



## Safe Operating Procedure (SOP)

### Epoxy Systems and Fiberglass

#### Introduction

This safe operating procedure will ensure ALS workers safety during the handling, mixing, lay-up, and curing of epoxy resin systems. The hazards of epoxy resin systems will be outlined, and detailed procedures will be given to minimize the risk of exposure to uncured or incompletely cured epoxy resins.

#### Process

Epoxy resin systems consist of an epoxy resin and a curing agent, which may be referred to as a hardener or catalyst. Epoxy resins can be powders, or they can be thick, clear or yellow liquids. Curing agents react with epoxy resin monomers to form epoxy products. They are usually liquids with strong, unpleasant odors, and may contain additives to enhance strength or shorten drying time. There are several types of curing agents, including aliphatic and aromatic amines, and formaldehydes. The additives can be organic solvents such as toluene, xylene, or methyl ethyl ketone (MEK), and fillers such as sand, clay, fiberglass, or silica. In a two-component epoxy product, the epoxy resin and the curing agent are packaged separately and must be mixed together just before being used. In a single-component product, the resin and the curing agent are supplied in a pre-mixed form.

When epoxy resin systems are used, the epoxy resin chemical and the curing agent combine to form a hard polymer. Some epoxies cure in a few minutes at room temperature, while others need additional time or heat to harden. The hardened, finished polymers are almost non-toxic, but the exposure to the uncured resin components can be harmful.



## **Safety Analysis**

The chemicals in epoxy resin systems can enter the bloodstream by adsorption through the skin, accidental ingestion, or by inhalation of the vapors or dust particles. The acute effects of overexposure are irritation of the eyes, nose, throat, and skin, skin allergies, and asthma.

The solvent additives can cause other effects such as headaches, dizziness, and confusion. Specific hazards are as follows:

**Lungs:** Vapors and spray mists of most epoxy resin system chemicals can irritate the lungs. Some people develop asthma from the curing agents. Symptoms of asthma include chest tightness, shortness of breath, wheezing, and coughing. These symptoms may occur after work or at night. Once a person becomes allergic to curing agents, even the dusts from sanding or grinding the hardened plastics can cause an asthma.

**Skin:** Epoxy resins can cause skin irritation. Symptoms include redness, swelling, flaking, and itching on the hands, face, or other areas of contact. Some people develop a skin allergy or sensitivity to epoxy liquids or mists. Skin allergies may develop after just a few days of contact or after many years of exposure to epoxies. Sensitized skin may become red, inflamed, blistered, and itchy even from brief contact with epoxy resins.

**Eyes, Nose, and Throat:** Most epoxy resin system chemicals and their vapors (especially the curing agents and solvents) can irritate the eyes, nose, and throat. Some people develop headaches as a result of this irritation. If the liquids are splashed into your eye they will sting, and they can severely damage the eye.

**Nervous System:** Solvents inhaled or absorbed through the skin can affect the central nervous system resulting in symptoms similar to alcohol (ethanol) poisoning. Symptoms of solvent overexposure include headache, nausea, dizziness, slurred speech, confusion, and loss of consciousness.

**Cancer:** Epoxy resins causes skin cancer in laboratory animals probably due to epichlorohydrin, a contaminant that can probably cause cancer in humans.



Certain glycidyl ethers used in epoxy products cause cancer in laboratory rats. It is not known if glycidyl ethers cause mutations or cancer in humans. Bisphenol-A is an epoxy resin component that has been linked to breast cancer in epidemiology studies.

Most other components of epoxy resin systems have not been adequately tested to determine if they can cause cancer.

**Endocrine System:** Bisphenol-A is an epoxy resin contaminant that disrupts the endocrine system in animals, and probably in humans, although the levels at which these effects are observed are being hotly.

**Reproductive System:** Bisphenol-A may cause birth defects in animals, and the effects on human embryos. In addition, some of the diluents and solvents in epoxy resin systems may affect reproduction. Two solvents sometimes found in epoxy resin systems (2-ethoxyethanol and 2-methoxyethanol) cause birth defects in laboratory animals and reduced sperm counts in men. Some glycidyl ethers also damage the testes and cause birth defects in test animals. It is not known whether they have the same effects in humans.

Most other solvent additives have not been adequately tested to determine if they affect reproduction.

### **Personal Protective Equipment**

- **Protective gloves:** Disposable nitrile gloves must be used during routine mixing and application, and should be sufficient to prevent skin contact with small quantities of uncured resin or curing agent. Nitrile gloves must be changed often when there is prolonged exposure to uncured resin or curing agents. Where solvents are to be used during spill clean-up, neoprene gloves shall be provided for the use of acetone; nitrile gloves shall be provided for the use of Freon TF; and poly-vinyl alcohol gloves shall be provided for the use of methylene chloride.
- **Glasses:** Ordinary safety glasses with side shields should be sufficient for most small scale epoxy operations. Employees and students who wear contact lenses or who do not wear glasses must wear splash-proof chemical goggles when mixing resins and curing agents.



- **Booties:** Employees at operations where spills may occur, such as pouring or transferring liquid resins into larger-sized molds, must wear disposable foot coverings which may be removed after the epoxy mixing and transferring operations are complete.
- **Spill materials:** Paper towels or adsorbent materials appropriate to the operation being performed must be on-hand to mop up any small spills. If paper towels or adsorbent materials are used for spills, these materials must be placed in a plastic sealed bag and labeled as hazardous waste.
- **Respirators:** In general, a fitted respirator with an organic vapor cartridge is required for all lay-up work with uncured epoxy resin. A fitted respirator or fitted dust mask is required for dry sanding of cured epoxy resins, cutting of carbon fiber composites, and for fiberglass work. Wet sanding operations may not require a fitted respirator, but must be evaluated on a case-by-case basis by the department safety coordinator. Small operations that are conducted completely within a functional fume hood without personnel using respirators may be acceptable with the approval of the department safety coordinator. This determination should be made with consultation with ALS EH&S. The respirator requirements for a given operation apply to everyone in the room that the operation is being conducted.

## **Procedures**

Mixing and Application of Very Small Quantities, pre-packaged in mixing bags:

1. Prior to initial use, read the Material Safety Data Sheet for the product and become familiar with the hazards of the material.
2. As minimum protection, wear disposable nitrile gloves.
3. Read and follow the directions on the package for mixing the material.
4. Place paper towels under the operation to absorb any leakage of excess material.



5. Do not leave scissors, spatulas, etc., which have been contaminated with uncured epoxies and curing agents, in areas where other people may pick them up or otherwise come into contact with them.
6. Excess material shall be allowed to harden in an adequately ventilated area. When the material is completely cured, it may be placed in the trash for disposal.
7. When cleaning up any spills or leaks, be sure to wear protective gloves. If material spills or contaminates the work area, sop up the excess material with a paper towel. Soap and water should be used to clean up any remaining material. It may be necessary to use a small amount of solvent, dispensed from a 500 ml squeeze bottle, to complete the cleaning.
8. Any needle syringes used to apply epoxies to very small components must be packaged properly for disposal. The syringe must be packaged intact (don't re-cap needle or separate the needle from the syringe) and placed in a sharps container.

### **Mixing and Application of Small Quantities (i.e., container sizes up to one cup)**

1. Prior to beginning the operation, read the Material Safety Data Sheet for the product and become familiar with the hazards of the material.
2. Whenever containers from which curing agents will be dispensed have a capacity greater than 500 milliliters, employees shall not work alone and shall ensure that there are other people in the vicinity of the operation who could help in the event of an emergency.
3. Ensure that there are adequate paper towels, sand, or vermiculite nearby in the event that uncured resins or curing agents are spilled.
4. Ensure that an eyewash is located nearby to flush the eyes in the event of eye contact. If there is not an eyewash nearby, another person who can escort the affected person to an eyewash shall remain in the vicinity of the epoxy operation.



5. Place a protective sheet of paper on the table, counter, or cart where the resin is to be mixed.
6. Wear safety glasses or protective goggles.
7. Wear protective gloves.
8. Assemble any mixing devices or other equipment prior to mixing the epoxy.
9. Weigh out the correct amount of resin and curing agent into a disposable container(s) according to the manufacturer's directions and immediately replace the caps on the containers. Hand pump dispensers must be removed from the container and placed in a separate plastic bag for storage.
10. Do not leave tools, stirrers, spatulas, etc., which have been contaminated with uncured epoxies and curing agents, in areas where other people may pick them up or otherwise come into contact with them.
11. Container and supplies contaminated with uncured epoxies and curing agents should be separated from other work areas. A sign indicating an epoxy work area should be displayed.
12. Store excess material in a laboratory fume hood or at a designated location within an adequately ventilated area and allow to harden. Uncured epoxy materials should be stored in a designated location, or a sign indicating the presence of uncured epoxies should be displayed. When the material is completely cured, it may be placed in the trash for disposal.
13. Cleaning of tools using small amounts of solvents such as acetone, dispensed from a 500 ml squeeze bottle, may be required. Any tools or brushes which must be cleaned by soaking or which would require dispensing of solvents from any containers other than a 500 ml squeeze bottle must be performed inside a laboratory fume hood.



**Mixing and Application of Larger Quantities (container size greater than one cup)**

1. Prior to beginning the operation, read the Material Safety Data Sheet for the product and become familiar with the hazards of the material.
2. Place a sign in areas where epoxy systems are dispensed, mixed, or transferred indicating that it is an epoxy work area.
3. Whenever containers from which curing agents will be dispensed have a capacity greater than 500 milliliters, employees shall not work alone during off-hours and shall ensure that there are other people in the vicinity of the operation who could help in the event of an emergency.
4. Ensure that there are adequate paper towels, sand, or vermiculite nearby in the event that uncured resins or curing agents are spilled.
5. Ensure that eyewash is located nearby to flush the eyes in the event of eye contact. If there is not eyewash nearby, another person who can escort the affected person to eyewash shall remain in the vicinity of the epoxy operation.
6. Place a protective layer of cardboard on the floor covering the areas where resins will be mixed and transferred. Also place a protective sheet of paper any tables, counters, or other working surfaces above the floor level where the resin is to be mixed or transferred.
7. Wear glasses or protective goggles.
8. Wear protective gloves.
9. Wear protective booties. Contamination of shoes with epoxies and subsequent cleaning with solvents is not an acceptable work practice.
10. Assemble any mixing devices or other equipment prior to mixing the epoxy.
11. Resins and curing agents which are shipped in 5-gallon containers will generally be transferred into secondary containers with dispensing valves. Thick, chemical-resistant protective gloves, aprons, booties, and splash-proof safety goggles, or safety glasses with side shields shall be worn when such transfer



operations take place. If the dispensing valve of the secondary container is positioned over the edge of a counter top or other working surface, a drip pan shall be placed below the dispensing valve. The drip pan shall be of an adequate size to contain any reasonably large leak through the dispensing valve.

12. Resins mixed in containers with a capacity of more than one cup shall be mixed in a fume hood whenever possible, or only in a well-ventilated area.

13. Weigh out the correct amount of resin and curing agent into a disposable container(s) and immediately close dispensing valves or replace the caps on any containers.

14. Do not leave tools, stirrers, spatulas, etc., which have been contaminated with uncured epoxies and curing agents, in areas where other people may pick them up or otherwise come into contact with them. Containers and supplies contaminated with uncured epoxies and curing agents should remain in a designated area with a sign indicating that it is an epoxy work area.

15. A vacuum-tight mold is essential for many of the applications requiring the preparation of more than one cup of epoxy resin at a time. Usually RTV silicone rubber is used. The uncured rubber, when applied to the mold, is a primary skin irritant. Therefore, employees shall always wear protective gloves while sealing molds.

16. Cleaning of tools using small amounts of solvent, dispensed from a 500 ml squeeze bottle, may be required. Any tools or brushes which must be cleaned by soaking or which would require dispensing of solvents from any containers other than a 500 ml squeeze bottle may only be performed inside a laboratory fume hood. Such cleaning outside of a laboratory fume hood may only be performed with permission of the supervisor.

17. Whenever compressed air is used to remove excess uncured resin from tubing or other equipment, the compressed air nozzle must be equipped with device to ensure that the air is delivered at pressures below 30 psig. The excess resin shall be collected onto a paper towel or other material which may then be placed in a container or area designated for the hardening of resin-





contaminated materials. Safety glasses shall always be worn when compressed air nozzles are used.

18. Containers contaminated with resinous mixtures shall always be stored until the resin hardens and then placed in the HW trash.

### **Curing of Epoxy Composites**

Curing of epoxy composites will take one week or even longer. During the curing process, epoxy components are released as vapors.

1. All curing epoxy work pieces must be stored in a fume hood, on a downdraft table, or outdoors.
2. Curing ovens shall be vented to the outside. If this is not feasible, the curing oven shall only be operated in an open, well-ventilated room, or shall be positioned as closely as possible to an exhaust vent which is ducted to the outdoors.
3. Store excess resinous mixtures or materials which have been contaminated with resinous mixtures (e.g. booties, disposable spatulas, paper towels) in a fume hood or at a designated location within an adequately ventilated area until it hardens. A written sign should indicate the presence of curing resinous materials. When resinous materials have completely cured, the hardened resin or contaminated materials may be placed in the trash for disposal.

### **Dry Sanding of cured epoxy composite materials**

Dry sanding and shaping operations may result in the release of airborne concentrations of particulates of cured epoxy or fiberglass. Particulates may accumulate on clothing or come into contact with the skin, resulting in adsorption of epoxies. All dry machine-sanding operations shall be performed only with the use of local exhaust ventilation and an appropriate fitted respirator with a particulate cartridge or a fitted dust mask.



1. Wear safety glasses or protective goggles.
2. Wear protective gloves, disposable nitrile gloves are adequate.
3. Wear clothing dedicated to epoxy sanding. Change into uncontaminated clothing immediately after the sanding is completed for the day or session. Contaminated clothing must be washed before using again.
4. Wear disposable booties over shoes.
5. Local exhaust ventilation must be used continuously during the sanding process. A shop vacuum with the nozzle held near the sanding operation should be adequate to capture the particulates.
6. After the sanding is completed for the day, use the vacuum to remove all particles from the floor and the bench. Empty the vacuum canister into a plastic bag and dispose in the HW trash.

### **Wet Sanding of cured epoxy composite materials**

Wet sanding and shaping operations may prevent the release of airborne concentrations of particulates of cured epoxy or fiberglass if performed properly. However, wash water contaminated with epoxy particulates may accumulate on clothing or come into contact with the skin, resulting in adsorption of epoxies. All dry machine-sanding operations shall be performed only with the use of local exhaust ventilation and an appropriate fitted respirator with a particulate cartridge or a fitted dust mask.

1. Wear glasses or protective goggles.
2. Wear protective gloves, disposable nitrile gloves are adequate.
3. Ensure that the sanding location remains wet at all times during the sanding operation.
4. Collect the water from the sanding operation in a trough or container, or use adsorbent to capture all of the contaminated water.



5. The water from the trough can be reused, and the adsorbent can be reused until liquid appears in the mixture. Dispose of the wet adsorbent or the water from the collection trough as hazardous waste.