

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-106-247

INMONT CORPORATION
PADDOCK ROAD FACILITY
CINCINNATI, OHIO

DECEMBER 1975

FILE COPY

I. TOXICITY DETERMINATION

A medical evaluation of dermatitis related to the manufacture of ultra-violet cured ink at the Inmont Corporation, Cincinnati, Ohio was conducted on June 11, and July 22-24, 1975. It was concluded that the dermatitis experienced by the working foremen, weighers and millhands may be attributed to (1) three polyfunctional acrylic monomers (namely trimethylol propane triacrylate, pentaerythritol triacrylate and 1,6-hexanediol diacrylate), (2) epoxy acrylate oligomers, and (3) two separate compounds of varying purity of mixed esters of amyl p-dimethylaminobenzoate. In vivo studies revealed that the acrylic monomers and oligomers were allergic contact sensitizers; in vivo and in vitro investigations demonstrated that the mixed esters of amyl p-dimethylaminobenzoate were phototoxic.

Recommendations for improved work practices and medical monitoring to improve control of dermatitis associated with exposure to polyvalent acrylic monomers (if they should be reintroduced into the ink formulations), epoxy acrylate oligomers, and the mixed esters amyl p-dimethylaminobenzoate have been presented in the body of the report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Health Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, Fifth and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

- a) Inmont Corporation, Cincinnati, Ohio
- b) Authorized Representatives of Employees
- c) U.S. Department of Labor - Region V
- d) NIOSH Regional Consultant - Region V

For purposes of informing the approximately 58 "affected employees" the employer will promptly "post" the Determination Report in a prominent place(s) near where affected employees work for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an employer or authorized representative of employees, to determine whether a substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees of the Paddock Road plant of Inmont Corporation in Cincinnati, Ohio. The request alleged that eight to fifteen production workers developed skin rash and swelling as a result of their exposure to the chemicals used in the formulation of ultraviolet (UV) cured inks. Approximately 58 of the 200 persons employed are directly affected by the alleged hazards. These persons work in the color mix and black rooms as weighers or work foremen, and as horizontal and vertical mill operators in the mill room.

IV. HEALTH HAZARD EVALUATION

A. Process Description - Conditions of Use

A pilot run at manufacturing UV cured ink took place in November 1974. The process was introduced in a more major manner in February 1975. The manufacturing process begins in the mixer rooms where weighed portions of the vehicle and pigment(s) are mixed in dual blade or butterfly type mixers and in large mixing tanks. When the desired mixture is obtained the ink is transported to a mill room where the entire mixture is milled at about 50°C to disperse the pigment. Necessary minor corrections are made at this stage after which the ink is transferred to suitable containers for shipping.

The composition of UV cured inks varies widely depending upon the printing method to be employed, the specific type of printing, the press speed etc. The ink usually consists of one or more conventional pigments dispersed in a polymeric vehicle. The vehicle usually contains (1) various monomers and oligomers such as polyfunctional acrylic monomers (trimethylol propane triacrylate, pentaerythritol triacrylate, 1,6-hexanediol diacrylate and others) and epoxy acrylate or epoxy oligomers, (2) one or more photoinitiators such as benzophenone, thioxanthane, 2,2-diethoxyacetophenone, 4,4' bis (dimethylamino) benzophenone (Michler's Ketone), or esters of amyl p-dimethylaminobenzoate, (3) diluents such as primary and aliphatic alcohols or phthalates, (4) hydrogen transfer agents such as triethanolamine and methyldiethanolamine, and (5) a variety of miscellaneous ingredients including stabilizers such as tetramethylthiuram sulfides and zirconium oxide, and surfactants.

B. Evaluation Progress

Field investigations were conducted at the Inmont Corporation facility on June 11, July 22-24 and September 8-10, 1975 by NIOSH investigators, Dr. Edward A. Emmett and Mr. John R. Kominsky.

Nine employees who disclosed symptoms of dermatitis were examined thoroughly. A detailed history of past and present health problems and employment history was obtained. This led to a diagnosis of occupational contact dermatitis in eight employees. In the ninth worker a diagnosis of dermatophytosis (superficial fungal infection) was confirmed following an examination of a potassium hydroxide preparation of skin which revealed numerous hyphae. In the eight workers in whom a diagnosis of occupational contact dermatitis was made the medical history suggested the possibilities of an allergic contact dermatitis or photocontact dermatitis. The latter was suggested by the history, in three employees, of severe exacerbations following sun exposure.

In order to evaluate the possibility of allergic contact dermatitis patch testing was performed with 29 materials used in the ink formulation process. The methods and results are detailed in Section C of this report, entitled "Allergic Contact Dermatitis".

Because of the apparent photosensitivity reported by at least three workers, various investigations were performed to elucidate the possibility. These investigations included (1) absorption spectrophotometry testing to determine which materials used in the process absorbed UV radiation of appropriate wavelengths to cause photosensitivity to sunlight, (2) in vitro phototoxicity testing to determine which of these compounds were potentially phototoxic, (3) photopatch testing of affected employees to determine whether the UV absorbing materials were causing photoallergic or phototoxic reactions, and (4) phototoxicity and photoprotection studies to more closely examine the different responses to two separate preparations of varying purity of mixed esters of amyl p-dimethylaminobenzoate designated as Absorber 0505 and Absorber 0802. The assessment of the phototoxicity of the UV ink components is detailed in Section D, entitled "Photocontact Dermatitis".

C. Allergic Contact Dermatitis

1. Methods

Eight employees were patch tested using the closed patch technique. The materials to be tested were applied to the upper back on the central gauze portion of 3.8 sq cm. square patch test plasters occluded with hypoallergenic surgical tape. Patches were removed 48 hours after application and readings were made approximately one hour after removal. In the case of mild or equivocal readings a further reading was made 72 hours after application. All materials were tested at concentrations which were found to be non-irritating by patch testing the materials in an identical manner on four healthy volunteers.

2. Results

The results of patch testing with trimethylol propane triacrylate, pentaerythritol triacrylate, 1,6-hexanediol diacrylate and epoxy acrylate are shown in Table 1. It will be seen that 7 of the 8 affected employees had unequivocal positive reactions to trimethylol propane triacrylate while 6 employees reacted to 1,6-hexanediol diacrylate and 4 to pentaerythritol triacrylate. In addition to these reactions to polyvalent acrylate monomers 3 employees had unequivocal reactions to epoxy acrylate oligomer including 1 employee who did not react to any of the polyvalent acrylates. Because the epoxy acrylate oligomers from different manufacturers have slightly different properties, patch testing was performed on the latter employee with similar dilutions of four different epoxy-acrylate oligomers. The results are shown in Table 2. It can be seen that this employee reacted to only two of the four commercial epoxy acrylates. No reactions were seen to any of the acrylates in the employee diagnosed as suffering from dermatophytosis.

No employees reacted to the other contactants tested namely polymerized epichlorhydrin-bisphenol A, 1% petrolatum; epoxidized linseed oil acrylate, 1% petrolatum; di-allyl phthalate, as is; zirconium octalate, 10% petrolatum; triethanolamine, 5% petrolatum; methyldiethanolamine 5% petrolatum; benzophenone, 5% petrolatum; thioxanthone, 5% petrolatum; 2,2-diethoxyacetophenone, 5% petrolatum; Michler's ketone, as is; absorber 0505, 5% petrolatum; tetramethylthiuram disulphide, 1% petrolatum; tetramethylthiuram monosulphide, 1% petrolatum; Tween 80, 5% aqueous; Nuosperse 657, 1% aqueous; Tergitol 15S fatty alcohol, 5% petrolatum; tartaric acid, 1% petrolatum; UV cleansing solution (butyl carbitol in kerosene) 60% olive oil, butyl carbitol, 25% olive oil, and kerosene, 60% olive oil.

3. Discussion

From the results of this investigation the polyfunctional acrylic monomers triacrylate propane triacrylate, pentaerythritol triacrylate and 1,6-hexanediol diacrylate appear to be strong allergens capable of sensitizing a significant percentage of the workforce exposed to them over a relatively short period of time. In this instance seven workmen were unequivocally sensitized to trimethylol propane triacrylate, six to 1,6-hexanediol diacrylate and five to pentaerythritol triacrylate. It is possible that some of the observed reactions represent cross reactions but as the employees were potentially exposed to each of the materials this possibility cannot be evaluated in this study. Jordan (1975) has observed cross-sensitization amongst other acrylate allergens. Two of the patch test reactions to each of trimethylol propane triacrylate and 1,6-hexanediol diacrylate were very severe bullous reactions and it may be advisable in future to test with these materials at a lower concentration, possibly 0.2% in petrolatum.

Three subjects demonstrated allergic sensitization to epoxy acrylate oligomer. In one instance the reaction to epoxy acrylate could not be accounted for by cross-sensitization as no reactions to other acrylates were observed. In these three employees a significant dermatitis persisted months after the withdrawal of the polyfunctional acrylates from the workplace presumably because they continued to be exposed to the epoxy acrylates.

The acrylate monomers and small oligomers are volatile under the conditions in which they are used in this operation and both the employees history and the distribution of the dermatitis suggested that airborne materials may play a role in eliciting the reaction in sensitized employees.

4. Recommendations

It is clear that the three polyfunctional acrylic monomers (namely trimethylol propane triacrylate, pentaerythritol triacrylate and 1,6-hexanediol diacrylate) are strong allergic sensitizers of human skin. These three materials have been removed from the UV cured ink formulations at this plant. If they should be reintroduced the most stringent applications of the recommended safety precautions delineated below should be enforced.

The epoxy-acrylate oligomers also appear capable of producing allergic skin sensitization in a significant number of employees under work conditions encountered during the formulation process. It is important that the outlined precautions be carefully followed when these agents are used.

a) Handling of Materials

Skin contact with these materials must be avoided as far as possible.

i) Gloves and aprons which are impervious to these substances must be used at all times when skin contact is likely.

ii) Long sleeved shirts (rolled down) and goggles should be used when working with these materials.

iii) If a possibility of contact to these substances exists the prior application of a suitable barrier cream to potentially exposed areas of skin may facilitate removal of the substances.

iv) If skin contamination does occur the material should be removed as expeditiously as possible using soap and water or a suitable water-free cleansing cream.

v) Rubber should be used over shoes if a spill onto the shoes is considered likely.

vi) Employees should shower or otherwise wash carefully after the shift each day.

vii) Contaminated clothing should be changed frequently and washed thoroughly. Uniforms which are frequently contaminated should be changed daily.

viii) Where splashing of UV components is likely to occur protective shields should be used.

ix) The airborne acrylate monomers appear to contribute to the dermatitis in some employees, especially those working in areas where the formulations may be heated. In such areas adequate ventilation should be provided to remove the volatile components.

x) The use of a closed process wherever possible will reduce potential skin exposures to a minimum.

b) Labelling

The acrylic monomers and epoxy acrylate oligomers should be clearly labelled to alert all employees to the dangers of allergic sensitization and subsequent dermatitis from skin contact with these materials.

c) Medical Management

i) A preemployment examination should be performed on new employees who may work with these materials. Persons with a history of atopic dermatitis, recurrent eczema or who currently have active dermatitis should not be exposed to these materials.

ii) Any employee who develops dermatitis should have a prompt medical examination and suitable treatment and the cause of the dermatitis should be determined in each case. If allergic contact dermatitis to a polyfunctional acrylate or to epoxy acrylate is suspected, patch testing with a suitable dilution of the agent may be necessary. If the dermatitis appears to be work related the work exposure should be evaluated carefully to determine where and why contact occurred and what additional hygiene measures, if any, are necessary. Severely affected workers should not return to their job until this evaluation has been made.

iii) Periodic medical examinations, at least yearly should be performed on all employees in this area to determine whether the occurrence of dermatitis is effectively controlled and to ensure that other adverse effects are not occurring from these agents.

d) Management of Affected Employees

i) As the polyfunctional acrylates have now been removed from the process further contact with these should not be a problem for the affected individuals. The epoxy acrylate oligomers are still being used. Although it may be possible that the use of very careful hygienic techniques will permit the employees allergically sensitized

to epoxy acrylates to continue their present work it is also possible that their dermatitis may be provoked by such very small quantities of the epoxy acrylates that they will be unable to tolerate any further exposure to these materials. If this occurs these employees should be placed in another position where contact with the offending material does not occur.

ii) Employees who develop allergic dermatitis from one material may also develop allergic reactions to chemically related materials. Thus affected employees should be watched carefully for the development of dermatitis if other acrylates are introduced in the process.

iii) For some months after the development of dermatitis although the skin appears healed its tolerance to injurious substances is reduced. Thus it will be more susceptible to damage from strong detergents, solvents or other irritating substances. Because of this affected employees should be particularly careful to avoid skin damage for several months after their dermatitis is apparently cured.

e) The Identification of Agents Which Produce Allergic Contact Dermatitis Prior to Their Introduction into the Work Environment

Although the materials in question are potent inducers of allergic contact dermatitis no information was apparently available to the Inmont Company to suggest this possibility. It should be possible to establish the allergenicity of these materials prior to widespread use by repeated insult patch testing in humans following prior animal screening. Suitable testing and evaluation may allow the least toxic useful ingredients to be substituted in the process.

D. Photocontact Dermatitis

Allergic contact dermatitis to polyfunctional acrylic monomers and to epoxy acrylate oligomers in UV ink manufacturers has been described in Section C. Three out of eight affected employees complained that their symptoms were markedly exacerbated by sun exposure. In addition a fourth employee in whom patch testing revealed no sensitization, complained of an eruption provoked by sunlight. In order to evaluate the possibility that photocontact dermatitis might be occurring in these employees, in vitro and in vivo studies were performed.

1. Investigations

a) Absorption Spectra

In order to determine which of the materials used in the UV formulation might cause photosensitization, the ultraviolet absorption spectra of the ingredients were obtained from the scientific literature and also determined using a Coleman 124 Double Beam Spectrophotometer.

Six chemical ingredients were found to absorb ultraviolet radiation above 290 nm namely benzophenone, thioxanthone, 2,2-diethoxyacetophenone, 4,4' bis (dimethylamino) benzophenone (Michler's ketone), and two different preparations of mixed esters of amyl p-dimethylaminobenzoate designated as Absorber 0505 and Absorber 0802.

b) In Vitro Phototoxicity

Each of the UV ink ingredients which absorbed ultraviolet radiation above 290 nm was evaluated for phototoxicity in an Ehrlich ascites cell system using a method which has been previously described (Tomson et. al., 1974).

The mean and variance was calculated for each set of results and the results compared by the analysis of variance of a two by two factorial so that it could be determined whether an interaction between the irradiation and the incubated chemical had occurred. The cells were irradiated either by a bank of four FS40 sunlamps or a bank of four BLB40 black lights with exposures of predominantly 330-380 nm radiation and of 293-325 nm radiation respectively. Where compounds were not readily soluble in water 5% ethanol in lactated Ringer's solution was used in place of lactated Ringer's solution for incubation.

The results obtained from the phototoxicity assay using 330-380 nm radiation are shown in Table 3. It will be seen that of the contactants being examined benzophenone and 2,2-diethoxyacetophenone were not demonstrably phototoxic whereas Michler's ketone, thioxanthone, Absorber 0505, and Absorber 0802 were phototoxic in the Ehrlich's ascites cell system.

Absorber 0505 and Absorber 0802 were also shown to be phototoxic using 293-325 nm radiation from a sunlamp .

c) Phototesting of Affected Employees

In order to determine whether the UV absorbing materials in the UV cured ink formulations might be causing photoallergic or phototoxic reactions in the employees photopatch testing was performed on seven employees with dermatitis, including three who complained of photo-sensitivity.

i) Method

Materials to be patch tested were applied evenly to the central gauze portion of adhesive plastic strips 3.8 sq cm in size before application to the skin. Two duplicate sets of patches were applied to the back and were covered, secured and occluded with several layers of

hypoallergenic surgical tape. One set of patches was removed at 24 hours and the area gently cleansed with 70% ethanol in water. The sites were then exposed to sunlight. Four employees working a day shift were exposed to 25 minutes of Cincinnati (39° N) noonday sun on July 22, 1975. Three employees working an evening shift were exposed to 35 minutes of sunlight from 3:50 P.M. that same day. Reactions were observed during the irradiation. The second set of patches which functioned as a dark control for the development of allergic contact or irritant reactions was removed at 48 hours and the site gently cleansed with 70% alcohol. Reactions at both sites were read and graded one hour later.

ii) Results

During the sun exposure several employees complained of a stinging or burning sensation localized to the exposed areas where Absorber 0505 and Absorber 0802 had been applied. The burning sensation was evident within a few minutes and four subjects developed erythema confined to these sites during the period of sun exposure. No burning was observed at the other tested sites.

The results observed when the sun exposed and nonsunexposed areas were compared 48 hours after application of the patches are shown in Table 4. It will be seen that six of the seven men had a reaction consisting of uniform erythema or erythema and edema on the area exposed to undiluted Absorber 0505 which was exposed to sunlight. Two of the seven men also had reactions to undiluted Absorber 0802 under the same conditions. One who had a reaction to Absorber 0505 in sunlight was a darkly pigmented Negro, the other subjects were Caucasian. No reactions were seen on control areas exposed to either Absorber 0505 or Absorber 0802 for 48 hours and shielded from the sun. No reactions were seen on any sites tested with either Absorber 0505 or Absorber 0802 diluted to 5% in petrolatum. Additionally, no reactions were seen on either sun exposed or control sites to the other materials tested namely Michler's ketone, as is; benzophenone, 5% petrolatum; diethoxyacetophenone, 5% petrolatum; and thioxanthone, 5% petrolatum.

Several characteristics of these reactions, the relatively immediate responses to sun exposure, the intense burning sensation while exposed to sunlight, the reaction in virtually all the employees whether complaining clinically of photosensitivity or not, and the occurrence of reactions only when these materials were undiluted were felt to indicate a phototoxic rather than a photoallergic reaction.

d) Phototoxicity and Photoprotection Studies in Previously Unexposed Human Subjects

In order to examine the characteristics of the phototoxic responses to Absorber 0505 and Absorber 0802 more closely further observations were made in four previously unexposed Caucasian volunteers whose ages ranged from 25 to 35 years.

i) Method

Two patches each of Absorber 0505 and Absorber 0802 were applied as described above to the backs of subjects who had no previous industrial exposure to them. After 24 hours one set of patches was removed and the area lightly cleansed with 70% ethanol in water while the second set was covered with an additional layer of black plastic tape. Twenty minutes after removal of the first set of patches subjects were exposed to clear, noonday, August 5, 1975, Cincinnati (39° N) sunlight for 30 minutes. Immediately afterwards the second, previously occluded set of patches was removed and the area similarly cleansed with 70% ethanol in water. On three subjects a third and fourth set of patches were applied which were also removed and the areas cleansed 20 minutes before sun exposure. The third set was immediately evenly covered with 2.5 μ l/sq cm of a sunscreen containing 5% p-aminobenzoic acid in alcohol (Presun®) and the fourth evenly covered with 2.5 μ l/sq cm of a sun screen containing 10% sulisobenzone (Uva®) 15 minutes prior to sun exposure. The reactions were observed during sun exposure, hourly for 5 hours and again 48 and 72 hours after patch application. No subjects had further sun exposure over this observation period.

ii) Results

Three of the four subjects noted a sharp burning sensation which commenced a few minutes after the areas patch tested with Absorbers 0505 and 0802 were exposed to sunlight. No burning occurred on the covered areas. The burning sensation was accompanied by erythema and in one case prominent edema. In each case the burning stopped within a few minutes after sun exposure ceased.

The reaction was observed to be diphasic, the erythema and swelling began to fade shortly after sun exposure ceased and had disappeared in two subjects within one hour and in the third after two hours. Four to five hours after sun exposure the erythema recurred and remained for 2-5 days. Mild discomfort and irritation accompanied the reappearance in each case but the intense burning noted during sun exposure was not evident.

Two of the three subjects in whom the sunscreens were applied developed a phototoxic response so that the degree of photoprotection could be estimated. The prior application of a 5% p-aminobenzoic acid sunscreen provided partial protection against the reaction whereas the application of a 10% sulisobenzone sunscreen was able to completely suppress the development of the phototoxic response under the experimental conditions.

3. Discussion

The two preparations of mixed esters of amyl p-dimethylaminobenzoate designated as Absorber 0505 and Absorber 0802 were demonstrated to be phototoxic with UVA (320-400 nm) and UVB (290-320 nm) to Ehrlich's ascites cells in vitro and with sunlight to human skin in vivo. There was no clinical or other evidence to suggest photoallergy. The phototoxic reaction could be reproduced even in deeply pigmented Negro skin and could be seen on the first exposure. Although Michler's

ketone was noted to be phototoxic in vitro a phototoxic response to this substance could not be reproduced by topical application to human skin and subsequent exposure to sunlight. Thioxanthone also gave a phototoxic response in vitro, was not phototoxic at a 5% concentration in vivo and was not studied further as it was rarely used in the industrial process. Three of the four employees complaining of photosensitivity also had allergic contact sensitization to acrylic monomers and epoxy acrylate oligomers to which they were simultaneously exposed. However, sun exposure of skin involved in allergic contact dermatitis does not usually provoke the very intense burning and exacerbations described in these subjects (Fisher 1973, Haniszko and Suskind 1963), and does not explain the photosensitivity.

It has previously been reported (Kahn 1971) that the allergenicity of benzyl salicylate, a weak contact sensitizer was greatly enhanced by the phototoxic effect of topical methoxsalen applied simultaneously. The same effect may have enhanced the allergenicity of the acrylate monomers and epoxy acrylate oligomers in this case. It is also possible that the simultaneous allergic contact dermatitis in several of these subjects with the attendant damage to the epidermal barrier increased the penetration of the phototoxic materials and thus the phototoxic response was more easily elicited.

The phototoxic reactions observed on human skin after experimental application were noted to be diphasic. The burning sensation described during sun exposure and the ensuing exacerbations of the dermatitis observed by employees using these materials in their work appear to parallel the two phases observed in volunteers.

No phototoxicity was observed in these employees when a 5% concentration of amyl p-dimethylaminobenzoic acid was applied. The difference in protective and toxic responses depending on the circumstances of use illustrates the important toxicologic principle that the hazard from any material is highly dependent on the circumstances of its use.

4. Recommendations

a) Hygienic Measures

Employees should avoid skin contact with Absorber 0505 and Absorber 0802, as far as possible.

i) Impervious gloves should be used when these materials are handled. Contaminated clothing should be changed frequently and washed before reusing.

ii) If any of these substances comes in contact with the skin it should be rapidly removed using soap and water or an appropriate waterless cleanser. This step is very important because of the avid tendency of these Absorbers to bind quickly with skin components. Employees exposed to these materials should wash carefully before leaving the plant and going out into sunlight.

iii) Where necessary guards and shields should prevent any splashing of these materials.

iv) Clear labelling of containers of Absorber 0505 and 0802 should warn that skin contact may be hazardous.

b) Protection Against Simultaneous Sun Exposure

If an employees skin has come in contact with Absorber 0505 or 0802 he should avoid sun exposure as far as possible for the next 24 hours in order to avoid suffering from a phototoxic reaction. If sun exposure is necessary he should apply a sunscreen which is effective against the particular wavelength which causes the reaction. Recommended are sunscreens containing sulizobenzone (2-hydroxy-4-enzophenone-5-sulphonic acid) such as Uva[®] lotion (Dome Laboratories) or Sunguard[®] (Miles Laboratories).

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Table 1
Results of Patch Testing with Various Acrylates

Compound	Concentration & Vehicle	48 hr Patch Test Readings* in 8 Subjects							
		1	2	3	4	5	6	7	8
Trimethylol propane "triacylate"	1% in petrolatum	+++	+++	++	++	++	++	++	-
Trimethylol propane "triacylate"	0.1% in petrolatum	NT	NT	NT	NT	NT	NT	NT	-
Pentaerythritol triacylate	0.2% petrolatum	++	+	-	?+	++	-	++	-
1,6-Hexanediol diacylate	1% in petrolatum	++	+++	+	+	+++	-	++	-
1,6-Hexanediol diacylate	0.1% in petrolatum	NT	NT	NT	NT	NT	NT	NT	-
Epoxy Acrylate	1% in petrolatum	++	-	-	-	-	-	++	++

* Grading of reactions was performed using the scale recommended by the International Contact Dermatitis Group (Wilkinson et al 1970); negative reaction, -, doubtful reaction, ?+; weak (nonvesicular) reaction +; strong (edematous or vesicular) reaction, ++; extreme reaction, +++; not tested, NT.

Table 2

Results of Patch Testing Subject 8 with Various Epoxy Acrylates

Compound	Concentration & Vehicle	48 hour patch test reading
Epoxy Acrylate (Shell)	1% petrolatum	++
Epoxy Acrylate (Dow, RS4005)	1% petrolatum	++
Epoxy Acrylate (Dow, RV3570)	1% petrolatum	-
Epoxy Acrylate (Dow, RV3569)	1% petrolatum	-

Table 3

Potential Phototoxicity of Photoinitiators Determined In Vitro
Using Black Light (330-380 nm)

and

An Ehrlich's Ascites Cell Preparation

Test Material	Concentration	Result
Benzophenone	$5 \times 10^{-5} \text{M}$	Negative
Thioxanthone	$5 \times 10^{-5} \text{M}$	Positive (p <0.001)
2,2-diethoxyacetophenone	$5 \times 10^{-5} \text{M}$	Negative
4,4'-bis (dimethylamino) benzophenone (Michler's ketone)	$5 \times 10^{-5} \text{M}$	Positive (p <0.001)
Absorber 0505 (mixed esters of amyl p-dimethylaminobenzoate)	$5 \times 10^{-5} \text{M}$ $5 \times 10^{-6} \text{M}$	Positive (p <0.001) Positive (p <0.02)
Absorber 0802 (mixed esters of amyl p-dimethylaminobenzoate)	$5 \times 10^{-5} \text{M}$ $5 \times 10^{-6} \text{M}$	Positive (p <0.001) Positive (p <0.001)

Table 4

Reactions* Observed at Sunexposed and Sun Protected Sites 48 Hours after Application

Ingredient	Concentration and Vehicle	Sites Exposed to Sunlight							Sites Occluded from Sunlight						
		Subjects with Photosensitivity				Subjects without Photosensitivity			Subjects with Photosensitivity				Subjects without Photosensitivity		
		1	2	3	4	5	6	7	1	2	3	4	5	6	7
Absorber 0505	5% petrolatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Absorber 0802	5% petrolatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Absorber 0505	as is	++	-	+	++	+	+	+	-	-	-	-	-	-	-
Absorber 0802	as is	-	-	+	+	-	-	-	-	-	-	-	-	-	-

*Grading of reactions was performed using the scale: negative reaction, -
doubtful reaction, ?+
weak (nonvesicular) reaction, +
strong (edematous or vesicular) reaction, ++
extreme reaction, +++
D3 refers to the third day after application

RECOMMENDATIONS OF BARRIER CREAMS WHICH COULD BE TRIED

Dr. Lucas would recommend trying the following barrier creams to protect against the effects of stoddard solvent.

- (1) Kerodex No. 51. Ayerst Laboratories, Special Products Department, 685 3rd Avenue, New York, N.Y. 10017
- (2) PLY No. 9. The Milburn Company, 4246 E. Woodbridge Detroit, Michigan 48207
- (3) West Protective Cream No. 411. West Chemical Products, Inc., 42-16 West Street, Long Island City, N.Y. 11101

It is recognized that there may be other equally effective products on the market. Mention of these companies or products names, therefore, is not to be considered an endorsement by NIOSH.