24C

SAFE-T-POXY®

An epoxy system for room temperature curing laminates.

SCOPE

Any industrial reactive chemical product can potentially cause an allergic response or dermatitic skin irritation. Safe-T-Poxy® has been especially formulated to minimize such problems by advanced state of the art materials. Before use, the following precautions should be read and understood.

INTRODUCTION

Until a comparatively few years ago, the use and availability of thermosetting resin systems have been in the hands of knowledgeable professionals and commercial manufacturing companies.

The increasingly available leisure time and sophistication of the adult sport oriented toys has led a whole new group of people into personally building complex devices such as light aircraft, surfboards, sail boats, automobile bodies and the like.

The greater number of these ambitious efforts are undertaken by non-technical and uninformed individuals who can follow a set of instructions and, by purchase of a kit, eventually achieve their goals.

Inasmuch as any thermosetting resin system is chemically reactive by nature, it is obvious that the possibility of interaction of such materials with the human organism on contact is likely. These reactive resin forming systems are normally used as impregnants for fiberglass, graphite, Kevlar and other fibers in various forms to produce desired shapes which means that relatively large resin-fiber surfaces are probably exposed during layup prior to cure. The tools used for mixing and laminating will necessarily become contaminated and, during cleaning, could permit the resin to contact the skin.

Since a large number of applications are non-commercial the amateur builder will possibly set up his operation in a garage space which in winter is probably poorly ventilated. This will greatly enhance inhalation exposure to the uncured resin, clean-up solvents, sanding dusts, fiberglass, other fibers and particles of broken glass bubbles which can become airborne during mixing with the resin and other similar potential inhalation exposures.

The aim of this note is to warn of the possible effects of these potential hazards and how to avoid them, if possible.

Initially, one can categorically state that the human body exists in a hazardous environment, irrespective of industrial materials. Allergic reactions to poison oak, bee stings, household dusts, etc. can cause prompt physiological response in the form of local irritation or respiratory distress. It should not be so surprising, therefore, that other foreign chemical materials can cause similar problems.

SKIN CONTACT

The reaction of the intact skin barrier to materials and, in particular, liquid, depends on the nature of the exposure which can cause different types of inflammatory conditions.

A. Contact Dermatitis can result from contact with an alkaline or acidic substance, such as acid, or a caustic, such as with an aliphatic amine similar to ammonia.

   The concentration, temperature and time of exposure as well as the chemical nature of the irritant to develop cutaneous cell damage are all inter-related. The point of contact is essentially the only area affected due to the concentration rapidly decreasing below the threshold level due to dilution effects in adjacent tissues.

B. Irritant Dermatitis can develop with weak irritants used over a long period such as those hairdressers who use shampoo all day and machinists using cutting oils constantly.

   The use of strong active solvents and detergents to clean the hands will defat the skin. The stratum corneum constitutes the main protective layer. The flexibility of the skin is maintained by the water content which is protected by cell wall lipids that can be removed or damaged by frequent solvent exposure or washing. The skin then becomes dry and cracks and becomes highly susceptible to further attacks or bacterial invasion.

   The epithelium of follicular root sheath and the sebaceous glands can absorb fat-soluble chemicals which can lead to subcutaneous inflammation.

C. Allergic Contact Dermatitis is an inflammatory process of the skin due to contact with a chemical class to which the skin has undergone an acquired specific alteration of its reactivity. Such a sensitization reaction is not directly proportional to local concentration, but is an allergic response which can be very active with any contact of very low concentrations of the sensitizer, or by respiratory absorption.

The list of known, active sensitizing agents reportedly involved in the etiology of contact dermatitis antigens is very large and includes soaps, metals, amines, antibiotics, oils, paints and the like.

A further complication to this situatio is the fact that some chemicals absorbed by the skin can cause an abnormal sensitivity to sunlight and develop photo-allergic reactions which produce sunburn-like conditions.

The obvious answer to this potential situation is to avoid contact of any chemical product with the skin. Do not use solvents for accidental contamination, other than a wipe with a paper towel moistened with alcohol or mineral spirits to remove stickiness and do not wash with harsh soaps excessively. Use a hand cream containing lanolin at the end of the day to keep the skin of the hands pliable.

BARRIER CREAMS

There are available a large number of skin creams that are proported to protect against skin irritation.

The commercial formulations vary considerably in composition and the degree of protection is dependent on the nature of the potential soiling material. The chief advantages are that removal of resin is facilitated and that the skin is lubricated. However, it is not recommended that reliance be placed on the anticipated protective nature of any cream against dermatitis.

GLOVES

Cheap vinyl or polyethylene gloves provide little protection against dermatitis because of a small cross section which, upon stretching, becomes very thin. The permeability to chemicals is also quite high, especially with low molecular weight solvents, specific chemical products and vapors.

For increased protection against irritation, the use of heavy-duty butyl rubber gloves and cotton liners is recommended. The gloves are resistant to the permeation of epoxy resins and curing agents and have been found to offer the greatest protection of any gloves tested. The cotton inner liners are designed to be used in conjunction with the gloves. The combination of the roomy butyl glove and a soft cotton liner reduces the tendency of the hands to perspire inside the glove and provides extra comfort when working long hours. Although these gloves provide protection from solvents such as MEK and acetones, it is suggested that soap and water be used for clean-up.

For short term protection, an inexpensive glove made of high quality rubber latex may be used. The cotton liner described above should also be used with the latex gloves. The combination of glove and liner will provide good protection, but the rubber latex is neither as durable nor as resistant as the butyl rubber glove and therefore is recommended only for smaller projects involving shorter exposure time.

Barrier creams should not be used under tightly stretched, thin gloves. Problems will arise due to excessive sweating on the hands, even with no chemical contact, due to blockage of the pores.

STEROID CREAMS

Recently there has been made available non-prescription preparations for topical use that contain active ingredients with cortico-steroid physiological effects.

Primarily, they have been used on dermatoses for the anti-inflammatory action. However, they are potent drugs and must be used sparingly. If applied over large skin surfaces for prolonged periods, severe systemic and permanent physiological changes can occur.

Application to the back of the fingers strictly on the affected area has been known to produce remission, but cannot prevent recurrence of dermatoses of allergic origin.

Under no circumstances should surgical tape or tight plastic gloves be used over a topical application of a steroid cream because of the possibility of systemic absorption and the development of local infections.

The foregoing is not a recommendation for use, but is intended as a warning against misuse.

INGESTION

Ingestion of potentially harmful substances into the body systems could be via various routes, such as inhalation, oral ingestion and skin absorption.

INHALATION

Inhalation via the respiratory system requires either of the following:

A. Air supported dusts, fibers, sanding particles and the like that could accumulate in the lungs.

   Most operations where laminates are made involve sanding at some stage to develop a specific shape or surface finish. The sanding dust can contain sharp, minute fibers of the reinforcement that can cause respiratory distress or, if allowed to remain on the skin, can cause mechanical irritation dermatitis.

   Glass bubbles are sometimes used in slurry form to fill the holes in foams. A certain percentage of the bubbles consist of very thin, broken glass which can become airborne during incorporation into a resinous mixture. If these glass fragments become lodged in the airway, considerable respiratory distress can result.

   The simple solution is to wear a dust mask during sanding, fiber handling or when mixing bubbles.

B. Chemical irritation from primary irritants in the form of fumes, such as those from aliphatic, low molecular weight diamines, typically ethylene diamine or diethylene triamine which have been used for epoxy hardeners in the past. High vapor pressure solvents such as acetone, when used in a confined space, can create respiration difficulties.

If an excessive amount of room temperature setting epoxy resin and hardener are allowed to remain in the mixed form in a container, especially on a hot day, a high exotherm can result which might possibly result in the decomposition of the resinous mixture. The fumes given off are quite irritating and inhalation could cause a sensitization to the components. Such an exposure could result in a practical prohibition of further work on <u>any</u> epoxy system because of allergic systemic sensitivity.

The solution would be to not allow more than a hundred grams or so of a mixed resin to remain in a paper cup beyond the useful pot life. If more material is required, use a metal mixing vessel, such as a can, and place in a pan of water.

On a hot day, the pot life is much shorter and the exotherm higher.

Also, wear an organic vapor mask, if possible.

C. <u>Allergic Sensitization</u> can occur under the high temperature conditions described above or by exposure to large surfaces of uncured resin-fiber combinations with poor ventilation.

Epoxy resins and reactive diluents used to reduce viscosity are relatively high molecular weight chemicals whose molecular size will not permit passage through the intact skin barrier. The vapor pressure is low and the boiling point high.

However, during the manufacture of these resins there are residual, low molecular weight, chemically active components measured in parts per million that cannot be reduced in concentration much further without a considerable increase in selling price. With all commercially available liquid resins there are at least 10 to 20 of these active species of different compositions, including chlorohydrins, which are known or suspected sensitizers.

So even if an epoxy laminating resin were specified as being 100% diglycidyl ether of "Bisphenol A", it could still contain 1 to 100 parts per million of chlorohydrins and be an active sensitizer. The sensitization route could be by excessive inhalation of the fumes from a warm surface or by absorption through the skin by prolonged exposure, such as the use of contaminated gloves or the bad practice of washing off the hands in solvent previously used for cleaning up tools or resin spills.

Hardener problems with Safe-T-Poxy®, if encountered, are generally related to careless handling and gross or excessive skin contamination. The hardener is essentially neutral in nature and does not constitute a chemical irritant, nor is it known to be an active mutagen or carcinogen. However, excessive direct skin exposure can easily create an allergic condition due to the presence of an aromatic diamine.

FIRE

Do not dispose of any resin-containing material in a fire where the products of combustion can be inhaled. Sensitization is possible from absorption of the gaseous products of combustion.

SKIN IRRITATION

The resin and hardener separately have been submitted to an independent biological science testing laboratory for patch testing on albino rabbits. The conclusion was drawn that the products can be considered as non-irritant to the skin.

ALLERGIC DERMATITIS

Allergic dermatitis is possible after excessive contact or careless handling which is common to all epoxy resins. The epoxies in Safe-T-Poxy® have been carefully formulated with this in mind and any known content of low molecular weight chlorohydrins reduced to an irreducable minimum. Once a person has become sensitized, however, a minor exposure is all that is needed to provoke a reaction.

ACCIDENTAL INGESTION

Accidental ingestion should not create a crisis since no primary irritants are present and no cellular destruction is expected. The resin-hardener composition contains no unusually potent physiological agents.

Induce vomiting and, if needed, gastric lavage. Toxic hepatitis has been reported in rats fed substantial amounts of aromatic amines over a long period of time.

RECOMMENDATIONS

1. Develop good work habits. Practice intelligent hygiene.
2. Do not permit resin or hardener to remain in contact with skin.
3. Wear heavy gloves, such as butyl rubber, with cotton gloves underneath. Launder cotton gloves daily or use disposable type.
4. Do not use harsh solvents or soaps to clean hands.
5. Wear dust respirator when sanding.
6. Make layups under good ventilation conditions and/or wear an organic vapor mask.
7. At end of day, wash hands thoroughly with soft soap and apply an emollient lotion.
8. Get medical attention if problems arise.

NOTICE

The foregoing information is offered in an effort to be helpful and attempt to point out possible sources of problems in using any epoxy resin.

Responsibility for use of the resin systems and application of the application suggestions reside strictly with the user. Definitive technical information can be found in the references on the following page.

Safe-T-Poxy® is a registered trademark of Applied Plastics Company, Inc., El Segundo, California.

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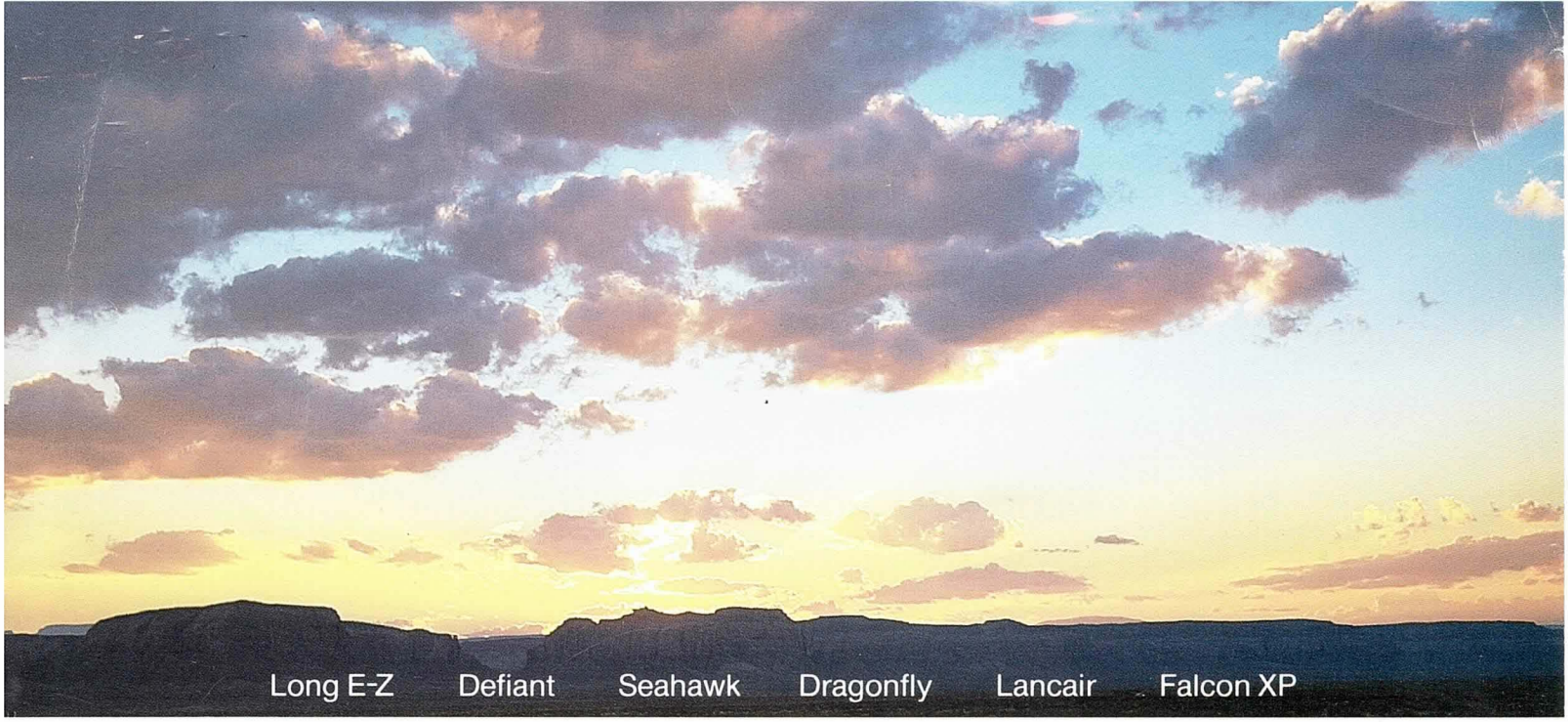

Without Hexcel, The Skies Would Be Empty.

Hexcel's composite fabrics and laminating resins make possible Sport Aviation, as we know it today.

In truth, modern aviation is absolutely dependent upon composite structures and components. These materials provide affordable, lightweight construction with exceptional strength and unmatched performance.

In the Sport Aviation industry, the number one composite fabric supplier is the Trevarno Division of Hexcel Corporation, offering bidirectional and unidirectional weaves in a variety of fibers including glass, Kevlar® and graphite. And don't be surprised to learn that the leading resin supplier to Sport Aviation is also Hexcel Corporation and it's Resin Chemicals Group, with APCO Safe-T-Poxy.® Hexcel's fabric and resin combination is so dominant that it's used to construct more than nine out of every ten composite sport aircraft built today.

Hexcel's Trevarno fabrics and Safe-T-Poxy laminating resins are actually specified by an overwhelming majority of sport aviation's designers and manufacturers as the only acceptable materials that assure the structural integrity these aircraft demand. In fact, Hexcel's composite materials are major structural components of Burt and Dick Rutan's exotic Voyager, conceived to circle the globe non-stop, non-refueled.

Dominance of Hexcel's magnitude is possible only with technology of the most advanced kind, with products reflecting all the benefits of that scientific knowledge.

Our record of leadership in the composite field speaks for itself. For decades, Hexcel has been involved in countless, diverse and highly sophisticated areas. Many of the products we developed for aerospace applications have become industry standards. Our materials are used to manufacture some of the most advanced medical devices. We're on the forefront of plastic tooling and filament winding technology. In fact, wherever advanced composite technology is used, you'll find Hexcel.

It's this background of leadership that Hexcel brings to Sport Aviation. Trevarno's composite fabrics and Safe-T-Poxy laminating resin systems are engineered, formulated and manufactured for perfect compatibility to insure the ultimate in advanced composite construction.

Imagine Sport Aviation without composite materials from Hexcel. There would be nothing but empty skies.

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ATTRIBUTES

	Best ———			——→ Least
Cost	E Glass	S Glass	Kevlar	Graphite	Ceramic
Weight (Density)	Kevlar	Graphite	S Glass	E Glass	Ceramic
Stiffness	Graphite	Kevlar	S Glass	Ceramic	E Glass
Heat	Ceramic	S Glass	E Glass	Kevlar	Graphite
Toughness	Kevlar	S Glass	E Glass	Ceramic	Graphite
Impact Resistance	Kevlar	S Glass	E Glass	Ceramic	Graphite

S-2® GLASS

The chemical formulation of S glass is different from E glass. S glass is stronger, tougher and stiffer than E glass and retains these properties up to 1500°F. It costs about $5/lb. S glass is easy to work with and is in the same weight range as E glass. Used in recreation and marine applications including surfboards, power boats, fishing rods and rackets.

KEVLAR®

Kevlar is an organic fiber from DuPont which chemically is part of the aramid family of compounds. Nomex is also an aramid while nylon is a close cousin. Kevlar is yellow in color and soft to touch. It is extremely strong and tough and about the lightest structural fiber on the market today. However, it must be vigorously cleaned or scoured (Hexcel treatment F100) before it will bond to resins. Its price is moderate at approximately $10/lb. Kevlar is the most resistant fiber to impact and abrasion damage available on the market today. Its compressive strength is low. Used extensively in marine, sports aviation, and often with glass and graphite.

GRAPHITE

Graphite fibers begin as PAN (polyacrylonitrile), rayon or pitch fibers which are stretched to high tension and slowly heated to extremely high temperatures (over 3000°F.). This process causes all the molecules in the fiber to change into long parallel chains of carbon atoms. The results are fibers which (1) have low density (weight/unit/volume), (2) are very stiff (modulus) and (3) strong (tensile). Current cost runs from $25/lb. for high strength fibers to over $70/lb. for super high modulus version. Used in race cars, recreation equipment, golf shafts, fishing rods, tennis rackets and bicycle parts.

CERAMIC

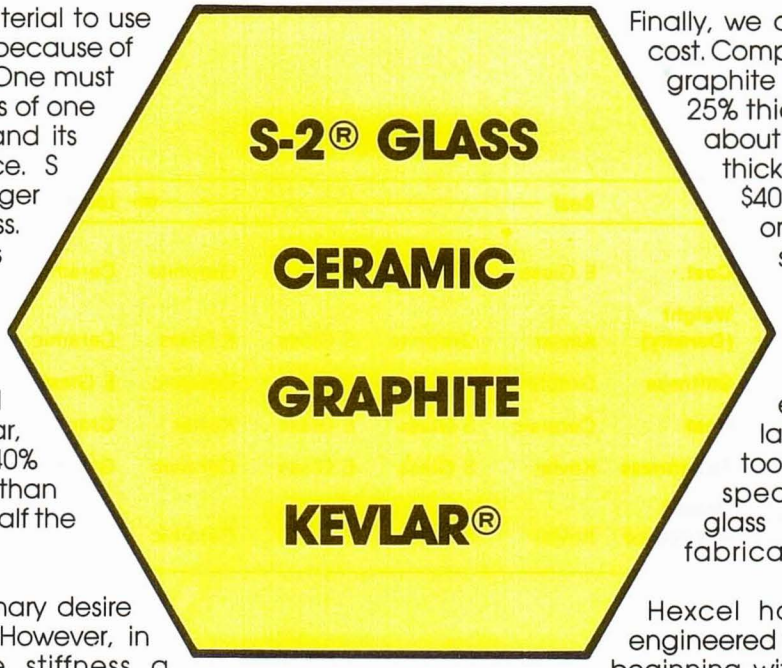
A number of fiber manufacturers have recently developed the technology to produce continuous filaments of inorganic (mineral) fibers which can be woven into cloth. These fabrics produce laminates approaching the mechanical properties of S glass plus they can withstand temperatures of almost 3000°F. Their handling is similar to fiberglass. Ceramic fibers are currently in use as lightweight fire protection barriers replacing heavier metal on many of today's newest aircrafts. Also used as insulation blankets for metal heat treatment. The cost is over $90/lb.

HEXCEL®

THE NEW ADVANCED COMPOSITE REINFORCEMENTS

Which family of these hi-performance fabrics are you using? **Hexcel offers them all**. The comparative data shown here can help you choose. In addition we provide maximum quality and service. Design of custom fabrics can be made to suit your needs.

Often, the choice of material to use for a laminate is difficult because of the required properties. One must consider the advantages of one material over another, and its anticipated performance. S glass is about 30% stronger and 15% stiffer than E glass. It has 20-25% the stiffness of graphite, and is as strong, but it's 30% heavier. S glass, though, has only half the strength and stiffness of Kevlar and twice the weight. Kevlar, on the other hand, is 40% stronger and 25% lighter than graphite but it has only half the stiffness of the fiber.



Stiffness is often the primary desire for many applications. However, in building in adequate stiffness a material could be over-designed for strength.

By blending different materials such as S glass/Kevlar or glass/graphite in the laminate, it is possible to achieve a proper balance of properties. Since stiffness is proportional to the cube of the thickness, the stiffness of a foam or honeycomb core construction can be met without excess weight gain, by using different materials to maximize properties and minimize cost. A good example of this procedure would be a boat hull which uses Kevlar and glass for the outside skin for toughness and abrasion resistance, and graphite on the inner skin to take the structural loads.

Finally, we come to the question of cost. Comparatively, if a laminate of graphite costs $100.00/sq. yd., a 25% thicker part of S glass costs about $20-25/sq. yd., and a 40% thicker Kevlar part would cost $40.00/sq. yd. These costs are only relative and are exclusive of resin and labor costs. Obviously thicker laminates require more resin. Glass, graphite, S glass and ceramic are easier to use in hand layup than Kevlar. Special tools for handling Kevlar and special hybridized Kevlar/glass weaves can assist the fabrication of a Kevlar part.

Hexcel has been a weaver of engineered yarns for over 3 decades, beginning with fiberglass. A weaving plant in Seguin, Texas continues to serve a network of sophisticated distributors throughout the United States.

Rapid response to customer needs by enthusiastic and knowledgeable personnel has helped Hexcel's growth in the marketplace. A network of trucks and warehouses supports this efficient distribution team.

A full line of advanced composite reinforcements is now available from your Hexcel distributor.

FOR FURTHER INFORMATION CONTACT: