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Fact Sheet	
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Epoxy Resin Systems

(two or more chemicals combined to form epoxy paint, plastic, or adhesive products)

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Health Hazard Summary: *The most common effects of overexposure to the chemicals used in epoxy resin systems are eye, nose, throat, and skin irritation, skin allergies, and asthma. Chemicals in some epoxy resin systems have additional health effects. Finished, hardened epoxy products are practically non-toxic unless they are cut, sanded, or burned.*

Are You Working With an

Epoxy Resin System?

Epoxy products are used for paints and other surface coatings, molded and reinforced plastics, electronic component potting resins, and adhesives ranging from spray foams to dental cement. They are often used in jobs where tough, durable coatings or adhesives are needed. This factsheet is for workers who use epoxy products in a variety of workplaces, including shipyards, auto body shops, and the electronics, aerospace and construction industries.

What Is In an Epoxy Resin System?

Epoxy resin systems are made up of an epoxy resin and a curing agent (also called a hardener or catalyst). Many epoxy products also contain additives such as organic solvents, fillers such as fiberglass or sand, and pigments. See the box on page 2.

When epoxy resin systems are used, single molecules (monomers) of the epoxy resin chemical and the curing agent combine to form long chains of molecules (polymers). As the mixture "cures," it becomes a hard polymer. Some epoxies cure in a few minutes at room temperature. Others need additional time or heat to harden. The characteristics of hardened epoxies (such as whether they are firm or flexible, or resistant to heat or chemicals) depend on which epoxy monomers, curing agents, solvents, and fillers are added.

The hardened, finished polymers are almost non-toxic; it is exposure to the uncured resin components that can be harmful. 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. Each component can be hazardous. In a single-component product, the resin and the curing agent are supplied in a pre-mixed form. Single-component systems are usually safer, because the hazardous chemicals are already partly combined into less toxic polymers and because they do not evaporate into the air as easily.

You Have the Right to Know: Under California's Hazard Communication Standard (GISO 5194), your employer must tell you if you are working with any hazardous substances, including epoxies, and must train you to use them safely.

Because different additives to epoxy resin systems can affect your health in different ways, you should find out what chemicals are in the products you use. Ask to see the

Material Safety Data Sheets (MSDSs) for the products in your work area. An MSDS lists the hazardous chemical contents of a product, describes its health and safety hazards, and gives methods for its safe use, storage, and disposal. The MSDS should also include information on fire and explosion hazards, reactivity, first aid, and procedures for handling leaks and spills. Your employer must have an MSDS for any workplace product that contains a hazardous substance, and must make the MSDS available to employees on request.

This Fact Sheet is an aid for worker training programs. It does not take the place of Material Safety Data Sheets. HESIS Fact Sheets are available for several of the chemicals commonly added to epoxy resin systems; see page 6.

Examples of Epoxy Resin System Chemicals

Epoxy Resins (monomers or oligomers) can be powders, or they can be thick, clear or yellow liquids. Some common epoxy resins are: the diglycidyl ether of bisphenol A (DGEBA), novolac resins, cycloaliphatic epoxy resins, brominated resins, epoxidized olefins, Epon^R and Epikote^R.

Curing Agents react with epoxy resin monomers to form epoxy products. They are usually liquids with strong, unpleasant odors. There are several categories of curing agents. Examples include:

- **Aliphatic amines** such as triethylenetetramine (TETA) and diethylenetriamine (DETA);
 - Aromatic amines**, including diaminodiphenyl sulfone (DDS) and dimethylaniline (DMA);
 - Anhydrides** such as phthalic anhydride and nadic methyl anhydride (NMA);
 - Amine/phenol formaldehydes** such as urea formaldehyde and melamine formaldehyde;
 - Catalytic curing agents** such as tertiary amines and boron trifluoride complexes.
- Diluents** and solvents are used to dilute or thin epoxy resins. Diluents are usually clear liquids. Some examples are:
- Glycidyl ethers** (reactive diluents) such as n-butyl glycidyl ether (BGE), isopropyl glycidyl ether (IGE) and phenyl glycidyl ether (PGE);
 - Organic solvents** such as toluene (toluol), xylene (xylenol), acetone, methyl ethyl

ketone (MEK), 1,1,1-trichloroethane (TCA), and glycol ethers.

Fillers add bulk and body to epoxy products. They are usually powders or fibers such as sand, clay, calcium carbonate, fiberglass, asbestos, or silica.

HOW DO EPOXIES ENTER AND AFFECT YOUR BODY?

The chemicals in epoxy resin systems can affect your health when they come in contact with your skin, or if they evaporate or form a mist or dust in the air you breathe. The main 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.

Lungs: Vapors and spray mists of most epoxy resin system chemicals can irritate your 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 attack.

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 your 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. In case of eye contact, immediately rinse the eyes with water. Continue rinsing for 15 minutes and then seek medical attention.

Nervous System: Solvents inhaled or absorbed through your skin can affect your central nervous system (your brain) the same way drinking alcohol does. Symptoms of solvent overexposure include headache, nausea, dizziness, slurred speech, confusion, and loss of consciousness. For more information, ask for the HESIS Guide to Industrial Solvents.

Cancer: Older epoxy resins caused skin cancer in laboratory animals. This may have been due to epichlorohydrin, a contaminant that can probably cause cancer in humans. Most newer epoxy resins, which contain less epichlorohydrin, do not seem to cause cancer in animals.

Diaminodiphenyl sulfone (DDS), a curing agent in some epoxy resin systems, is carcinogenic in laboratory animals. Certain glycidyl ethers used in epoxy products cause genetic mutations in laboratory animals. This suggests that they may be cancer-causing agents. It is not known if glycidyl ethers cause mutations or cancer in humans. Most other components of epoxy resin systems have not been adequately tested to determine if they can cause cancer.

Reproductive System: Epoxy resins and curing agents themselves probably do not affect pregnancy and reproduction in humans. However, 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. However, we do know that solvents inhaled by a woman can reach a developing fetus and may contaminate the woman's breast milk. They may affect the fetus just as they affect the mother. We recommend that pregnant and nursing women minimize their exposure to solvents, just as they should minimize their exposure to alcohol.

Find out which chemicals are in the epoxy resin system you use. Epoxy resin systems that contain hazardous solvents and diluents can be replaced with safer ones. See the section on "Reducing Your Exposure" on page 5.

TESTS FOR EXPOSURE AND MEDICAL EFFECTS

There is no medical or laboratory test that can accurately measure the amount of epoxies in your body. Most of the chemicals found in epoxy resin systems are not stored in the body. However, it is generally recommended that workers who are frequently exposed to epoxy resin systems receive a complete physical examination, including an occupational

and medical history and a pulmonary function test (spirometry), at the beginning of their employment. A spirometry test measures how well your lungs work. Spirometry can be performed before and after the same work shift to determine whether lung function is affected by work activities. Spirometry is also a recommended part of the medical evaluation before respirator assignment. A spirometry factsheet for workers is available from HESIS.

People who work with epoxies on a regular basis should also have annual follow-up examinations, including skin examinations and spirometry. A doctor or other health care provider can choose other specific tests on a case-by-case basis to evaluate effects of chemical exposure. Patch testing can be performed for the diagnosis of skin allergies. If you are sensitized to a chemical, the doctor will see a reaction on your skin within a few days of the test.

You have the right to see and copy your own medical records and records of your exposure to toxic substances. These records are important in determining whether your health has been affected by your work. Employers who have such records must store them and make them available to you for at least 30 years after the end of your employment.

LEGAL EXPOSURE LIMITS

California's Division of Occupational Safety and Health (Cal/OSHA) sets and enforces workplace chemical exposure limits. Cal/OSHA has adopted Permissible Exposure Limits (PELs) for the amounts of some, but not all, of the epoxy resin system chemicals that may be in the air you breathe.

Legally, your exposure may be above the PEL value at times, but only if it is below the PEL value at other times, so that your average exposure for any 8-hour workshift is not greater than the PEL for that chemical. See the box below.

If you work with epoxy resin systems and think you may be overexposed, talk to your supervisor and/or your union. If any worker might be exposed to a substance at more than the legal exposure limit, the employer must measure the amount of the chemical in the air in the work area (Cal/OSHA regulation GISO 5155). You have the right to see the results of such monitoring relevant to your work (GISO 3204).

<u>Legal Exposure Limits for Some Epoxy Resin System Chemicals*</u>	<u>Cal/OSHA PEL</u>
<u>Chemical Name</u>	
n-butyl glycidyl ether (BGE)	25 ppm
isopropyl glycidyl ether (IGE)	50 ppm
phenyl glycidyl ether (PGE)	1 ppm
diethylenetriamine (DETA)	1 ppm
toluene	100 ppm
xylene	100 ppm
2-ethoxyethanol	5 ppm
2-methoxyethanol	5 ppm
methyl ethyl ketone	200 ppm
phthalic anhydride	1 ppm
* PELs are measured as parts of chemical per million parts of air ("ppm").	
REDUCING YOUR EXPOSURE	

Your employer is required to protect you from being exposed to any chemical at levels that are above the PEL. For information about how Cal/OSHA and Cal/OSHA Consultation Service can help you and your employer, see the "Resources" section on page 6.

Substitution: The most effective way to reduce hazardous chemical exposures is to use a safer chemical, if one is available. For example, you or your employer may be able to choose an epoxy resin system that:

- contains little or no residual epichlorohydrin (a contaminant that causes cancer in experimental animals and possibly in humans). Check the MSDS to see how much

epichlorohydrin is in the resin you use.

- is hardened with curing agents that are less irritating than the simpler aliphatic chemicals. For example, polyamides and cycloaliphatic amines are generally less irritating than other curing agents. (Your supervisor or the manufacturer or supplier of the product can tell you which type is contained in the epoxy system you use).
- contains high-molecular-weight resins. Resins with higher molecular weights are less likely to sensitize the skin. (Ask your supervisor or chemical supplier about molecular weights.)
- has a reduced-solvent content or is solvent-free, to minimize health effects due to solvents.
- is a single-component epoxy system. These are usually safer than two-part products because the hazardous monomers are already partly reacted.
- does not contain asbestos, fiberglass, or silica fillers in a dry form. These substances can cause severe lung diseases if you breathe their dusts. Do not sand or grind hardened epoxies that contain these substances. Avoid products that contain asbestos.

The health and safety hazards of substitutes must be carefully considered to ensure that they are actually safer.

Engineering Controls: When feasible, employers must use engineering controls rather than personal protective equipment to prevent overexposures. Engineering control methods include installing ventilation, changing the work process, and changing work practices.

- Containers and vats of epoxy resins and solvents should be tightly covered to prevent evaporation.
- Local exhaust ventilation systems ("hoods") are the most effective type of ventilation control. These systems capture contaminated air at its source before it reaches your breathing zone.
- Heating epoxies during curing or any other process can cause chemicals to

evaporate (turn into gases) more quickly. The higher the temperature, the greater the amount of chemical released into the air you breathe. Use the lowest possible curing temperatures, avoid heating epoxies unnecessarily, and be sure that adequate ventilation is used when epoxies must be heated or when the curing reaction generates heat.

- Certain work processes, such as heat-curing of epoxy resin systems, can be isolated, enclosed, or automated to reduce exposures.
- Electrostatic spray systems can reduce the amount of workplace contamination and waste from spray-on epoxy resin system chemicals.

Personal Protective Equipment: When engineering controls cannot sufficiently reduce exposures, a respirator must be worn and a respiratory protection program must be developed, as outlined by Cal/OSHA regulations (GISO 5144). An industrial hygienist or other knowledgeable person should be consulted to ensure that the equipment is appropriate and is used correctly. In some cases a supplied-air respirator may be required.

If frequent or prolonged skin contact with epoxy resin systems is unavoidable or if splashing may occur, protective equipment such as gloves, goggles, or faceshields should be worn. Protective clothing should be made of a material that will protect you from the chemicals in the epoxy resin system you use. Butyl rubber is resistant to some of the chemicals commonly used in epoxy resin systems, while polyvinyl alcohol is resistant to others. Glove materials must be evaluated on an individual basis for each specific product.

Personal Hygiene: Remove clothing contaminated with epoxy resin system chemicals and immediately wash off any epoxies that get on your skin. Pay particular attention to your fingernails and the area around the nail bed.

Dry or irritated skin can absorb chemicals and become sensitized to epoxies more easily than healthy skin. Use soap and water or a commercial hand cleaner. Don't use solvents to clean your hands; they remove the natural protective oils from your skin and leave your skin dry and irritated. After washing, use a skin conditioner or lotion to help keep the skin on your hands in good condition.