Soldering Equipment

Objectives

* Describe basic soldering equipment.
* Describe characteristics of electric soldering irons.
* Describe features of soldering iron tips.
* Describe features of gas-powered soldering torches.
* Distinguish between types of solder.
* Describe characteristics of lead-free solder.
* Describe how flux is used in soldering.
* Describe features of rosin-based flux.
* Describe features of water-soluble flux.
* Describe practices for preventing ESD while soldering.
* Distinguish between types of desoldering equipment.
* Identify types of soldering accessories.
* Describe types of soldering safety equipment.

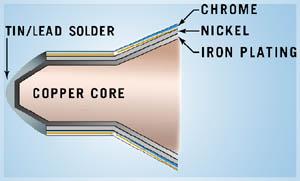
What is Soldering Equipment?

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| |  | | --- | | **Soldering** is an assembly method used to join delicate electrical parts. In the soldering process, metal filler known as **solder** is heated to liquid form and used to join two other pieces of metal or wire together. The liquid filler then cools and solidifies to form the **joint**. Today, many industries rely on skilled soldering technicians to work on sophisticated electrical components.   Essential equipment for soldering typically includes a **soldering iron** and solder. Figures 1 and 2 show examples these materials. There are many varieties of these basic items from which to choose for various soldering applications. Aside from essential soldering tools, there are additional kinds of equipment used by soldering technicians in industry today. This class describes various types of soldering equipment, discusses how soldering equipment is used in industry, and provides basic safety precautions for using soldering equipment. | |

Electric Soldering Irons

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| |  | | --- | | The primary tool used in soldering is a **soldering iron**, which transfers heat to an exposed metal surface and melts the solder to create a joint. Figure 1 shows a soldering technician using a soldering iron. A typical soldering iron can reach temperatures up to 800°F (430°C), so it must be handled with care.  There are several types of irons that can be used for soldering applications. The most common type is a pen-shaped device with a metal tip, such as the iron in Figure 2. This type of iron is usually powered by electricity and is available in varying levels of **wattage**. Irons with lower wattage, such as 15-30 **watts**, can be used for smaller joints. Irons with higher wattage are generally used for applications where soldering larger joints is necessary. Battery-powered soldering irons are also available for portable applications, but electric soldering irons are more common. Figure 3 shows a battery-powered soldering iron.  Some electric soldering irons are available with optional temperature control. Generally, more expensive irons with higher wattage have this feature. While soldering irons without temperature control can be effective for smaller joints, irons with temperature control are better for larger joints because they maintain a constant heat level while soldering. In addition, an iron with temperature control is also an effective safety precaution so that you do not solder at too high a temperature. | |

Soldering Iron Tips



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| |  | | --- | | Every soldering iron requires a soldering iron tip. There are different styles of soldering tips available for different soldering applications. Most soldering iron tips are made primarily of copper due to its high **conductivity**, which allows heat to transfer more quickly to the joint. A common soldering iron tip design features iron plating over the copper tip, with nickel plating over the iron. Often, there is a chrome plating over the iron as well. These materials protect the copper tip. Figure 1 illustrates the composition of a soldering iron tip.  Soldering iron tips are also available in different shapes, as shown in Figure 2. You should select a tip that is close in size to the objects you are soldering. As a rule, flat tips transfer heat more effectively because they provide a bigger contact area with the joint. Soldering iron tips are also available in other shapes, such as bevel and conical shapes, to suit a particular application.  Special soldering iron tips for using **lead-free solder** are also available. Lead-free solders use a higher iron temperature and also contain chemicals that can cause traditional soldering iron tips to wear out faster. If you are working with lead-free solder, you should use a tip that is specifically manufactured for it. | |

Gas Powered-Solder Torches

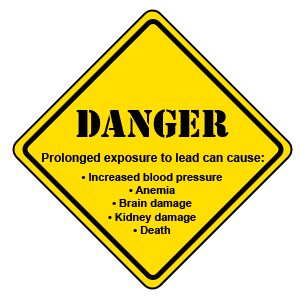
A gas-powered **soldering torch**, shown in Figure 1, is often used for portable applications. Small gas-powered torches are usually inexpensive, powered by **butane** fuel, and are often available with a traditional soldering iron tip and a **blowtorch tip**. When used with the blowtorch tip, the flame of the soldering torch is generally adjustable so you can control the temperature.  
  
Gas-powered soldering torches are often used for outdoor applications or quick repairs in hard-to-reach places. Most gas-powered soldering torches can operate only for limited periods of time before they must be refueled. Gas-powered soldering torches also must have an outlet for exhaust, which can blow hot fumes toward you or the materials you are soldering.  
  
In addition to pen-shaped gas-powered soldering torches, larger soldering torches are also available. This type of soldering torch can be used for joints that are too large to heat with a soldering iron or smaller torch. Unlike smaller soldering torches, a large soldering torch should not be used on electronic equipment but is instead used for large joints such as pipe or cable connections. The flame from the torch could damage surrounding equipment, and the water vapor that the flame gives off can cause condensation and corrosion of metal near the joint.  
  
Figure 2 lists characteristics of gas-powered soldering torches. There are alternatives to soldering irons and torches such as **soldering guns** and **hot-air pencils**, but these are not as common.

Types of Solder

**Solder** is the metal alloy that melts during the soldering process and then hardens when cooled to join metallic surfaces. Numerous solder materials are available. However, the most common type of solder for electronics is an alloy of 60% **tin** and 40% **lead**, also known as **60/40 solder**. Figure 1 shows this solder wire type. 60/40 solder is preferred because of its quick **wetting** properties and low melting point, which is around 365°F (185°C).  
  
Another common variety of solder used for electronic applications is **63/37 solder**, composed of 63% tin and 37% lead. This type of solder is also known as eutectic solder, which refers to the melting point of the two materials. The slightly increased ratio of tin to lead in eutectic solder allows it to transition from a completely solid state to a completely liquid state.  
  
The melting property of 63/37 solder is advantageous because, with other types of solder such as 60/40, there is an intermediate state between liquid and solid form. When the solder is in this state, the soldering iron and workpiece must be held perfectly still so as not to cause vibration and disturb the cooling solder, which would damage the joint. However, 63/37 solder is more expensive than 60/40 solder.

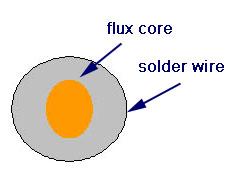
Lead-Free Solder

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| |  | | --- | | While many solders available today are alloys containing lead, the use of **lead-free solder** is becoming increasingly common in industry due to the health hazards of prolonged exposure to lead. Figure 1 lists health hazards presented by lead exposure. Lead-free solder is defined as any solder that contains less than 0.2% lead by weight.  Because there is no single substitute for lead, lead-free solders must be developed from various alloys. Some of the more commonly used lead-free alloys are **SAC**, composed of tin, silver, and copper, and **SnCu**, composed of tin and copper. The melting point of lead-free solder depends on the mix of its alloys, though all lead-free solders have significantly higher melting points than lead-based solders. SAC is often preferred for its relatively low melting point among lead-free solders.  Unlike lead-based solders, which are smooth and shiny, lead-free solders have a dull and grainy appearance They also have a higher **surface tension** than lead-based solders, which leads to reduced wetting capability. Lead-free solder is not suitable for all applications because some delicate components cannot tolerate the high temperatures needed to melt the solder. Also, finished joints created with lead-free solder are shaped differently than those created with lead-based solder. If you are concerned about the effects of lead exposure, ask your supervisor about using lead-free solder in your shop. | |



What is Flux?

Before components can be joined together in the soldering process, they must be cleaned so that the solder can flow evenly and bond to the metal. This is accomplished through the use of **flux**, which prevents **oxidation** on the surfaces of the joined metals. Flux can be applied with a **flux pen**, as shown in Figure 1, but most solders come with flux already inside, as illustrated in Figure 2. In these types of solders, the flux cleans the joint as the solder melts.  
  
There are two major categories of flux: **rosin-based flux** and **water-soluble flux**. Both types of flux are available inside different types of solder. Flux strength is measured by its **activity**, which refers to how effectively the flux cleans. Fluxes with higher activity are more effective. However, using flux often leaves a **residue**. Depending on the type of flux, this residue may need to be removed. Water-soluble flux residues can usually be removed with water. Rosin-based flux residues often require different cleaning agents based on the type of flux used.



Rosin-Based Flux

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| |  | | --- | | The most commonly used type of flux for electronics soldering is rosin-based flux. Rosin-based fluxes are made from purified pine sap and are available in three activity levels: rosin only (R), rosin mildly activated (RMA), and rosin activated (RA).  Rosin-only (R) fluxes are the least active, making them suitable only for surfaces that are already fairly clean. RMA fluxes are more active, with RA fluxes being the most active and providing the best cleaning. RA fluxes leave the most residue on the surfaces they clean, which may need to be removed before soldering. Generally, RA fluxes are not recommended for use on sensitive electronic components such as circuit boards because their high activity can cause corrosion, as shown in Figure 1.  A type of flux known as **no-clean flux** has recently been introduced and is being used in some industries. This type of flux is preferred because it requires no cleaning after the components have been soldered. No-clean flux still has potential to leave some residue on the components, but this residue does not require cleaning since it is noncorrosive. No-clean flux is less active than other types of flux and should be used with base metals that are easy to solder. | |

Water-Soluble Flux

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| |  | | --- | | Not all fluxes are rosin based. Water-soluble fluxes are generally more active than rosin-based fluxes, providing more cleaning action. However, water-soluble fluxes can also leave residue on components that must be removed. Figure 1 shows flux residue on an electronic component.  The name "water-soluble" indicates that these residues can be removed with water. This is the main advantage of water-soluble flux, because it does not require the use of a cleaning agent. Some types of cleaning agents contain chemicals which can be hazardous to health and also to the environment.  Water-soluble flux can be either **organic** or **inorganic** in composition. Inorganic water-soluble flux is considered the most active and corrosive type of flux, but organic water-soluble flux is still more active than all types of rosin-based flux. Figure 2 illustrates the various categories of flux. | |

ESD-Safe Devices

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| |  | | --- | | Soldering electronic components presents the risk of **electrostatic discharge** (ESD). ESD is the buildup and release of static electricity. In addition to being a fire and safety hazard, ESD can damage the components you are soldering. Figure 1 shows a safety sign advising ESD precautions. Even very small amounts of ESD can damage sensitive electronic components. Your workstation should be configured to reduce this risk.  Some soldering stations and materials are designated as **ESD-safe**, such as the station in Figure 2. These materials are designed to transfer static energy from your body to the ground instead of from the tip of the soldering iron and through the components. Precautions for ESD-safe workstations include ESD-safe workbenches and bench mats, insulated floor mats, and even anti-static fabric on the chair at the workstation.  Other materials such as ESD-safe **wrist straps**, smocks, and even special shoes can be worn to avoid transmitting static electricity from your body and damaging components. You should also avoid wearing jewelry such as metal bracelets and rings that can conduct electricity. Different work environments require different types of devices, so ask your supervisor which devices are required in your shop. | |

Desoldering Equipment

Even skilled assemblers sometimes make mistakes while soldering. When this happens, you may need to desolder a joint and then resolder the connection. One way to remove solder from a bad joint is with a **desoldering pump**, which is shown in Figure 1. This type of device features a spring-loaded plunger that sucks liquid solder into the pump.  
  
To use a desoldering pump, heat the solder of the bad joint until it becomes liquid, then position the pump over the molten solder and release the plunger. The molten solder will be sucked into the pump, where it cools. The pump can then be emptied. Another option is a **desoldering iron**, shown in Figure 2, which combines features of a soldering iron and a desoldering pump. This device heats the joint and also allows you to suction the liquid solder into the iron’s hollow tip. Some sensitive components may require desoldering pumps or irons that are ESD-safe.   
  
**Solder wick**, also known as desoldering braid, can be used to remove small amounts of solder. Figure 3 shows a spool of solder and a spool of desoldering braid. To desolder a joint with solder wick, place the solder wick onto the joint and heat the solder with your iron. The molten solder will flow into the solder wick, which you can then remove from the joint. If necessary, you can use both a desoldering pump and solder wick on the same joint to remove all the solder.

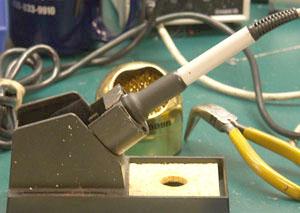






Soldering Accessories

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| |  | | --- | | Though the essential tools needed for soldering include solder, a soldering iron, and flux, there are many other accessories that make your job easier. A soldering iron holder, such as the holder in Figure 1, is an important safety precaution for your workstation. Always replace your iron in its holder. This prevents you from picking it up by the wrong end, or from placing it on flammable material.  You should always solder with a clean iron tip. To clean your soldering iron during use, you can keep a damp sponge or a **metal sponge tip cleaner** in a holder at your workstation, as shown in Figure 2. Another accessory you may use while soldering is a **clamp**, which can hold the components you are soldering. This leaves your hands free to hold both the solder and the soldering iron. A magnifying glass or lamp, shown in Figure 3, can help prevent eye strain when you are soldering small components.  Since soldering jobs often involve wire, **wire cutters** and **wire strippers** are also convenient to keep at or near your workstation. Figure 4 shows a pair of wire cutters. However, make sure to keep all your soldering accessories organized and your workstation free of clutter so that your equipment does not pose a safety hazard. | |









Soldering Safety Equipment

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| |  |  |  | | --- | --- | --- | | Like all industrial applications, there are safety hazards involved in soldering. To protect yourself, make sure that your workstation is equipped with proper safety precautions. Because hot solder can burn your skin, you may wish to wear **safety gloves** while soldering to protect your hands. Molten solder can also spatter, so you should always wear **safety glasses** to protect your eyes. Figure 1 shows appropriate safety glasses.  Some of the **fumes** given off by solder and flux contain harmful chemicals such as lead. If there is no ventilation system in your shop, you should have a **benchtop fume extractor**. This device draws smoke and fumes away from your soldering workstation so that you will not inhale the toxins they may contain. Figure 2 shows a benchtop fume extractor.  Because soldering is a high-heat application, there is the risk of fire, even with the proper safety precautions. Make sure that a multi-purpose **dry chemical extinguisher**, shown in Figure 3, is easily accessible to your work area. Ask your supervisor if you should operate the fire extinguisher in case of fire.  Summary   |  |  | | --- | --- | | |  | | --- | | The primary tool used in soldering is a soldering iron. The most common type is an electric pen-shaped device with a metal tip. Most soldering iron tips are made primarily of copper due to its high conductivity. Soldering iron tips are available in different shapes. When working with lead-based solder, use a tip that is specifically manufactured for it.  Gas-powered soldering torches are often used for portable applications. Unlike smaller soldering torches, a large soldering torch should not be used on electronic equipment, but is often used for large joints. The most common type of solder for electronics is 60/40 solder. However, 63/37 solder is often preferred because it transitions directly from a solid to a liquid state. Lead-free solder is defined as any solder that contains less than 0.2% lead by weight.  There are two major categories of fluxes: rosin-based flux and water-soluble flux, with rosin-based being the most common for electronics work. Rosin-based fluxes are available in three activity levels and are generally less active than water-soluble fluxes.  Soldering electronic components presents the risk of electrostatic discharge (ESD). Your workstation should be configured to reduce this risk. Sometimes you may need to desolder a joint. One way to remove solder from a bad joint is with a desoldering pump. There are many optional soldering accessories, such as clamps. To protect yourself, make sure that your work station is equipped with proper safety precautions, such as a benchtop fume extractor if necessary. | | | |