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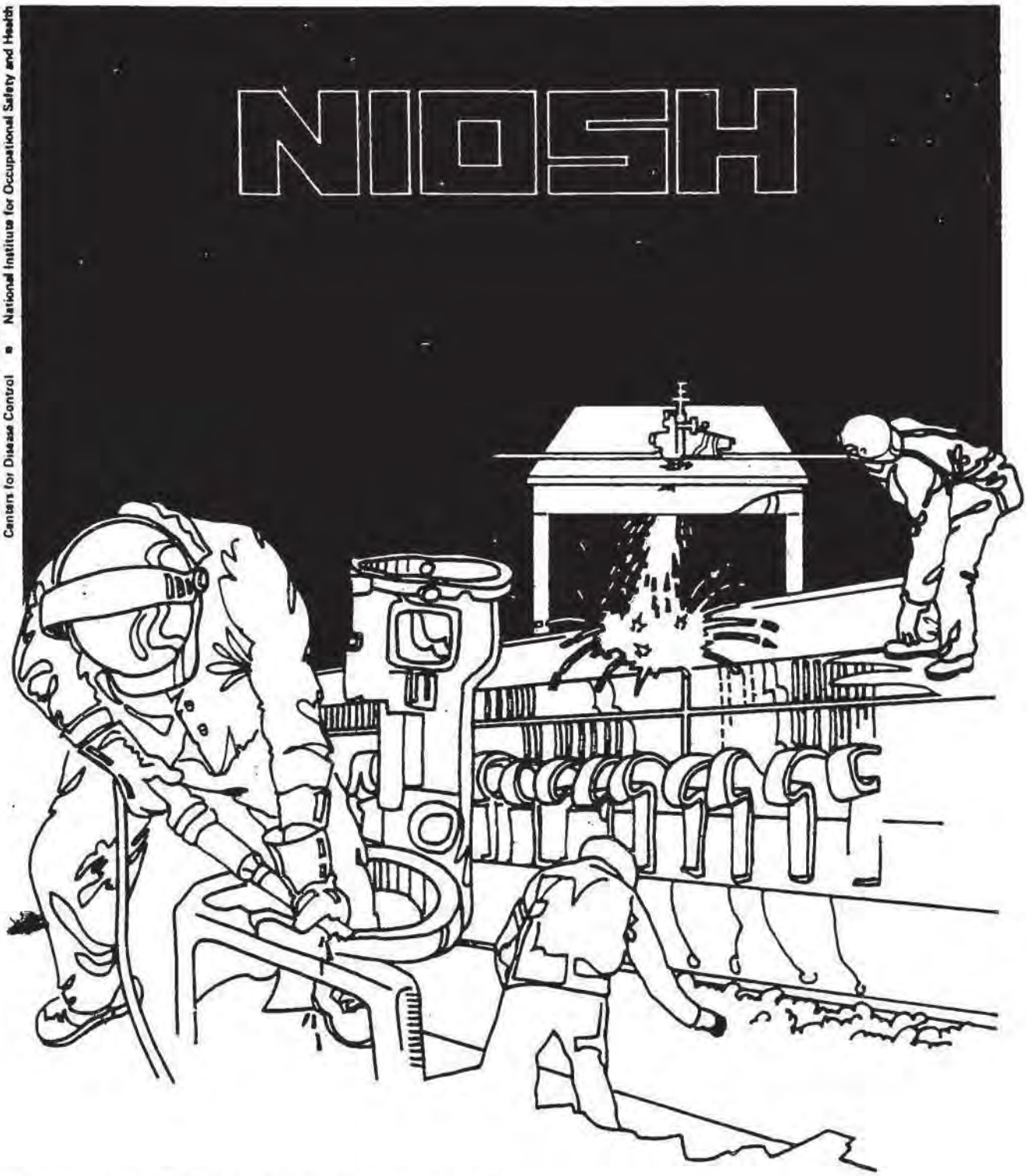
NIOSH



Health Hazard Evaluation Report

HETA 83-107-1574
DANA CORPORATION
FORT WAYNE, INDIANA

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DANA CORPORATION
FORT WAYNE, INDIANA

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I. SUMMARY

In January 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate the extent and cause of dermatitis among machine operators at the Dana Corporation in Fort Wayne, Indiana. It was suggested that a particular cutting fluid (Trim® Sol) in use at the plant since 1981, might be the cause.

On May 9 and 10, 1983, representatives of NIOSH visited the plant. During this visit, 20 bulk samples of various cutting fluids and oils as well as 3 air samples were collected for subsequent analysis. NIOSH medical personnel administered a questionnaire to a stratified random sample of 95 workers, selected from the 1070 hourly workers on shifts one and two. This questionnaire sought information on demographic data, work history, chemical exposures, maintenance schedule of machines, history of skin problems, and use of personal protective equipment. NIOSH medical personnel also examined six workers identified by the company as having dermatitis, and reviewed the dispensary log.

Results of the environmental sampling showed the presence of N-nitrosodimethylamine (NDMA) and triethanolamine in seven samples of new and used cutting fluid. Nickel, chromium, and zinc, all of which are known skin irritants or sensitizers, were present in a sample of used cutting fluid residue. Chloromethyl phenol, an ingredient of the cutting oil germacide and related to a class of skin irritants, was found in two cutting fluid mix samples.

The plant dispensary records showed a large number of visits for new skin problems during 1981 - 1983. Forty-four percent of the sample of plant workers reported skin problems at the time of the survey. The data from the dispensary log suggested that the problems were ongoing and already present in Fall 1981, the first time plant records were compiled for skin problems.

Most of the skin problems described in the dispensary log and in the survey were consistent with irritant or allergic dermatitis, although a few cases of folliculitis were also seen or reported.

The questionnaire results suggests that exposure to cutting fluids or solvents during work and not the practice of washing with solvent was a principal risk factor for dermatitis at Dana. However, the use of one

solvent, chlorothene, did appear to be related to at least some cases of skin problems. No other single chemical could be identified as a major cause of the skin problems.

Thus, both the environmental sampling and medical survey suggest that a number of chemicals are contributing to the skin problems and that general control measures must be undertaken to resolve then.

Based on the environmental and medical findings, NIOSH has determined that a health hazard existed at this work site. Skin problems appear to be related to exposure to cutting fluids and solvents in general, rather than to a specific agent, although exposure to one solvent, chlorothene, was implicated for a few workers. General control measures to reduce exposure are contained in the body of this report and in Section VIII.

KEYWORDS: SIC 3714 (Manufacturing Motor Vehicle Parts); cutting fluids, dermatitis, mineral oil, nitrosamines, Trim® Sol.

II. INTRODUCTION

In January 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Dana Corporation in Fort Wayne, Indiana, to evaluate the extent and cause of dermatitis among machine tool operators at the plant. In initial discussions, the union safety committeeman described a major problem with skin disease and suggested that a particular cutting fluid (Trim® Sol) in use at the plant since 1981, might be the cause. A management representative, however, felt that the extent of dermatitis was much more limited and he was less sure of the etiology. On May 9 and 10, 1983, NIOSH representatives conducted an initial investigation at this plant. Preliminary findings from this investigation were distributed in two interim letters dated August 30 and October 24, 1983, and one interim report dated May 23, 1984.

III. BACKGROUND

An environmental control firm had visited the plant in October 1982, to evaluate potential exposures and had sampled the cutting fluid for analysis. Based on their observations and the results of their sample analyses, they suggested changes in both the manufacturing process and work practices to reduce the potential for exposure to cutting fluids and solvents. Nevertheless, the skin problems persisted and the manufacturing firm asked NIOSH to evaluate the problem.

The Dana Corporation produces axles and gears for light trucks and recreational vehicles. Various machining operations are employed and workers use individual cutting, grinding, lathing, or broaching machines. Each machine tool has its own recirculating cutting fluid system to lubricate and cool the metal parts as they are worked.

The cutting fluid used at Dana Corporation is a mixture of Trim® Sol, Trim® 9106, and deionized water, plus a germicide, Trim® TC-143. Three different dilutions (strengths) of this Trim® Sol mix are used depending on the machining process and lubricating/cooling characteristics desired. A 2.5 percent mix (1.5% Trim® Sol, 1% Trim® 9106, and 97.5% deionized water) is normally used for grinding operations, a 5 percent mix (3% Trim® Sol, 2% Trim® 9106, and 95% deionized water) is normally used for cutting operations, and a 15 percent mix (13% Trim® Sol, 2% Trim® 9106, and 85% deionized water) is normally used for broaching operations. The germicide, Trim® TC-143, is added to these cutting fluid mixes as necessary to keep microbial growth to a minimum.

The cutting fluid is mixed and distributed to most machine tools from the chiphouse through an automatic cutting fluid delivery system. In

areas not served by this system, the cutting fluid is batch-mixed on-site. The cutting fluid is changed periodically according to the specific machine's maintenance schedule and recycled in the chiphouse for future use. Additionally, the cutting fluid is routinely monitored for pH and microbial organisms. The few machine tools not using a Trim® Sol cutting fluid mix use other cutting fluids or oils. Some of these are also recycled.

The Trim® cutting fluids are supplied by Master Chemical Corporation, Perrysburg, Ohio. This cutting fluid was introduced at the Dana Corporation in 1980. According to the manufacturer, these cutting fluids are composed of amine borates, non-ionic surfactants, soluble oils, and water. In addition to cutting fluids, various solvents are used in the plant for cleaning and degreasing metal parts prior to working and assembly.

At the time of the site visit there were a total of 1281 hourly employees working over three shifts (670 on the first shift; 400 on the second shift; 131 on the third shift). The plant has 67 departments which are grouped into eight divisions based on function or type of production. Approximately 350 employees were working in machining operations, 315 in assembly, 230 performing plant and machine maintenance, 200 in plant support, and the remainder in quality control.

IV. MATERIALS AND METHODS

A. Environmental

Bulk and area air samples were collected in the machining area of the plant on May 10, 1983. A total of 20 bulk samples were collected in the machining area of the plant. These samples were obtained from all of the commonly-used cutting fluid mixes, cutting oils, and solvents. These were collected in small glass vials with teflon®-lined caps.

To identify compounds associated with skin problems, selective samples were analyzed for the presence of chlorinated organic species or the metals nickel, chromium, and zinc. Additionally, several of the samples were analyzed for amines and nitrosamines. Both undiluted and diluted, and unused and used fluids were collected to obtain a representative sample.

Eight bulk samples were qualitatively analyzed for chlorinated organic compounds. Aliquots of each sample were added to carbon disulfide and the carbon disulfide extract was then screened by gas chromatography (FID). A 30 meter DB-1 bonded phase fused silica capillary column (splitless mode) was used for analysis. Based on these GC results, representative samples were further analyzed by GC/MS to identify major extracted compounds.

Three bulk samples were quantitatively analyzed for the metals chromium, nickel, and zinc. Aliquots of the samples were weighed, then ashed with nitric and perchloric acids. The residues were redissolved in dilute acid and analyzed by inductively coupled plasma-atomic emmission spectroscopy (ICP-AES).

Seven bulk samples were analyzed for amines and nitrosamines. The samples were liquid-liquid extracted with dichloromethane (DCM). The extracts were combined and dried with anhydrous sodium sulfate, filtered and the sodium sulfate cake extracted twice with DCM. The combined extracts were concentrated on a Kudema-Danish using isooctane as a keeper. Aliquots of the final concentrate were analyzed by gas chromatography with a Thermal Energy Analyzer (TEA) detector. All seven bulk samples were submitted for mass spectrometric confirmation.

General area air samples were collected at sites near three representative machining operations that were judged to have the highest potential for aerosol mist generation. These were collected to estimate the aerosol contribution to skin exposure. Air samples were collected on 37 mm 0.8 um pore size Millipore AA filters in 3-section plastic cassettes (closed face) using duPont Model 2500A personal sampling pumps calibrated at 2.0 liters per minute (lpm). The samples were analyzed by infrared spectrophotometry as described in NIOSH Method 283.(1)

B. Medical

NIOSH medical personnel reviewed the plant's dispensary log and physician reports; interviewed the plant nurse and physician; and interviewed six employees identified by the union and by company records as having the worst cases of dermatitis.

To determine the extent of the skin problems in the plant, their epidemiology, and their associated risk factors, a questionnaire was administered to a stratified random sample of 95 workers selected from the 1070 hourly workers on shifts one and two. This sample was chosen from the 11 non-production and 25 production departments having at least 15 workers. The selected workers represented a ten percent random sample of each of these 36 departments. After presenting an explanation of the study, NIOSH distributed the questionnaire to the selected workers.

In addition to demographic data, the questionnaire sought information on work history; chemical exposures (both inside and outside the plant); maintenance schedule for machines; history of skin problems (both during and prior to employment at the plant); and use of personal protective equipment.

V. EVALUATION CRITERIA

Cutting Fluids

There are three major types of metalworking (or cutting) fluids: neat (insoluble) oils, emulsified (oil-in-water) oils, and synthetic aqueous (water-based) fluids. Each is described below:

Neat oils may be of mineral, animal, or vegetable origin and may contain sulfur, chlorine, phosphorus, or other additives to confer improved performance.(2)

Emulsified oils are complex mixtures of mineral, animal, or vegetable oils, emulsifiers (surfactants), and other additives and are emulsified by the addition of water at the factory. The emulsifiers may include petroleum sulfonates and carboxylic acid soaps. Among the additives are corrosion inhibitors, phase stabilizers, extreme pressure additives, antifoams, dyes, and microbiocides.(2)

Synthetic solutions have no emulsified oil content and are composed of water, surfactants, and other additives.(2)

Types of disease

Skin exposure to neat oils has long been known to cause oil acne or folliculitis and, when prolonged, hyperpigmentation, keratoses, and cancer of the scrotum and other exposed skin.(3) The folliculitis results from plugging of the hair follicles and usually develops in workers soon after initial exposure. Machines with high cutting speeds and heavy oil flow, permitting continuous contact, cause the highest risk.(4) Eczematous dermatitis, rather than folliculitis, occasionally occurs and is usually of irritant cause. Some allergens may be present in neat oil, however, and produce rare cases of allergic contact dermatitis (See etiology below).(3)

There have been several reports of skin cancer in workers exposed to cutting oils. The latent period before development of skin cancer may be as long as 20-25 years. In addition, skin cancers have been produced on the skin of mice following repeated applications of two cutting oils. Polycyclic aromatic hydrocarbons may be the causative agents (See prevention section below).(4)

With emulsified oils, oil acne usually does not occur, and keratoses and skin cancer are much rarer. On the other hand, eczematous dermatitis is common. Aqueous solutions also produce eczematous dermatitis, since many of their constituents are the same as the emulsified oils.(2)

Incidence

In machinists heavily exposed to either emulsified or aqueous metalworking fluids, the prevalance of dermatitis has been reported as high as 30%.(3) Another author states that dermatitis due to petroleum products may account for 15-20% of the reported cases of occupational skin disease.(4)

Etiology

The major contributing factors to cases of oil folliculitis are inadequate or nonfunctioning guards on machines, inadequate supervision of workers, lack of convenient washing facilities, poor factory housekeeping, failure to provide clean clothing daily, and poor personal hygiene.(4)

Soluble cutting oil dermatitis is usually irritant and rarely allergic in nature.(2) The reason for the irritant nature of soluble oils is not entirely known, but may be due to the combination of its wetness, alkalinity and surfactant content.(3) The soluble oils tend to defat the skin, producing a dermatitis in its early stages that is similar to that caused by prolonged contact with soaps and detergents.(4)

Cutting oil sensitization most commonly occurs with mercaptobenzothiazole and hydroxylamine, used as anticorrosives; triethanolamine, used as an emulsifying agent; triazine derivatives, used as antiseptics; diethyleneglycol; and the metals from the used oil.(2) Antibacterial agents that release formaldehyde are especially likely to induce allergic contact dermatitis.(4) Cresols, used as germicides, are skin and eye irritants and may be absorbed through the skin.(8)

Patch testing of patients with soluble oil dermatitis is frequently negative. When sensitization occurs, constituents must be tested separately to determine the causative agent.(3)

Several metals may be present in used cutting oil depending on the type of metal being machined. The two most common metal contaminants, chromium and nickel, have been found in both new and used samples of oil. Both are well known sensitizers and have been associated with allergic dermatitis in machinists.(2) In contrast, another report states that under ordinary working conditions in grinding operations, neither nickel nor chromium could be detected by spot testing in used oil.(4) In addition, both of these compounds are carcinogenic.(5) Chromium has produced an increased incidence of lung cancer among workers in the chromate-producing industry and of local sarcomas at the site of implantation in animals. The nickel refining process is associated with an increased incidence of cancer of the upper

respiratory tract and lung, but specific nickel compounds have not been implicated. In rats, nickel subsulphide is carcinogenic after inhalation exposure, producing lung cancer. Exposure of several animal species, including mice, rats, hamsters, and rabbits, to various nickel compounds has produced tumors in diverse tissues.

Metalworking machines frequently have inadequate shielding, resulting in soaked clothing. Small cuts from slivers of metal in the oil are common and may become infected. Oil- and metal-contaminated shop towels add to the development of dermatitis, as do abrasive hand cleaners and solvents.(4)

Nitrosamines are frequently found as either additives or contaminants (formed most commonly from nitrites and amines in acidic solution) in cutting fluids. Many of these are well known carcinogens, although their potency varies. There has been recent speculation about the possible association between nitrosamine content in fluids and skin cancer, but further studies are needed to settle this question.(3)

Bacteria grow plentifully in soluble oils but do not directly cause disease in man. They may possibly play a role in making the oils more irritating, but this has not been proven.(3,4)

One textbook states that long-used soluble oils are more irritant than fresh soluble oil and attributes this to the formation of condensation products of oil constituents and metabolic products of bacteria.(3)

Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace, exposures, the general environment, or with medications or personal habits of the worker to produce health effects, even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus

potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation crtieria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high-level, short-term exposures.

Currently, OSHA limits occupational oil mist exposure to 5 milligrams per cubic meter (mg/m^3) of air averaged over an 8-hour workday.[6] The ACGIH also recommend an 8-hour limit of 5 mg/m^3 for exposure to oil mist.[7] These standards were developed to prevent the airborne level of oil mist from reaching a nuisance level. They are directly applicable to mineral-type oil mists.

Prevention

Prevention programs should focus on the machine, the oil, and the worker. Machines should be designed to reduce exposures to oil. They should be easy to take apart and clean; and cleaning should be done on a regular basis, preferably by someone assigned to this task who can ensure regular and thorough cleaning.

The metalworking fluids should not contain known irritants and allergens. Oil should be kept free of fine particulates and regularly changed. Workers should be encouraged to report rashes early so that preventive action can be taken, and no economic penalty should occur when workers with persistent skin problems must transfer to jobs with no oil exposure.

Due to the incidence of skin tumors from mineral oil exposure, probably from contamination with polycyclic aromatic hydrocarbons (PAH), all mineral oils used in metalworking fluids should be solvent refined.[3] Even so, there are still reports of some carcinogenic contaminants in refined oils.[4,5]

Cases of dermatitis should be evaluated by a dermatologist who is familiar with the problems of metalworking fluids and able both to perform the appropriate diagnostic tests and treat the different types of dermatitis.

VI. RESULTS

A. Environmental

The qualitative analysis of eight bulk samples for chlorinated organic compounds showed the presence of chloromethyl phenol (chlorocresol) in four of the samples (Table 1).

The analysis of three bulk samples for metals resulted in an apparent increase in metal content with age (Table 1). The unused 2.5% Trim® Sol mix contained <1.5 ppm chromium and nickel, and 4.3 ppm zinc. In the 2.5% Trim® Sol mix used 3 days, chromium and nickel were still <1.5 ppm, but the zinc concentration increased to 26.5 ppm. A sample of 2.5% Trim® Sol mix aerosol residue that had collected on a Dept. 373 grinder and concentrated (as the water evaporated) over an undetermined period of time, showed 13.3 ppm chromium, 41.3 ppm nickel, and 185.4 ppm zinc. The seven bulk samples analyzed for amines and nitrosamines all contained n-nitrosodimethylamine (NDMA) and triethanolamine (Table 1). The presence of triethanolamine, however, could not be confirmed by mass spectroscopy. There were no apparent differences between new and used materials.

The air sample results indicated airborne Trim® Sol mist concentrations of 0.24 to 0.61 mg/m^3 and an airborne oil mist concentration of 0.73 mg/m^3 (Table 2). All of these results are well below the current OSHA PEL of 5 mg/m^3 for oil mist.[6] Even though Trim® Sol is not a "true" oil, the standard is appropriate to prevent the airborne concentration from reaching nuisance levels.

B. Medical

During the site visit six workers, identified previously as having severe dermatitis, were individually interviewed and examined by NIOSH medical personnel. All six had a history of moderate to severe dermatitis involving their forearms and hands. In these six

men the onset of dermatitis had occurred over the course of several years. Most of these men had identified contact with the cutting and lubricating fluids as the most likely cause of their dermatitis. Five of the six had been seen by a dermatologist. Three had been diagnosed as having irritant dermatitis based on history, physical exam, and patch testing. One man had allergic dermatitis, and the last had irritant dermatitis with a questionable allergic component.

In addition to these interviews, NIOSH reviewed all available lists of plant dispensary visits for a complaint of "skin problem". These had been compiled by the plant nurse for the period September 1981, through April 1983. During this 20 month period, 139 workers were seen for the first time with a complaint of dermatitis or other skin condition. This represents an average of seven new workers per month.

The exact month of the visits was only available for the ten month period July 1982, through April 1983 (Figure 1). During this period there was an average of 5 new workers seen per month, although there is great variability month to month.

Eighty-six (91%) of the 95 selected workers completed the self-administered questionnaire. (See note at end of results section). The median age was 46 years (range 31-67 years); the median duration of employment at the plant was 20 years (range 11-37 years); and the median time spent in the worker's current department was 5 years.

The most common responses to the question "Have you had any of the following problems while working on your present job?" were "dry, cracked skin" on hands (24) and "red, itchy skin" on hands (17) or arms (12) (Figure 2). This is consistent with the widespread occurrence of irritant or allergic dermatitis that is usually associated with soluble cutting oils rather than the folliculitis, most commonly associated with insoluble oils.

For the subsequent analysis a "skin problem" case is defined as a Dana worker checking a box under either "Face and Head," "Arms," or "Hands" for a condition of either "red itchy skin with or without scaling," "dry cracked skin," "red skin with blisters or pus pimples," or "blackheads or pimples." These boxes are shown in Figure 2.

Thirty-eight (44%) of the 86 workers responded that they had skin problems in their current job. Of the 86, eleven (13%) reported a history of skin problems predating employment at the plant, and they were removed from the analysis. There remained 32 (43%) of 75

randomly selected workers who had skin problems which had developed since the start of employment at Dana. Of these 32, 29 (91%) reported work exposure to cutting fluid or solvents. This exposure was significantly associated with self reported skin problems ($p = 0.002$) (Figure 3).

In an attempt to identify a specific cause of the skin problems, we looked at their association with eight distinct chemicals or classes of chemicals. Only one chemical exposure out of seven (the seven included barthow, chlorothene, any type of cutting fluid, oils, solvent, stoddard solvent, and Trim® Sol) was associated with skin problems, although the number of workers using several of the chemicals was insufficient to allow adequate analysis. This chemical was chlorothene (Figure 4). However, only 8 of the 32 workers with skin problems were exposed to chlorothene and, therefore, chlorothene exposure can account for only a small portion (25%) of the problems.

We next looked at the duration of skin problems that developed while at Dana. Fifty-five percent reported that they had had their problem for 5 years or more whereas only 9% reported having the problem less than one year. Sixty-one percent reported that the problem began within 1 year after starting their present job. Seventy-two percent indicated improvement and 13% reported complete clearing of their skin problem during or after weekends or days off. When asked if the skin problem improved or cleared completely during or after vacations, 41% reported improvement and 56% indicated that the problem completely cleared.

There was a suggestion of an association between increasing number of years at Dana and the occurrence of skin problems (Figure 5).

As expected, the presence of skin problems was also associated with the use of a barrier or protective cream. Those with skin problems are the ones who use the barrier cream.

Further analysis of the questionnaire responses showed no significant association (at $p = 0.05$) between self-reported skin problems and the following:

1. Regular cleaning of machines;
2. Dipping or placing hands in cutting oil during work;
3. The practice of washing hands with solvent;
4. Exposure to specific cutting fluids or solvents (see Figure 6 for Trim® Sol);
5. Wearing gloves during work;
6. Frequency of oil change in machines.

In attempting to evaluate possible associations between self-reported skin problems and several exposure-related factors, there were too few responses on the questionnaires to allow proper statistical analysis. These included the following:

1. Individual departments (there were too few respondents per department for analysis);

2. Job title (there were too few respondents per job title for analysis); one title, "grinder", was suggestive of a positive association; three titles, "machine operator (mill wright)", "quality controllers", and "truckers" were suggestive of a negative association (less chance of skin problems than other job titles);

3. More time during the workday with hands in cutting fluid;

4. Frequency of handwashing at work;

5. Type of metal machined (steel vs. cast steel alloy).

Note: Some slight discrepancies appear in the number of responses to different questions, since not all workers answered all questions.

VII. DISCUSSION

The finding in the plant dispensary records of a large number of new skin problem complaints over the last 2 years and the finding of the self-reported skin problems in 44% of a random sample of plant workers suggests that there is a greater problem with skin disease at Dana than was previously thought. The data from the dispensary log suggest that the problem is ongoing and that it was already present in the fall of 1981, the first time plant records were compiled for skin problems. No clear seasonal pattern emerges from this data. However, without data from several years, an adequate assessment of seasonal trends is not possible.

The types of problems described are consistent with the widespread occurrence of irritant or allergic dermatitis that is usually associated with soluble cutting oils rather than insoluble oils. However, a few cases of folliculitis were reported and suggest a need for attention to the use of insoluble oils, as well.

Our analysis of questionnaire results suggests that occupational exposure to cutting fluids or solvents during work and not the practice of washing with solvent was the principal risk factor for dermatitis at Dana. However, we did find that exposures to one solvent, chlorothene,

does appear to be related to at least some cases of skin problems. No other single chemical could be identified as a major cause of the skin problems. None of the other factors that we assessed in the survey appears to be associated with skin problems. In fact, there probably are multiple causes of the skin problems. This is similar to what has frequently been found in other machine shop settings where there have been exposures to several cutting fluids, oils, and solvents. Since it is unlikely that further epidemiologic and environmental analysis will determine a single cause of the skin problems, general control measures must be undertaken to resolve them.

Initially it was suggested that Trim® Sol might be a cause of the skin problems. However, since the onset of skin problems in most workers predated the introduction of Trim® Sol, we are not able to implicate the change to Trim® Sol as a cause of the skin problems. This conclusion is also supported by the lack of an association of skin problems with Trim® Sol use.

In spite of the lack of association of specific chemical or work practices with skin problems, environmental sampling pinpointed some potential problem areas. The germicide mixed with Trim® Sol, chlorocresol, comes from a class of chemicals known to cause skin irritation. In addition, the contents of metals in the Trim® Sol appears to increase with age, and the aerosol residues on one of the machine tools contained chromium, nickel, and zinc which have been known to produce dermatitis. These results indicate that the residue from the evaporated cutting fluid found on most of the machines in use, may have a greater potential for the production of dermatitis than the cutting fluid solution as used. This shows the need for routine cleaning of the machines.

Nitrosamines were found in both unused and used Trim® Sol mixes as well as several different oils. This was unexpected as the manufacturer does not mention that Trim® Sol contains nitrosamines.

General air sampling showed that airborne mist does not contribute significantly to the total exposure; direct skin contact is the primary route of exposure.

Finally, NIOSH did not determine cutting fluid pH. If too alkaline, the fluid could produce skin irritation. Fluid pH should be maintained to the manufacturer's specifications.

VIII. RECOMMENDATIONS

Since no specific cause of the skin problems was identified, we recommend the following general, preventive measures, in addition to those already described in the prevention section of the Evaluation Criteria:

1. Gloves, gauntlets, and aprons may be used in settings where neither substitution of a less irritating oil nor engineering controls can be utilized to reduce exposure. Such clothing should be kept clean. Often protective clothing is not worn because of the danger that it might be caught in machinery or because it slows the worker down in his task. If the job may move somewhat slower and at no health risk or financial disadvantage to the worker, protective clothing may reduce the chance of developing dermatitis.

2. Continue use of waterless hand cleaner instead of solvent. If solvent-use is continued, you may consider switching to a water-based (detergent) degreaser instead. This is not practicable for all types of machining operations and, therefore, would have to be used on a pilot basis until proven.

3. Routinely clean the cutting fluid mist residue off all machine tools to prevent the increased concentration of metals on the surface.

4. Continue to check the cutting fluid for pH and microbes and maintain at manufacturer's recommendations.

5. Avoid, where practicable, skin contact with chlorothene.

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS

can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Dana Corporation
2. Allied Industrial Workers of America
3. NIOSH, Region V
4. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1

Environmental Results: Bulk Samples

Dana Corporation
Fort Wayne, Indiana
HETA 82-107

May 10, 1983

Sample Description				Analysis Requested	Compounds Identified
Name	Strength	Age in Use	Location		
Trim® Sol Cutting Fluid	Undiluted	Unused	Chiphouse	O, N	Chloromethyl Phenol, NDMA, Triethanolamine
Trim® 9106 Cutting Fluid	Undiluted	Unused	Chiphouse	N	NDMA, Triethanolamine
TC-143 Germacide	Undiluted	Unused	Chiphouse	O	Chloromethyl Phenol
Trim® Sol Mix Cutting Fluid	2.5% Solution	Unused	Chiphouse	M	<1.5 ppm Chromium, <1.5 ppm Nickel, 4.3 ppm Zinc
Trim® Sol Mix Cutting Fluid	2.5% Solution	3 days	Dept. 604 Grinder	M	<1.5 ppm Chromium, <1.5 ppm Nickel, 26.5 ppm Zinc
Trim® Sol Mix Aerosol Residue	From a 2.5% Solution	Used	Dept. 373 Grinder	M	13.3 ppm Chromium, 41.3 ppm Nickel, 185.4 ppm Zinc
Trim® Sol Mix Cutting Fluid	5% Solution	Unused	Chiphouse	O	Chloromethyl Phenol
Trim® Sol Mix Cutting Fluid	5% Solution	4 weeks	Dept. 151 Drill	O	Chloromethyl Phenol
Trim® Sol Mix Cutting Fluid	15% Solution	Unused	Chiphouse	N	NDMA, Triethanolamine
Trim® Sol Mix Cutting Fluid	15% Solution	3 to 4 weeks	Dept. 355 Broach	N	NDMA, Triethanolamine
Armix 308 B-3 Cutting Oil	Undiluted	Unused	Chiphouse	O	No chlorinated compounds identified
Armix 308 B-3 Cutting Oil	Undiluted	Used	Dept. 132 Gear Cutter	N	NDMA, Triethanolamine
Mineral Lard Oil	Undiluted	Unused	Chiphouse	O	No chlorinated compounds identifed

Cont

Table 1
(Continued)

Sample Description				Analysis	
Name	Strength	Age in Use	Location	Requested	Compounds Indentified
Mineral Lard Oil	Undiluted	Used	Dept. 171 Gear Cutter		No analysis performed
Dana Mix Cutting Oil	Undiluted	Unused	Chiphouse	O	No chlorinated compounds identified
Dana Mix Cutting Oil	Undiluted	Used	Dept. 171 Lathe	N	NDMA, Triethanolamine
Polar Kool Cutting Fluid	Undetermined	2 to 3 days	Dept. 45 Cutter Grinder	O	No chlorinated compounds identified
Buckeye Lubricant	Undiluted	Used	Dept. 111 Spline Roller	N	NDMA, Triethanolamine
Chlorothene	Undiluted	Unused	Chiphouse		No analysis performed
Stoddard Solvent	Undiluted	Unused	Chiphouse		No analysis performed

(O) Samples submitted for qualitative chlorinated organic compound analysis.
(N) Samples submitted for qualitative amine/nitrosamine analysis; triethanolamine could not be confirmed by mass spectrometry
(M) Samples submitted for quantitative Chromium, Nickel, and Zinc analysis.
(NDMA) N-nitrosodimethylamine

Table 2

Environmental Results: Air Samples

Dana Corporation
Fort Wayne, Indiana
HETA 82-107

May 10, 1983

Sample Description						Airborne Concentration (mg/m^3)	
Location	Machine	Cutting Fluid	Flow Rate (lpm)	Time	Volume (Liters)	Trim® Sol Mist	Oil Mist
Div. 87/Dept. 373/Post N18	Bickford Drill	5% Trim® Sol Mix	2.0	0905-1419	628	0.61	
Div. 83/Dept. 356/Post 528	Detroit Vertical Broach	15% Trim® Sol Mix	2.0	0853-1415	644	0.24	
Div. 82/Dept. 171/Post K7	Gleason Revacycle Gear Cutter	Dana Mix	2.0	0840-1422	684		0.73
Environmental Criteria:				OSHA ACGIH			5 mg/m^3 5 mg/m^3

FIGURE 1.

NUMBER OF NEW CASES OF SKIN PROBLEMS
BY MONTH OF FIRST VISIT TO PLANT DISPENSARY.
FORT WAYNE, INDIANA, JULY 1982 - APRIL 1983

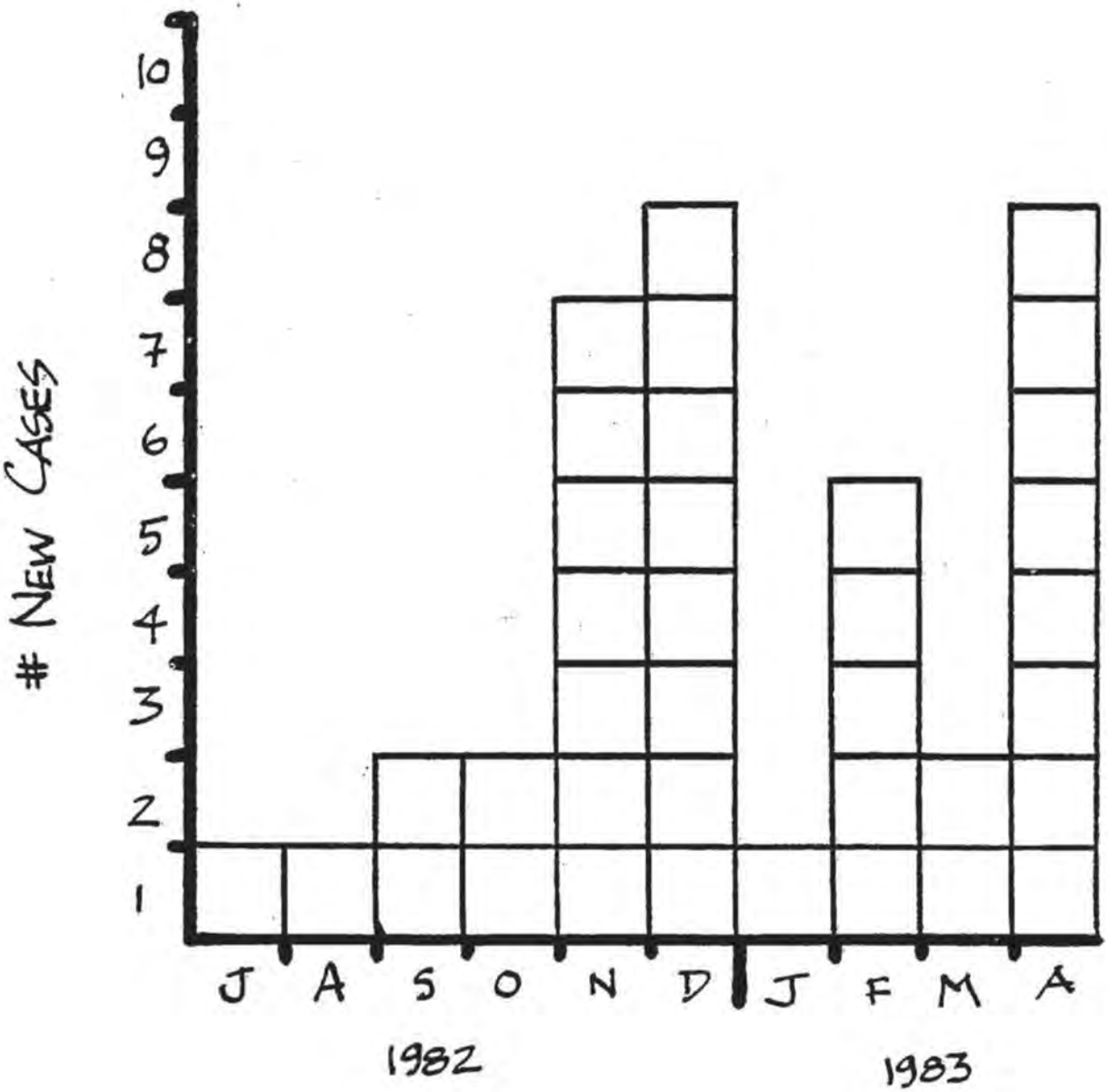

FIGURE 2.

NUMBER OF WORKERS REPORTING SPECIFIC SKIN PROBLEMS (N=86). FORT WAYNE, INDIANA, 1983.

Please check (X) if you have had any of the following problems while working on your present job. Also check (X) where on your body you have noticed each problem.

	Face & Head	Neck & Underarms	Arms	Hands	Chest, Back, Abdomen	Groin	Legs	Feet
red itchy skin with or without scaling	3	1	12	17	2		3	1
dry cracked skin	2		7	24	1			
red skin with blisters or pus pimples	1		1	3			1	1
patches of thickened heavy skin			7				1	3
unusual patches of skin with color change	1		3	5	1			
frequent skin sores	1		1	2			2	
blackheads or pimples	9		3	1	3		4	
cracked, deformed or flaking fingernails				10				

Figure 3. Cases of skin problems and their association with work exposure to solvents and/or cutting fluids. Dana Corporation, Fort Wayne, Indiana, 1983.

		Skin Problems		
		Yes	No	Total
Work Exposure to Solvents and/or cutting fluid	Yes	29	24	53
	No	3	17	20
	Total	32	41	73

Fisher's exact p = 0.002

Figure 4. Cases of skin problems and their association with exposure to chlorothene. Dana Corporation, Fort Wayne, Indiana, 1983.

		Skin Problems		
		Yes	No	Total
Exposure to Chlorothene	Yes	8	1	9
	No	24	42	66
	Total	32	43	75

Fisher's exact p = 0.003

Figure 5. Cases of skin problems and their association with duration of employment. Dana Corporation, Fort Wayne, Indiana, 1983.

		Skin Problems			
		Yes	(%)	No	Total
at Dana # of years	0 - 5	13	(31)	29	42
	5 - 10	12	(57)	9	21
	10 - 15	7	(58)	5	12
	Total	32		43	75

chi-square = 5.4 (2 degrees of freedom) p = 0.07

Figure 6. Cases of skin problems and their association with exposure to Trimsol. Dana Corporation, Fort Wayne, Indiana, 1983.

		Skin Problems		
		Yes	No	Total
Exposure to Trim® Sol	Yes	7	7	14
	No	25	36	61
	Total	32	43	75

chi-square = 0.1 p = 0.75