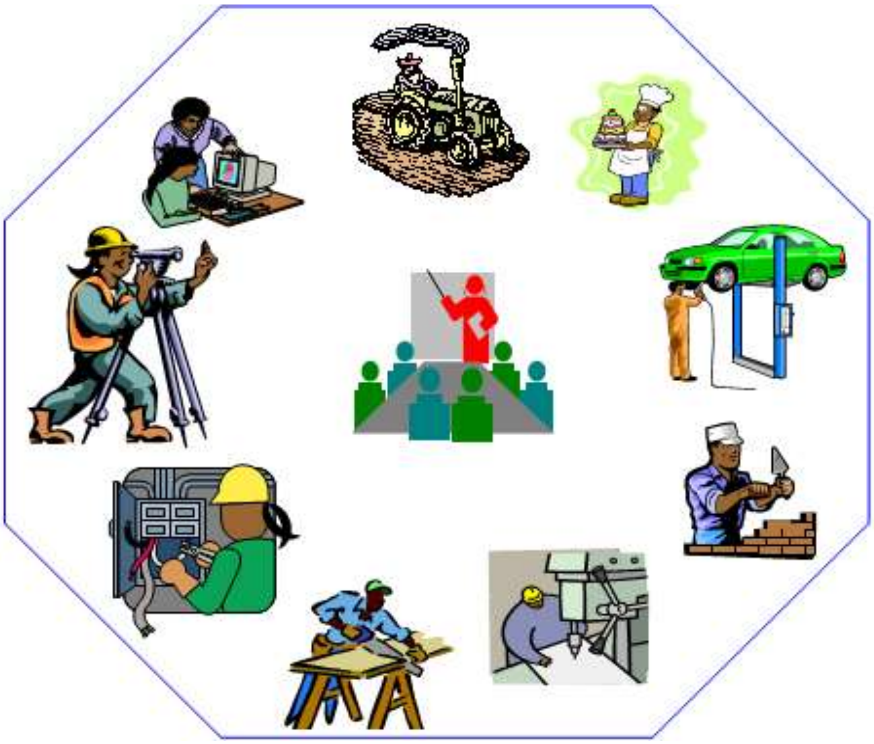
Welding

Level-IV

Based on May 2017, Version 1 Occupational standard (OS)



Module Title: - Performing High Reliability Soldering and De-soldering

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LG #41	LO #1- Determine work requirements

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Working requirement is determined using data sheets, technical drawings based on specifications and consultation with technical experts
- Correcting and appropriate tools, equipment and material are selected according to operational procedure

Clarifying the Process steps are documented and clearly represented in accordance with standard operating procedures This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to;

- Work requirement is determined using data sheets, technical drawings based on specifications and consultation with technical experts
- Correct and appropriate tools, equipment and material are selected according to operational procedures

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described blow
3. Read the information written in the "Information Sheets 1 and "Information Sheets 2 on page 3 and 27 respectively.

   Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
4. Accomplish the "Self-check 1" and "Self-check 2" in page 26 and 29 respectively.

- Fit and adjust machine components and related attachments
- Enter processing/operating parameters
- Check and adjust equipment performance
- Carry out pre-start checks Carry out pre-start checks

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 work requirement using data sheets and technical drawings.

1.2. **Introduction to soldering**

- Soldering is the process of melting the solder onto the desired joints to connect the joint materials together both physically and electrically.
- Is a process of joining two metals by using another low temperature metal alloy? The metal used for joining process is called solder. Data Sheet: Durability of GFRP Profiles

- This data sheet aims at demonstrating that GFRPs undergo a progressive reduction in performance after exposure to hot wet environment for the change in stiffness of the matrix. This is particularly noticeable in all the mechanic tests involving the matrix rather than the fibers (e.g., flexure and torsional tests rather than tensional test along fibers direction).

✓ **Data sheet: -** reports the results of an experimental campaign aimed at verifying the effects of hot–wet environments in the durability of glass fiber-reinforced pultruded profiles. Torsional and flexural tests were selected to highlight the performance reduction after aging. Specifying solder preform requirements is a critical part of any electronics assembly design process....

✓ Solder preforms are the most versatile form of solder used in the widest variety of applications. They come in over 250 different alloys and countless..

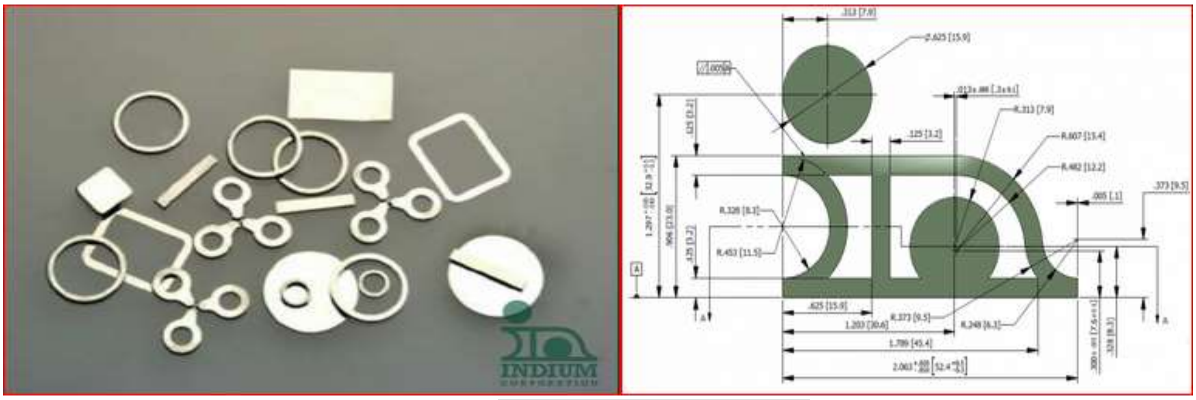
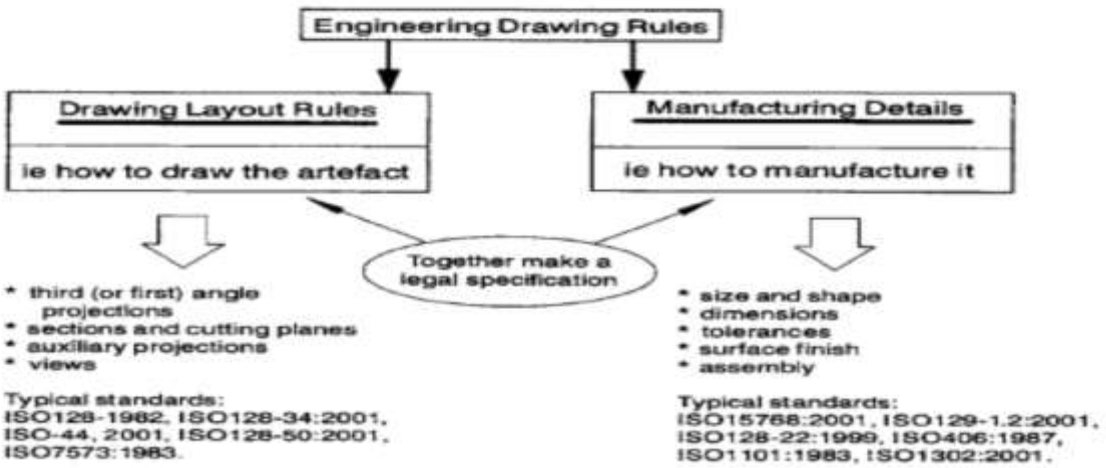


Fig:-1 data sheet

Drawing rules



Solders are can be classified in to two: -

- ✓ hard solder
- ✓ Soft solder

- Hard solder is an alloy of **copper** and **zinc** whereas The soft solder is an alloy of **tin** and **lid _Application s**:
- soldering is widely used for sheet metal work and in radio and television work for joining wires.

Advantages

- ✓ Joining cist is low.
- ✓ equipment is very simple
- ✓ good sealing in fabrication as compared to other processes like rivet, spot weld, Bolts.
- ✓ It provides positive electrical connection.
- ✓ Due to low operating temperature, the properties of base metal are not affected.

Disadvantage

- ❖ Joint firmed are weak.

The Hard Soldering Process

Using a finger ring project as an example, study the following procedure to do the soldering:

1. Clean and true the joint with a file. Then file a slight V notch at the joint to hold the solder (Figure 43-3).
2. Bend the joint ends together until they touch. Bind the ring with wire to keep it from springing apart. Place the ring on a brick or a charcoal block so that it does not move. Apply flux (Figure 43-4).
3. Flatten the solder if necessary. Cut it into tiny pieces on a sheet of clean paper. Flux the joint with a small brush.

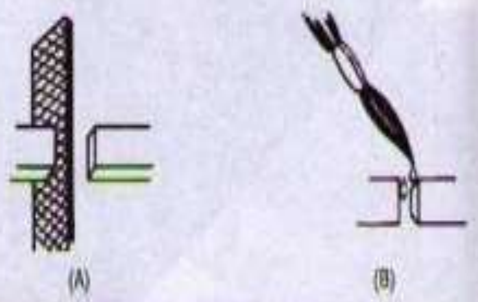


Fig. 43-3 The hard-solder brazing process: (A) filing and (B) applying flux.

surface, oxidation of metal, the skill of the individual doing the soldering, etc.

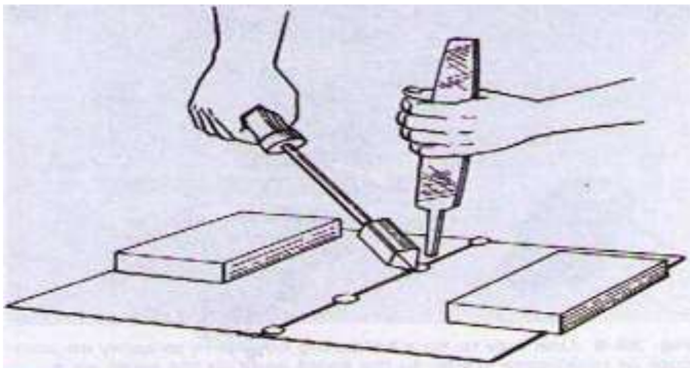
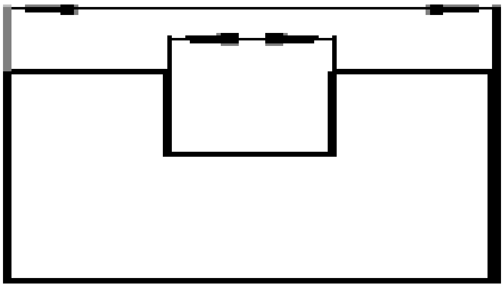


Fig:-2 soldering application

Technical Drawing

- **Lay outing the surface**
- Each side of sheet metal is lay out and cut properly.
- Put the sheet metal on the working   table.
- Lay out properly as per drawing.
- Scratch lines viscidly by scriber.
- Cut lines.



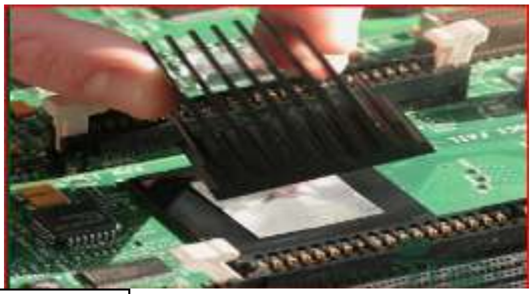


Fig:-3 drawing

100mm

50mm

Depth 25mm

Precaution: use safety gloves during working

Quality Criteria:

The lay outs are done in correct sequence in 5 minutes

Steps are cut correctly.

Specifying solder preforms and making solder preforms, although none of that is important until we actually use the preforms... When it comes to manufacturing solder preforms, alloying solder is an important first step in providing consistent final parts. This is the step where the bulk physical properties are, more or less, set. Strict attention to the percentage of each element (including impurities and dopants) helps provide solder products that always reflow the same way and form consistent mechanical, electrical, and thermal interfaces.

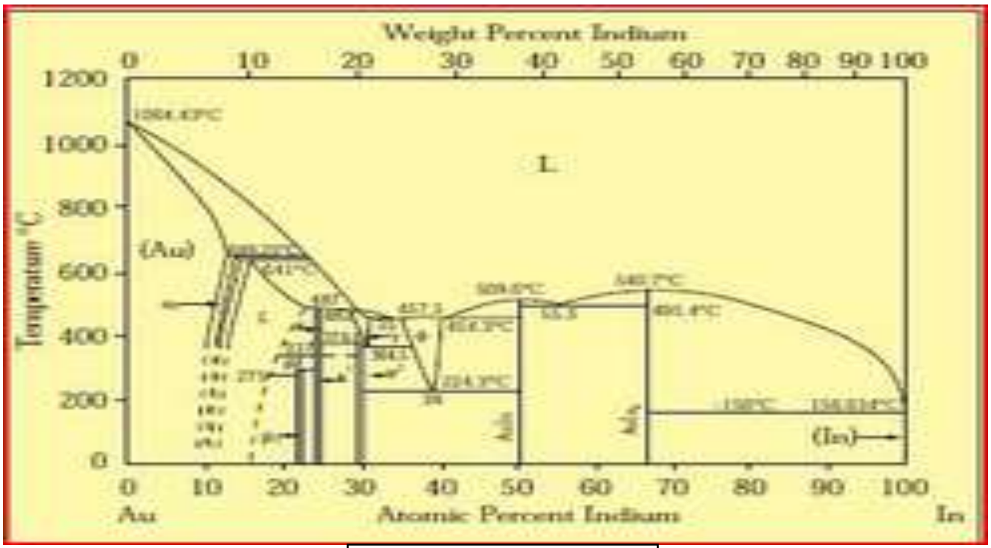


Fig:-4 drawing

Depending on the elements involved, an alloy that is off just a few weight percent can raise or lower the melting point of the solder considerably. Take, for instance, two alloys which may seem similar at first glance: 99.99% pure indium and 97In/3Ag. These two alloys differ by the addition of only 3% Ag, yet that addition lowers the melting point around 13°C.

Solder alloy	solidus(^{0}c)	commences &applications
-tin-lead alloys	183	-circuit boards, gas and vacuum assemblies
		Microelectronics, radiators, auto body repaired
Tin antimony	240	- potable water conduit, food handling equipment
Tin-zinc(aluminum)	199	-for joining AL base metals(avoid galvanic corrosion)
Bismuth solders	138	-sealing electronics-expands on solidification low
		Temperature electronic assemblies
Precious metal solders	280	attaching integrated circuits to packages, hermetic
		Sealing, good oxidation resistance.

The melting point isn't the only thing that changes though. The physical properties also become quite different. In this case, the tensile strength increases from 273 to 800psi! This is only a simple example; a metallurgist could more accurately describe interesting changes that occur with intermetallic and off-eutectic liquidus spikes with certain solder alloy systems. Hopefully, it is clear why we pay so much attention to providing very accurate alloy compositions

The exact alloy composition for the lot of preforms you order is available on the shipment's Certificate of Analysis (CofA) which accompanies each order. This is your verification that the alloy is made perfectly every time.

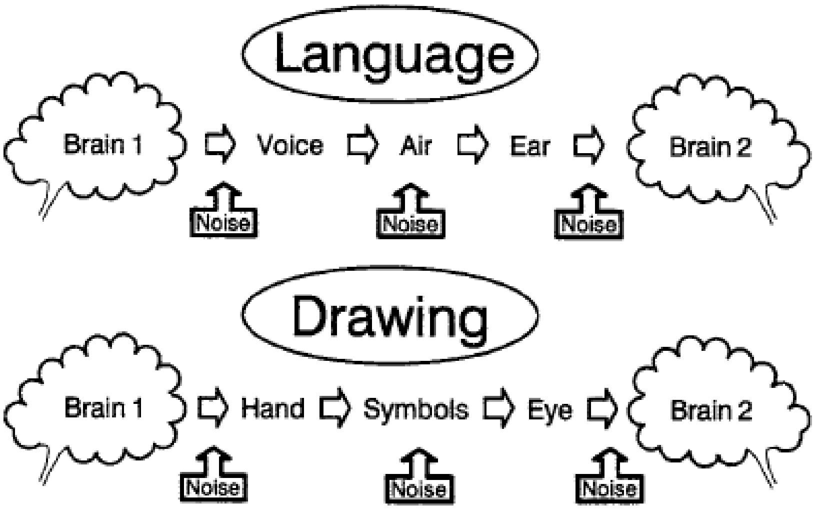


Fig:-5 drawing

Soldering Devices

For most soldering, you will need some type of device to heat the soldering copper. The most common kinds are: soldering coppers, electric soldering coppers, the soldering furnace, the propane torch, and the butane torch.

Soldering coppers are purchased in pairs (Figure 35-1A). The coppers of a two-pound pair weigh one pound apiece. This is an average size for regular sheet metal work. They are available in smaller or larger sizes, from three ounces to three pounds per pair. They are sold in pairs so that one can be used while the other is being heated.

An **electric soldering copper** is much more convenient because it will maintain uniform heat and can be used wherever there is an electric outlet (Figure 35-1B). Electric coppers are specified by their wattage. They range from 50 to 300 watts. A 150- to 200-watt soldering copper is a good size for most sheet metal soldering. One as small as 25 watts might be used for electronic work. One as large as 300 watts might be used for rugged work.

Another type of electric soldering copper is the *soldering gun* (Figure 35-1C). This gives instant heat when the trigger is pulled. It is used primarily for electrical work.

Both nonelectric and electric soldering coppers are commonly called *soldering irons.*

The **soldering furnace** (Figure 35-2), **propane torch,** (Figure 35-3), and **butane torch** (Figure 35-4) are also heating devices used for soldering.

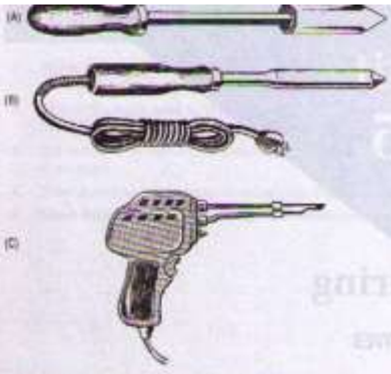


Fig. 35-1 Common heating devices for soldering: (A) a regular soldering copper, (B) an electric soldering iron, and (C) an electric soldering gun.

Fig. 35-2 Combination soldering and melting furnace. (Courtesy of Johnson Gas Appliance Company)

When you learn the requirements of successful soldering technique, you have made a good beginning. Thereafter, soldering skill will increase with application and with practice.

- ✓ **Demonstrate some things to avoid when soldering.**
- ✓ They are presented as an aid to forming proper soldering technique and show such pitfalls to good soldering as:

Poorly forged and tinned copper.

1. It is impossible to solder with a poorly forged or tinned copper
2. Overheated copper. The temperature of the soldering copper should never be so hot that i Will not hold a proper tinned coating.
3. The ken handle. Obviously, it is impossible to control the copper attentively when the handle Is broken.
4. Using raw acid as a flux on anything but galvanized metal. Solder will not correctly adhere To other metals with raw acid as flux.
5. Dirty solder. It is impossible to solder with dirty or greasy solder.
6. Bar too small. A stub or small piece of solder is too short to hold in the hand.
7. Soldering with the tip of the copper. It is impossible to get the proper flow using only the tip Of the soldering copper.
8. Soldering over a piece of steel. A steel plate under the metal being soldered absorbs heat
9. Thus chilling the solder as it is applied. This makes for a poorly soldered joint.
10. Cold copper. The soldering copper must be hot enough to make the solder flow smoothly Over the metal.

.

- **De-soldering tools and materials include the following:**
  - ✓ Solder wick
  - ✓ Heat guns, also called hot air guns
  - ✓ De-sordering pump
  - ✓ Removal alloys
  - ✓ Removal fluxes
  - ✓ Heated soldering tweezers
  - ✓ Various picks and tweezers for tasks such as pulling at, holding, removing, and scraping components. Vacuum and pressure pumps with specialized heater tips and nozzles Rework stations, used to repair printed circuit board assemblies that fail factory test.

Fig:-6 De-soldering with gun

✓ **De-soldering pump**

Electrically operated pumps are used for several purposes in conjunction with a hand-held head connected by a tube.Suction pumps are used to suck away molten solder, leaving previously joined terminals disconnected. They are primarily used to release through-hole connections from a PCB. The de-soldering head must be designed so that the extracted solder does not solidify so as to obstruct it, or enter the pump, and can be removed and discarded easily. It is not possible to remove a multi-pin part by melting solder on the pins sequentially, as one joint will solidify as the next is melted; pumps and solder wick are among methods to remove solder from all joints, leaving the part free to be removed.

- ✓ **De-soldering Methods**

A soldered joint which is improperly made will be electrically "noisy", unreliable and is likely to get worse in time. It may even not have made any electrical connection at all, or could work initially and then cause the equipment to fail at a later date! It can be hard to judge the quality of a solder joint purely by appearances, because you cannot say how the joint actually formed on the inside, but by following the guidelines there is no reason why you should not obtain perfect results.

A heated soldering iron tip is first placed on the solid solder until it melts. The solder sucker is then placed directly on the molten flux and a button on its side is pushed that quickl sucks the flux.

- **De-soldering with Solder Sucker**

Solder sucker is basically a small tube connected to a vacuum pump. Its purpose is to suck the molten flux off of pads. A heated soldering iron tip is first placed on the solid solder until it melts. The solder sucker is then placed directly on the molten flux and a button on its side is pushed that quickl sucks the flux.

Fig: -7 De-soldering with Solder Sucker

- ✓ **De-soldering with Heat Gun**

De-soldering with a heat gun is generally used to de-solder SMD components, though it can also be employed for through-hole components. In this method, the board is placed on a perfectly flat place and a heat gun is pointed directly at the components to be de-soldered for a few seconds. This quickly melts the solder and on the pads, loosening the components. They are then immediately lifted with the help of tweezers. The downside of this method is that it is very difficult to use for small, individual components since the heat can melt the solder on nearby pads, which can dislodge components that are not be de-soldered. Also, the molten flux can flow to nearby traces and pads, causing electrical shorts. It is therefore very important to keep the board as flat as possible during this process. De-soldering with Copper Braid

- ✓ **Copper braid** is commonly used to de-solder electronic components. This technique involves melting the solder flux and then allowing the copper braid to absorb it. The braid is placed on the solid solder and gently pressed with a heated soldering iron tip. The tip melts the solder, which is quickly absorbed by the braid. This is an efficient but slow method of de-soldering components since each soldered joint must be worked on individually.

Self-check 1	Written test

Name…………………………………………… ID………………………… Date……

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. List purpose de-soldering with Heat Gun ?(5pts)
2. List de-soldering tools and materials?(5pts)
3. List and draw technical drawing of solder ?(5pts)
4. List different between soldering and de-soldering?(5pts)

***Note:* Satisfactory rating - 20 points Unsatisfactory - below 20 points**

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

Score = ____________

Rating: _____________

Answer Sheet

Name: ___________________________ Date: ________________

Test I

1.____

2.____

Test II

1.____

Information Sheet-2	Selecting tools, equipment and material.

1.1. **2.1**. Selecting tools, equipment and material.

- Soldering equipment that is presented in our catalog: soldering stations, hot air soldering stations, infrared soldering stations, lead-free soldering stations, infrared and hot air preheaters, hot tweezers, soldering irons, gas powered soldering irons, soldering iron tips, replacement air nozzles, spare parts for soldering, antistatic equipment, ancillary equipment, reballing equipment and many more. This activity will enhance the student skills in constructing the method how to weld sheet metals using soldering process. Conditions or Situations for the Operation: Given the sheet metal with a thickness of 0.6 mm, the student is
- **Soldering machine**

Fig:-8 soldering machine

- **Required to weld using soldering process.**
  - ✓ **A, gas torch brazing:** - it is commonly used process in which oxy-acetylene torch is **used.**
  - ✓ **Furnace brazing:** - the surfaces to be joined are placed in a furnace already hot.
  - ✓ **Dip brazing:** - the surfaces to join to be joined are dipped in molten filler metal.
  - ✓ **Electrical brazing:-**in electrical brazing heat is produced by resistance or induction method

- **Equipment, Tools and Materials:**
  - ✓ Sheet metal
  - ✓ Steel rule
  - ✓ Schreiber
  - ✓ Center punch
  - ✓ Divider
  - ✓ Snipe
  - ✓ Soldering gun
  - ✓ Lead
  - ✓ Soldering Flax
  - ✓ Sand paper

✓ **Precautions: or steps**

1. Prepare all materials, tools and equipment needed.
2. Prepare working drawing.
3. Lay out the sheet metal according drawing.
4. Cut sheet metal according to specification.
5. Roll to the required shape
6. Join using soldering method
7. Clean by sand paper

✓ **Solder is**

A. Used to hold two (or more) conductors in electrical contact with each other.

B. Solder is not used to make the electrical contact.

C. Solder is not used to provide the main mechanical support for a joint.

D. Solder is used to encapsulate a joint, prevent oxidation of the joint, and provide minor

- ✓ **Mechanical support for a connection.**

Soldering Iron Types

1. **Temperature-controlled iron**. A soldering iron with electronic temperature control is highly recommended. Irons without temperature control can reach temperatures that are high enough to irreversibly damage the tips. Since temperature is not proportional to wattage with this type of iron, the wattage rating is relatively unimportant. A higher wattage iron results in a faster temperature recovery time between soldering operations (40 W to 60 W units seem to work well). See Figure 1.
2. **Non-temperature-controlled iron.** A low wattage (10 W to 25 W) pencil-type (not gun-type) can be used but is not recommended. This type of iron must be unplugged when not in use to save the tips. The temperature is proportional to wattage and most of these types of soldering irons will reach temperatures that can destroy tips quickly.
3. **Modified, non-temperature-controlled iron.**

   A 10 W to 40 W pencil-type iron can be operated from a variance to limit the wattage (and therefore the temperature) and is a reasonable substitute for a temperature-controlled iron. However, a variac can cost more than a temperature controlled station and will yield less satisfactory results!

A. **Sponge**. A sponge is required for keeping tips clean for best heat transfer. A clean soldering iron tip is one of the most important steps towards producing good solder joints. Most soldering stations come with sponges and sponge holders.

B. **Tips.** Currently, most tips sold for electronics work are iron-clad copper and have long life spans. Iron-clad tips cannot be filed or sanded when they become oxidized; they must be replaced. Many tip shapes are available, but miniature needle or chisel point tips are best for most work. The tip shape should be chosen to provide the highest contact surface area for best heat conduction. Minimizing the shank length can increase the heat transfer from the iron (heater) to the tip. Copper tips can still be purchased but are not recommended because of their short life span and poor wetting properties.

✓ Solder and Flux

A FLUX

1. Flux is used to prepare the surfaces of the conductors prior to soldering. Flux removes oxidation from the conductors and maintains oxide-free surfaces at elevated temperature during the soldering process. This allows all surfaces to "wet" properly.
2. The most common flux used in hand soldering of electronic components is rosin, a combination of mild organic acids extracted from pine trees (some manufacturers use synthetic compounds).
3. Although fluxes can be obtained in liquid or paste form, they are typically contained in solders (rosin core) used for hand assembly of electronics. Fluxes labeled as "Acid" are strong acids (as opposed to the mild rosins) and should never be used for electronics assembly.

C. Solder

1. Rosin core. 60/40 Sn/Pb (M.P. 361-376°F) and 63/37 Sn/Pb (M.P. 361°F) solders are the most common types used for electronics assembly. These solders are available in various diameters and small diameters are most appropriate for small electronics work (0.02" - 0.05" dia. is recommended)

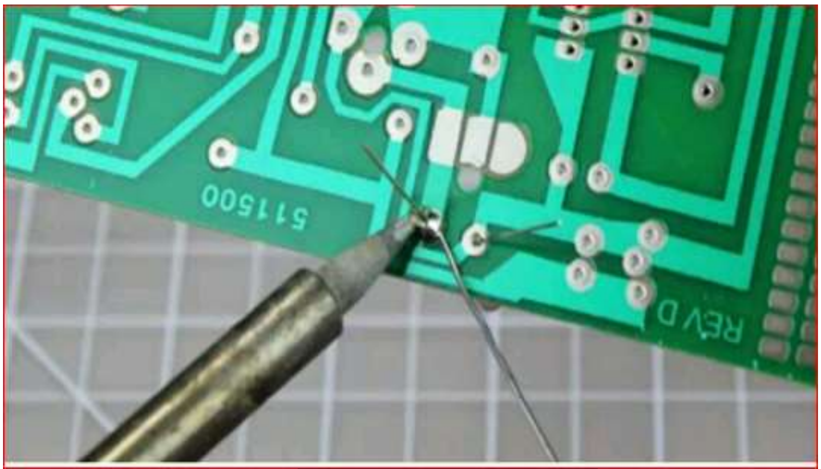


Fig: 9 iron and

- ✓ **How to Solder:**

  Learning how to solder w/ proper soldering techniques is a fundamental skill every maker should master. In this tutorial, we outline the basics of soldering irons, soldering stations, types of solder, de-soldering and safety tips. Whether you are building a robot or working with Arduino, knowing how to solder will come in Handy.

What Is Soldering?

If you were to take apart any electronic device that contains a circuit board, youâ€™ll see the components are attached using soldering techniques. Soldering is the process of joining two or more electronic parts together by melting Solder around the connection.

Solder is a metal alloy and when it cools it creates a strong electrical bond between the parts. Even though Soldering can create a permanent connection, it can also be reversed using a de-soldering tool as described below.

- ✓ **Soldering Tools**

  The good thing about learning how to solder is the fact that you don’t need a lot to get started. Below we’ll outline the basic tools and materials you will need for most of your soldering projects.

- ✓ **Soldering Iron**

  A soldering iron is a hand tool that plugs into a standard 120v AC outlet and heats up in order to melt solder around electrical connections. This is one of the most important tools used in soldering and it can come in a few variations such as pen or gun form. For beginners, it’s recommended that you use the pen style soldering iron in the 15W to 30W range.

  Most soldering irons have interchangeable tips that can be used for different soldering applications.

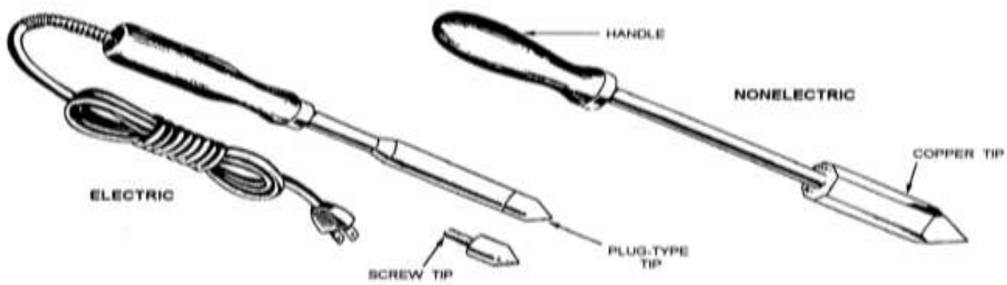


Fig: 10 iron and lead

Be very cautious when using any type of soldering iron because it can heat up to 896’ F which is extremely hot.

Fig:-11 soldering iron

- ✓ **Soldering Station**

A soldering station is a more advanced version of the basic standalone soldering pen. If you are going to be doing a lot of soldering, these are great to have as they offer more flexibility and control. The main benefit of a soldering station is the ability to precisely adjust the temperature of the soldering iron which is great for a range of projects. These stations can also create a safer workspace as some include advanced temperature sensors, alert settings and even password protection for safety.

Fig:-12 Soldering Station

✓ **Soldering Iron Tips**

At the end of most soldering irons is an interchangeable part known as a soldering tip. There are many variations of this tip and they come in a wide variety of shapes and sizes. Each tip is used for a specific purpose and offers a distinct advantage over another.

The most common tips you will use in electronics projects are the conical tip and the chisel tip.

- **Conical Tip** -- Used in precision electronics soldering because of the fine tip. Because of its pointed end, itâ€™s able to deliver heat to smaller areas without affecting its surroundings.
- **Chisel Tip** -- This tip is well-suited to soldering wires or other larger components because of its broad flat tip.

Fig: 14 Soldering Iron Tips

✓ **Brass or Conventional Sponge**

Using a sponge will help to keep the soldering iron tip clean by removing the oxidation that forms? Tips with oxidation will tend to turn black and not accept solder as it did when it was new. You could use a conventional wet sponge but this tends to shorten the lifespan of the tip due to expansion and contraction. lso, a wet sponge will drop the temperature of the tip temporarily when wiped. A better alternative is to use a brass sponge as shown on the left.

Fig:-15 Brass or Conventional

- ✓ **Soldering Iron Stand**

A soldering iron stand is very basic but very useful and handy to have. This stand helps prevent the hot iron tip from coming in contact with flammable materials or causing accidental injury to your hand. Most soldering stations come with this built in and also include a sponge or brass sponge for cleaning the tip.

Fig:-16 Soldering Iron

Solder - is a metal alloy material that is melted to create a permanent bond between electrical parts. It comes in both lead and lead-free variations with diameters of .032'' and .062'' being the most common. Inside the solder core is a material known as flux which helps improve electrical contact and its mechanical strength.

For electronics soldering, the most commonly used type is lead-free rosin core solder. This type of solder is usually made up of a Tin/ Copper alloy. You can also use leaded 60/40 (60% tin, 40% lead) rosin core solder but it's becoming less popular due to health concerns.

If you do use lead solder, make sure you have proper ventilation and that you wash your hands after use.

Fig: 17 Lead free rosin

When buying solder, make sure NOT to use acid core solder as this will damage your circuits and Components. Acid core solder is sold at home improvement stores and is mainly used for plumbing and metal working. As mentioned earlier, solder does come in a few different diameters. The thicker diameter solder (.062'') is good for soldering larger joints more quickly but it can make soldering smaller joints difficult. For this reason, it's always a good idea to have both sizes on hand for your different projects.

- ✓ **Helping Hand (Third Hand)**
  A helping hand is a device that has 2 or more alligator clips and sometimes a magnifying glass/light attached. This clips will assist you by holding the items you are trying to solder while you use the soldering iron and solder. A very helpful tool to have in your maker space

Fig: 18 helping hands

- ✓ **Soldering Safety**

  Now that you know what tools and materials are required, it's time to briefly discuss ways of staying safe while soldering. Soldering irons can reach temperatures of 800'F F so it's very important to know where your iron is at all times. We always recommend you use a soldering iron stand to help prevent accidental burns or damage.

Fig: 19 Soldering Safety

Make sure you are soldering in a well-ventilated area. When solder is heated, there are fumes released that are harmful to your eyes and lungs. It's recommended to use a fume extractor which is a fan with a charcoal filter that absorbs the harmful solder smoke you can visit sites like Integrated Air Systems for air filtration systems.

It's always a good idea to wear protective eye wear in case of accidental splashes of hot solder.

Lastly, make sure to wash your hands when done soldering especially if using lead solder.

- ✓ **Tinning the Tip**

  Before you can start soldering, you need to prep your soldering iron by tinning the tip with solder. This process will help improve the heat transfrom the iron to the item you are soldering.

✓ **Tinning will also help to protect the tip and reduce wear**.

Step 1: Begin by making sure the tip is attached to the iron and screwed tightly in place.

Step 2: Turn on your soldering iron and let it heat up. If you have a soldering station with an adjustable temp control, set it to 400â€² C/ 752â€² F.

Step 3: Wipe the tip of the soldering iron on a damp wet sponge to clean it. Wait a few seconds to let the tip heat up again before proceeding to step 4.

Step 4: Hold the soldering iron in one hand and solder in the other. Touch the solder to the tip of the iron and make sure the solder flows evenly around the tip.

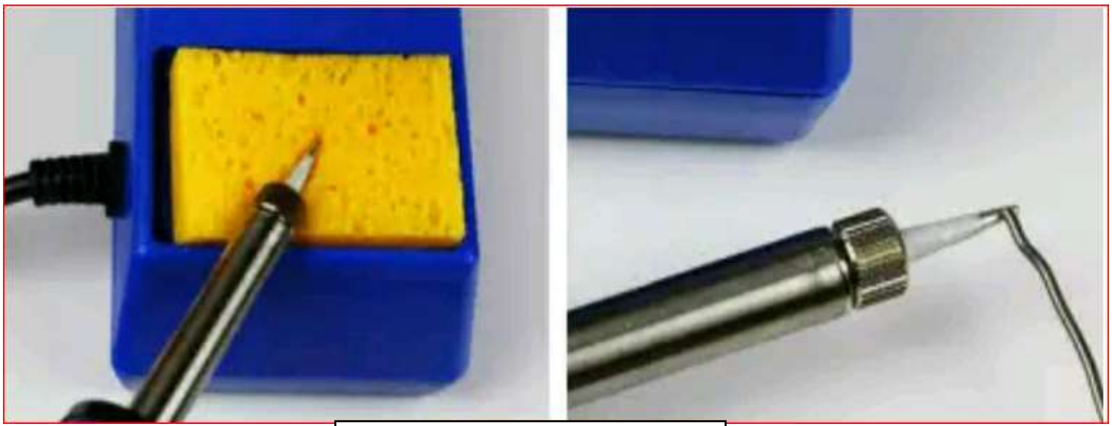


Fig: 20 Tinning the Tip

You should tin the tip of your iron before and after each soldering session to extend its life. Eventually, every tip will wear out and will need replacing when it becomes rough or pitted.

Self-check- 2	Written test

Name…………………………………………… ID………………………Date…….

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. List steps of tinning will also help to protect the tip and reduce wear.?(5pts)
2. List soldering iron tips ?(5pts)
3. List about solder and flux?(5pts)
4. List equipment, tools and materials solder?(5pts)
5. List soldering Iron types?(5pts)

Note: **Satisfactory rating - 20 points Unsatisfactory - below 20 points**

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

Answer Sheet

Name: ___________________________ **Date:** ________________

Test I

1.____

2.____

Test II

1.____

LG #42	LO #2- Prepare for soldering

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Material/device is cut, shaped and/or drilled to specification.
- Materials/devices are cleaned to specifications using correct and appropriate materials and procedures.
- Correct and appropriate set-up and/ or mounting techniques are used due to requirements

Clarifying the Process steps are documented and clearly represented in accordance with standard operating procedures This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to;

- Material/device is cut, shaped and/or drilled to specification.
- Materials/devices are cleaned to specifications using correct and appropriate materials and procedures.
- Correct and appropriate set-up and/ or mounting techniques are used due to requirements

Learning Instructions:

5. Read the specific objectives of this Learning Guide.
6. Follow the instructions described blow
7. Read the information written in the "Information Sheets 1 and "Information Sheets 2 on page 3 and 27 respectively.

   Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
8. Accomplish the "Self-check 1" and "Self-check 2" in page 26 and 29 respectively.

   - Fit and adjust machine components and related attachments
   - Enter processing/operating parameters

- Check and adjust equipment performance
- Carry out pre-start checks Carry out pre-start checks

Learning Instructions:

10. Read the specific objectives of this Learning Guide.
11. Follow the instructions described below.
12. 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.
13. Accomplish the “Self-checks” which are placed following all information sheets.
14. 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).
15. If you earned a satisfactory evaluation proceed to “Operation sheets
16. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
17. If your performance is satisfactory proceed to the next learning guide,
18. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet-1	Cutting shaping and/or drilling Material/device.

2.1. How to Solder

To better explain how to solder, we are going to demonstrate it with a real world application. In this example, we are going to solder an LED to a circuit board.

2.2. ON OPERATION STEPS

Step 1: Mount The Components Begin by inserting the leads of the LED into the holes of the circuit board. Flip the board over and bend the leads outward at a 45' angle. This will help the component make a better connection with the copper pad and prevent it from falling out while soldering.

Step 2: Heat the Joints Turn your soldering iron on and if it has an adjustable heat control, set it to 400'C. At this point, touch the tip of the iron to the copper pad and the resistor lead at the same time. You need to hold the soldering iron in place for 3-4 seconds in order to heat the pad and the lead.

Step 3: Apply Solder to Joints a Continue holding the soldering iron on the copper pad and the lead and touch your solder to the joint.

IMPORTANT – Don't touch the solder directly to be the tip of the iron. You want the joint to be hot enough to melt the solder when its touched. If the joint is too cold, it will form a bad connection.

Step 4: Snip The Leads Remove the soldering

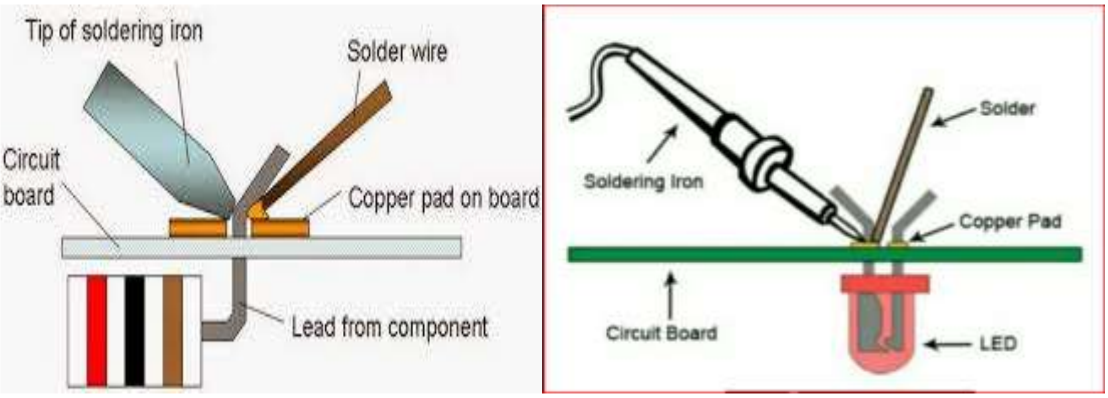


Fig:-21 solder operation

iron and let the solder cool down naturally. Don’t’ blow on the solder as this will cause a bad joint. Once cool, you can snip the extra wire from
leads. A proper solder joint is smooth, shiny and looks like a volcano or cone shape. You want just enough solder to cover the entire joint but not too much so it becomes a ball or spills to a nearby lead or joint. How To Solder Wires Now it’s time to show you how to solder wires together. For this process, itâ€™s recommended to use helping hands or other type of clamp device. Begin by removing the insulation from the ends of both wires you are soldering together. If the wire is stranded, twist the strands together with your fingers. Make sure your soldering iron is fully heated and touch the tip to the end of one of the wires. Hold it on the wire for 3-4 seconds. Keep the iron in place and touch the solder to the wire until itâ€™s fully coated. Repeat this
process on the other wire.
Hold the two tinned wires on top of each other and touch the soldering iron to both wires. This process should melt the solder and coat both wires evenly. Remove the soldering iron and wait a few seconds to let the soldered connection cool and harden. Use heat shrink to cover the connection.

De-soldering

The good thing about using solder is the fact that it can be removed easily in a technique known as de-soldering. This comes in handy if you need to remove a component or make a correction to your electronic circuit. To de-solder a joint, you will need solder wick which is also known as de-soldering braid.

Steps 1 - Place a piece of the de-soldering braid on top of the joint/solder you want removed.

Step 2 - Heat your soldering iron and touch the tip to the top of the braid. This will heat the solder below which will then be absorbed into the de-soldering braid. You can now remove the braid to see the solder has been extracted and removed. Be careful touching the braid when you are heating it because it will get hot. Optional â€ If you have a lot of solder you want removed, you may want to use a device called a solder sucker. This is a handheld mechanical vacuum that sucks up hot solder with a press of a button. To use, press the plunger down at the end of the solder sucker. Heat the joint with your soldering iron and place the tip of the solder sucker over the hot solder. Press the release button to suck up the liquid solder. In order to empty the solder sucker, press down on the plunger.

Soldering & Electronics

Digikey

Sparkfun

Adafruit

Jameco

Velleman

Makerspaces.com Makerspaces.com was built to help schools and libraries start and run their own maker spaces. We truly believe that adding a maker space to a school or library can help students acquire the skills needed for the 21st century.

Self-check 1.	Written test

Name…………………………………………… ID……………………… Date……

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. 1. ----------------is composed of leas and tin.

A. Soft soldering C. iron soldering

B. Hard soldering D. A and C

2. ---------------are a source of heat used for soldering

A. Welding torch C. forges

B. Furnace D. All

3. -------------is a cleaning agent to prevent oxidation of metal at the soldering point.

A. Fluxes C. copper

B. Zinc D. waxes

4. ---------------are consist of inorganic acid, mixture of zinc and ammonium chloride.

A. Organic fluxes C. zinc

B. Inorganic fluxes D. A and C

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

Answer Sheet

Name: ____________________________ **Date:** _________________

Test I

1.____

2.____

Test II

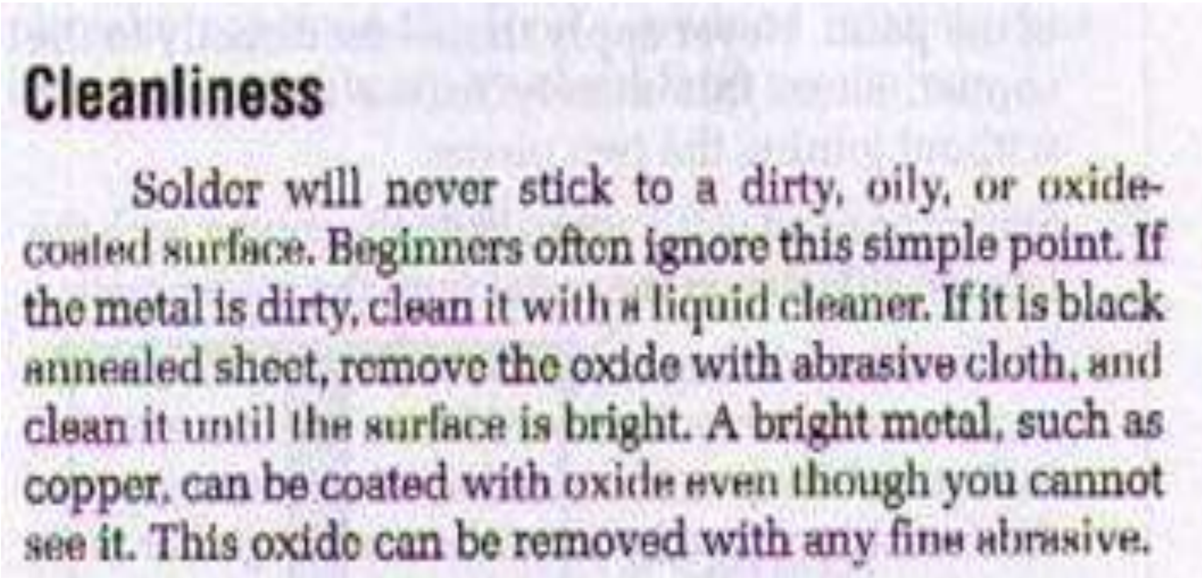
1.____

Information Sheet-2	Cleaning materials/devices.

2.1. Cleaning materials/devices

The surface to be joined is cleaned & is placed on each other .the flex is employed to prevent oxidation .zinc chloride is commonly used for this purpose. The soldering iron is heated either electrically or by some external heat. Then the hot end is dipped into the flux and solder is pressed against the surface to be joined. A Joint is formed by melted the solder.

Brazing the surface to be joined is cleaned from all oil, dirt or oxides. Then both the surface is placed in joining position. Flux is sprinkled (dotted) or placed on it. The heat is given to the surface and the filler metal. The molten filler metal flows to the surface to be joined. On cooling, brazing joint is formed. The filler metals used are copper, copper alloy, silver alloys, &aluminum alloy. In brazing is filler metal melted but the surface to be joined remain unmelted.the various methods used to melt the filler metal flux


Cleanliness

Solder will never stick to a dirty, oily, or oxide-coated surface. Beginners often ignore this simple point. If the metal is dirty, clean it with a liquid cleaner. If it is black annealed sheet, remove the oxide with abrasive cloth, and clean it until the surface is bright. A bright metal, such as copper, can be coated with oxide even though you cannot see it. This oxide can be removed with any fine abrasive.

- ✓ Before starting welding we will clean the welding part of the work piece
- ✓ After finished the welding you can clean the welding gun
- ✓ After completing our work you will clean the welding area and working area

There are also several destructive and mechanical testing methods, often used in random or lot testing:

- ✓ Peel testing - useful for evaluating lap joints and production quality control for general quality of the bond plus presence of voids and flux inclusions-where one member is held rigid while the other is peeled away from the joint
- ✓ Metallographic examination-testing the general quality of joints-detecting porosity, poor filler metal flow, base metal erosion and improper fit
- ✓ Tension and shear testing - determines strength of a joint in tension or in shear-used during qualification or development rather than production
- ✓ Fatigue testing - testing the base metal plus the brazed joint-a time-consuming and costly method
- ✓ Impact testing - determines the basic properties of brazed joints-generally used in a lab setting
- ✓ Torsion testing - used on brazed joints in production quality control-for example, studs or screws brazed to thick sections
- ✓ The size, complexity and severity of the application determine the best inspection method, and several methods may be required. If you are unable to develop an accurate and dependable method of inspecting a critical brazed joint, consider revisiting your joint design to allow adequate inspection.

3.4 Demonstrating the procedures for minimizing distortion of the materials being /soldered.

What is distortion?

Distortion or deformation can occur during welding as a result of the non-uniform expansion and contraction of the weld and base metal during the heating and cooling cycle. Stresses form in the weld as a result of the changes in volume, particularly if the weld is restrained by the fixed components or other materials surrounding it. If the restraints are partly removed, these stresses can cause the base material to distort and may even result in tears or fractures. Of course, distortion can be very costly to correct, so prevention is important.

What are the main types of distortion? There are various types of distortion and dimensional change including longitudinal; transverse; angular; twisting and bowing. Two or more types of distortion may occur at the same time.

What are the main causes of distortion? There are many factors that can cause welding or cutting distortion and it is very difficult to predict the exact amount of distortion that is likely to occur. Some of the factors that should be considered include the degree of restraint; the thermal and other properties of the parent material; inherent stresses induced from previous metal-working processes such as rolling, forming and bending; design of weldment; accuracy of manufacture and the nature of the welding process itself – the type of process, symmetry of the joint, preheat and the number and sequence of welds required.

What can I do to limit distortion? The effects of weld shrinkage can never be entirely eliminated but you can keep them to a minimum by taking a few practical steps as follows:

- Reducing the metal weld volume to avoid overfill and consider the use of intermittent welding • Minimizing the number of weld runs
- Positioning and balancing the welds correctly round the axis
- Using back step or skip welding techniques, which involves laying short welds in the opposite direction
- Making allowance for shrinkage by pre-setting the parts to be welded out of position
- Planning the welding sequence to ensure that shrinkages are counteracted progressively

To minimize weld distortion, the design and welding should be addressed the following step also minimize the distortion.

a. Avoid over welding
b. Intermittent welding
c. Fewer weld passes
d. Place weld near the neutral axis, or the center of th part
e. Balance weld around the neutral axis.
f. Use clamping

Clamping — Clamps, jigs, and fixtures that lock parts into a desired position and hold them until welding is finished are probably the most widely used means for controlling distortion in small assemblies or components. While there is some movement or distortion after the welded part is removed from the jig or clamps, it will be lower compared to the amount of movement that would occur if no restraint were used during welding.

Avoid over welding — The bigger the weld, the greater the shrinkage. Correctly sizing a weld not only minimizes distortion, but also saves weld metal and time.

Use the back step welding technique — In the backstep technique, the general progression of welding may be left to right, but each bead segment is deposited from right to left. As each bead segment is placed, the heated edges expand, which temporarily separates the plates at B. As the heat moves out across the plate to C, expansion along outer edges CD brings the plates back together. This separation is most pronounced as the first bead. With successive beads, the plates expand less and less because of the restraint from the prior welds.

Identifying the procedures for inspecting brazed/ soldered joints.

Inspection operations must be carried out **thoroughly and professionally** to assure compliance with drawing and service requirements. A previous page on B outlines the definitions of the processes and presents the **advantages and limitations** that help producing successful applications. A certain **familiarity with the processes** assists in understanding Brazing-inspection requirements.

As it is by now clear to all, much of the strength properties of brazed joints depend upon creating and maintaining the proper capillary **clearances** between elements to be brazed.

Therefore one of the first and most important Brazing-inspection steps, well before starting the joining process, consists in verifying that the right **fabrication tolerances** are observed and realized in practice even before assembling.

Much of the brazing success depends, as is widely known, on **cleanliness** and freedom from surface oxides. Therefore Brazing inspection has to determine that **suitable means and procedures** are used, and that no contaminants are permitted to come in contact with the materials.

The assembly procedures may be complex and demanding, and the use of proper and clean fixtures may need **attention and fussiness**. The placement of the proper amount of brazing filler metal and of flux in all joints may be quite exacting. The time permitted from the end of cleaning to the start of heating **is limited** because of the need to avoid that oxides form again. All these requirements must be assured for successful brazing.

The Brazing-inspection function catering to the fulfillment of all assembly requirements must be performed by a **responsible and experienced** worker or inspector, to avoid oversight that cannot be easily repaired after brazing. Then, whatever the heating method, the brazing process itself must be controlled by proper **automatic means** to assure that all parameters be at any time within the tolerances established in the development stage.

If the process is manual, however, its control is in the **very hands** of the blazer whose skill and experience are the best assurance of success. Once the parts are finally brazed, Brazing-inspection is called to verify that all joints are correctly made to meet all requirements. The search is for **discontinuities** in the joint, meaning lack of metallurgic ally bonded filler metal or presence of cracks or voids, caused by entrapment of flux or gas.

The importance of the discontinuities that were found has to be interpreted against the **criteria** set up by applicable Codes or by drawing requirements.

For simple joints, visual inspection may verify the proper filler flow at the opposite side from the emplacement of the filler metal. **Liquid penetrant** inspection (see Welding Inspection) expands the sensitivity of visual examination and may display fine cracks open to the surface, invisible to the naked eye.

Leak test or pressure tests may be required for more demanding applications.

Proof tests, consisting in submitting the joints to loads exceeding those to be sustained in service, may be required. However Brazing-inspection should make sure that the test itself **does not compromise** joint integrity. Occasionally a test piece may be **tested to destruction**, to expose the brazing filler metal in all parts of the joint. Cracks are not admitted but **isolated voids** may be tolerated if not open to the surface.

The quantity and distribution of accepted internal voids and the method to determine them, (usually by radiography or ultrasonic testing, see Welding Inspection) must be **established by the designer** according to function and importance of the application.

Less common techniques like thermo graphic examination, laser holography or other specialized methods were developed to meet exceptional requirements not readily covered by regular Brazing-inspection.

Self-check 2.	Written test

Name…………………………………………… ID……………………….. Date…….

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. List Identifying the procedues for inspecting brazed/ soldered joints.?(5pts)
2. List step of minimize the distortion?(5pts)
3. List mechanical testing methods?(5pts)
4. List Use the back step welding technique?(5pts)

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

Answer Sheet

Name: _________________________ Date: _______________

Test I

1.____

2.____

Test II

1.____

Information Sheet-3	Using set-up and/ or mounting techniques.

3.1. Using set-up and/ or mounting techniques.

- ✓ **SOLDERING TECHNIQUES**

The two soldering methods most often used are soldering with coppers or torch soldering. The considerations that apply to these methods of soldering are as follows:

1. Clean all surfaces of oxides, dirt, grease, and other foreign matter.
2. Use the proper flux for the particular job. Some work requires the use of corrosive fluxes, while other work requires the use of noncorrosive fluxes. Remember, the melting point of the flux must be BELOW the melting point of the solder you are going to use.
3. Heat the surfaces just enough to melt the solder. Solder does not stick to unheated surfaces; however, you should be very careful not to overheat the solder, the soldering coppers, or the surfaces to be joined. Heating solder above the work temperature increases the rate of oxidation and changes the proportions of tin and lead.
4. After making a soldered joint, you should remove as much of the corrosive flux as possible.

- ✓ **Sweat Soldering**

Sweat soldering is used when you need to make a joint and not have the solder exposed. You can use this process on electrical and pipe connections. To make a sweated joint, you should clean, flux, and tin each adjoining surface. Hold the pieces firmly together and heat the joint with a soldering copper or a torch until the solder melts and joins the pieces together. Remove the source of heat and keep the parts firmly in position until the solder has completely hardened

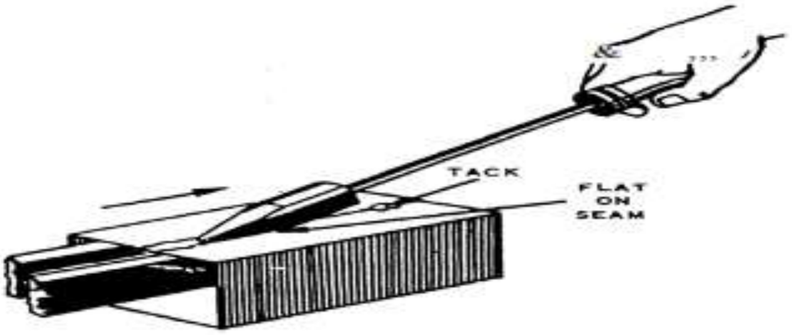


Figure 6-9.—Soldering a seam.

- ✓ **Seam Soldering**

Seam soldering involves running a layer of solder along the edges of a joint. Solder seam joints on the inside whenever possible. The best method to use for this process is soldering coppers, because they provide better control of heat and cause less distortion.

Clean and flux the areas to be soldered. If the seam is not already tacked, grooved, riveted, or otherwise held together, tack the pieces so the work stays in position.Position the piece so the seam does not rest directly on the support. This is necessary to prevent loss of heat to the support. After you have firmly fastened the pieces together, solder the seam. Heat the area by holding the copper against the work. The metal must absorb enough heat from the copper to melt the solder, or the solder will not adhere.Hold the copper so one tapered side of the head is flat against the seam, as shown in figure 6-9. When the solder begins to flow freely into the seam, draw the copper along the seam with a slow, steady motion. Add as much solder as necessary without raising the copper from the work. When the copper becomes cold, you should use the other copper and reheat the first one.Change coppers as often as necessary. Remember, the best soldered seams are made without lifting the copper from the work andAllow the joint to without retracing completed work. Cool and the solder to set before moving the joint. When you use a corrosive flux, clean the joint by rinsing it with water and then brushing or wiping it with a clean, damp cloth.Riveted seams are often soldered to make them watertight. Figure 6-10 shows the procedure for soldering a riveted seam.

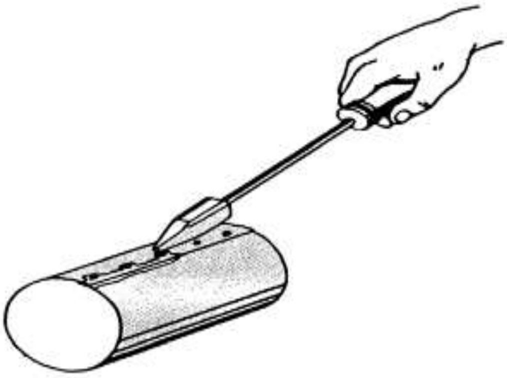


Figure 6-10.—Soldering a riveted seam.

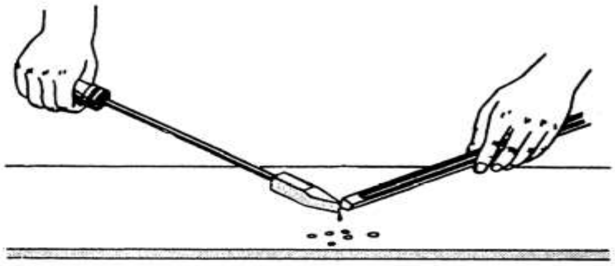


Figure 6-11.—Making solder beads.

Hold the copper in one position until the solder starts to flow freely into the seam. Draw the copper slowly along the seam, turning the work as you go. Add more beads as you need them and reheat the copper as necessary.

To heat an electric soldering copper, you merely plug it in. Otherwise, the procedure is much the same as that just described. Be very careful not to let an electric soldering copper overheat. Overheating can burn out the electrical element as well as damage the copper and tinning,

Self-check 3.	Written test

Name…………………………………………… ID………………………… Date…….

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. List soldering and de-soldering technics ?(5pts)
2. List importance of Seat Soldering?(5pts)
3. List uses of flux?(5pts)
4. List importance of sweat Soldering?(5pts)

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

Answer Sheet

Name: ___________________________ Date: ________________

Test I

1.____

2.____

Test II

1.____

LG #43	LO #3- Solder components

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Material/device is cut, shaped and/or drilled to specification.
- Materials/devices are cleaned to specifications using correct and appropriate materials and procedures.
- Correct and appropriate set-up and/ or mounting techniques are used due to requirements

Clarifying the Process steps are documented and clearly represented in accordance with standard operating procedures This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to;

- Material/device is cut, shaped and/or drilled to specification.
- Materials/devices are cleaned to specifications using correct and appropriate materials and procedures.
- Correct and appropriate set-up and/ or mounting techniques are used due to requirements

Learning Instructions:

9. Read the specific objectives of this Learning Guide.
10. Follow the instructions described blow
11. Read the information written in the "Information Sheets 1 and "Information Sheets 2 on page 3 and 27 respectively.

    Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
12. Accomplish the "Self-check 1" and "Self-check 2" in page 26 and 29 respectively.

- Fit and adjust machine components and related attachments
- Enter processing/operating parameters
- Check and adjust equipment performance

- Carry out pre-start checks Carry out pre-start checks

Learning Instructions:

19. Read the specific objectives of this Learning Guide.
20. Follow the instructions described below.
21. 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.
22. Accomplish the “Self-checks” which are placed following all information sheets.
23. 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).
24. If you earned a satisfactory evaluation proceed to “Operation sheets
25. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
26. If your performance is satisfactory proceed to the next learning guide,
27. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet-1	Mounting material/device. .

1.1. Mounting material/device.

2.1. Applying soldering techniques and use of flux.

A FLUX Fluxes

Brazing processes require the use of a flux. Flux is the substance added to the metal surface to stop the formation of any oxides or similar contaminants that are formed during the brazing process. The flux increases both the flow of the brazing filler metal and its ability to stick to the base metal. It forms a strong joint by bringing the brazing filler metal into immediate contact with the adjoining base metals and permits the filler to penetrate the pores of the metal.

You should carefully select the flux for each brazing operation. Usually the manufacturer's label specifies the type of metal to be brazed with the flux. The following factors must be considered when you are using a flux:

- Base metal or metals used
- Brazing filler metal used
- Source of heat used

Flux is available in powder, liquid, and paste form. One method of applying the flux in powdered form is to dip the heated end of a brazing rod into the container of the powdered flux, allowing the flux to stick to the brazing rod. Another method is to heat the base metal slightly and sprinkle the powdered flux over the joint, allowing the flux to partly melt and stick to the base metal. Sometimes, it is desirable to mix powdered flux with clean water (distilled water) to form a paste.

Flux in either the paste or liquid form can be applied with a brush to the joint. Better results occur when the filler metal is also given a coat.

The most common type of flux used is borax or a mixture of borax with other chemicals. Some of the commercial fluxes contain small amounts of phosphorus and halogen salts of iodine, bromine, fluorine, chlorine, or astatine. When a prepared flux is not available, a mixture of 12 parts of borax and 1 part boric acid may be used.

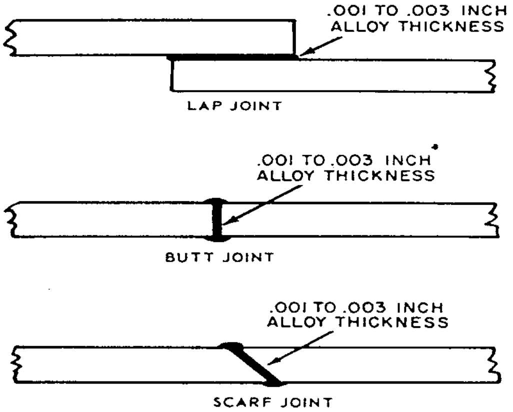
JOINT DESIGN

In brazing, the filler metal is distributed by capillary action. This requires the joints to have close tolerances and a good fit to produce a strong bond. Brazing has three basic joint designs lap, butt, and scarf.

These joints can be found in flat, round, tubular, or irregular shapes.

Lap Joints

The lap joint is one of the strongest and most frequently used joint in brazing, especially in pipe work. The primary disadvantage of the lap joint is the increase in thickness of the final product. For maximum strength, the overlap should be at least three times the thickness of the metal. A 0.001-inch to 0.003-inch clearance between the joint members provides the greatest strength with silver-based brazing filler metals. You should take precautions to prevent from



closing

1. Flux is used to prepare the surfaces of the conductors prior to soldering. Flux removes oxidation from the conductors and maintains oxide-free surfaces at elevated temperature during the soldering process. This allows all surfaces to “wet” properly.
2. The most common flux used in hand soldering of electronic components is rosin, a combination of mild organic acids extracted from pine trees (some manufacturers use synthetic compounds).
3. Although fluxes can be obtained in liquid or paste form, they are typically contained in solders (rosin core) used for hand assembly of electronics. Fluxes labeled as “Acid” are strong acids (as opposed to the mild rosins) and should never be used for electronics assembly.

SOLDERING

2. Rosin core. 60/40 Sn/Pb (M.P. 361-376°F) and 63/37 Sn/Pb (M.P. 361°F) solders are the most common types used for electronics assembly. These solders are available in various diameters and small

Self-check 2.	Written test

Name…………………………………………… ID……………………… Date…….

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. List soldering and de-soldering technics ?(5pts)
2. List advantages of Lap Joints?(5pts)
3. List uses of flux?(5pts)
4. List all joint design?(5pts)
5. ?(5pts)

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

Answer Sheet

Name: ____________________________ **Date:** _________________

Test I

1.____

2.____

Test II

1.____

Information Sheet-3	Undertaking techniques to protect materials/ devices from heat damage. .

3.1. Distortion or deformation can occur during welding as a result of the non-uniform expansion and contraction of the weld and base metal during the heating and cooling cycle. Stresses form in the weld as a result of the changes in volume, particularly if the weld is restrained by the fixed components or other materials surrounding it. If the restraints are partly removed, these stresses can cause the base material to distort and may even result in tears or fractures. Of course, distortion can be very costly to correct, so prevention is important.

What are the main types of distortion? There are various types of distortion and dimensional change including longitudinal; transverse; angular; twisting and bowing. Two or more types of distortion may occur at the same time.

What are the main causes of distortion? There are many factors that can cause welding or cutting distortion and it is very difficult to predict the exact amount of distortion that is likely to occur. Some of the factors that should be considered include the degree of restraint; the thermal and other properties of the parent material; inherent stresses induced from previous metal-working processes such as rolling, forming and bending; design of weldment; accuracy of manufacture and the nature of the welding process itself – the type of process, symmetry of the joint, preheat and the number and sequence of welds required.

What can I do to limit distortion? The effects of weld shrinkage can never be entirely eliminated but you can keep them to a minimum by taking a few practical steps as follows:

- Reducing the metal weld volume to avoid overfill and consider the use of intermittent welding • Minimizing the number of weld runs
- Positioning and balancing the welds correctly round the axis
- Using back step or skip welding techniques, which involves laying short welds in the opposite direction
- Making allowance for shrinkage by pre-setting the parts to be welded out of position
- Planning the welding sequence to ensure that shrinkages are counteracted progressively.

To minimize weld distortion, the design and welding should be addressed the following step also minimize the distortion.

g. Avoid over welding
h. Intermittent welding
i. Fewer weld passes
j. Place weld near the neutral axis, or the center of th part
k. Balance weld around the neutral axis.
l. Use clamping

Clamping — Clamps, jigs, and fixtures that lock parts into a desired position and hold them until welding is finished are probably the most widely used means for controlling distortion in small assemblies or components. While there is some movement or distortion after the welded part is removed from the jig or clamps, it will be lower compared to the amount of movement that would occur if no restraint were used during welding.

Avoid over welding — The bigger the weld, the greater the shrinkage. Correctly sizing a weld not only minimizes distortion, but also saves weld metal and time.

Use the back step welding technique — In the backstep technique, the general progression of welding may be left to right, but each bead segment is deposited from right to left. As each bead segment is placed, the heated edges expand, which temporarily separates the plates at B. As the heat moves out across the plate to C, expansion along outer edges CD brings the plates back together. This separation is most pronounced as the first bead. With successive beads, the plates expand less and less because of the restraint from the prior welds.

To prevent distortion in soldering are;

- ✓ Keep solder iron always on its stand.
- ✓ All electrically operated instruments/equipment should have proper earthling.
- ✓ Sometimes emission of (smoke) soldering operation may be poisonous due to a particular type of flux. Operator should have protection from the same.
- ✓ Flux should be applied gradually while soldering.
- ✓ While diluting HCl, water should not be added to HCl but HCl should be mixed into the water drop by drop, to avoid accident.
- ✓ Work place should have enough ventilation and smoking should be strictly Prohibited during the operation.
- ✓ It should be noted down good quality surface preparation always contributes To good quality joint.

Assembling and setting up heating equipment safely

Heat Sources

soldering processes are defined mostly by the source of the heat

- Torch brazing
- Torch soldering
- Infrared soldering
- Furnace brazing
- Electrical-induction brazing

Preheating

A proper heating process is critical. Improper heat procedure is a major problem in brazing and can adversely impact integrity of the joint. The most challenging part in heating is knowing when (and if) the inside surfaces have reached a uniform proper temperature. The operator cannot see the inner surfaces, and it is not easy to measure this surface during mass production.

Self-check 3.	Written test

Name…………………………………………… ID……………………… Date……

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. List Assembling and setting up heating equipment safely (5pts)
2. List Use the back step welding technique ?(5pts)
3. List A proper heating process?(5pts)
4. List all source of the heat?(5pts)

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

Answer Sheet

Name: ____________________________ **Date:** ________________

Test I

1.____

2.____

Test II

1.____

Information Sheet-4	**Handling printed circuit boards, assemblies and components.** **..**

4.1. Handling printed circuit boards, assemblies and components.

LG #44	LO #4- Assure quality soldering process

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Material/device is cut, shaped and/or drilled to specification.
- Materials/devices are cleaned to specifications using correct and appropriate materials and procedures.
- Correct and appropriate set-up and/ or mounting techniques are used due to requirements

Clarifying the Process steps are documented and clearly represented in accordance with standard operating procedures This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to;

- Material/device is cut, shaped and/or drilled to specification.
- Materials/devices are cleaned to specifications using correct and appropriate materials and procedures.
- Correct and appropriate set-up and/ or mounting techniques are used due to requirements

Learning Instructions:

13. Read the specific objectives of this Learning Guide.
14. Follow the instructions described blow
15. Read the information written in the "Information Sheets 1 and "Information Sheets 2 on page 3 and 27 respectively.

    Try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
16. Accomplish the "Self-check 1" and "Self-check 2" in page 26 and 29 respectively.

- Fit and adjust machine components and related attachments
- Enter processing/operating parameters
- Check and adjust equipment performance

- Carry out pre-start checks Carry out pre-start checks

Learning Instructions:

28. Read the specific objectives of this Learning Guide.
29. Follow the instructions described below.
30. 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.
31. Accomplish the “Self-checks” which are placed following all information sheets.
32. 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).
33. If you earned a satisfactory evaluation proceed to “Operation sheets
34. Perform “the Learning activity performance test” which is placed following “Operation sheets” ,
35. If your performance is satisfactory proceed to the next learning guide,
36. If your performance is unsatisfactory, see your trainer for further instructions or go back to “Operation sheets”.

Information Sheet-1	Carrying out Visual inspection.

1.1. Reporting or recording inspection results using standard operating procedures as required.

Visual examination - with or without magnification-for evaluating voids, porosity, surface cracks, fillet size and shape, discontinuous fillets plus base metal erosion (not internal issues such as porosity and lack of fill)

- ✓ Leak testing - for determining gas- or liquid-tightness of a brazement. Pressure (or bubble leak) testing involves the application of air at greater-than-service pressures. Vacuum testing is useful for refrigeration equipment and detection of minute leaks, employing a mass spectrometer and a helium atmosphere.
- ✓ Proof testing - subjecting a brazed joint to a one-time load greater than the service level-applied by hydrostatic methods, tensile loading or spin testing
- ✓ Radiographic examination - useful in detecting internal flaws, large cracks and braze voids, if thickness and X-ray absorption ratios permit delineation of the brazing filler metal-cannot verify a proper metallurgical bond.
- ✓ Ultrasonic examination - a comparative method for evaluating joint quality, in immersion mode or contract mode-involves reflection of sound waves by surfaces, using a transducer to emit a pulse and receive echoes
- ✓ Liquid penetrant examination - dye and fluorescent penetrants may detect cracks open to the surface of joints-not suitable for inspection of fillets, where some porosity is always present
- ✓ Acoustic emission testing - evaluating the extent of discontinuity-using the premise that acoustic signals undergo a frequency or amplitude change when traveling across discontinuities

Soldering aluminum alloys

is more difficult than soldering many other metals. The difficult y arises primarily from the layer of oxide that always covers aluminum alloys. The thickness of the layer depends on the type of alloy and the exposure conditions.

Using the proper techniques, many of the aluminum alloys can be successfully soldered. Wrought aluminum alloys are usually easier to solder than cast aluminum alloys. Heat-treated aluminum alloys are extremely difficult to solder, as are aluminum alloys containing more than 1% magnesium.

The solders used for aluminum alloys are usually tin-zinc or tin-cadmium alloys. They are generally called ALUMINUM SOLDERS. Most of these solders have higher melting points than the tin-lead solders used for ordinary soldering. Corrosive and noncorrosive fluxes are used for soldering aluminum.

The first step in soldering aluminum is to clean the surfaces and remove the layer of oxide. If a thick layer of oxide is present, you should remove the main part of it mechanically by filing, scraping, sanding, or wire brushing. A thin layer of oxide can often be removed by using a corrosive flux. Remember; remove any residual flux from the joint after the soldering is finished.

After cleaning and fluxing the surfaces, you should tin the surfaces with aluminum solder. Apply flux to the work surfaces and to the solder. You can tin the surfaces with a soldering copper or with a torch.

If you use a torch, do not apply heat directly to the work surfaces, to the solder, or to the flux. Instead, play the torch on a nearby part of the work and let the heat conduct through the metal to the work area. Do not use more heat than is necessary to melt the solder and tin the surfaces.

Work the aluminum solder well into the surfaces. After tinning the surfaces, the parts may be sweated together.Another procedure you can use for soldering aluminum alloys is to tin the surfaces with an aluminum solder and then use a regular tin-lead solder to join the tinned surfaces.

This procedure can be used when the shape of the parts prevents the use of the sweating method or demands a large amount of solder. When using tin-lead solder with aluminum solder, you do not have to use flux.

After soldering is complete, you should clean the joints with a wire brush, soap and water, or emery cloth. Ensure that you remove all the flux from the joint since any flux left will cause corrosion. Brazing is the process of joining metal by heating the base metal to a temperature above 800°F and adding a nonferrous filler metal that melts below the base metal.

Brazing should not be confused with braze welding, even though these two terms are often interchanged. In brazing, the filler metal is drawn into the joint by capillary action and in brazes welding it is distributed by tinning.

Brazing is sometimes called hard soldering or silver soldering because the filler metals are either hard solders or silver-based alloys. Both processes require distinct joint designs.

Brazing offers important advantages over other metal-joining processes. It does not affect the heat treatment of the original metal as much as welding does, nor does it warp the metal as much. The primary advantage of brazing is that it allows you to join dissimilar metals.

EQUIPMENT

Brazing requires three basic items. You need a source of heat, filler metals, and flux. In the following paragraphs these items are discussed.

Heating Devices

The source of heat depends on the type and amount of brazing required. If you are doing production work and the pieces are small enough, they can be put into a furnace and brazed all at once. Individual torches can be mounted in groups for assembly line work, or you can use individual oxyacetylene or Mapp-oxygen torches to braze individual items.

Self-check 1.	Written test

Self-check 1 Written test

Name…………………………………………… ID……………………… Date…….

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. List purpose of visual examination?(5pts)
2. List soldering aluminum alloys?(5pts)

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

Answer Sheet

Name: ___________________________ Date: ________________

Test I

1.____

2.____

Test II

1.____

Information Sheet-2	Undertaking mechanical/electrical tests..

2.1. Measuring instruments there are also several destructive and mechanical testing methods, often used in random or lot testing:

- ✓ Peel testing - useful for evaluating lap joints and production quality control for general quality of the bond plus presence of voids and flux inclusions-where one member is held rigid while the other is peeled away from the joint
- ✓ Metallographic examination-testing the general quality of joints-detecting porosity, poor filler metal flow, base metal erosion and improper fit
- ✓ Tension and shear testing - determines strength of a joint in tension or in shear-used during qualification or development rather than production
- ✓ Fatigue testing - testing the base metal plus the brazed joint-a time-consuming and costly method
- ✓ Impact testing - determines the basic properties of brazed joints-generally used in a lab setting
- ✓ Torsion testing - used on brazed joints in production quality control-for example, studs or screws brazed to thick sections The size, complexity and severity of the application determine the best inspection method, and several methods may be required. If you are unable to develop an accurate and dependable method of inspecting a critical brazed joint, consider revisiting your joint design to allow adequate inspection.

ELECTRIC SOLDERING COPPERS;

Electric soldering coppers, or soldering irons, as they sometimes are called, are built with internal heating coils. The soldering heads are removable and interchangeable.

Tinning is basically the same with the exception that the tip usually does not become cherry red. Forging or reshaping is not necessary, because the heads are easily replaced.

Electric soldering irons are usually used for electrical work or other small jobs. They are especially suited for this type of work, because they do not require auxiliary heating athecan be manufactured as small as a pencil.

Fig:-Measuring instruments

GAS TORCHES; Gas torches can be used in combination with soldering head attachments or as a direct heat source. The Presto lite heating unit is ideal for soft soldering, because it delivers a small controllable flame. It also may be used effectively to heat soldering coppers. this heating unit includes a fuel tank regulator, hose, and torch. It burns acetylene or MAPP gas as fuel in the presence of oxygen.

The torch tip (stem); is interchangeable with other tips that come with the unit.

Soft Solder

There are many different types of solder being used by industry. Solders are available in various forms that include bars, wires, ingots, and powders. Wire solders are available with or without a flux core. Because of the many types of solder available, this chapter only covers the solders most commonly used by Steelworkers.

TIN-LEAD SOLDER; The largest portion of all solders in use is solders of the tin-lead alloy group. They have good corrosion resistance and can be used for joining most metals. Their compatibility with soldering processes, cleaning, and most types of flux is excellent.

In describing solders, it is the custom of industry to state the tin content first; for example, a 40/60 solders means to have 40% tin and 60% lead.

Tin-lead alloy melting characteristics depend upon the ratio of tin to lead. The higher the tin content, the lower the melting temperature. Tin also increases the wetting ability and lowers the cracking potential of the solder.

The behavior of tin-lead solder is shown by the diagram in figure 6-8. This diagram shows that 100% lead melts at 621°F and 100% tin melts at 450°F. Solders that contain 19.5% to 97.5% tin remain a solid until they exceed 360°F. The eutectic composition for tin-lead solder is about 63% tin and 37% lead. ("Eutectic" means the point in an alloy system that all the parts melt at the same temperature.) A 63/37 solder becomes completely liquid at 361°F. Other compositions do not. Instead, they remain in the pasty stage until the temperature increases to the melting point of the other alloy. For instance, 50/50 solder has a solid temperature of 361°F and a liquid temperature range of 417°F. The pasty temperature range is 56°F—the difference between the solid and the liquid.

Solders with lower tin content are less expensive and primarily used for sheet metal products and other high-volume solder requirements. High tin solders are extensively used in electrical work. Solders with 60% tin or more are called fine solders and are used in instrument soldering where temperatures are critical.

Self-check 2. **Written test**

Name…………………………………………… ID……………………….. Date……

Directions:

Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Test I Short Answer Questions

1. List Assembling and setting up heating equipment safely (5pts)
2. List Use the back step welding technique ?(5pts)
3. List A proper heating process?(5pts)
4. List all source of the heat?(5pts)

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

Answer Sheet

Name: ___________________________ Date: ________________

Test I

1.____

2.____

Test II

1.____

Information Sheet-3	Supporting operation in the workplace

1.1 Introduction

- The process of operational controlling allows converting strategic plans in the operational plans.
- These plans must be tailored to specific units that make up the whole company. The whole process takes often place in the so-called "budgeting process".
- Operational control normally takes the form of budgetary control, and is performed by comparing the short-term performance of organizational units with those established in the budget. Then managers analyze the deviations of actual values from the values set in goals for specific unit and the whole company.

1.2 Supporting and controlling operation

- Operational controlling is used to regulate the internal processes necessary to monitor and direct of the company in the short term.
- It allows making decisions related to on going

1.3. The main tasks of operational controlling include

- Controlling of the results,
- Liquidity planning,

1.4. Operations Controlling

- Controlling of the results,
- Liquidity planning,
- Monitoring of profitability,
- Improving effectiveness of use of existing resources.

.

1.1. Whole system is mainly divided into three elements:

- Internal reporting system;
- Budgetary control;
- Operational planning (budgeting).

✓ **It is easy to see in the figure that there are three stages in production control function:**

- **PLANNING STAGE**:
  This stage deals with the activities such as product planning,
  Forecasting of the demand on the basis of past trends;
- **ACTION STAGE**
  It is concerned with the real implementation of the plan. It begins with the dispatching function, which deals with the progress of the work or job;
- **MONITORING STAGE:**
  In this stage, the planned activities are controlled and monitored by using various techniques such as inventory control, tool control, cost Control, quality control.

Reporting helps in controlling the whole process.

1.2. Characteristics of Control System:

Some important characteristics of control system may be mentioned as hereunder:

- Control is a continuous process
- Control is a management process
- Control is embedded in each level of organizational hierarchy
- Control is forward looking
- Control is closely linked with planning
- Control is a tool for achieving organizational activities
- Control is an end process
- Control compares actual performance with planned performance*
- Control point out the error in the execution process
- Control helps in minimizing cost
- Control helps in achieving standard
- Control saves the time

1.3. Elements of Operations Control

As we have already discussed in chapter one that production plans are prepared in advance at top level whereas, production control is exercised at machine shop floor (bottom level) where actual production is taking place.

Some important elements production and control

1.4. The important elements may be listed as following:

- **Materials**:
  Planning for procurement of raw material, component and spare parts in the right quantities and specifications at the right time from the right source at the right place. Purchasing, storage, inventory control, standardization, variety reduction, value analysis and inspection are the other activities associated with material.
- **Method:**
  Choosing the best method of processing form several alternatives. It also includes determining the best sequence of operations (process plan) and planning for tooling, jigs and fixtures etc.
- **Machines and equipment:**
  Manufacturing methods are related to production facilities available in production systems. It involves facilities planning, capacity
- **Manpower:**
  Planning for manpower (labour and managerial levels) having appropriate skills and expertise.
- **Routing;** determining the flow of work material handling in the plant, and sequence of operations or processing steps. This is related to consideration of appropriate shop layout plant layout, temporary storage location for raw materials, component and semi-finished goods, and of materials handling system
- **Route Sheet:** a route sheet is a document providing information and instructions for converting the raw material in finished part or product. It defines each step of the production operations and lay down the precise path or route through which the product will flow during the conversion process.
  Route sheet contains following information:
  Planning, allocations, and utilization of plant and equipment, machines etc.

Self-Check – 3	Written test

Name…………………………………………… ID………………………… Date…….
Directions: Answer all the questions listed below.

Examples may be necessary to aid some explanations/answers.

Test I write short answer

1. List the important elements planning and scheduling (5pts)
2. List three stages in production control (5pts)
3. List the main tasks of operational controlling (5pts)

Note: **Satisfactory rating – 15 points Unsatisfactory - below 15 points**

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

Information Sheet-4	Inspecting and testing repair/rework.

4.1. Introduction to maintenance

Maintenance is a set of organised activities that are carried out in order to keep an item in its best operational condition with minimum cost acquired (British Standard Glossary of terms3811:1993)

All actions necessary for retaining an item, or restoring to it, a serviceable condition, include servicing, repair, modification, overhaul, inspection and condition verification

- Increase availability of a system
- Keep system's equipment in working order

4.2. Terms of maintenance

Many terms and definitions are used in maintenance engineering work. The section presents some of the frequently used terms and definitions in these areas taken from various sources:

Maintainability: The probability that a failed item will be restored to its satisfactory operational state

Maintenance: All actions necessary for retaining an item or equipment in, or restoring it to, a specified condition

Reliability: The probability that an item will perform its assigned mission satisfactorily for the stated time period when used according to the specified conditions

Availability: The probability that an item is available for use when required

Mission time: The time during which the item is carrying out its assigned mission

Downtime: The total time during which the item is not in satisfactory operating state

Logistic time: The portion of downtime occupied by the wait for a required part or tool

Failure: The inability of an item to operate within the defined guidelines

Serviceability: The degree of ease or difficulty with which an item can be restored to its working condition

Redundancy: The existence of more than one means for accomplishing a stated function

Failure mode: The abnormality of an item's performance that causes the item to be considered to have failed

Human reliability: The probability of accomplishing a task successfully by humans at any required stage in the system operation with a given minimum time limit (if the time requirement is stated)

Useful life: The length of time a product operates within a tolerable level of failure rate

Maintenance concept: A statement of the overall concept of the product specification or policy that controls the type of maintenance action to be taken for the product under consideration.

Corrective maintenance: The repair or unscheduled maintenance to return items or equipment to a specified state, performed because maintenance personnel or others perceived deficiencies or failures

Continuous task: A task that involves some kind of tracking activity (e.g., monitoring a changing situation)

Human performance: A measure of human functions and actions under some specified conditions

Active redundancy: A type of redundancy in which all redundant units are functioning simultaneously

Human error: The failure to carry out a specified task (or the performance of a forbidden action) that could result in disruption of scheduled operations or damage to property or equipment

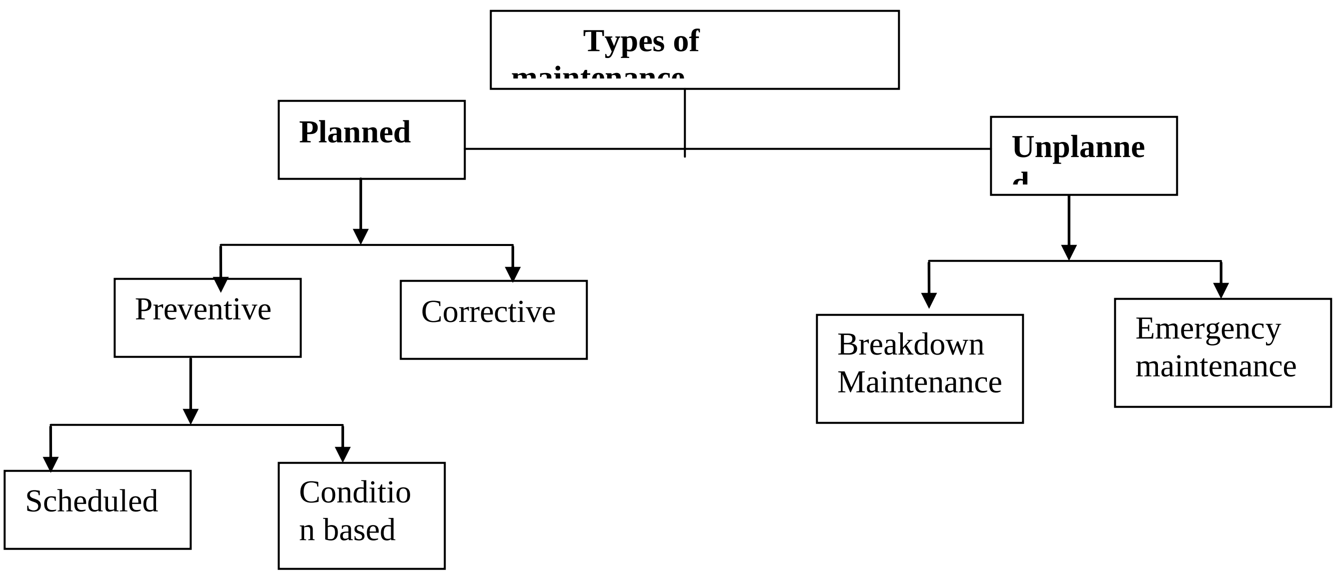
Active repair time: The period of downtime when repair personnel are active to affect a repair

Inspection: The qualitative observation of an item's condition or performance

Overhaul: A comprehensive inspection and restoration of a piece of equipment or an item to an acceptable level at a durability time or usage limit

1.1. Types of maintenance

British Standard 3811 classified maintenance as the followings:



- **Unplanned Maintenance**: "The maintenance carried out to no predetermined plan."
  - ✓ **Emergency maintenance**: it is carried out as fast as possible in order to bring a failed machine or facility to a safe and operationally efficient condition. "The maintenance which it is necessary to put in hand immediately to avoid serious consequences"
  - ✓ **Breakdown maintenance:** it is performed after the occurrence of an advanced considered failure for which advanced provision has been made in the form of repair method, spares, materials, labour and equipment. Repair is undertaken

only after failure of system. Equipment is allowed to run till it fails. Lubricating and minor adjustments are done during the period. Small factories where equipment is very small and doesn't use special tools Isn't suitable for big industries

- **Planned Maintenance**: "The maintenance organized and carried out with forethought, control and the use of records to a predetermined plan."

  - ✓ **Preventive Maintenance (PM)** Condition-based **(Predictive)** Maintenance: "The preventive maintenance initiated as a result of knowledge of the condition of an item from routine or continuous monitoring." In predictive maintenance, machinery conditions are periodically monitored and this enables the maintenance team to take timely actions, such as machine adjustment, repair or overhaul.

  - ✓ **Scheduled Maintenance:** "The preventive maintenance carried out to a predetermined interval of time, number of operations, etc.

  - ✓ **Corrective Maintenance (CM)** Corrective Maintenance: "The maintenance carried out after a failure has occurred and intended to restore an item to a state in which it can perform its required function."In this type, actions such as repair, replacement, or restore will be carried out after the occurrence of a failure in order to eliminate the source of this failure or reduce the frequency of its occurrence.

    E.g Shutdown corrective maintenance, which is a set of corrective maintenance activities that are performed when the production line is in total stoppage situationThe main objectives of corrective maintenance are the maximisation of the effectiveness of all critical plant systems, the elimination of breakdowns, the elimination of unnecessary repair, and the reduction of the deviations from optimum operating conditions.

    The difference between corrective maintenance and preventive maintenance is that for the corrective maintenance, the failure should occur before any corrective action is taken.

The way to perform corrective maintenance activities is by conducting four important steps:

- ✓ Fault detection/finding
- ✓ Fault isolation./separation
- ✓ Fault elimination./removing
- ✓ Verification/proof of fault elimination.

In the fault elimination step several actions could be taken such as adjusting, aligning, calibrating, reworking, removing, and replacing

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Which one of the following is not an action of maintenance

A. Servicing & Repair
B. Modification& Overhaul
C. Inspection and Condition verification
D. None

2. Which one of the following is not Unplanned Maintenance

A. Emergency maintenance
B. Breakdown maintenance
C. Preventive maintenance
D. All

3. Which one of the following is not Planned Maintenance

A. Preventive Maintenance (PM)
B. Corrective Maintenance (CM)
C. *Breakdown maintenance*
D. *All*

4. Which one of the following is not preventive Maintenance activity

A. Inspection
B. lubrication
C. Repair
D. Overhaul of equipments
E. All

5. The main objectives of maintenance is

A. Improve and ensure maximum utilization of maintenance facilities
B. Reduce the amount and frequency of maintenance

C. Improve maintenance operation

D. All

6. Which one of the following is not Advantage of preventive maintenance

A. Avoid major break downs

B. Increased production

C. Less down time of plant

D. Increase life of plant

E. None

Part II

Say True or False

1. All actions necessary for retaining an item or equipment in, or restoring it to, a specified condition is called Maintenance.
2. The qualitative observation of an item's condition or performance is called Inspection.
3. Most accidents are caused by ignorance and carelessness and lack of skill.
4. Prevention of accidents-grater safety is one of Advantage of preventive maintenance.
5. The main purpose of maintenance is to reduce the business risks.

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