Technical Information Bulletin (TIB):

Safe Handling of Epoxy Resin Systems

GENERAL OVERVIEW

Epoxy products are a complex blend of chemicals specially selected to give each system its desired characteristics. As with any chemical, poor handling or misuse can be potentially hazardous to health. Risks can be minimized by using simple precautions, appropriate care, and control. It is essential, then, that those who handle epoxies be properly trained to understand the hazards, take precautions to avoid them and work safely.

This document is intended as a general guide to the safe use of epoxy resin systems. Recommendations in this guide should be followed. Materials Safety Data Sheets are available on request. A glossary of terms is provided at the end of this document.

ADDITIONAL RESOURCES

Wolverine Coatings Corporation (WCC) has developed this bulletin along with other technical information to help all interested parties, from specifiers to applicators to owners, have a better understanding of the considerations, materials, and techniques required for proper installation. Consult all recommended information before attempting to use WCC materials.

WCC Technical Information Bulletins
TIB: N/A

WCC Technical Detail Drawings
TDD: N/A

WCC Technical Data Sheets
TDS: N/A

WCC Safety Data Sheets
SDS: All

SAFETY

Prior to commencing work, carefully read and follow all SDS, technical data sheets, and any instruction manuals for products and equipment used during installation. Following the safety regulations of jobsite, local, state, and federal authorities is the responsibility of the installation company, general contractor, and/or facility owner.

Concrete dust is a source of silica particles and other hazardous materials that can cause silicosis and other illnesses. Proper safety equipment and methods are the responsibility of the installation company, general contractor, and/or facility owner.

DISCLAIMER

This Document does not purport to address all applicability and safety concerns, if any, associated with its use. It is the responsibility of the user to determine applicability of the information and to establish appropriate safety practices.

HEALTH EFFECTS

From the outset, it should be emphasized that major health problems associated with epoxy use are:

- That some resins are adhesive and tacky and thus will readily adhere to and remain on any surface, including the skin.
- That some resins and many curing agents cause primary irritation of the skin, and may cause sensitization.
- That vapor, droplets and dusts of some of the materials may be irritating to the eyes and respiratory passages.

The first aim of all safety precautions, then, is to prevent skin contact and to avoid indiscriminate spreading of the materials. Mixing epoxy chemicals may generate heat, and with certain systems, can even cause smoke.

REMEDIAL FIRST-AID MEASURES

Eyes: First-aid should consist of immediate and continued washing of the eye for up to 15 minutes with copious amounts of clean water. If there is any suspicion of eye damage or persistent irritation, contact a doctor.

Skin: Immediately wash thoroughly with soap and water. (See "Personal Hygiene.") If this doesn't work, try a waterless cleanser (one with little or no petroleum solvents or defatting agents.) Remove dried or cured epoxy with denatured alcohol. Follow up by washing with soap and water, then applying skin cream. Skin showing evidence of burn should be washed thoroughly in cold water, covered with a dry dressing and the employee referred to a doctor.

Inhalation: Remove to fresh air and keep at rest until any symptoms of respiratory irritation distress have disappeared. If rapid recovery does not occur, obtain medical attention.

IRRITATION / SENSITIZATION

The main hazards in using epoxy resin systems primary are irritation of the skin, eyes and respiratory tract, and skin sensitization. Each component of an epoxy product will have hazards associated with it. Epoxy resins are known to be skin sensitizers. The hardener is usually classed as a corrosive and as irritant when in contact with the skin or by inhalation. Epoxy can take more than two weeks at room temperature for post-curing to cure completely. Once fully cured, an epoxy system is essentially inert and nonhazardous.

IRRITATION / SENSITIZATION (CONTINUED)

Primary skin irritation or contact dermatitis is the result of the direct action of the material on the skin. The degree of the skin reaction is related to the concentration of the chemical and the duration of the exposure: skin irritation is seen only in the contact area.

Factors predisposing to contact dermatitis are:

- Chronic skin disease or previous skin disease
- Defatting and dehydration of the skin by the use of solvents
- Skin damage caused by contact with glass fiber or strongly alkaline substances e.g. some of the curing agents
- Poor personal hygiene
- Poor housekeeping
- Repeated contamination of the skin by constituents of resin systems.

Skin sensitization or allergic dermatitis is a different reaction of the skin to the material, although its appearance is frequently indistinguishable from that of contact dermatitis. Skin sensitization may occur after continued or repeated contact. It usually develops after a period of exposure to a material which previously had not adversely affected the subject. Once sensitization has taken place, slight or even minimal contact with the material is capable of inducing a violent reaction, often involving other skin areas in addition to a local effect.

Whether this allergic reaction will occurs depends principally on one or more of these factors:

- The sensitizing capacity of the chemical concerned
- The frequency and intensity of the exposure
- The allergic predisposition of the person involved (Workers known to be predisposed should be excluded from contact working.)

Skin sensitization effects do not necessarily resolve as soon as contact is discontinued. In practice, this means that a sensitized worker is permanently unfit for handling epoxy resin systems containing the sensitizing agent. A worker who has been sensitized—often by an amine-curing agent—can also be or become sensitized to other materials such as the resins themselves. Generally, resume work only after symptoms disappear, usually after several days, and increase safety precautions to prevent exposure. If problems persist, stop exposure and consult a physician.

Because it is not possible to identify otherwise healthy individuals who may develop a sensitization, handling precautions must be developed on the assumption that any uncontrolled exposure, especially to the curing agents, in solid, liquid or vapor form, may be excessive for some individuals.

All employees should be instructed to report immediately to their supervisor any sign of dermatitis. Such reports may reveal improper handling procedures and immediate investigation, if necessary, corrective measures should be enforced.

Eye irritation is caused by liquid components and vapors if present that may be irritating to mucous membranes, in particular to the respiratory tract. If contact occurs, flush the eyes with water under low pressure for 15 minutes. If discomfort persists, seek medical attention.

VENTILATION AND PERSONAL PROTECTIVE EQUIPMENT

In an ideal situation, all work using hazardous products would be carried out in an enclosed environment with the operator isolated from the chemical. However, practically, this is difficult to achieve, particularly with the materials used in the manufacture of composite components. This being the case more reliance must be placed on ventilation and personal protective equipment.

VENTILATION

As a significant amount of exposure can be from airborne materials in the form of fume, vapors and dusts, it is important that a good level of ventilation is maintained. The level of ventilation depends upon the task being undertaken and may vary from general background, as in a well aired workshop, to specialized facilities to provide general and / or local exhaust ventilation through forced extraction systems. The design of such systems can be complicated and specialist knowledge is often required.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

An important part of working safely with composites, PPE takes several forms.

- **Gloves:** The industry standard is the disposable latex type. These, while being freely available and inexpensive, do exhibit certain problems during use. They offer relatively poor chemical resistance, particularly to solvents, and are easily torn. An increasing problem is allergic skin reactions due to sensitivities to proteins found in natural rubber latex, and the powdered variety cause the most concern as the powder can exacerbate the skin reaction. The related problem of hypersensitivity to latex should also be considered due to the possible seriousness of the reactions. Because of these factors, disposable Nitrile gloves are recommended for most applications. This type of glove has a number of advantages over the latex variety, including greater tear resistance and no latex allergy. Gloves are regarded as offering splash protection only when direct contact with chemicals is to be avoided. For use with solvents, a heavier glove is recommended to give additional protection. As solvents are usually quite aggressive to glove materials it is advisable to ascertain what type of glove is best suited to the particular solvent used.

- **Eye Safety Wear:** This can take many forms and correct selection is important. For operations such as sanding, a pair of goggles is advisable to prevent ingress of dust. Otherwise, safety spectacles will suffice.

- **Overalls:** When working with epoxies it is important to prevent skin contact, so long-sleeved overalls that offer a good level of protection should be used. If they become contaminated, and there is a possibility of the contamination soaking through to undergarments and the skin, overalls should be removed immediately. Regular washing of overalls is advisable.

- **Respiratory Protection:** It is important that adequate levels of ventilation are maintained when using epoxy resins. Inhalation is a primary route of entry for chemicals into the human body and must be prevented as far as possible. Good general and / or local exhaust ventilation should be considered before turning to respiratory protection. If workplace conditions are such that it is difficult to achieve a good level of ventilation then respiratory protection is an option. There are two types of protection available. For low levels of fume, a face mask conforming to BS EN 141 (organic vapor) is recommended. This will not protect the wearer against higher concentrations of fume - in these conditions an air fed mask with an independent air supply may be necessary. It is important to consider the risks of working in confined spaces with high concentrations of fume, as the atmosphere may not be respirable.

RECOMMENDED INDUSTRIAL HYGIENE PRACTICES

The success of these recommendations depends on their observance and strict supervision of work practices should be obligatory. These recommendations refer to all stages of the processes, that is from storage and decanting procedures through mixing, application whether this is in casting, laminating, etc., up to and including the curing reaction.

Selection and Training of Personnel

Those with chronic skin disease or a history of allergy should not be allowed to work with epoxy resin systems unless certified by a medical adviser. People who are of a careful and methodical nature and of good hygienic standard with an aptitude for good housekeeping should be selected.

Regulation cannot be fully effective unless employees understand the nature of the hazards and the reasons for recommended precautions. Therefore, all personnel should receive basic information concerning the effects that can be produced by the materials with which they are working. They should appreciate that dermatitis is an indication of inadequate handling precautions, and is not a result of any systemic intoxication, and that in some hypersensitive individuals a superimposed allergic dermatitis may result. It is most important that all employees understand and practice the handling precautions, correct procedures, personal hygiene and protective measures detailed below. Compromise should not be allowed.

Workshop Design and Handling Procedures

The workshop for handling epoxy resin systems should be separated from other operations and constructed in such a way that accidental spillages may easily be cleaned and the work area can be kept in a tidy, clean state. Mixing operations should be confined to one well-defined area with the workshop. The area should be cool, dry, and equipped with a good general ventilation system, and an additional fume cupboard or a satisfactorily ventilated bench-type hood should be

provided for the actual operations. A movable local exhaust system may prove to be very useful, for instance, when machining cured epoxy resins, as for any other dust hazard.

Benches etc. should have hard impervious surfaces to facilitate cleaning. Bench tops and floor area that are subject to contamination should be protected with disposable paper. Disposable mixing cups should be used whenever possible. Waste bins should be freely available and all waste material deposited directly into them, and incinerated later.

The handling process should be mechanized as far as possible and the equipment should be kept in good order. All equipment used in the proceeding of epoxy resin systems should be cleaned regularly and thoroughly with solvents such as acetone or methyl ethyl ketone. This is especially necessary before using such equipment for any other purpose. Special attention should be paid to the prevention of leakages and spillages. To prevent any of this contaminated solvent meeting the skin.

Adequate fire precautions are necessary as certain components of epoxy resin systems may be flammable.

Mixing and the applying epoxy resin systems should be done without skin contact and minimal vapor exposure. This may be accomplished by weighing and mixing the epoxy resin with the other components, such as curing agents, under a bench-type hood or in a fume cupboard. Filling, handling and reaction temperatures should not exceed those recommended for a given system, to minimize exposure to vapor.

In general, meticulous housekeeping stands should be established and vigilantly maintained. Strict supervision of all recommended procedures is essential to ensure that all employees comply with them. Spills should be cleaned with a scraper, followed by absorbent towels. Use sand, clay or other inert absorbent material to contain large spills. Do not use sawdust or other fine cellulose materials to absorb hardeners. Clean resin or mixed epoxy residue with acetone, lacquer thinner, alcohol or other Cleaning Solutions. Follow all safety warnings on solvent containers. Clean hardener residue with warm soapy water. Uncontaminated resin or hardener maybe reclaimed for use. Do not dispose of hardener in trash containing sawdust or other fine cellulose materials, as spontaneous combustion can occur.

Storage

Lids for the containers should be replaced immediately after use, and products should be kept in their original containers which are correctly marked and bear the appropriate hazard labels. The labels should be kept clean and intact. Storage should be in a cool, dry, secure place. Accidental spills should be absorbed using clay or other inert absorbent materials. Contaminated absorbents and the empty product containers should be disposed of correctly.

Disposal

Metal containers are designed with recycling in mind. Some of the containers are fitted with disposable liners to facilitate the disposal process, minimizing the amount of hazardous waste and maximizing the possibility of easy recycling of clean metal containers. Spillages of filler powders should be removed by vacuuming.

General

Heating for workshops should be carefully considered, as with solvent based systems and use of solvents in the workplace generally there is the potential for sparks from electrical equipment and tools to create a fire risk. If vacuum pumps or curing ovens are used in processing then the exhaust should be vented outside the working area.

Exotherms

An exotherm is an uncontrollable reaction between a solvent-free resin and hardener, which happens when the heat generated by the resin-hardener reaction cannot escape readily. The trapped heat accelerates the reaction that in turn generates more heat and further accelerates the reaction until it becomes uncontrollable. This normally happens only in bulk mixes, as mixed resin applied to a job is usually in a thin film (e.g. coating, glue line, laminate layer, filler layer, etc) from which heat readily escapes. Causes of exotherm are usually a combination of the following circumstances:

- Mixing a large volume of resin / hardener and not transferring to a tray with a large surface area.
- Not using the mixed materials quickly enough, particularly if it is a ‘fast’ resin / hardener system (gel time 5-20 mins).
- Higher than normal ambient temperature, or components and / or mixed material left in direct sunlight.

The appropriate methods of working should be used to reduce the likelihood of exotherm. Systems designed for thick application have formulations whose chemistry does not generate large volumes of heat (and therefore such systems are often slow curing). If an exothermic reaction between the resin and hardener occurs then the container should be removed immediately from the workshop. The best way to deal with an exotherm is to immerse it in water, which cools it and reduces the volume of fumes produced. The fumes are noxious: do not inhale. To extinguish burning epoxy material the correct media is Carbon Dioxide, Dry Powder, Foam or a Water fog. Do not use a full water jet.

Personal Hygiene

Workers handling epoxy resin systems should have separate lockers: one for their work clothes and protective equipment and another for their personal clothes and effects.

Facilities for maintaining personal cleanliness should include showers, washbowls (both with hot and cold water), mild soap, appropriate skin cleansing agents, paper towels and a supply of clean overalls. Use of these facilities should always be enforced.

Drinking, eating and smoking should be prohibited in the work area, and employees should understand the need for, and practice, hand washing before these activities as well as before using the toilet. Wash again before breaks and after work. Remove protective equipment carefully to avoid contact with skin. Launder contaminated clothing before reuse. Watch out for contamination inside work gloves and on tools. Clean before reuse.

Skin cleansing agents should be readily accessible in the working area, together with disposable paper towels.

Remove protective equipment carefully to avoid contact with your skin.

Work Areas

Select an area next to where the work is to be performed. The space should be large enough to work without restrictions. The space should be clean and well ventilated. Lay drop cloth or plastic sheeting over the work area for protection against accidental spills. Keep all materials in the work area to avoid spreading contaminants outside the work area. Read product literature and label instructions on containers before beginning a job. Throw away empty resin and hardener containers. Do not reuse. For proper disposal, puncture a corner of the can and drain residue into the appropriate new container of resin or hardener. Do not dispose of resin or hardener in a liquid state. Waste resin and hardener can be mixed and cured (in small quantities) to a non-hazardous inert solid. CAUTION! Pots of curing epoxy can get hot enough to ignite surrounding combustible materials and give off hazardous fumes. Place pots of mixed epoxy in a safe and ventilated area, away from workers and combustible materials. Dispose of the solid mass only if cure is complete and the mass has cooled. Follow federal, state or local disposal regulations.

Personal Protection

Hands, wrists, face, eyes and other exposed areas of the body should be protected against contamination. This particularly applies when handling the liquid epoxy resins, curing agents, modifiers and solvents, and of course, the formulated product in liquid or semi-liquid form. Any liquid component is liable to cause irritation of the exposed skin, and any vapor can irritate the face, eyes and respiratory passages. Therefore, an OSHA approved respirator should be worn applying epoxy. Otherwise, gloves and eyewear are to be worn when handling epoxy; coveralls and shoe/boot covers are to be added when mixing epoxy. Skin cream can be applied as a protective barrier on exposed areas. Use protective creams as supplements to, not replacements for, gloves. Resin is not water soluble, so a waterless skin cleanser must be used to remove it or mixed epoxy from skin. Hardener is water soluble, so soap and warm water will remove it or sanding dust from skin. Never use solvents to remove epoxy from skin.

The following should be provided and used as required:

- Gloves, sleeves and aprons. These should be worn if there is a possibility of skin contact. They may be rubber or plastic; cotton linings minimize discomfort from sweating. Contaminated protective clothing can be reconditioned by washing first with acetone or methyl ethyl ketone and then water and soap. To prevent contaminating the inside of the protective gloves, wash with soap and warm water before putting them on and after removing them. Disposable polyethylene gloves may have advantages. Cracked or punctured gloves, or gloves contaminated on the inside, should be replaced at once. Clothing made from plasticized polyvinyl chloride or from PVC coated cloth should not be cleaned with strong solvents.

RECOMMENDED INDUSTRIAL HYGIENE PRACTICES (CONTINUED)

- Full face-shields or panorama goggles should be worn when materials that form irritant dusts are being handled and when there is any danger of contamination by splashing, droplets or mist, as in spraying processes. When spraying, use full-face, air-supplied respirators. When spraying in confined areas or where mists could be present, wear air-supplied chemical suits.
- A source for protective clothing and equipment for use in laboratories is Lab Safety Supply, 1-800-356-0783, or online at www.labsafety.com.

FINAL CLEANUP

All personnel working with epoxy should complete a thorough cleanup of the work and application areas. Carefully dispose of all contaminated drop cloths, plastic sheeting, rags, contaminated clothing and supplies in compliance with federal, state and local guidelines. Thoroughly wash with soap and water all exposed skin, especially around the eyelids.

REFERENCE PUBLICATIONS

The editions of the following codes that are in effect at the time of publication of this technical information bulletin are cited here. The applicator shall be familiar with and comply with the procedures established in the following publication:

Occupational Safety and Health Administration, 200 Constitution Avenue, N.W., Room N3101, Washington, DC 20210

The applicator shall be familiar and comply with the rules and regulations of OSHA as published in 29 Code of Federal Regulations, Part 1910:

Subpart H: Hazardous Materials, 106 – Flammable and Combustible Liquids

Subpart I: Personnel Protective Equipment, 132 – General Requirements and 134 – Respiratory Protection

Subpart J: General Environment Controls, 145 – Specifications for Accident Prevention Signs and Tags

TECHNICAL ASSISTANCE

For information about Wolverine Coatings Corporation's products or handling recommendations, contact our technical services department at (864) 342-9292.

Please call our Technical Service Department or contact www.wolverinecoatings.com to receive the latest copy of this document.

TRAINING

The safe use and handling of epoxy resin systems require that all employees who work with these systems must be trained in safe handling procedures. The training program should address at a minimum the following items:

- Labels, Safety Data Sheets, and Technical Data Sheets
- Health and Safety Hazards
- Emergency Procedures
- First Aid
- Work Place Controls
- Personal Protective Equipment
- Safe Handling Procedures.

The applicator assumes all responsibility for the selection of Wolverine Coatings products, for exercising appropriate safety measures in the application of any such products, for the suitability of such products for any application including the durability and safety of any such product.

GLOSSARY

Corrosive – Certain chemicals are classified as corrosive, which means that they damage or destroy living tissue on contact. A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. Typically, the effect will be seen as redness and blistering of the skin.

Curing Agents/Hardeners – The purpose of the epoxy curing agent or hardener is to join or crosslink epoxy resin reactive sites (functional groups) to form a fully reacted or cured polymer. Just as there are many epoxy resins, there are a variety of curing agents that are commonly used that contribute to the characteristics of the final products. Amines are the most widely used curing agents for epoxy resins systems. The amine curing agents fall into several chemical families that include the aliphatic amines, cycloaliphatic amines, and aromatic amines. Anhydrides are another class of curing agents for epoxy resin systems. Some effects of common curing agents are described below.

The aliphatic amines, cycloaliphatic amines and anhydride curing agents may cause irritation or damage to the skin, eyes, and lungs. Certain aliphatic and cycloaliphatic amines are skin sensitizers. Solid anhydride curing agents may cause sensitization in workers exposed to the curing agent dust. The aromatic amines are not strong irritants, but several are skin sensitizers. Certain aromatic amines may absorb through the skin and cause damage to organs such as the liver and interfere with the blood's ability to carry oxygen. Certain aromatic amine curing agents are known to cause cancer in laboratory animals.

De-fatting – Action in which solvents permeate the skin and cause the natural body oils and fat layer in the skin surface to be removed, causing dry skin leading to increased skin cracking and drying, allowing for increased potential for skin reactions.

Dermatitis – There are two types, irritant and allergic.

Dermatitis (Allergic) – The allergic reaction involves an overreaction of the body's immune system, which, once triggered, tends to be a long term or permanent effect (see Sensitizations). The symptoms only appear when there is exposure to the trigger chemical and once exposure is removed, the symptoms recede as the body recovers. The onset of symptoms is usually very quick - seconds or minutes. The symptoms may be apparent over the whole body, which can manifest in a similar way to irritant reactions. It is not possible to determine in advance why a particular person may be affected. It is an individual intolerance to a particular material.

Dermatitis (Irritant) – The irritant reaction occurs where the chemical damages the skin directly at the point of contact. The damage may not be immediately apparent, but if the exposure is repeated, it may result in an accumulation of damage until the skin can no longer tolerate any further exposure. The result is that the skin can become inflamed, itchy and often a red rash with cracking and blistering appears. If the exposure is minor, the skin will heal when the contact is removed. However, extensive contact may cause more severe damage.

Epoxy Resins – A family of synthetic resins including products that range from liquids to solids. The most common resins are produced by reacting epichlorohydrin with bisphenol A or bisphenol F. The three general classes of epoxy resins are liquid, solid and modified liquid.

Epoxy Resin System - The individual components of the epoxy resin system are blended together for final application. The hazards of the system may change as the individual components are blended together.

Exposure - Having bodily contact with a material, including inhalation, oral, and dermal (skin) contact.

Exposure Limit/Guideline - An air concentration of a material to which nearly all persons can be exposed day after day without adverse effects. Exposure limits/guidelines are most commonly used as a point of reference in assessing work place exposures.

Fibers and Reinforcements – A range of materials, including carbon, aramid (Kevlar™ or Twaron™) and glass fiber, is used in conjunction with resins and hardeners. If good hygiene practices are followed, the health risk from using these materials is low. There are various factors to take into consideration. Carbon fiber is electrically conductive and free-floating fiber in the air can be drawn into electrical equipment that has the potential to cause short circuits. All of the fibers can be an irritant to the lungs, skin and eyes and suitable protection should be worn when using and particularly when cutting these materials.

Filler Powders – These tend to be very light and are easily carried into the air. They are primarily irritating by inhalation and in contact with the skin and eyes. Care should be taken when mixing these powders into resin systems and good hygiene practices observed.

Fillers – Added to epoxy resins to enhance the properties of the cured resin system. The properties most commonly enhanced with fillers include: thermal, mechanical, electrical, chemical resistance, and flame resistance. Examples of fillers are fiberglass, silicas, calcium carbonate, powdered metals, and pigments. Fillers added to epoxy resin formulations present a potential inhalation and dermal contact hazard. They can cause mechanical damage to the skin, which may aggravate the irritant effects of the epoxy resin system. Since fillers are generally handled in the liquid matrix of the epoxy resin system, their potential to present an inhalation hazard is low. However, inhalation exposure to fillers can occur when they are handled in the dry state or when machining or grinding cured epoxy products. Inhalation exposure to fillers such as crystalline silica or fiberglass may result in delayed lung injury.

Hazard – The potential of the material to cause harm.

Irritant – A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of the contact.

Liquid resins are mild to moderate irritants to the skin, eyes and mucous membranes. The irritant potential is increased by their "sticky" nature, which tends to lead to prolonged skin contact. These resins are generally mild to moderate dermal (skin) sensitizers in susceptible individuals.

Modified liquid resins are resins modified by the addition of reactive diluents (see page 3) or solvents (see page 2). Both chemicals and water are used as solvents. When water is used, the resins are referred to as "waterborne resins." These resins should be handled with the same precautions as those in chemical solvents. They are mild to moderate skin irritants. These low molecular weight resins and the reactive diluents are moderate to strong sensitizers. Their sensitizing potential tends to increase with decreasing molecular weight. Epoxy components with significant volatility could cause irritation to skin, eyes and respiratory tract, but inhalation is normally not a hazard except under certain conditions of use, i.e., heating, spraying, or applications with large surface areas. Certain modified resins, such as cycloaliphatic epoxy resins have been shown to cause skin cancer in laboratory animals.

Reactive Diluents– Liquids used to reduce the viscosity or "thin" the epoxy resin. Unlike solvents, reactive diluents become part of the polymer. The reactive epoxy diluents fall into the chemical family known as the glycidyl ethers. The glycidyl ethers vaporize more readily than the epoxy resin material and, therefore, have an increased potential for inhalation exposure. These diluents are also likely to be much stronger sensitizers than the epoxy resins.

Route of Exposure – The path by which a material enters the body, most commonly the mouth (ingestion), skin (dermal absorption) or respiratory tract (inhalation).

Sensitizations – If a person exhibits a reaction to a particular material but only after a period of repeated contact it is called sensitization. Once the allergic reaction has been established then even a low level of brief repeat contact will trigger the reaction. The symptoms will usually appear as a rash of varying coverage, intensity and discomfort. The period between first contact and subsequent development of sensitizations, causing the rash to appear, can vary from days to years. This is a highly individual problem. Some workers will be able to handle so-called 'sanitizers' for years with no effect. Some will react almost immediately and others may only show the reaction after having handled the material for many weeks or months. Sensitizations can occur through skin and respiratory contact.

Sensitizer – A substance that may cause an allergic reaction in some individuals after repeated exposure. Epoxy resin system components may be skin sensitizers, pulmonary sensitizers or both.

Solid resins are not readily absorbed through the skin and present a low risk of skin irritation. Direct contact with solutions of these resins can cause mild to moderate irritation of the skin and the eyes, principally because the solvents "de-fat" the skin. When crushed to a fine powder, the materials should be considered an irritant dust; inhalation and skin contact should be avoided. Solid resins are generally low to mild sensitizers.

Solvents – May be present in the epoxy resin system formulations or may be used as a cleaning agent for equipment. Examples of solvents typically used in epoxy resin systems are acetone, methyl ethyl ketone (MEK), toluene, xylene, glycol ethers, and alcohols. Solvents commonly used in epoxy resin applications present a flammability hazard. These solvents present other special health hazards. Contact with solvents will cause "de-fatting" and drying of the skin, which may result in an increased chance of skin irritation. Some solvents are absorbed directly through the skin and absorption may be enhanced if the skin is abraded or irritated. They also have the ability to dissolve other epoxy resin system chemicals and carry them through the skin. The inhalation of solvent vapors or mists may cause

GLOSSARY (CONTINUED)

Solvents (continued)– respiratory irritation and depression of the central nervous system. This may result in dizziness and sleepiness, lack of coordination, loss of equilibrium, unconsciousness, and even death, if severe overexposure occurs.

Solvents and Solvent Based Systems – Some epoxy products are solvent based and working with these can present particular hazards due to this solvent content. Inhalation should be avoided as the vapors can lead to nausea, headaches, and in serious cases loss of consciousness. Adequate ventilation must be ensured and work in confined spaces limited as solvent vapors are harmful and can be flammable above certain concentrations. Skin contact should be avoided as solvents can help induce dermatitis by removing the natural oils that are the skin's protection. The washing of hands in solvents is not recommended and is a major cause of skin problems.

Toxicity – The sum of adverse effects resulting from exposure to a material, generally by the mouth (ingestion), skin (dermal absorption) or respiratory tract (inhalation).

TABLE 1 : TYPICAL EXPOSURE EFFECTS ASSOCIATED WITH EPOXY RESIN SYSTEMS

EPOXY RESIN SYSTEMS COMPONENTS*	EXAMPLES/TYPE	DERMAL EXPOSURE	INHALATION EXPOSURE	INGESTION EXPOSURE
Liquid Epoxy Resins	based on the reaction product of epichlorohydrin and bisphenol A or bisphenol F	- mild to moderate irritants - mild to moderate sensitizers	- low volatility, exposure unlikely unless heated, sprayed, or spread over large unventilated surfaces	low toxicity
Solid Epoxy Resins	based on the reaction product of epichlorohydrin and bisphenol A or bispehnol F	- mild to moderate irritants and mild sensitizers - not readily absorbed through skin	- low volatility, exposure unlikely unless crushed or ground	low toxicity
Modified Liquid Epoxy Resins	liquid epoxy resins with added reactive diluents or solvents	- mild to moderate irritants - moderate to strong sensitizers	- low volatility, exposure unlkely unless heated, sprayed, or spread over large unventilated surfaces	low toxicity
Aliphatic and Cycloaliphatic Amine Curing Agents	-	- irritants, sensitizers, corrosive, absorbed through skin	- respiratory irritants	high toxicity
Aromatic Amine Curing Agents	-	- sensitizers, long term health effects, absorbed through skin	- respiratory irritants	moderate to high toxicity
Anhydride Curing Agents	-	- corrosive, severe sensitizers	- dusts may be sensitizers	high toxicity
Reactive Diluents	glycidyl ethers	- moderate to strong sensitizers	- moderate volatility, exposure possible	low toxicity
Solvents	acetone, methyl ethyl ketone (MEK), toluene, xylene, glycol, ethers, alcohol	- de-fats and dries skin - some may be absorbed - may carry other components through skin	- high volatility, exposure possible - irritation - central nervous system depression (e.g. dizziness, loss of coordination)	low to high toxicity, long term effects
Fillers	fiberglass, silicas, calcium carbonate, powdered metal pigments	- some may be absorbed	- dust inhalation	low toxicity

* Consult SDS, label, or company Technical Data Sheet (TDS) for details on the specific products

TIB: Safe Handling of Epoxy Resin Systems - Rev 191219

SAFETY

For your safety, all required personal protection equipment should be used when operating machinery or handling chemicals. Concrete dust is a source of silica particles and other hazardous materials that can cause silicosis and other illnesses. Proper safety equipment and methods are the responsibility of the installation company, general contractor, and/or facility owner.

WARRANTY

Wolverine Coatings Corporation warrants its products to be free from defects in material and workmanship. Wolverine Coatings Corporation's sole obligation and Buyer's exclusive remedy in connection with the products shall be limited, at Wolverine Coatings option, to either replacement of products not conforming to this Warranty or credit to the Buyer's account in the invoiced amount of the nonconforming products. Any claim under this warranty must be made by the Buyer to Wolverine Coatings in writing within five (5) days of Buyer's discovery of the claimed defect, but in no event later than the expiration of the applicable shelf life, or one year from the ship date, whichever is earlier. Buyer's failure to notify Wolverine Coatings of such nonconformance as required herein shall bar Buyer from recovery under this warranty.

Wolverine Coatings makes no other warranties about the product. No other warranties, whether expressed, implied, or statutory, such as warranties of merchantability or fitness for a particular purpose, shall apply.

Any recommendation or suggestion relating to the use of the products made by Wolverine Coatings, whether in its technical literature, or in response to specific inquiry or otherwise, is based on data believed to be reliable; however, the products and information are intended for use by Buyers having requisite skill and know-how in the industry, and therefore it is for the Buyer to satisfy itself of the suitability of the products for its own particular use and it shall be deemed that Buyer has done so, at its sole discretion and risk. Variation in environment, changes in procedure of use, or extrapolation of data may cause unsatisfactory results.

LIMITATION OF LIABILITY

Wolverine Coatings Corporation's liability on any claims based upon Wolverine Coatings Corporation's negligence or strict liability, for any loss or damage arising out of, connected with, or resulting from the use of the products, shall in no case exceed the purchase price allocable to the products or parts thereof which give rise to the claim. In no event shall Wolverine Coatings Corporation be liable for consequential or incidental damages.

LITERATURE REVISION

Published literature is subject to change without notice. Wolverine Coatings Corporation is constantly formulating innovative products, new technologies, and practices. Please check www.wolverinecoatings.com for the latest product data sheets.

WOLVERINE COATINGS corporation

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