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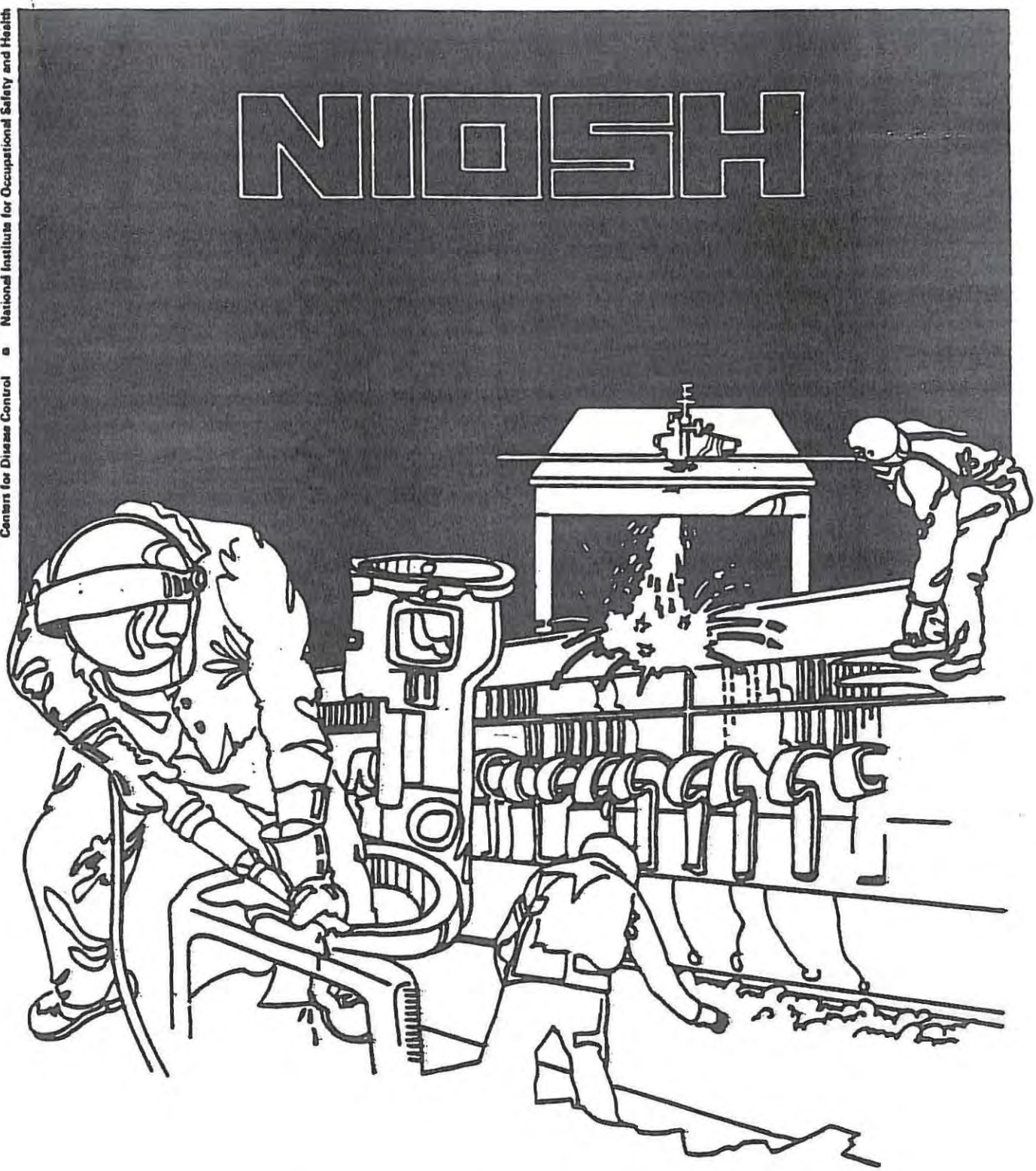

Health Hazard Evaluation Report

HETA 85-039-1723
E.L. SMITHE MACHINE COMPANY
DUNCANSVILLE, PENNSYLVANIA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 85-039-1723
August 1986
E.L. SMITHE MACHINE COMPANY
DUNCANSVILLE, PENNSYLVANIA

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I. SUMMARY

In November 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Association of Machinists Local 2348 for medical and technical assistance at the E.L. Smithe Machine Company of Duncansville, Pennsylvania. The request stated that employees were experiencing skin rashes and headaches, associated with the use of cutting and cooling oils, and solvents in the machine shop areas of the plant. NIOSH conducted medical and environmental investigations in January and February 1985.

Psychometric measurements were taken with a portable psychometer, and the ventilation system was examined by the industrial hygienist. A review of the material safety data sheets concerning the cutting oils and solvents used in the machining area revealed that there were several cutting oils and solvents all of which have the potential to cause dermatologic problems through frequent or prolonged contact with the skin. The cutting oils at E.L. Smithe are not changed on a regular basis which can further contribute to skin problems through changes in concentration, and through contamination of the cutting oils by leaking machine oil, products of bacterial metabolism, and metals from machining. SuperSolve S, a solvent sprayed onto finished machines by workers in the Final Assembly area, was felt by the machinists to cause headaches, dizziness, and respiratory complaints.

Psychrometric measurements showed a dry bulb temperature of 76.5°F at 30% relative humidity throughout the machinery areas. Studies of other indoor areas with low humidity (less than 40%) and high temperatures (greater than 72°F) in the presence of low-level air contaminants have found these conditions to enhance eye and upper respiratory problems and skin complaints including dermatitis. The ventilation system at E.L. Smithe consists of several overhead, indoor heating/cooling units which recirculate air completely; no fresh air is brought in.

Observations of the work methods and reports of skin irritations and hydrogen sulfide (H_2S) and ammonia (NH_3) odors, although circumstantial, support the promise that chemicals in the coolant/cutting fluid systems and/or substances produced by micro-organisms growing in the coolant solutions are the likely sources of irritation to the machinists.

The random nature of potential solvent exposures to machinists (adjacent to the solvent spraying area0 does not allow for any meaningful air sampling to be conducted. The only practical and effective means to control solvent overspray and/or vapor transport is to provide the appropriate ventilation controls. This will prevent any potential overexposures to the aliphatic chlorinated hydrocarbons (1,1,1, trichloroethane).

Of the 62 employees interviewed, 42 (68%) reported having had skin problems since coming to work at E.L. Smithe. One of these had psoriasis and was removed from the analysis. All of the remaining 41 noted that in the past year they had experienced at least two of the following conditions: red skin, dry skin, cracked skin, or itchy skin. Everyone reporting these problems reported them as being on the hands or the arms; a few people also reported having skin problems in other areas. These responses are consistent with the widespread occurrence of irritant or allergic dermatitis that is usually associated with soluble cutting oils. The fact that all of these employees noted that their skin problems occurred primarily on their hands or their arms, or both, makes an association with cutting oils likely.

Skin examinations revealed that 17 (63%) from the Lathe and 18 (60%) from the Milling Department showed xerosis, lichenification, or eczema of the hands and arms on examination. Ten workers from each of the two departments had xerosis; seven workers from Lathe as opposed to eight from Milling had actual eczema. Many workers in both departments had a variety of respiratory and neurological complaints which are detailed in section IX.

Based on the results presented in this report, NIOSH concludes that employees in the machining area at E.L. Smithe have high rates of xerosis and hand and arm eczema in a distribution that implies an association with cutting oil exposure. Inadequate ventilation and humidification was found; these conditions may be responsible for widespread symptoms/complaints. Recommendations for procedures to minimize skin exposure and provide adequate ventilation and humidification are also presented in Section X.

Keywords: SIC 3549 (Metalworking Machinery), 3555 (Printing Trade Machinery and Equipment), dermatitis, cutting oils, solvents.

II. INTRODUCTION

In November 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Association of Machinists Local 2348 for medical and technical assistance at the E.L. Smithe Machine Company of Duncansville, Pennsylvania. The request stated that employees were experiencing skin rashes and headaches, associated with the use of cutting and cooling oils, and solvents in the machine shop areas of the plant.

On January 30 and 31, 1985, two NIOSH physicians visited E.L. Smithe. An introductory meeting was held with representatives of the employees, and management, to explain the reason for our visit and to ascertain what the perceived health problems were. Following this meeting, a tour of the areas included in the request was made. A visit was made to the medical department and medical records were reviewed of all employees from the areas of concern who had reported skin problems in the past year. Finally, all employees on the first and second shifts who worked in the Milling and Lathe departments of the machine shop area were interviewed. Skin examinations were conducted on all these employees

On February 13, 1985, a NIOSH industrial hygienist visited the facility and conducted a survey which consisted of:

1. a review of the ventilation system and work operations.
2. a review of the various cutting and cooling oils used in the areas of concern.
3. % relative humidity (%RH) and temperature (T) measurements.
4. unstructured interviews with the machinists.

Most of the complaints found in both the medical officer's interviews and the industrial hygienist's interviews concerned skin rashes on the hands and arms, dry, irritated hands and arms, and upper respiratory irritation experienced by the machinists using cutting fluids. Dizziness and headaches were also associated with work in the machining area at certain times.

III. BACKGROUND

The E.L. Smithe Machine Company, Inc. manufactures envelope machinery and allied equipment. Their major products include high speed envelope folding machines, printing presses for both aniline and oil base inks, automatic die cutting equipment, and high speed web machinery. Some of these machines extend to up to 38 feet in length. The company operates in a facility containing over 150,000 square feet of production and

warehouse space and is located on a 15 acre site. Over 450 people are employed at the company. In the machining area, employees produce parts and assemblies from all types of materials from plastic to steel on milling machines, lathes, drill presses, boring machines, and grinders. In other parts of the plant, assemblers assemble these parts into sub-assemblies and then into finished machines.

A. Major Departments of Concern in the Machine Shop Area

1. Milling (53 employees in all)

   a. Milling operators (37 employees) use cutting oils, including the coolant Northern Cutting Oil, also called H-109, and Trim-tap heavy oil.
   b. DeVlieg set up operators (3 employees) use H-109, Trim-tap heavy oil and a blue-green spraymist Detrex Crown Cool 4700, a synthetic oil
   c. Gear cutting operators (2 employees) use 31A cutting oil and a heavy sulfur-based oil
   d. Tool and Cutter Grinder operators (3 employees) use the blue-green spraymist, Detrex Crown-Cool 4700

2. Lathe (41 employees on first and second shifts), where cutting oils, "Trim-tap", and the coolant Northern Cutting Oil, also called H-109, is used.

3. Drilling (27 employees), where spray coolants, cooling oils, and "Trim-tap" heavy oil are used

4. Grinding (15 employees), where cutting oils, Trim-tap heavy oil, and coolants are used.

Dermatitis has occurred in employees in all these departments. Employees are also concerned about long-term effects of the use of cutting oils; a specific concern is cancer. Another concern of employees in all these departments is that workers in Final Assembly, which is next to their area, spray a solvent, SuperSolve S, onto assembled machines. Breathing this solvent is thought to cause headaches, nausea, and dizziness in employees in the machining departments listed above. The workers who spray the solvent are issued respirators, but those around them are not.

In the metal-cutting tools section, a hardened tool edge removes chips by different mechanical means, such as turning, planing, shaping, drilling, milling, boring, and broaching. Most of this work generates heat, which if not dissipated, can cause welding of metal to tool point, loss of the hardness of the tool point and distortion of the workpiece. Grinding is a kind of cutting in which metal is removed by a grinding wheel containing abrasive grains that act as miniature

cutters. Cutting and grinding fluids, also known as lubricoolants, have two primary functions: (a) to cool the workpiece and tool, thus preventing heat damage, and (b) to lubricate, thus reducing frictional heat at the chip-tool interface and between the tool and the freshly cut surface. Secondary functions are to flush away chips and swarg, reduce strain hardening of the machined metal, and protect the workpiece against rusting. Considerable quantities of these coolants may be needed on high-speed machines.

Cooling and Cutting Fluids and Other Chemicals Used in the Machining Area at E.L. Smithe

Gult-Cut 31A and 11D (lubricant mixtures)
Detrex Crown Cool, 4710, a synthetic cutting oil
Northern Cutting Oil, also called "H-109" (containing butyl cellusolve less than 1%, Mineral seal oil less than 13%, bioban P-1487 (a germicide) less than one-half %)
Trim-tap Heavy metalworking fluid, a mixture of fats, chlorinated paraffin wax and odorants
SanaCool (hexhydro-1,3,5-tris [2-hydroxyethyl-s-triazine])
PNT88 Lacquer thinner (containing toluene 20%, isobutyl acetate 20%, isopropanol 20%, naphtha 20%, propylene glucol methyl ether acetate 10%, acetone 5%, xylene less than 5%)
Super S Cleaning solvent (aliphatic chlorinated compounds) (1,1,1--trichloroethane)

A new coolant, Magnacool 200, containing chlorinated petroleum oils and alknolamines, has begun to be used in the Lathe Department since the NIOSH visits.

All of the cooling and cutting fluids have the potential to cause skin or respiratory irritation from contact with the liquid, vapor, fume or mist.

One maintenance worker is responsible for filling the drums of Northern Cutting Oil (H-109) diluted with water. The drums are then taken to the area and put into the machine reservoirs either by the employees on the machines, or, if the coolant in the reservoirs is being changed, by the one maintenance worker who also fills the drums. The manufacturer states that Northern Cutting Oil should be diluted to a 25:1 ratio. One and one-half gallons of H-109 are added to a fifty-five gallon drum by the maintenance worker if the drums are nearly empty, and then they are nearly, but not completely, filled with water (approximately a 36:1 ratio). The drums are cleaned once yearly during the shut-down in July; otherwise they are never completely empty -- "There are always a couple of gallons in the bottom." Often when the drums are half full, one-half gallon of coolant will be added to them and then enough water added to fill them almost to the top. They are never completely filled because they must be taken back to the machining area and full drums are too heavy to move.

There is no set schedule on which the coolants in the machine reservoirs are changed. In the Grinding area, one grinder stated that he added water daily; then when the coolant became "obviously weak" he added more from the drum. The coolant in his machine was changed approximately every three months, when it looked dirty. Another grinder stated that he changed his own coolant whenever it gets too sticky to work properly; this was about every two weeks because the machine was in use for all three shifts. Still another stated that his machine was changed "about" every three months. Still another worker said that his was changed every two months, but that he added "new stuff" daily -- two gallons of the already diluted coolant mixture and enough water to make what he considered a fifty to one concentration.

In the area of the Milling Department where milling machine operators work, the maintenance person adds H-109 coolant and "coolant deodorant" to the reservoirs when needed, or operators get their own from the uncovered drums. The coolant in the machines is reportedly only changed "after the stuff smells so bad that we complain." Employees in this department also complain that the Trim-tap heavy oil, put on metal parts when threading, drips down and mixes with the coolant, contaminating it. On some machines, there is a reservoir for "blue-green spray mist" (Detrex Crown Cool 4700). The employees state that these reservoirs are never changed; when the spray mist runs low, more is added.

In the Lathe department, the operators state that they take about three gallon buckets per shift of diluted H-109 from the drums, and add them to the reservoirs of their machines. The coolant in their machines is changed irregularly, "whenever the foreman puts a note in." Employees in this department also use Trim-tap Heavy oil, which is put onto metal parts when threading; they complain that this drips down and contaminates the coolant constantly.

In the Drilling Department Gulf-Cut 31A is used in two machines. This is taken straight from the 55 gallon barrel. Trim-tap Heavy is also used. The employees in this department complain of an oil mist in the air.

Respirators are occasionally used by some of these employees although they are not required. They are dispensed by the foreman.

The medical department is staffed on the day shift by an occupational nurse who takes a yearly American Academy of Occupational Nurses occupational nursing course. The record keeping is of the "problem-list" variety; each chart has a chronological list of problems which is up-to-date and easy to read. Dermatitis problems are frequently noted. Patch testing to some of the coolants was reportedly done by the company's insurance company physician but no positive results were found in any of the charts.

Barrier cream is available in the medical department but not on the shop floor or the washrooms. It is Jergens SBS-40 (allantoin 0.2%; chloroxylenol 0.2%) and is dispensed by the nurse on the day shift. Employees from other shifts can come in to get the cream in the nurse's absence. A liquid soap, SBS-71, and a powdered soap, Boraxo, are available in the washrooms.

Rags which were cleaned commercially are provided by the company for use by the employees at their work-stations. Paper towels are sometimes available in the washroom.

IV. ENVIRONMENTAL EVALUATION METHODS

A. Cutting and Cooling Oils

Material safety data sheets were reviewed for all cutting and cooling oils used in the machining area.

Six bulk samples of cutting fluids were collected and submitted for analysis of nitrosamines. Two mL of each bulk sample liquid were placed in a vial. Then, a liquid extraction was performed in a separatory funnel three times with 10 mL of dichloromethane (DCM) each time. The extracts were combined and dried over anhydrous sodium sulfate, filtered, and the sodium sulfate washed 2 times with 5 mL of fresh DCM. The combined extracts plus washings were concentrated on a Kuderna-Danish using isoctane as a keeper to a volume of 1 mL. Aliquots of the final concentrate were analyzed by gas chromatograph with a Thermal Energy Analyzer (TEA) detector for volatile nitrosamines. Aliquots were also analyzed by high pressure liquid chromatography for non-volatile nitrosamines.

B. Temperature and Relative Humidity

Psychometric measurements were taken on February 13, 1985 with a portable psychometer.

C. Ventilation

The ventilation system was examined. Due to the extremely low concentrations of microbiological degradation gases (H_2S, NH_3) and the intermittent nature of the potential exposure, air sampling was not used as a method of evaluation. Health hazard evaluations in similar settings have proved air sampling to be a fruitless approach.

V. MEDICAL EVALUATION METHODS

Prevalence of various specific skin complaints and skin examination results were tallied from questionnaires administered by the medical

officer, and skin exam records, and compared to the latest National Health Survey data[1] detailing the prevalence of such symptoms among the U.S. male population, in order to give a rough idea of whether these complaints were higher in employees than in the U.S. population as a whole. Exposures during hobbies, gloving, the number of times hands were washed at work each day, and materials used to wash the hands were also analyzed to see if they had any bearing on skin problems. Respiratory complaints were noted, as well as the associations perceived by the workers who made them. Smoking history was analyzed to see if it might be associated with respiratory complaints.

VI. EVALUATION CRITERIA

Occupational Dermatitis

There are two classifications of dermatitis: irritant dermatitis and allergic dermatitis. Most (80%) occupational dermatitis is caused by primary irritant chemicals.[2] Almost any normal skin will react to a primary irritant if the intensity or quantity of the agent and length of contact time is sufficient. Strong irritants such as sulfuric acid and sodium hydroxide produce immediate effects. Weak, or marginal irritants such as acetone, soap, and mineral oil may require several days before recognizable change occurs. The mechanism of how primary irritants insult the skin are not fully understood. Strong acids form acid albuminates on the skin, which resemble a thermal burn. Strong alkaline irritants, which include some cutting oils, produce a subtle dehydration of keratin by loss of cell cohesion, cracking, and loss of continuity.

Exposure to sensitizers can result in an allergic reaction to a given substance. It is estimated that 20% of occupational contact dermatitis is caused by allergenic materials.[2] Most sensitizers do not produce recognizable cutaneous changes on first contact. The sensitizer induces specific cellular changes in the skin, so that after one or many exposures, and after a further incubation period of five to seven days or more, the skin becomes "sensitive" to the chemical. Further contact with the chemical may result in an allergic dermatitis which may not look any different from an irritant dermatitis.

The essential differences between a primary irritant and allergic sensitizer is the time and mechanism of action. Another difference is that an irritant usually affects many or most of the exposed employees, whereas a sensitizer may affect only a few. In spite of these differences, it may be difficult to distinguish between a marginal irritant and a cutaneous sensitizer, because the marginal irritant also requires prolonged or repeated contact before a dermatitis appears. Some chemicals such as organic solvents (i.e., petroleum solvents, perchloroethylene, and methylene chloride) are known to result in both primary irritant and allergic dermatitis.

Cutting Fluids

Cutting fluids are used primarily as coolants during machining to prevent distortion of the workpiece and to prolong cutting tool life. The cooling characteristics also facilitate higher cutting speeds and the machining of harder metals. Cutting fluids also act as lubricants for reducing friction and improving the finish on a metal cut. They prevent rusting of the cutting tools and the machined parts. Finally, they flush chips and debris away from the point of operation.[3,4] There are three major types of metalworking (or cutting) fluids: neat (insoluble) oils, emulsified (oil-in-water, also called soluble) oils, and synthetic aqueous (chemical-in-water)fluids. Each is described below:

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

Emulsified or soluble 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 stablizers, extreme pressure additives, antifoams, dyes, and microbiocides.[5]

Synthetic solutions have no emulsified oil content and are composed of water, surfactants, and other additives. Semi-synthetic cutting fluids are chemical-in-water based but have some oil added as well.[5]

Types of disease associated with cutting fluids

It is estimated that one percent of all machinists in the United States have developed dermatitis associated with cutting fluids.[6]

Approximately 27% of all dermatitis cases observed clinically have been attributed to industrial cutting fluid exposure.[3] The chemical characteristics of industrial cutting fluids have changed over time. Insoluble oil based cutting fluids were once the only cutting fluids available, but soluble oil based cutting fluids have replaced them in many machining processes. Soluble oil based cutting fluids are mixed with water and provide better machining characteristics and environmental conditions than most insoluble oil based cutting fluids. Semi-synthetic and synthetic cutting fluids have in turn begun to replace the soluble oil based fluids. These currently make up 1/2 to 2/3 of the cutting fluid market.[3,7]

Skin exposure to neat oils has long been known to cause oil acne or folliculities and, when prolonged, hyperpigmentation, keratoses, and cancer of the scrotum and other exposed skin.[8] 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.[2] 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).[8]

There have been several reports of skin cancer in workers exposed to neat 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.[2] In one proportional mortality study pancreatic cancer mortality was statistically significantly associated with both machining and grinding in neat oil cutting fluids.[9]

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. Soluble cutting fluids act as skin irritants by removing the protective fatty layer from the skin (defatting). This damages the skin and reduces the escape of water from the tissues. A condition of chronic dryness of the skin (xerosis) may progress to eczema with repeated exposures.[2]

Aqueous solutions also produce eczematous dermatitis, since many of their constituents are the same as the emulsified oils.[5] The increasing use of synthetic and semi-synthetic cutting fluids has been directly correlated to an increase in the number of low-grade, irritant dermatitis cases.[7] Low grade irritant dermatitis has replaced folliculitis and pyoderma as the most common skin problem associated with cutting fluids.[11,12]

Two studies have found excesses of digestive cancers and a particular association of stomach cancer with grinding work in water-based cutting fluids.[9,10] Potential carcinogenic agents include nitrosamines, polyaromatic hydrocarbons, abrasive dusts, and chlorinated oils.

Incidence

In machinists heavily exposed to either emulsified or aqueous metalworking fluids, the prevalence of dermatitis has been reported to be as high as 30%.[8] Another author states that dermatitis due to petroleum products may account for 15-20% of the reported cases of occupational skin disease.[2]

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.[5] Therefore patch testing, which tests for skin allergies, is often not helpful in determining which of several oils may be causing a dermatitis. The cause of the irritant nature of soluble oils is not entirely known, but may be due to the combination of its wetness, alkalinity, and surfactant content.[8] As noted above, 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.[2]

Cutting oil sensitization, when it occurs, most commonly occurs with mercaptobensothiazole and hydroxylamine, used as anticorrosives; triethanolamine, used as an emulsifying agent; triazine derivatives, used as antiseptics; diethyleneglycol; and the metals from the used oil.[5] Antibacterial agents that release formaldehyde are especially likely to induce allergic contact dermatitis.[2] Cresols, used as germicides, are skin and eye irritants and may be absorbed through the skin.[12]

Patch testing of patients with soluble oil dermatitis is frequently negative. When sensitization (skin allergy) does occur, constituents must be tested separately to determine the causative agent.[8]

Several metals may be present in used cutting oils 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.[13] 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.[5] In addition, both of these compounds are carcinogenic.[13] 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.[13]

Metalworking machines frequently have inadequate shielding, resulting in soaked clothing. Small cuts from slivers of metal in the oils 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.[2]

Nitrosamines are frequently found either as additives or contaminants (formed most commonly from nitrites and amines in acidic solution) in cutting fluids. Many of these are well know carcinogens, although their potency varies. Nitrosamines have been found by NIOSH in several different oils which were not listed by the manufacturer as containing nitrosamines.[14] 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.[8]

Micro-organisms in Cutting Oil Solutions

Water-based coolant solutions normally contain one to sixty million bacterial organisms per milliliter of solution.[15] Fungi or mold also grow in these coolants, but they do not generally represent a significant health risk.[16] The bacteria do not usually cause skin or respiratory infections; however, they can generate noxious chemical vapors through their biological activity. In essence, the bacteria ingest chemicals in the coolant solution and, through metabolism, produce other chemicals as by-products. These by-product chemicals include irritating substances, such as hydrogen sulfide, ammonia, and amines.

The biology of metal-working fluids has been studied for over 25 years and is well summarized by Bennett.[15] The most important organisms found in these solutions are Pseudomonas species, Desulfovibrio sp., and coliform bacteria. The major organisms and their capabilities for growing in water-based coolants are indicated in Table I. Pseudomonas sp. are virtually always present as the major organisms in coolants.[17] Coliform bacteria survive in the solutions for only a limited time and do not appear to cause enteric infections.[18] They are present in coolants only through repeated contamination. Desulfovibrio species are anaerobic bacteria which can survive and grow only when there is oxygen. Their metabolism is primarily based on reducing substances containing sulfur and, thus, they are known as sulfate-reducing bacteria. A major product of their metabolism is hydrogen sulfide.[19]

The bacteria come from dirt in the air and on the metal stock and clothing of personnel. Primary sources include the soil, water, intestinal tracts, respiratory tracts, and the skin of animals (rodents). Initially the Pseudomonas species and other facultative anaerobic organisms break down unsaturated aliphatic and ring hydrocarbon chemicals in the coolant to 2-carbon fragments, which are

converted to organic acids. Pseudomonas sp. do not produce significant odors; however, they destroy chemicals toxic to the sulfate-reducing bacteria, allowing them to begin growing.

The further growth of the sulfate-reducing bacteria results in the production of hydrogen sulfide, ammonia, and other volatile amines, which cause the rancid odors associated with aging coolants. In addition to generating foul odors, the overgrowth of bacteria causes corrosion of metals, deterioration of the circulating system, loss of stability and lubricating qualities of the coolant, and discoloration of the metal. Dermatitis is not a direct result of bacterial overgrowth.[15] Pathogenic bacterial organisms, such as Staphylococcus sp. or streptococcus sp., do not survive in the coolant solution. The organisms that do survive do not cause primary skin infections. However, they can produce chemical by-products which act as primary irritants and can cause secondary infections in already damaged skin.

Factors influencing the growth of bacteria include the ratio of coolant oil to water, pH, coolant temperature, amount of circulation of the solution, and the sulfur content of the solution. An oil-to-water ratio of 1:25 to 1:50 is ideal for maximum growth of bacteria. A pH between 7 to 9 supports growth well, while there is no growth above a pH of 9.5. The optimum temperature for bacterial growth is 98°F. Since the source of heat is the operating metal-cutting and grinding tools, general bacterial growth is enhanced when a system is in operation more than one shift per day, maintaining warmer coolant temperatures. On the other hand, circulation of a solution aerates the water and suppresses the growth of the sulfate-reducing bacteria. These organisms grow best during weekends when the system is not in operation. Increased sulfur content provides more substrate for bacteria and increases the rate of growth. All these factors affecting the growth of the bacteria influence the working life of coolant solution.

The acceptable ranges of the above parameters are primarily determined by the required lubrication and mechanical properties of the coolant solution. The coolant oil-to-water ratio, pH, and amount of circulation can not be easily altered to minimize bacterial growth. The major mechanisms for preventing bacterial growth are including bactericidal chemicals in the fresh coolant and establishing good housekeeping procedures to minimize contamination. Overgrowth of bacteria or mold is reduced by adding more biocide to the coolant system, but a concentration of biocide that is too great may cause dermatitis. Bennett recommends that "Efforts should be made to maintain microbial content under ten million organisms per milliliter, because a coolant so controlled will usually give satisfactory service for several years."[15] Recently, he recommended that bacteria be maintained between one to ten million organisms per milliliter.[20] He commented that systems with greater than 10 million bacterial organisms per milliliter should be considered "out of control."

Fungi or mold are a different class of micro-organisms which also inhabit water-based coolants.[15,16] They do not cause primary irritation of the eyes, nose, and throat, or primary dermatitis. Like bacteria, they may cause secondary infections of already damaged skin. Bacteria and mold compete for the same substrates so that the growths of the two types of micro-organisms are inversely related. Where bacteria predominate, molds are rarely present as active sub-populations.[16] The major adverse consequence of fungal overgrowth is that the mold colonies can foul pumps or filtration equipment. The level of growth that will cause this problem depends upon the type of equipment used in a system and can not be predicted a priori. Bennett recommends that fungi be maintained between 200 to 2500 organisms per milliliter.[15]

Finally, additional irritating substances can be produced through chemical reactions between the various additives to the system and the substances generated by the micro-organisms. These substances can not be predicted a priori and should be assayed by periodically sampling the coolant system.

One textbook states that long-used soluble oils are more irritating than fresh soluble oil and attributes this to the formation of condensation products of oil constituents and metabolic products of bacteria in long-used oil.[8]

Concentration Variations on Cutting Fluids

Most synthetic cutting fluids are mixed with water at ratios that vary between 20-30 parts water to 1 part cutting fluid. Continual aeration and high cutting fluids temperatures cause significant evaporation of the water fraction, resulting in a more concentrated cutting fluid. The actual evaporation of the chemical fraction of cutting fluids is minimal. One study monitored concentration variations in three groups of metal-working machines using synthetic cutting fluids and water emulsion cutting oils. As at Smithe, addition of fresh coolant (topping off) was permitted over the eight weeks of the sampling period. Results of the sampling study indicated that an increase in the concentration of the cutting fluid emulsion occurred regularly in both large- and small-sump machines due to loss of the water fraction of the cutting fluid emulsion.[7] Concentration increases in highly alkaline components of the cutting fluid resulted in an increase in the total alkalinity of the cutting fluids over the sample periods. Significant concentration variations occurred which led to the cutting oils often becoming "highly irritating," making it likely that dermatitis could be caused in machine operators.[7]

Exposure to Solvents

In the past the effects of solvents most often described were the acute irritating effects on mucous membranes, intoxication effects, and the effects on blood components. More recently, extensive studies in Scandanavia have shifted the focus to chronic, neurologic, and neuropsychological effects, as well as to the cancer-causing potential of the aromatic and halogenated hydrocarbons.[21] These have resulted in progressively declining recommended exposure levels for organic solvents, and regulations requiring the enclosure of processes and substitutions of less hazardous solvents for the more toxic ones.

Solvent Effects on Mucous Membranes

Nasal and sinus symptoms are common among solvent-exposed workers, and, along with eye irritation, form the basis for many of the existing TLVs.[9] A study of solvent-exposed painters revealed higher prevalence of asymtomatic histologic abnormalities on nasal mucosal biopsy compared with nonexposed controls.[22] Paraosmia and hyposmia (smell disorders) are also commonly induced by respiratory exposure to solvents.

Neurologic Effects of Solvents

Organic solvents easily cross the blood-brain barrier, with high concentrations found in the white matter. The assessment of neuropsychological effects of exposure to solvents has been a controversial subject beginning with individual case reports in the mid 1940s associated with carbon disulfide exposure and the studies of 50 workers chronically exposed to tricholoroethylene while degreasing metal. Using a test battery and psychiatric evaluations investigators defined a syndrome they called the "psychoorganic syndrome."[23] The syndrome comprises memory disturbances, difficulties in understanding, and mood changes. The presence of acute intoxication symptoms such as dizziness usually follow exposures. The symptoms are worse during the week and resolve over the weekend. Later, anxiety and depression are common with chronic symptoms of headache and dizziness. Memory impairment, fatigue, difficulty in concentration, emotional lability, and dysfunction of the autonomic nervous system follow (bursts of perspiration, palpitations, diarrhea, and impotence).[24]

Compared with nonexposed workers, workers exposed to mixtures of organic solvents have increased symptoms of fatigue, difficulty concentrating, and headache.[21] In some cases, pre-exposure military neuropsychological test results were available for comparison, showing deterioration of intellectual performance and memory, differences in psychomotor performance and dexterity, and reduction in emotional responsiveness.[25]

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 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 criteria 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 primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in the report, it should be noted that industry is legally required to meet 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 short-term exposures.

VII. ENVIRONMENTAL RESULTS AND DISCUSSION

Psychrometric measurements showed a dry bulb temperature of 76.5° at 30% relative humidity throughout the machinery areas. Studies by NIOSH and other research groups of indoor areas with low humidity (less than 40%) and high temperatures (greater than 72°F) in the presence of low-level air contaminants have found these conditions to enhance eye and upper respiratory problems and skin complaints including dermatitis.[28] Also dizziness, disorientation, headaches, and lethargy have been attributed to sinus and inner ear problems stemming from or being aggravated by such conditions. The ventilation system consists of several overhead, indoor heating/cooling units which provide only for air circulation; no fresh air is brought in through these units.

Observations of the work methods and reports of skin irritations and H_2S and NH_3 odors, although circumstantial, support the promise that chemicals in the coolant/cutting fluid systems and/or substances produced by micro-organisms growing in the coolant solutions are the likely sources of irritation to the machinists.

No peaks for nitrosamines were detected in any of the six bulk samples taken for Detrex Crown Coll 710, Gulf Cut 11D, Trimtap+ Coolant, Culfcut 31A, PNT88, and SuperSolve.

VIII. MEDICAL RESULTS AND DISCUSSION

Of the 62 employees interviewed, 42 (68%) reported having had skin problems since coming to work at E.L. Smithe. One of these had psoriasis and was removed from the analysis. All of the remaining 41 noted that in the past year they had experienced at least two of the following conditions: red skin, dry skin, cracked skin, or itchy skin. Everyone reporting these problems reported them on the hands or the arms; a few people also reported the problems in other areas. These responses are 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. The fact that all of these employees noted that their skin problems occurred primarily on their hands or their arms, or both, makes an association with cutting oils likely. Only three employees also said they had had pimples or "bumps". These occurred on the arms of all three, and, in one case, on the thighs; both areas are associated with work-related oil folliculitis.

Twenty-seven workers were interviewed from the Lathe Department and thirty, including two grinders, from Milling. Of these, 21 (77%) from Lathe reported that they had skin problems as opposed to only 15 (50%) from Milling. This difference is significant at less than the 0.05

level. However, actual skin examinations revealed no significant difference between the two departments: 17 (63%) from Lathe as opposed to 18 (60%) from Milling showed xerosis, lichenification, or eczema of the hands and arms on examination. Ten workers from each of the two departments had xerosis; seven workers from Lathe as opposed to eight from Milling had actual eczema. One maintenance worker, one subassembly worker, one drilling worker, one stockroom worker, and one welder were also interviewed and examined. All of these reported dry, red, itchy skin of the arms and hands. The subassembly worker, the maintenance worker, and the welder showed xerosis of the lower arms and hands on examination. The drilling worker had eczema of the hands and arms. The stockroom worker had a negative skin examination.

Use of Barrier Creams

Fourteen (23%) of the sixty-two employees interviewed reported using a barrier cream "always" at work. Sixteen stated that they used a barrier cream "sometimes"; of these, seven mentioned that they used it only in winter, two that they used it only to protect against cast iron, and one that he used it to protect against the coolant H-109. Most used the Jergens SBS-40 provided by the company; five used a product called "Protec", one used Neutrogena, and one used Kerodex 51 made by Ayerst Labs. One worker stated that he had had a bad dermatitis two years before and that a dermatologist had told him he was allergic to the Jergens SBS-40 cream; he no longer uses a barrier cream.

Of the 41 who reported skin problems that were possibly work-related, 26 (63%) used a barrier cream "sometimes" or "always".

Gloving

Seventeen employees (27%) of the sixty-two interviewed stated that they wore gloves "sometimes" during their work; the rest stated that they never gloved. Of those who gloved, six mentioned that they wore gloves to protect against sharp parts or burrs, two to protect against grease, one when he worked with heavy gears, and two when they worked with cast iron.

Of the 41 who reported skin problems, 13 (33%) were among those who gloved "sometimes".

Perceived Associations with Skin Problems

Twenty-five (61%) of the forty-one reporting skin problems that were possibly work-related associated their skin problems specifically with the use of the coolant H-109. Two (5%) noted that "dirt and dust" were associated with their problems. Seven (17%) believed that cold weather also made their problems worse. One (2%), the welder, attributed his skin problems to the use of heavy oils.

Because the workers in all departments are exposed to a variety of coolants and oils,.it was not possible to find an association between skin problems and any one chemical exposure. All but three of the workers interviewed, for instance, were exposed to the coolant H-109, so we had no "control" population available for a comparison which could confirm the perceived association between H-109 and skin problems.

Perceived Associations with Improvement in Skin Problems

Ten of the forty-one (24%) stated that they felt the barrier cream "made their skin problems better." Three (7%) noted that using clean rags from home rather than the rags provided made their skin problems better. Two (5%) noted that using a hand dryer or paper towels rather than the rags provided by the company made their skin problems better. Four (10%) noted that treatment with cortisone cream had made their skin improve. Twenty-two (54%) noted that their skin problems improved on vacation. Four (10%) noted that frequent washing while at work improved their problems.

Interpretation of Rates of Skin Problems Found on Examination

The rate per one thousand persons for xerosis in white males in the general U.S. population is 4.0 for those aged 25-34, 6.8 for those aged 35-44, 5.4 for those aged 45-54, and 15.3 for those aged 55-64. The comparable rates for hand eczema are 5.8, 5.5, 5.2, and 9.4 respectively.[1] The rate for xerosis for the workers examined at Smithe is 23/62, which is equivalent to 371 per thousand; the rate for hand and arm eczema is 16/62, which is equivalent to 258 per thousand. No precise statistical comparisons can be made between the National Health Survey data and the rates for workers at E.L. Smithe, but the workers' rates are clearly in excess of the norms.

These high rates are not surprising given the widespread exposure to soluble and synthetic cutting oils, but it is an indication of the need for preventive action. Only approximately 25% of individuals developing occupational contact dermatitis (eczema) heal completely. Approximately 50% of people with occupational dermatitis improve, but do not clear up completely, and the remaining approximately 25% continue to have eczema at about the same level of severity even if they change jobs to avoid potential exposures. All contact with cutting oils cannot be avoided, but the provision of regularly changed oils in proper concentrations should minimize exposure to metal and other contaminants, to bacteria, and to inappropriately high levels of germicides and other potentially irritating chemicals. Our recommendations (see Section X) contain further suggestions for minimizing contact with the oils and minimizing potential harm to the skin.

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Respiratory, Neurological, and Gastrointestinal Symptoms

Of the sixty-two employees interviewed, thirty-two (52%) mentioned that they frequently had stuffy runny noses. Of these, eight (25%) of the thirty-two said that there was no difference in the occurrence of this symptom between work and home. Three (9%) stated that it was worse during certain types of weather. Seven (22%) said that this symptom occurred only at work, but did not attribute it to any particular substance or process. Three (9%) attributed it specifically to the coolant H-109. Two (6%) said that it occurred only when SuperSolve S was sprayed onto assembled machines in the department next to their area.

Three (5%) of the sixty-two interviewed mentioned that they frequently experienced nausea. One (33%) of these three attributed this symptom to the coolant H-109. Two (67%) said that it occurred only when SuperSolve S was sprayed onto assembled machines in the department next to their area.

Twenty-one (34%) stated that they frequently had sinus pains or congestion. Seven (21%) of these stated that there was no difference in the occurrence of this symptom between work and home. Two (10%) stated that it occurred only at work, but did not attribute it to any particular substance or process. One (5%) attributed it to the green spraymist Crown Cool 4700. One (5%) attributed it to H-109. One (5%) attributed it to cast iron dust.

Fifteen (24%) stated that they frequently had a dry scratchy throat. Two (13%) stated that there was no difference in the occurrence of this symptom between work and home. One (7%) stated that it occurred only at work, but did not attribute it to any particular substance or process. Two (13%) attributed it to cold weather. One (7%) attributed it to a barrel of "Sta-Dri" located near his work station. Two (13%) attributed it to cast iron dust. Two (13%) said that it occurred only when SuperSolve S was sprayed onto assembled machines in the department next to their area.

Twenty-one (34%) stated that they frequently had headaches, lightheadedness, or dizziness. Seven (11%) stated that there was no difference in the occurrence of this symptom between work and home. Two (10%) stated that it occurred only at work, but did not attribute it to any particular substance or process. One (5%) attributed it to the green spraymist Crown Cool 4700. One (5%) attributed it to cold weather. Six (29%) said that it occurred only when SuperSolve S was sprayed onto assembled machines in the department next to their area.

Eighteen (29%) of the sixty-two interviewed stated that they frequently had eye irritation. Four (22%) of the eighteen stated that there was no difference in the occurrence of this symptom between work and home. Four (22%) stated that it occurred only at work, but did not attribute it to any particular substance or process. One (6%) attributed it to cast iron dust. One (6%) attributed it to cold weather. One (6%) attributed it to H-109. Two (11%) said that it occurred only when SuperSolve S was sprayed onto assembled machines in the department next to their area.

Smoking Status

Fifteen (24%) of the sixty-two interviewed were current smokers. Fifteen (24%) were former smokers. Thirty-two (52%) had never smoked. There was no association between smoking status and the reporting of respiratory symptoms, gastrointestinal symptoms, or neurological symptoms.

Hobbies

Five workers did carpentry at home and had some exposure to wood dust and adhesives. One did auto work and had occasional exposure to paints. Many workers hunted or played sports, but these were not considered to expose them to any relevant chemicals. There was no association between hobbies and the reporting of dermatologic symptoms, respiratory symptoms, gastrointestinal symptoms, or neurologic symptoms.

Discussion of respiratory, gastrointestinal, and neurologic symptoms

The reporting of headaches, dizziness, and mucous membrane irritation may be associated with oil mists, but may also be associated with respiratory exposure to solvents. Many of those interviewed stated that they associated their symptoms with the spraying of machines with SuperSolve S in the Final Assembly Department. Respiratory protection, better ventilation, enclosure of the process, or a combination of these measures, may serve to minimize these symptoms.

IX. RECOMMENDATIONS

Preventive measures should focus on reducing skin contact with oils and solvents.

A. Machine Design and Operations

1. Leaking machines should be repaired to reduce the contamination of cutting fluids with Trim-tap or other oils.

2. Existing guards should be in place or installed to reduce splatter of oil.

3. Plant engineers and employees operating the machines with the greatest potential for oil exposure should work jointly to design machine guards and special tools. 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 scheduled basis, preferably by someone assigned to this task who can ensure regular and thorough cleaning.

4. Bare hand contact with sharp edges should be avoided since such contact can abrade the skin and contribute to irritation and skin infection.

B. Cutting Fluids

1. The metalworking fluids should not contain known irritants and allergens. The Biocide Bioban P-1487 contained in H-109 has been shown to be a sensitizer in one human study, and it may be preferable to using an oil containing another biocide. An occupational dermatologist familiar with cutting oils can evaluate the potential of cutting oils to cause problems before it is brought into use in the plant.

2. Oil should be kept free of fine particulates of metal and other contaminants by regularly changing the fluid, by more frequent filtering, or both. Such changes should be made on a regular schedule; workers should not have to request such a change.

3. With synthetic and semi-synthetic cutting fluids, it is important to keep the solution in the concentration the manufacturer recommends. If the fluid is diluted with water well ahead of the time it will be used, even in a more dilute solution than is recommended by the manufacturer, the water may evaporate, leaving the concentration of cutting fluid higher and making contact with it more irritating. Therefore, the concentration of the cutting fluid should be tested prior to use, according to procedures recommended by the specific manufacturers. A central system with continuous circulation or one with scheduled recycling can help facilitate concentration control. The following general criteria have been developed for monitoring concentration variations in an individual cutting fluid system:[7]

   a. Monitor cutting fluid prior to delivery to the machine sump.

   b. Monitor cutting fluid concentration on a daily basis. Refractometers may provide quick, semi-accurate results

that should be adequate to detect potentially irritating levels of the concentrate.

c. Monitor cutting fluid by the titration method on an intermittent basis. Use the titration method for machines containing excessive tramp oil.

d. Provide tap water to the machine sump for correcting concentration levels.

e. Remove excessive tramp oil from machines by skimming to improve refractometer readings and to remove contaminants.

f. Utilize the services provided by the cutting fluid manufacturer to assist in regular monitoring. Utilize laboratory support in analyzing the cutting fluid.

g. Maintain the machine sump level of cutting fluid at a moderate to high level to avoid exposure to high concentrations.

h. Replenish or "top off" machine sumps according to the measured concentration level of the cutting fluid. Replenish with tap water if the concentration is high so it can be reduced to normal levels. Replish with the cutting fluid emulsion if the concentration approximates normal levels.

4. If no biocide is contained in a cutting fluid, control of bacterial growth requires the addition of an appropriate biocide to the coolant solution. Northern Cutting Oil ("H-109") contains a biocide, but the "coolant deodorant" added to it (according to some workers) may be an additional biocide. Bacteria in coolant solutions have a tendency to develop resistance to biocides [26]. Therefore, bacterial culture and sensitivity testing should be performed periodically to determine the in vitro effectiveness of the biocide. The recognized procedures for testing solutions for bacterial growth and adding a biocide to a coolant are as follows:

a. The time between sample collection and analysis should be minimized. Plating the solution to count bacteria could be done at the facility to improve accuracy of the bacterial counts.

b. Biocide should be added on a regular schedule to maintain low levels of bacterial and mold growth. Adding biocide only when bacterial counts become excessive increases the risk that the exponential growth of bacteria will become

uncontrolled.

5. Bacterial growth within the coolant solutions should also be restricted through control of the primary sources of the bacteria:

   a. Employees should be notified that all dirt and foreign matter should be kept out of the coolant systems. This notification may include having periodic training sessions for employees, as well as posting educational notices.

   b. Appropriate housekeeping procedures should be established to minimize contamination of the coolant systems.

6. Because of 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.[8] However, there are still reports of some carcinogenic contaminants in refined oils, so workers should be educated in the importance of minimizing contact.[2,13]

C. Personal Protection

1. Where feasible, gloves that are oil and solvent resistant should be required and provided. Nitrile rubber gloves should be effective for both cutting oils and Stoddard solvent.[27] Gloves should be replaced when cracked. Cotton inserts should be used to absorb perspiration. Since the use of gloves in some operations may be hazardous, special tools may be necessary to remove parts or scrap from an oil or solvent.

2. Light-weight, impervious aprons and gauntlets (sleeves) should be worn.

3. Employees who may potentially be exposed to oils should be instructed in the use of barrier creams, although their usefulness is limited. Creams should be applied whenever the hands are washed and should be made available at the work stations or in the rest rooms, not only in the clinic.

4. A consulting dermatologist with a good knowledge of occupational skin disease should periodically review and recommend the best selection of barrier creams that are effective against the cutting oils and solvents currently in use at E.L. Smithe.

D. <u>Facilities and procedures for employee personal hygiene</u>

1. Oil contacting skin should be wiped off immediately. Oil

cloths for work purposes should not be used to wipe oil off the skin, as metal particles present may cause skin abrasions which can become infected. Soft disposable paper towels should be supplied at the work stations for wiping the skin.

2. Care should be taken to prevent street clothes and underwear from becoming saturated with cutting fluids and solvents; otherwise persistent skin contact and irritation will result. Employees and supervisors should understand the importance of immediately changing clothes that have become wet with oils or solvents, in odor to diminish skin contact time.

3. Work clothes should be changed and washed frequently.

4. Excessive use of abrasive soaps (such as Boraxo) should be avoided since they alone can irritate and damage skin. Given adequate time for clean-up, mild (rather than abrasive) soaps such as the Jergens soap provided in the washrooms will generally be sufficient for removing oils. Employees should be encouraged to use milder soaps both at work and at home.

5. Adequate time for personal clean-up (for example, 15 minutes at the end of a shift) should be allowed.

6. At breaks, lunchtime, and at the end of the day, the skin should be thoroughly washed and a conditioning cream used to counter defatting of the skin.

7. Adequate and well-maintained washing facilities with a plentiful supply of disposable paper towels and conditioning creams should be provided.

8. Employees should be informed that they should never use a solvent to clean their skin.

E. Medical

1. Because of the importance of early accurate diagnosis and treatment of occupational dermatoses, all skin problems more severe than dry skin should be referred to an occupational dermatologist who is familiar with the problems of cutting fluids and able to perform the appropriate diagnostic tests and treat the different types of dermatitis. It is important for the company and the union to understand that negative patch tests with a chemical do not mean that the chemical is not causing skin problems, but only that it is not causing skin allergies.

2. A second medical opinion may sometimes be advisable because occupational dermatoses can be difficult to diagnose and treat.

3. Pre-placement skin evaluation should be performed on new employees. Persons with a history of atopic dermatitis, recurrent eczema, or persons who currently have active dermatitis should not work in areas where they are heavily exposed to cutting oils or solvents.

4. The fact that skin contact with cutting oils and solvents can cause potentially serious skin conditions should be recognized by management and employees. Employees should be instructed regarding the importance of periodic self-examination of the skin. Any unexplained or changed wart, rash, or sore should receive medical attention and advice. Employees should be encouraged to report rashes early so that preventive action can be taken. Employee compliance is more likely if no economic penalty occurs when workers with persistent skin problems must transfer to jobs with no oil exposure.

5. Immediate first-aid treatment should be provided for any injury, and open wounds kept covered and away from any contact with cutting fluids and other chemicals until healed.

6. The excellent practice of recording complaints on a problem sheet at the front of each worker's medical chart should be maintained. In addition, a log of skin complaints could be maintained by the plant nurse. Cases of possible occupational dermatitis should be recorded by department, so that any problem areas may be identified as early as possible. This information, minus personal identifiers, should be available to management and union representatives.

7. Employees should be informed of the possible skin problems that may occur from frequent contact with cutting fluids. An educational program should be provided to employees (as well as supervisors and foremen) by E.L. Smithe, the union's international health and safety office, or some other source. The NIOSH slide show, "Occupational Dermatoses," could be shown.

F. Ventilation

1. Fresh air intake should be provided of at least 20%. Humidity should be maintained at 40-50% RH and temperature should be maintained at 68^{o} - 72^{o} F. The increase of fresh air may bring the humidity up to recommended levels, otherwise humidifier(s) may be needed to resolve this problem.

2. A canopy hood arrangement should be used on solvent spraying operations. A capture velocity of 100 ft./minute (minimum) would be appropriate. The sprayer operator should use a combination mist-organic vapor cartridge respirator during these operations for extra precautions.

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Table I

THE MOST IMPORTANT ORGANISMS FOUND IN METAL-WORKING FLUIDS*

Organisms	Times Isolated (percent)	Capability of Growing In Coolants
Pseudomonas species	100	+++++
Desulfovibrio species	85	++
Escherichia species	48	++
Paracolobactrum species	47	+++
Proteus species	55	+++++
Klebsiella species	32	++++
Aerobactera species	18	+++
Fungi	14	+++

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