy into the joint between the tube and the fitting. Only after the base metals have been heated to brazing temperatures should the filler metal be added. At that time, the flame may be deflected momentarily to the tip of the filler metal to begin the melting process. Always keep both the fitting and the tube heated by playing the flame over the tube and the fitting as the brazing alloy is drawn into the joint. The brazing alloy will diffuse into and completely fill all joint areas. Do not continue feeding brazing alloy after the joint area is filled. Excess fillets do not improve the quality or the dependability of the braze and are a waste of material.

CLEAN AFTER BRAZING All flux residues must be removed for inspection and pressure testing. Immediately after the brazing alloy has set, quench or apply a wet brush or swab to crack and remove the flux residue. Use emery cloth or a wire brush, if necessary.

Preparation of soldering

Wetting / Flowing. The joint surfaces shall be mechanically and chemically protected with a flux during soldering.

Mechanical Cleaning. The following methods can be used for removing foreign material:

a. Sanding or grinding

b. Hand filing or sanding

c. Wire brushing or scraping

d. Shot blasting

Chemical Cleaning. Mechanically cleaned metal surfaces exposed to air react and form oxide films. Aluminum, magnesium, and stainless steel form refractory oxide films. Copper and silver form easily dissolved oxides. Refractory oxides require use of a corrosive flux. Softer oxides require only a less corrosive material.

Solders

Except for potable (drinking) water systems, tin-lead solder (50/50) can be used for the majority of applications.

Use the lead-free solders listed in Table IA for potable water systems. For selection of the appropriate solder, see Tables I and II. The Pasty Range is the difference between the maximum temperatures the alloy is solid and the minimum temperature it is liquid.

Fluxes

After mechanically cleaning the metal, fluxes are used to prevent oxides from reforming thus enhancing flow during soldering. Fluxes can be a liquid or paste, corrosive or noncorrosive. Use the mildest flux that will adequately remove and exclude oxides from the joint being soldered.

The disadvantage of corrosive (inorganic and organic) fluxes is that they produce a residue. If not removed or neutralized, they remain active after the joint is soldered, thus corroding the adjacent areas. Chloride containing fluxes may cause stress corrosion cracking when used on stainless steel material. Phosphoric acid type fluxes can avoid the stress corrosion problem. Their use is limited to below 260 C (550 F). For reasons of the residue problem, corrosive fluxes shall not be used on delicate electronic work and instruments.

There are three basic types of noncorrosive fluxes: nonnative rosin, mildly activated rosin, and activated rosin. Rosin fluxes shall not be used with flame heating as they will decompose without cleaning effectively.

Soldering Methods and Techniques

After the surfaces to be joined are properly cleaned, apply sufficient flux to completely cover the joint surface(s). The joint is now ready for the application of heat either by soldering irons (copper bit or quick-heating gun type) or by flame.

Soldering irons consist of a copper alloy bit that is electrically or flame-heated. The bit conducts heat readily and is easily ‘tinned’ (coated with solder). The temperature of the iron shall be maintained between 371-399C (700-750F) for efficient soldering. Temperatures in excess of 399 C (750 F) will cause the bit to scale introducing tinning problems (tin will burn out of tin-lead solder resulting in poor solder adhesion) and cause rosin fluxes to carbonize.

Silver soldering

Silver brazing filler metals have low melting point, good wettability and filling performances. They also have features of high mechanical strength, fine plasticity, electrical conductivity and corrosion resistance.

Clean and Prepare Your Metal

The basic idea with silver soldering is less about "melting silver" and more about heating two separate pieces of metal to a point where the silver will flow onto and between them. This silver will then form a bond between the two pieces of metal. In the case of a high-silver solder like I use (Harris Safety-Silv 56%), the bond is VERY strong. As I show in my video, the joint can take significant stress and bending.

Apply Flux

Soldering flux must be applied to each metal surface at the joint. Flux prevents oxidation during the heating process, allowing the solder to flow properly onto/into those areas.

Cut Your Silver Solder

While you CAN simply apply the silver solder directly from the roll while you are torching, you may end up using much more silver than you need to. I prefer to cut an appropriate-sized piece of silver solder for the joint. Once you have your silver solder pieces cut, go ahead and apply flux to them as well.

Position Your Parts and Solder Pieces

Using your "helping hands", titanium clamps, metal assistance wire, or whatever your preferred clamping/holding setup may be, situate the pieces as you want them to be, and ensure they are butted together as CLOSELY as possible. You don't want any big gaps here. Silver solder flows well into areas that are tightly fitted. Carefully place your silver solder pieces on top of the joints. The paste flux helps hold them in place initially.

Apply Heat

Once everything is in position, you are ready to turn on the torch and apply heat. (I almost always have to dial the heat back on my Mapp gas torch. You will get a feel for how much is too much.)

Pickle (or Just Sand It)

Once your piece is cooled, you can remove the clamps and it should all hold together on its own. You'll notice the burnt flux and oxidation, which you'll want to remove. You can use a "pickle" for this (see video for recipe) or you can simply sand it. My favorite way to finish the piece is with a wire brush attached to a drill.

You've got a Strong Silver-soldered Joint

Give your joints a little twist/bend to be sure it's secure. I'm not saying to bend it out of whack, but just check to make sure it feels good and strong.

At this point you can apply a clear coating to your piece to prevent oxidation/rust, or you can leave it as is. Harris Safety-Silv 56% works with steel, stainless steel, copper, brass and other metals. With stainless steel in particular, you can get some very nice, color-matched joints.

1.4 Typical applications of brazing/braze welding and silver soldering processes

1.4.1 Typical applications of brazing/braze welding

The braze welding process is considered an excellent choice for the joining of coated (eg galvanized) thin sheet steels. These steels, when welded using a traditional arc-welding process produce large quantities of zinc vapor. This has several negative effects. Firstly, the vapor can cause defects in the weld such as pores or gas voids reducing the strength of the welded joint. Secondly, the loss of zinc from the surface of the parent plate results in a significant reduction in its corrosion resistant properties, sometimes necessitating re-coating of the steel.

The welding process also introduces significant heat into the base metal, resulting in significant distortion and a wide heat-affected zone. These effects can be reduced by using a brazing process, due to the lower heat needed to melt the filler wires compared to a standard welding process. The reduced damage to the zinc coating means that it will still provide galvanic protection to the base steel even in the 1–2mm region around the joint where the coating has been lost. This also produces less zinc containing welding fume.

TWI has recently completed an investigation into the use of arc brazing for the joining of 1mm-thick galvanized DP600 sheet with a CuSi3 filler metal. This work showed that with the correct joint fit-up and suitable process parameters, the strength of the joint is capable of overmatching the ultimate tensile strength (UTS) of the parent plate. The adhesion of the braze material on the top and bottom surfaces of the DP600 plate provides sufficient strength such that the overall joint has a UTS greater than 600MPa, despite the UTS of the filler being approximately 350MPa.

Typical applications of silver soldering

The following are brazing alloys that, thanks to the addition of specific elements, or to their particular composition, have improved characteristics that make them suitable for specific applications or to operate in difficult conditions.

In particular, the addition of Nickel helps in joining difficult-to-braze materials (such as stainless steel, tool steel, tungsten carbide, nickel and nickel alloys, etc.) and improves corrosion resistance.

Manganese helps in brazing carbides.

Alloys without Copper are ammonia resistant.

Alloys without Zinc are suitable for brazing in oven and may be used to join stainless steels in wet conditions to avoid interfacial corrosion problems.

Alloys with Indium are suitable to join pieces that will undergo TiN coating.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (9Pts)

1) Write brazing procedure shortly (3Pts)
2) Torch flame adjusting is one of the processes of brazing procedure. If YES, WHY? IF NO? WHY? (3Pts)
3) Write preparation of soldering (3Pts)

Note: Satisfactory rating - 9 points **Unsatisfactory - below 9 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

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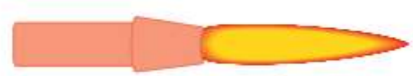
Information Sheet 2	Preheating materials

2.1 Introduction

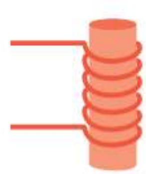
Preheating is often necessary to control or reduce the rate of expansion or contraction in a structure during welding. This is done by preheating the entire structure before welding and maintaining the heat during welding. When preheating be sure that you move the torch in a circular or constant motion. Overheating should be avoided as this weakens the final joint, and is recognized by black areas of burnt flux.

2.2 Heat source of brazing

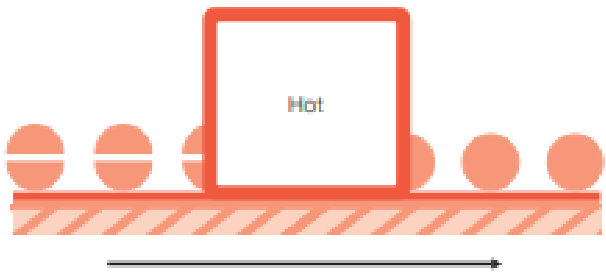
Torch brazing a heating source supplied by a fuel gas flame. Gases include acetylene, hydrogen or propane. A typical application is to braze a tube into a fitting using copper or silver brazing filler metals.



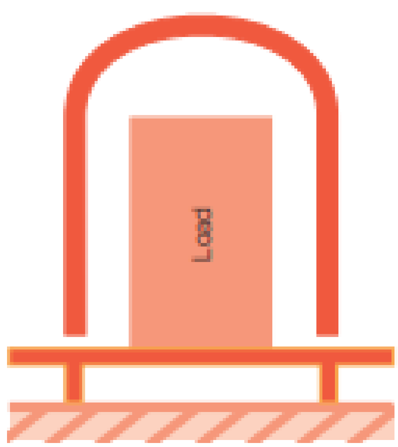
Inductions brazing Electric coils, which are designed for specific joint geometries, are used to heat the part and the brazing filler metal until the liquid metal flows via capillary attraction into the joint. This process is primarily used for brazing with copper and silver alloys. A typical application is a tube to tube assembly



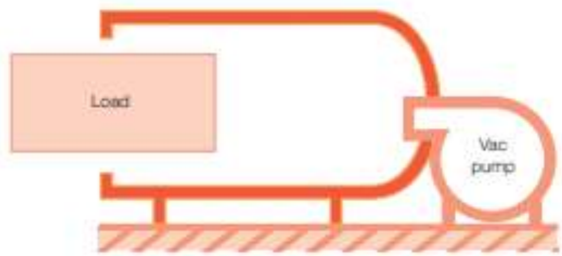
Continuous furnace Conveyor belts transport the pre-alloyed components through preheating, heating and post-heating zones where the braze alloy reaches temperature, and then solidifies during cooling. Silver and copper based brazing filler metals are most commonly used in these processes.



Retort or batch furnace the furnace used can be refractory lined and heated by gas, oil or electricity. Atmospheres can be either a generated gas (endothermic or exothermic) or an inert gas such as argon or nitrogen. Hydrogen gas is also used for brazing filler metals that oxidize in other atmospheres. Copper, silver, nickel and gold based brazing filler metals can be brazed successfully in these types of furnaces.



Vacuum furnace A furnace with electrically heated elements that surround the workload and heat the brazing filler metal to the liquids state so flow and capillary attraction are achieved. To permit brazing of alloys that are sensitive to oxidation at high temperatures, a pumping system is employed that removes oxygen. Gold, copper, nickel, cobalt, titanium and ceramic based filler metals are successfully vacuum brazed.



Self-Check -2	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (6Pts)

1) What is preheating? (3Pts)
2) Write heat source of brazing (3Pts)

Note: Satisfactory rating - 6 points Unsatisfactory - below 6 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

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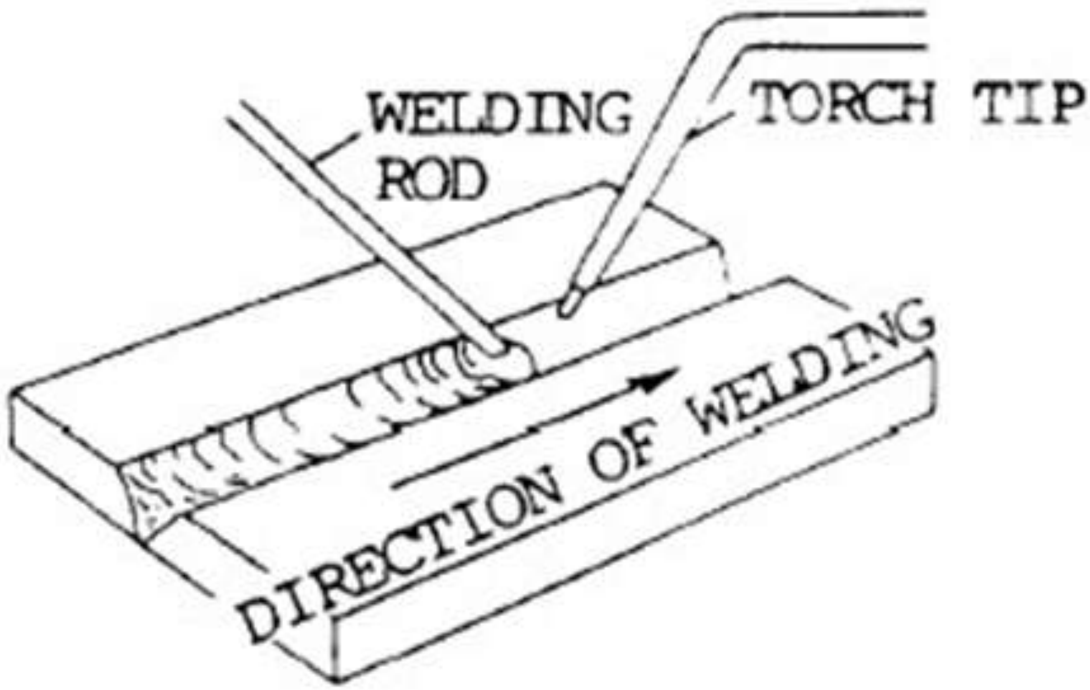
3.1 Use appropriate techniques while using consumables

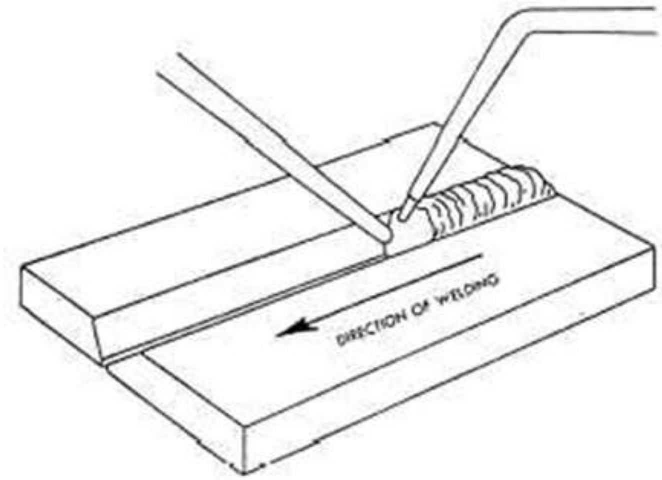
Forehand welding technique

In this method the welding rod precedes the torch. You should hold the torch at an approximately 30-degree angle from the vertical, in the direction of the weld. The flame is pointed in the direction of welding and directed between the rod and the molten puddle. This method is satisfactory for welding sheets and light plates in all positions.



Backhand welding technique

In this method, the torch precedes the welding rod. You should hold the torch at an angle approximately 30-degrees from the vertical, away from the direction of welding, with the flame directed at the molten puddle. The welding rod is between the flame and the molten puddle. This position requires less transverse motion than is used in forehand welding. Backhand welding is used principally for welding heavy sections because it permits the use of narrower V's at the joint



Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (4Pts)

1) Write and describe welding technique

Note: Satisfactory rating - 4 points   Unsatisfactory - below 4 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________   Date: _______________

Test I

1.____

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Information Sheet 4	Appling jointing material

4.1 Introduction

Ensure the surfaces to be welded are metallically clean, while taking care to not damage any coating. A range of joint configurations can be used, including butt, lap and tee-fillets. The joint design needs to be constructed so as to provide good wetting and capillary action of the braze material and to ensure that the stresses are not placed directly into the braze metal as tensile stresses. The stress needs to be supported through the adhesive surfaces of the braze metal to the parent sheet. A gap on the order of 0.5–1mm between the components to be joined will allow successful flow of the braze metal into the joint, improving adhesion and increasing the strength of the joint.

4.1.1 Joint properties

Shear strength the ability to resist the angular deformation, calculated as the sideways displacement of two adjacent planes divided by the distance between them.

Butt tensile strength the ability to resist a force applied perpendicular to a given plane without rupturing.

Stress rupture a fracture caused as a result of repeated physical strain.

Hardness The ability of a material to resist scratching, abrasion, indentation or machining g, as measured by a specifically chosen method or standard.

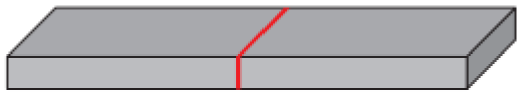
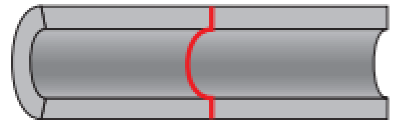
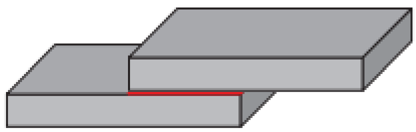
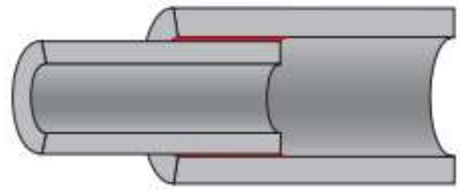
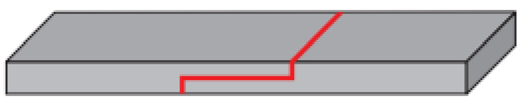
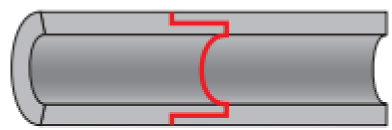
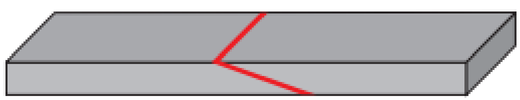
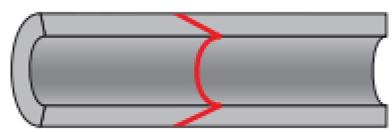
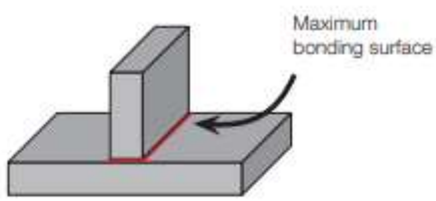
Corrosion resistance the ability of a material to resist attack resulting from environmental, chemical or galvanic action.

Oxidation resistance the ability of a material, particularly a metal, to resist reaction with oxygen, which can cause a loss of structural integrity resulting from the formation of undesirable oxide compounds.

Microstructure The composition and microscopic structure of a material, as studied using metallographic methods.

Joint configuration the design and shape of the joint chosen to join members that will meet or exceed structural requirements in service. Types of joint configurations include lap, butt, tee, tubing, tube thru plate and scarf

Type of joint

Joint type	Flat part	Tubular part
Butt joint		
Lap joint		
Butt lap joint		
Scarf joint		
T joint		

APPLY JOINT MATERIAL CORRECTLY AND IN APPROPRIATE QUANTITIES TO MEET JOB SPECIFICATIONS

Surfaces of the metals worked on for joining, should be brought to just above the melting point of the filler rod, when the flux boils and melts into the joint. The filler rod tapped with flux should now be touched on to the joint at the hottest part until it begins to melt and flow into the joint. On no account should you melt the rod and allow it to drop off on the joint. The joint should now be progressively heated and braze/silver soldered.

Welding is always done in the flat position whenever possible. The puddle is much easier to control, and the welder can work longer periods without tiring. Quite often it is necessary to weld in the overhead, vertical, or horizontal position in equipment repair. The flat position is used when the material is to be laid flat or almost flat and welded on the topside. The welding torch is pointed downward toward the work. This weld may be made by either the forehand or backhand technique.

The overhead position is used when the material is to be welded on the underside, with the torch pointed upward toward the work. In welding overhead, you can keep the puddle from sagging if you do not permit it to get too large or assume the form of a large drop. The rod is used to control the molten puddle. You should not permit the volume of flame to exceed that required to obtain a good fusion of the base metal with the filler rod. Less heat is required in an overhead weld because the heat naturally rises.

You should use the horizontal position when the line of the weld runs horizontal across a piece of work, and the torch is directed at the material in a horizontal or near horizontal position. The weld is made from right to left across the plate (for the right-hand welder). The flame is inclined upward at an angle of 45° to 65°, and the weld is made with a normal forehand technique. Adding the rod to the top of the puddle will prevent the molten metal from sagging to the lower edge of the bead (the weld puddle). If the puddle is to have the greatest possible cohesion, it should not be allowed to get too hot.

In a vertical weld, the pressure exerted by the torch flame must be relied upon to a great extent to support the puddle. It is important that you keep the puddle from becoming too hot, and to prevent the hot metal from running out of the puddle onto the finished weld. It may be necessary for you to remove the flame from the puddle for an instant to prevent overheating, and then return it to the puddle.

Vertical welds are started at the bottom, and the puddle is carried upward with a forehand motion. The tip should be inclined from 45° to 60°, the exact angle depending upon the desired balance between correct penetration and control of the puddle. A continual forward and backward movement should be used. The rod is added from the top and in front of the flame with a normal forehand technique.

USE CORRECT TEMPERATURE AND APPROPRIATE TECHNIQUES DURING OPERATION

The flame that you use should be neutral except when the parent or filler metal contains an appreciable amount of zinc, in which case the flame should be sufficiently oxidizing to prevent the zinc fuming off.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (8Pts)

1) Write at least four joint properties (4Pts)
2) List at least three type of joint (4Pts)

Note: Satisfactory rating - 8 points Unsatisfactory - below 8 points

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

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Information Sheet 5	Annealing material

5.1 Introduction

In metallurgy and materials science, annealing is a heat treatment that alters the physical and sometimes chemical properties of a material to increase its ductility and reduce its hardness, making it more workable. It involves heating a material above its recrystallization temperature, maintaining a suitable temperature for an appropriate amount of time and then cooling.

In annealing, atoms migrate in the crystal lattice and the number of dislocations decreases, leading to a change in ductility and hardness. As the material cools it recrystallizes. For many alloys, including carbon steel, the crystal grain size and phase composition, which ultimately determine the material properties, are dependent on the heating rate and cooling rate. Hot working or cold working after the annealing process alters the metal structure, so further heat treatments may be used to achieve the properties required. With knowledge of the composition and phase diagram, heat treatment can be used to adjust from harder and more brittle to softer and more ductile.

In the case of ferrous metals, such as steel, annealing is performed by heating the material (generally until glowing) for a while and then slowly letting it cool to room temperature in still air. Copper, silver and brass can be either cooled slowly in air, or quickly by quenching in water. In this fashion, the metal is softened and prepared for further work such as shaping, stamping, or forming.

How does an Annealing Furnace Work

An annealing furnace works by heating a material above the recrystallization temperature and then cooling the material once it has been held at the desired temperature for a suitable length of time. The material recrystallizes as it cools once the heating process has caused atom movement to redistribute and eradicate dislocations in the workpiece.

Annealing works in **three stages** – the recovery stage, recrystallization stage and the grain growth stage. These work as follows:

2. **Recovery Stage**

This stage is where the furnace or other heating device is used to raise the temperature of the material to such a point that the internal stresses are relieved.

3. **Recrystallization Stage**

Heating the material above its recrystallization temperature but below its melting point causes new grains to form without any residual stresses.

4. **Grain Growth Stage**

Cooling the material at a specific rate causes new grains to develop. After which the material will be more workable. Subsequent operations to alter mechanical properties can be carried out following annealing.

The main advantages of annealing are in how the process improves the workability of a material, increasing toughness, reducing hardness and increasing the ductility and machinability of a metal. The heating and cooling process also reduces the brittleness of metals while enhancing their magnetic properties and electrical conductivity.

Purpose of annealing

- Reduce hardness and brittleness
- Alter the microstructure for a special property
- Soften the metal for better machinability
- Recrystallize cold worked (strain hardened) metals
- Relieve induced residual stresses

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (8Pts)

1) What is annealing (4Pts)
2) List the purpose of annealing processes (4Pts)

Note: Satisfactory rating - 8 points **Unsatisfactory - below 8 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

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LG #6	LO #3- Inspect joints

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content:

- Removing excess jointing materials.
- Undertaking Inspection of joints.
- Undertaking visual inspection
- Reporting/recording inspection results

This guide will also assist you to attain the learning outcome stated on the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Excess jointing materials are removed using correct and appropriate techniques
- Inspection of joints is undertaken to standard operating procedures
- Inspection results are reported/recorded using standard operating procedures as required

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to "Operation sheets
7. Perform "the Learning activity performance test" which is placed following "Operation sheets" ,
8. If your performance is satisfactory proceed to the next learning guide,

9. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet 1	Removing excess jointing materials

1.1 Removing excess material

There are two media options for removing excess brazing material from the surface of cutting tools: aluminum oxide, crushed glass, and pumice. In our sample tests, pumice stood out as the most efficient and reliable media. It took off the excess alloy filler efficiently without darkening or damaging the cutting tool features.

The media selection further enhanced the inherent precision and control already provided by micro-precision sandblasting. With the small, focused nozzle and a uniform mixture of air and abrasive, an operator can specifically target surface areas and control the removal process microns at a time.

Depending on your brazing process, you may need to perform post-braze joint cleaning to remove residual flux. This step can be crucial since most fluxes are corrosive. Post-braze cleaning is one of the Six Fundamentals of Brazing

Reasons to Remove Flux

Let's examine five reasons why post-braze flux removal is important:

1. You cannot inspect a joint that is covered with flux.
2. Flux can act as a bonding agent and may be holding the joint together, without successful brazing. This joint would fail during service.
3. In pressure service, flux may mask pinholes in a braze joint, even though it withstands a pressure test. The joint would leak soon after being placed into service.

4. Flux is hygroscopic, so residual flux attracts available water from the environment. This leads to corrosion.

5. Paint or other coatings do not stick to areas covered with residual flux.

You can remove excess materials by:

- Grinding
- Gouging

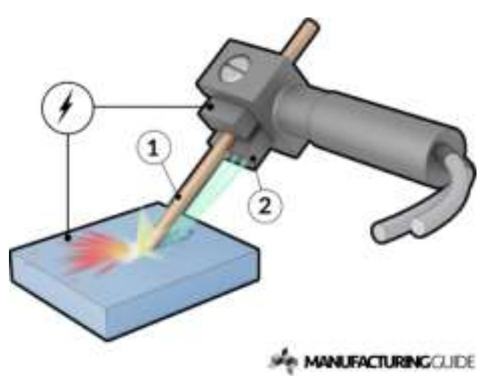
Grinding

Grinding practice is a large and diverse area of manufacturing and toolmaking. It can produce very fine finishes and very accurate dimensions; yet in mass production contexts it can also rough out large volumes of metal quite rapidly.

Brass grinding disc

Gouging

Gouging is generally a process used for removing of weld defects. To start gouging pre heat work piece to bright red using standard blow torch with special nozzle, then remove excess material.



Air arc gouging

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (4Pts)

1) Describe about excesses material removing method (4Pts)

Note: Satisfactory rating - 4 points **Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

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Information Sheet 2	Undertaking Inspection of joints

2.1 Inspection of joints

A weld defect is an imperfection in the weld, which may eventually lead to failure of the soldered joint under service conditions for which it is designed. You will perform visual inspection for general appearance. Inspection should include:

- meeting the standard of dimensions required from drawing
- nature of penetration
- signs indicating a lack of fusion
- proper filling of joint and where possible attaining complete penetration

2.2 Undertaking visual inspection

Visual inspection is a non-destructive testing (NDT) weld quality testing process where a weld is examined with the eye to determine surface discontinuities. It is the most common method of weld quality testing.

Advantages of nondestructive weld quality testing:

- Inexpensive (usually only labor expense)
- Low cost equipment
- No power requirement
- Quick identification of defects and downstream repair costs due to issues that weren't caught early

Disadvantages:

- Inspector training necessary
- Good eyesight required or eyesight corrected to 20/40
- Can miss internal defects
- Report must be recorded by inspector
- Open to human error

Visual Weld Quality Testing Steps

1. Practice and develop procedures for consistent application of approach

2. Inspect materials before welding
3. Weld quality testing when welding
4. Inspection when weld is complete
5. Mark problems and repair the weld

The procedures for inspecting brazed/braze welded/silver soldered joints

Brazed joints quality inspection

Compile brazed joints within the common defects and their causes are as follows:

1) Unreasonable joint design, assembly gap is too large or too small, crooked quarter ramp assembly parts.

(2) Flux is inappropriate, such as the activity difference, flux and solder melting temperature difference is too large, Yee agent caulking and poor; or gas purity and low gas brazing, vacuum brazing vacuum is low.

(3) Improper selection of solder, such as poor solder wetting, solder fluxes inadequate. Mongolia

4) Improper placement of solder.

(5), poor preparation before brazing, such as not washing the net and so on.

6) Soldering temperature is too low or unevenly distributed.

Brazing seam vents causes:

1) Joint gap inappropriate choice.

2) Parts clean before brazing without a net.

3) Flux to the membrane or protective role of oxide gas to the role of the weak.

4) Solder in the soldering or brazing at precipitated gas overheating.

Brazing seam slag Reason:

1) Flux use too much or too little.

2) Joint gap inappropriate choice.

3) Solder joints on both sides from the caulk.

4) Solder and flux melting temperature does not match.

5) Flux ratio is too large.

6) Uneven heating.

Brazing loss Reason:

1) Brazing temperature or holding time is too long.

2) Improper placement of solder from the capillary action is not so.

3) The local gap is too large.

6) Base metals is dissolved

Reason:

1) The brazing temperature, holding time is too long.

2) Base metal and filler metal between the role is too dramatic.

3) Excessive solder.

Brazed defect inspection method

Brazed flawed testing methods can be divided into non-destructive testing and destructive testing.

Surface defect inspection

Cooked surface defect inspection and test methods including fluorescence, color testing and magnetic particle inspection. They checked with the appearance of foam and inspection of solder joint surface cannot be found in defects such as cracks, holes and so on. Ying sleep test is generally used for small parts inspection, testing a large piece coloring method is used, only used for magnetic particle inspection method Sung-magnetic metal.

Internal defects inspection

Jazz X-ray and using the general, ray, ultrasound and dense test. Hole X-ray and y-ray inspection is an important piece of internal defects commonly used method, which can be displayed solder cracks pores, slag, and did not drill through the brazing seam and base metal cracking, ultrasonic inspection can find the range and ray defects the same test. Exclusion of the structure of compact brazed test methods are commonly used in general water pressure tests, air tightness test Qian, "through the test, kerosene penetration testing and test methods such as mass spectrometry, where the high-pressure hydraulic test Gang containers, leak test and gas permeability test for low container, kerosene penetration test for non-pressure containers Yi; MS test for vacuum sealing joints.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (6Pts)

1) What is visual inspection? (3Pts)
2) Write advantage and dis advantage of inspection (3Pts)

Note: Satisfactory rating - 4 points **Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

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Information Sheet 3	**Reporting/recording inspection results**

3.1 RECORD AND REPORTINSPECTION RESULTS

The works must prepare reports on the tests, which must contain all the necessary details for assessing the method. These especially include:

- Type of inspection or test (e.g. welding procedure test)
- Dimensions and numbers of test pieces
- Base materials
- Weld preparation
- Welding processes and positions
- Welding consumables and their dimensions, auxiliary welding materials
- Welding current source
- Welding current strength and voltage
- Post-weld heat treatment
- Test methods and forms of specimens
- Test results

The reports shall be submitted to the Surveyor in at least two copies for his perusal. He shall confirm the proper performance of the inspection and the correctness of the results by applying his stamp and signature.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page: (6Pts)

1) Write all necessary details for assessing method

Note: Satisfactory rating - 4 points **Unsatisfactory - below 4 points**

You can ask you teacher for the copy of the correct answers.

Score = ___________

Rating: ____________

Answer Sheet

Name: _________________________ Date: _______________

Test I

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Reference

1) Brazing & Soldering - International Guide
2) THE HARRIS PRODUCTS GROUP www.harrisproductsgroup.com
3) Free Technical Literature The following literature on brazing is available upon request from Lucas-Milhaupt. Call (414) 769-6000 in the U.S. and (416) 675-1860 in Canada.
4) DIN ISO 857-2:2007-05: Welding and allied processes Vocabulary Part 2: Soldering and brazing processes and related terms-First Edition
5) Massalski, T.B.: Binary Alloy Phase Diagrams, ASM International (1996)
6) N.N.: Technik, die verbindet, Band 1, S. 3–4, Degussa AG (1987)
7) [5] Dorn, L.: Hartlöten und Hochtemperaturlöten, S. 11, expert Verlag (2007)