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# Soldering Safety and Health Guidelines

## 1. Purpose / Background

Soldering is a group of joining processes that produce a joining of materials by using a soldering iron or gun and filler metal (solder) with a temperature not exceeding 840°F (450°C). In addition to the solder and the base metals, soldering operations may involve the use of fluxes, coatings, and cleaning agents. Electronic soldering present's potential exposure issues via inhalation, skin absorption, and accidental ingestion from hand to mouth routes, from both the products used or by-products of the soldering process. In many cases, soldering is done only occasionally and the use of best work practices including good ventilation provides adequate protection. It is important to request an assessment of the hazards from the EHS office if there are any health and safety concerns.

## 2. Scope

This document is intended to provide a guideline for staff, students, faculty, and researchers who may be exposed to soldering fumes and other contaminants during the soldering operation.

## 3. Procedures

### 3.1 Potential Hazards:

**3.1.1 Metal Fumes:** Solder usually contains lead and tin as primary constituents and also other metal ingredients. Solder composition may vary but is commonly 60% tin and 40% lead. Because of the relatively low temperatures in electronic soldering, fumes from these metal constituents themselves are not normally a concern. During the soldering process in the form of lead filler metals, lead oxide fumes are formed and excessive exposure to lead oxide fumes can result in lead poisoning. Symptoms of lead poisoning include loss of appetite, indigestion, nausea, vomiting, constipation, headache, abdominal cramps, nervousness, and insomnia. Other metals that can be found in solders include cadmium, silver, copper, nickel, zinc, arsenic, beryllium, antimony, indium, and bismuth. Based on standard soldering iron temperatures of 620°F-700°F and the melting point of lead (621°F), it is unlikely that lead fume will be generated during electronic soldering, unless the solder is heated to lead's vaporization temperature of 3182°F.

**3.1.2 Decomposition products from the heating of oil, paints, or coatings:** Lead or volatiles from paint, or residue from solvents used in surface preparation, can produce toxic fumes, gases, and vapors. It's recommended to solder the clean surfaces. Oils, paints, and coatings should be removed from surfaces to be

heated during soldering, to prevent the volatilization of these products. Acids, alkalis, and organic solvents may be used to clean surfaces prior to soldering and for removal of remaining unwanted solder or flux residues after soldering.

For example, Teflon (PTFE, or polytetrafluoroethylene) materials, or surfaces coated with Teflon materials, may evolve fumes when heated above 625°F (450°C). A large number of ultrafine particles and low concentrations of gas-phase compounds could be released during soldering. Exposure to Teflon fumes can cause influenza-like syndrome (polymer fume fever).

- 3.1.3 Fumes from fluxes:** Flux allows the solder to flow more smoothly. Soldering may involve the use of flux paste or liquid, or the solder itself may have a rosin core. When this flux is heated it may be volatilized to a gaseous state. While “fume” strictly speaking refers to the volatilized solid material that has then condensed in the air, the term is loosely used to include other airborne products including gases and vapors that may be produced in soldering. Because soldering fume generally rises vertically, it is easy for it to enter the breathing zone of the operator, unless ventilation is used. Even those who solder only occasionally should use fans or local exhaust ventilation to minimize their exposure to soldering fume.
- 3.1.4 Rosin based Flux & Colophony:** Flux is a chemical cleaning agent that is used in conjunction with solder in order to remove oxidation from the base and filler metals involved in soldering. It improves the overall flow and effectiveness of the solder. Rosin-based flux is made from extracts of pine tree sap (Colophony) and can cause health problems if fumes from soldering are inhaled. Colophony is composed of roughly 90% resin acid and 10% neutral material. Repeated or prolonged contact with Rosin may cause skin sensitization. Repeated or prolonged inhalation exposure may cause asthma. When the flux is heated, colophony has been known to generate fumes including aliphatic aldehydes (like formaldehyde) and hydrochloric acid and other gases containing benzene, toluene, styrene, phenol, chlorophenol, and isopropyl alcohol. Short term problems can include nose, sinus, eye and throat irritation and skin rashes, and long-term problems that may include asthma and dermatitis.

***“Rosin is a serious occupational health hazard.”***

Skin Contact with rosin-based solder flux, flux residues, and the fume itself can cause dermatitis. Wearing long-sleeved clothing and gloves can prevent skin contact. The early symptoms associated with respiratory effects of rosin-core solder or rosin flux include watery and prickly eyes, runny or blocked nose, sore throat, coughing, wheezing, or breathing difficulties.

National Institute for Occupational Safety and Health (NIOSH) recommends the rosin core flux pyrolysis products be measured as formaldehyde and limited to 0.1 mg/m<sup>3</sup> (for an 8-hour time-weighted average exposure).

## 3.2 Hierarchy of Control

**3.2.1 Elimination:** If possible, eliminate soldering using other techniques like crimping or twisting electrical wires, fastening screws or bolts, etc.

**3.2.2 Substitution:** Fluxes that do not contain rosin may be used as a substitute. It may affect the quality, tolerances, performances, and costs of operation. Before using any other fluxes, the ingredients and potential health hazards must be evaluated.

**3.2.3 Engineering Control:** An exposure Control Device (ECD) should be used to extract all fumes and gases from the soldering zone. Different local exhaust ventilation (LEV) may be used for fume control during manual soldering. All extract systems should be tested at least annually and maintained (i.e. change filters regularly). In all forms, the general exhaust ventilation should be applied.

**3.2.3.1 Local capture hood (snorkel):** This system removes the fumes directly to the outside (see Image 1 below). It must be located within a short distance from the soldering point approximately 5 inches.



Image 1: Exhaust Snorkel

**3.2.3.2 Extraction units:** It can enclose the soldering zone and facilitate the exhaust (see Image 2 below). It should be equipped with both a carbon filter and HEPA filter. They could be either benchtop (Images 2 and 3 below) or wall-mounted (Image 4 below).



Images 2-4: Different types of fume extractors

Other forms of fume absorbers without HEPA filtration **cannot** provide adequate control of the solder fumes. This is because the pores in the filter are very large, so the jet of exhausted air coming out of the back of the unit still contains an appreciable concentration of solder fume (see Image 5 to the left).



**Image 5:** Regular soldering fume extractor

- 3.2.4 Administrative controls:** Limiting the amount of time doing soldering work can help reduce the exposure to the fumes.
- 3.2.5 Personal protective equipment:** Depending on the situation using a respirator with combined particulate and organic filter is recommended. Suitable lab gloves and lab coat are needed where there is a risk of skin contact. Using eye protection is required if there is a risk of splash from liquid flux.
- 3.2.6 Working posture:** The amount of solder fume can be reduced by changing the working posture. The workpiece should be positioned so the person can keep their head out of the fume generated from the soldering tasks (see Figure 1 below). The workpiece can be elevated to enable the employee to perform the soldering task without breathing in the fume.



**Figure 1:** Correct positioning the soldering station

### 3.3 Recommended Work Practices

- Read and understand the SDS (Safety Data Sheets) for all materials before beginning work
- To avoid lead poisoning use lead -free solders wherever possible. Lead-free solder still may contain tin, copper, silver, and sometimes bismuth, indium, zinc, antimony, and other metals in varying amounts. The lead-free replacements have higher melting points.
- To prevent the ingestion of lead, hands should be washed with soap and water before breaks, lunch, prior to smoking, at the completion of soldering, and at the end of the workday.
- Work areas should be kept clean and wiped with a damp paper towel to minimize the presence of lead dust in the work area.
- Wear eye protection because molten solder can splash on the eyes.
- Keep cleaning solvents in dispensing bottles.
- Wear gloves if directly handling solder.
- Collect waste solder in a waste container. Replace lid when not in use.
- Label appropriately and dispose of as hazardous waste (contact EHS Office).
- Used solder sponges and contaminated rags should be placed in a sealable bag for disposal as hazardous waste.
- Never touch the element or tip of the soldering iron. They are very hot and will burn.
- Hold wires to be heated with tweezers or clamps.
- Keep the cleaning sponge wet during use.
- Always return the soldering iron to its stand when not in use. Never put it down on your workbench.
- Turn soldering iron off or unplug it when not in use.
- Give any soldered surface a minute or two to cool down before you touch it.
- Keep cleaning solvents in dispensing bottles to reduce inhalation hazards.
- Work in a well-ventilated area, to prevent the mildly caustic and toxic fumes from building up and causing eye or throat irritation.
- Avoid breathing it by keeping your head to the side of, not above, your work.

## 4. References

- NIOSH pocket guide, “Rosin core solder, pyrolysis products (as formaldehyde)”
- MONOXIVENT Source Capture Systems, Mini Source Capture Arms, Image 1: <https://monoxivent.com/products/series/mini-source-capture-arms>
- Sentry Air Systems, Solder Fume Extractors, Images 2-4: <https://www.sentryair.com/solder-fume-extractor.htm>
- Poafamx Fume Extractor, Image 5: <https://www.amazon.com/>
- HSE, “Controlling health risks from rosin (colophony)-based solder flux fume,” Figure 1: <https://www.hse.gov.uk/pubns/indg249.pdf>