HETA 92-280-2310
APRIL 1993
NTN BOWER CORPORATION

HAMILTON, ALABAMA

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I. SUMMARY

On June 1, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Auto Workers International Union (UAW) for a Health Hazard Evaluation (HHE) at the NTN Bower plant in Hamilton, Alabama. The specific health issues identified in the HHE request were urticaria and dermatitis. In response to this request, NIOSH investigators conducted a site visit on December 7-9, 1992. The NTN Bower facility employs approximately 390 persons in the manufacture of tapered roller bearings for use in industrial and agricultural equipment.

NIOSH personnel reviewed work practices and personal protective equipment; collected bulk and air samples for potential contaminants; inspected a local exhaust hood and the heating, ventilating, and air-conditioning (HVAC) system; reviewed medical records and material safety data sheets (MSDSs); and interviewed selected employees.

Although gloves were available throughout the facility, some employees with exposures to cutting fluids did not wear gloves because of decreased dexterity or discomfort. Additionally, the currently used glove has not been evaluated for protection against the widely-used rust preventive oil.

Chromium and nickel, which can be associated with occupational dermatitis, were found in the cutting fluid samples collected from the Roll Grind high speed line and the Cup Inside Diameter #224 line. Several other metals were also detected. The cutting fluids were all found to have a pH of approximately 9 (alkaline). Several metals, including nickel, were detected in the two personal and two area air samples. No air samples had concentrations exceeding the applicable occupational exposure limits.

Under certain operational conditions, face air velocity measurements made at the rust stripper local exhaust hood were less than the 75 feet per minute (ft/min) American Conference of Governmental Industrial Hygienists (ACGIH) recommendation. Additionally, workers occasionally must stoop over the tanks, placing themselves in the pathway of contaminant exhaust. Movement of the parts bin by hand from one tank to another may result in skin contact with rust preventive oil and caustic sodium hydroxide solution.

Inspection of two HVAC units revealed that the filters and coils were heavily coated with an oily, tar-like matter. The oil inside the HVAC units may be a fire hazard.

Review of the medical records revealed that the proportion of skin conditions reported from 1989 to 1991 declined from 11% to 5%. The data for 1992, although only reviewed through early December, 1992, appeared similar to the data for 1991. Several departments continue to have a large percentage of workers reporting dermatologic problems. Medical histories of eight employees on medical leave were not consistent with any one unifying diagnosis. Three of the eight employees did report a primary problem consistent with sensitization to petroleum products. These problems originated in the mid to late 1980's. No one set of factors or exposures was identified as being involved in the etiology of the different employee's medical problems.

Although steps have been taken to follow a number of the recommendations made in a previous NIOSH HHE (HETA 89-367) at NTN Bower, skin-related problems continue to occur. Efforts to decrease workers' exposures to cutting fluids and oils should be continued because prevention of these exposures is key to controlling occupational skin disease. A number of different substances used at this plant are potential urticants, sensitizers, and irritants. Specific recommendations include re-evaluation of the types of gloves used in different operations, improved maintenance of the ventilation system, and the creation of a log in the medical department to monitor dermatologic conditions. Additional air sampling for nickel should be conducted to better characterize employee exposures. NTN Bower should also place increased emphasis on education and communication regarding occupational safety and health issues.

KEYWORDS: SIC 3562 (Ball and Roller Bearings), cutting fluids, cooling fluids, petroleum oil, biocides, chromium, nickel, dermatitis, potential carcinogen, respiratory protection, engineering controls

II. INTRODUCTION

On June 1, 1992, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Auto Workers International Union (UAW) for a Health Hazard Evaluation (HHE) at the NTN Bower plant in Hamilton, Alabama. The specific health issues identified in the HHE request were urticaria and dermatitis and their relationship to cutting fluid and rust preventive oil exposures. In response to this request, NIOSH conducted a site visit on December 7-9, 1992.

An earlier NIOSH investigation (HETA 89-367) at NTN Bower, which was conducted in 1989 - 1990, also focused on exposures to cutting fluid and rust preventive oil. As in the current request, the health issues included chronic skin problems and urticaria. The previous evaluation consisted of a review of appropriate records, medical interviews with employees, and an industrial hygiene survey. Of 40 employees interviewed, 12 had a rash at the time of the medical interview, and none had wheals (hives) characteristic of urticaria. Other employees had a history of dermatitis in the past year. A review of 84 plant medical records revealed that 11 employees had a history of urticaria or angioedema. The proportions of skin conditions by department were estimated for 1989 and are presented in Table 1.

The previous NIOSH HHE concluded that skin problems may be caused by a number of different substances at the NTN Bower plant, including the cutting fluids, oils, additives, contaminants, or degradation products formed through heat or bacterial action. Further study to determine the work-relatedness of the urticaria was not pursued due to the varied clinical manifestations of urticaria and the difficulty in identifying a causal relationship between specific agent(s) and skin problems. Many recommendations were made focusing on the prevention of exposure to cutting fluids and oils, with the goal of primary prevention of dermatitis and urticarial reactions (see Appendix A).

This report will discuss the findings of the current HHE and the effectiveness of actions taken by NTN Bower to reduce skin exposures. Many of the changes at NTN Bower were made in response to the previous recommendations provided by NIOSH.

III. BACKGROUND

The NTN Bower plant has 393 employees and approximately 373,000 square feet under roof. At the time of the NIOSH investigation, management stated that the company was operating at approximately 60% capacity because of economic conditions.

NTN Bower Corporation manufactures tapered roller bearings for use in industrial and agricultural equipment (see following pictorial example).
A tapered roller bearing consists of rollers operating between tapered raceways. The bearings are manufactured in a variety of sizes and types to fill the needs of the various applications.

The cups and cones, rollers, and retainers are manufactured and assembled at the plant. Some of the primary processes include cold-forming (the use of a punch-press to form bearing components from flat stock), chucking (a lathe where turning operations are performed), carburizing (introducing carbon into steel heated above the transformation temperature), heat treatment and quenching (the operation of passing the part through heating and cooling cycles to produce the desired hardness of the part), grinding (an operation which results in a prescribed amount of stock being left on the part to produce finished part sizes), and honing (an operation to smooth the load-bearing surfaces of a roller, cup or cone). According to the material safety data sheets (MSDSs), most of the steel used to make the various bearing components contain small percentages of manganese, chromium, and nickel. For instance, the process tube and plate steel #4118 contains 1% manganese, 0.7% chromium, and 0.25% nickel.

The concerns about dermatitis centered around the Grinding and Assembly & Inspection areas, so these areas were the focus of the NIOSH investigation. The grinding operations (roll, cups, cones, etc.) are performed in automated, enclosed machines that use water-soluble synthetic (does not rely on hydrocarbons for lubricity) and semi-synthetic (contain 15 to 40% petroleum oil as an emulsion) cutting fluids. Roll grinding utilizes a synthetic cutting fluid, whereas the chuckers, cups, and cones grinding areas utilize semi-synthetic fluids.

Cutting fluids are also called cutting oils, lubricants, coolants, or cooling fluids. Cutting fluids are used in a variety of metal cutting and machining processes to dissipate heat and lubricate metal surfaces. These fluids prolong tool life, permit higher cutting speeds without increased friction, and when applied to the cutting zone, serve to capture and flush away metal chips.

Cutting fluid is continually fed into the various grinding machines from three 25,000-gallon central systems. An exception is the high-speed roll grinding area, where cooling fluid is manually added into a separate system. The cutting fluid in the central systems consists of water based solutions of Melkool 007® and Melkool AP-811N®. According to the MSDS, Melkool 007® contains a diacid soap, a borate amine, diethanolamine, and triethanolamine. Melkool AP-811N consists of an unspecified biocide, hexylene glycol, mono- and diethanolamine, an amide mixture, a borate amine, and a sulfonate detergent. Cutting fluid may be used for more than a year before a complete change is required. For example, the cooling fluid in the roll grind area is about 1½ years old, but a partial dump is performed every three months.

Several biocides are used in the cutting fluids: Triadine (R)10® (contains 1,3,5-triazine-1,3,5-triethanol) and Kathon 886® (contains 5-chloro-2-methyl-4-isothiazolin-3-one, 2-methyl-4-isothiazolin-3-one, magnesium nitrate, and magnesium chloride). The cutting fluid is tested twice daily for pH, dissolved oxygen, and trap oil, and a record of these measurements is kept in a log book. A sample also is sent to the cooling fluid manufacturer on a weekly basis. The pH is maintained at 9.0 to 9.2 (alkaline). Addition of biocide is determined by the dissolved oxygen content. Biocide is added when dissolved oxygen drops more than 50% from the manufacturer's recommended level. Biocide is generally added about every 30 to 60 days. Because of employee complaints about increased irritant properties of the cooling fluid when biocide is added, management indicated that addition is made on weekends whenever possible.

A rust preventive, Ferrocote 5856-HF-T1® oil, consisting of light aliphatic solvent,

high-viscosity naphtha oil, an antioxidant, and a sulfonate detergent, is applied to the parts before they enter the Assembly and Inspection (A & I) area. If the parts are not coated with oil, they begin rusting rapidly. In addition, a rust stripper bath is utilized inside the A & I area to clean corroding parts. The rust stripping procedure consists of dumping the parts into a concentrated sodium hydroxide solution, then into a neutralizer, and finally into an oil bath. The fluids are in the tanks when the parts are submerged. The rust stripper utilizes an enclosure hood, which features three sliding plexiglass doors to facilitate the introduction or removal of parts from the rust stripper. An electrical interlock prevents parts from being submerged unless all plexiglass doors are closed. When the parts need to be moved to the next tank, the operator presses a button to raise the parts, opens the plexiglass door, and manually slides the basket over rollers to the next tank. The parts are slid between tanks over rollers manually.

IV. METHODS

Industrial Hygiene

Walk-Through Survey NIOSH investigators observed work practices and personal protective equipment usage, especially glove usage in the Roll Grinding and A & I areas.

Bulk Samples Three bulk samples of cooling fluids (6 - 10 milliliters) were collected from the high-speed roll grind line, the conventional roll grind line, and the inside-diameter cup grinding line. The samples were analyzed for dissolved or suspended metals by NIOSH method 7300.[1] The samples were treated with perchloric and nitric acid and analyzed by inductively coupled argon plasma atomic emission spectroscopy (ICP/AES). The limits of detection (LODs) may be found in Table 2.

The pH of the cooling fluids was determined in the high-speed roll grind line, conventional roll grind line, and inside diameter cup grind line using pHydrion® Insta-check 0-13 pH paper (Micro Essential Laboratory, Brooklyn, New York).

Air Sampling Area and personal breathing zone air samples for metals were collected according to NIOSH method 7300 by drawing air through 0.8 micron cellulose ester membrane filters at an air flow rate of 2.0 liters per minute (L/min) using battery operated sampling pumps.[1] Two area samples (in the Cone Grind area and Roll Grind area) and two personal samples (in the Tool and Die area [dry grinding was performed] and the A & I [dry polishing]) were collected.

The samples were chemically digested and analyzed by inductively coupled argon plasma atomic emission spectroscopy (ICP/AES), according to NIOSH method 7300.[1] The LODs per sample may be found in Table 2.

Local Exhaust Inspection Air velocities around the perimeter of the rust stripper hood (A & I Department) were measured with a TSI VelociCalc Plus Model 8360 airflow meter. Three measurements, which were averaged, were taken at the front of each tank with the plexiglass shield in both the up and down position. The volumetric airflow rate could not be measured because the exhaust ducts were inaccessible.

The TSI VelociCalc Plus Model 8360 is an electronic meter with a digital readout. Velocity is measured by the cooling effect of air as it passes over a heated (hot-wire) sensor at the end of the probe.

HVAC Inspection The general ventilation system for the facility consists of 24 gas-fired heating and cooling units and 12 cooling units. NIOSH investigators examined two ventilation units on the roof, specifically HC-11 (the unit over the roll grind area) and HC-13 (the unit over the cone grind area). The filters, coils, condensate pans, and outside air intakes were examined in these two units.

Medical

Medical records kept at the NTN Bower plant for the years 1989-1992 were examined. These records included the Occupational Safety and Health Administration (OSHA) 200 logs and the logs of visits to the medical department. Primary attention was given to the reporting of skin conditions. Other records examined included personnel staffing sheets for the same time periods. These records were used to estimate the proportions of skin

conditions reported by employees of each department for each year. The numerator, or the number of cases of any type of skin condition, was derived using the OSHA 200 Log and the record of visits to the medical department. Each person with a skin condition was listed only once per year. The denominator, or the number of potentially exposed employees, was estimated using staffing lists for each year.

Confidential interviews were conducted at the local union hall with eight employees who were on medical leave.

V. EVALUATION CRITERIA

Cutting Fluids Skin exposure to cutting fluids can result in contact dermatitis or other skin problems caused by the fluids themselves, dissolved or suspended metals, or certain additives, some of which are designed to suppress bacterial growth and inhibit corrosion of metals. Some additives used in these fluids may be primary irritants or sensitizers.[2,3,4]

Cutting fluids tend to be alkaline (pH >9) and act very much like strong soap upon the skin, removing surface oils and fats and causing the skin to become dry, cracked, and susceptible to infections. Metals can be liberated during grinding and reach significant levels in the cutting fluid over time. Exposures to certain metals, such as nickel, chromium, and cobalt, can cause allergic contact dermatitis in machinists and grinders.[2] Additionally, suspended particles or shavings in the cutting fluids may have an abrasive action on the skin, causing cuts or scratches. Harmful bacteria could then enter the tissues and cause infection.

Petroleum oils (non-water soluble) can result in irritant contact dermatitis. Oils can remove the protective film present on normal skin, disturb the water-holding quality of the skin, and injure the membranous structure of skin cells. Generally, the lower-boiling- point solvents and oils tend to be more irritating.[4]

Airborne Metals As a guide to the evaluation of the hazards posed by work place exposures, NIOSH field staff use established environmental criteria for the assessment of a number of chemical and physical agents. These criteria 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 should be noted, however, that not all workers will be protected from adverse health effects if their exposures are below the applicable limit. A small percentage may experience adverse health effects due to individual susceptibility, pre-existing medical conditions, and/or hypersensitivity (allergy).

Some hazardous substances or physical agents may act in combination with other work place exposures or the general environment to produce health effects even if the occupational exposures are controlled at the applicable limit. Due to recognition of these factors, and as new information on toxic effects of an agent becomes available, these evaluation criteria may change.

The primary sources of environmental evaluation criteria for the work place are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor OSHA standards.[5,6,7] Often, NIOSH recommendations and ACGIH TLVs may be different than the corresponding OSHA standard (permissible exposure limit - PEL). Both NIOSH recommendations and ACGIH TLVs are usually

based on more recent information than OSHA standards due to the lengthy process involved with promulgating federal regulations. OSHA standards also may be required to consider the feasibility of controlling exposures in various industries where the hazardous agents are found; the NIOSH recommended exposure limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease. OSHA PELs are legally enforceable regulations.

Potential health effects and occupational exposure limits of metals found in the environmental samples are shown in Table 3. Because of a recent court decision, the OSHA exposure limits are those specified as "Transitional Limits" in the air contaminant standard 29 CFR 1910.1000.[7,8] These metals may be present during grinding, deburring or welding of various alloys.

Rust Stripper Enclosing Hood (A & I) The enclosing hood design is not illustrated in the ACGIH Industrial Ventilation manual.[9] However, for metal cleaning operations using alkaline sodium salts (such as sodium hydroxide), a minimum control velocity of 75 feet per minute (ft/min) for enclosing hoods with one open side is recommended by the ACGIH.

Occupational Skin Disorders Occupational skin diseases account for approximately 40 - 50% of all occupational illnesses, and approximately 80 - 90% of these skin diseases may be classified as contact dermatitis.[4] Contact dermatitis refers to the induction of changes in the skin, usually accompanied by inflammation, from direct skin exposure to a wide variety of chemical or physical substances. The inflammation of contact dermatitis is caused by irritation (80 - 90% of cases), allergy, or both. Regardless of the mechanism, the end result of both processes leading to inflammation is a progression of clinical changes usually involving transudation of serum through the outer skin.

The development of allergic contact dermatitis involves the affected individual becoming sensitized to the offending substance.[4,10] Once sensitized, the affected individual will react within several hours or days following re-exposure to even very small amounts of the substance. Allergic contact dermatitis may extend to other body surfaces, and massive exposures may lead to immediate reactions such as urticaria. The prognosis for those who develop occupational contact dermatitis, both irritant and allergic types, is generally poor. Only approximately 25% of those who develop occupational contact dermatitis experience complete clearing of their skin condition, despite measures such as changing jobs to decrease exposure to the offending agent(s).[4] This is why primary prevention of exposure to potentially causative agents is so important.

In general, urticarial reactions make up a small percentage of occupational skin diseases relative to contact dermatitis. Urticaria is a transient vascular reaction of the skin that leads to an accumulation of fluid and localized swelling of dermal tissue surrounded by an erythematous flare. These localized lesions are referred to as "wheals" or "hives". Urticaria may be provoked by a large number of substances, via four basic mechanisms: (1) nonallergic; (2) allergic; (3) combined allergic and nonallergic; and (4) combined allergic eczematous and urticarial.[4] Allergic contact urticaria occurs in individuals who have previously become sensitized to the causative agent; it may be accompanied by systemic symptoms. As reported in HETA 89-367, and earlier in this report, a number of potential urticants were identified at the NTN Bower plant.

VI. RESULTS

Industrial Hygiene

Walk-Through Survey The workers in the grinding and A & I areas use North® nitrile latex gloves (Catalog No. LA-132-G). These gloves are 12 inches in length and are 0.013 inches in thickness. The employees may use a single pair of gloves for several days. Each employee is given their own pair of gloves. Inner cotton gloves are available, but the inner gloves are not universally used by the employees. Surgical gloves reportedly are available for employees working in the roll grind area, because of a need for dexterity and ability to manipulate small parts and machinery. The use of surgical gloves was not observed during the NIOSH visit. Several types of barrier creams are utilized: Arretil® (for oil), Taktosan® (for cooling fluids), Stakoderm® (oil and cooling fluids), and Stoko-emulsion® (used under gloves to reduce perspiration). Most employees in the facility with exposure to cutting fluids and rust preventive oil were wearing gloves. However, the Roll Grind department was a major exception in that most employees did not use gloves for dexterity or comfort reasons. Most employees were wearing gloves in the A & I department. However, the nitrile latex gloves used at NTN Bower have not been evaluated by the glove manufacturer regarding their degradation, break-through time, and permeation rates against aliphatic hydrocarbons similar to the rust preventive oils (parts are coated in this oil in the A & I department).

Bulk Samples The pH's of all the cutting fluids were approximately 9 (alkaline). Chromium and nickel, which can cause dermatitis and urticaria, were found in the cutting fluid samples collected from the Roll Grind high speed line and the Cup Inside Diameter #224 line. No cobalt was detected. Several other metals, which are not usually associated with skin disease, were detected; a list of the metals and their concentrations can be found in Table 4.

Air Samples Table 5 lists the air sampling results for various metals and their respective exposure limits. Nickel was found in one personal sample (13.1 micrograms/cubic meter [$\mu g/m^3$], Tool and Die area) and one area sample (1.3 $\mu g/m^3$, Cone Grind area). None of the samples indicated airborne exposures exceeding the applicable occupational limits. NIOSH considers nickel a potential occupational carcinogen; the NIOSH REL is 15 $\mu g/m^3$.[5] This limit differs greatly from the present OSHA and ACGIH exposure limit of 1,000 $\mu g/m^3$.[6,7]

Rust Stripper Enclosing Hood When the plexiglass door for the sodium hydroxide wash was opened, air velocities ranged from 20 to 80 ft/min at the face of the hood and around the periphery of the hood. Most of the measurements were less than the 75 ft/min ACGIH recommendation. When the plexiglass doors were closed (position when fluids are agitated), velocities along the bottom perimeter openings increased to an average of 215 ft/min in front of the sodium hydroxide tank, 200 ft/min in front of the neutralizer tank, and 210 ft/min in front of the oil tank.

Adequate contaminant control probably occurs when the plexiglass doors are closed. However, the nature of the work forces workers to lean over the tanks when moving the parts bin, thus placing themselves in the pathway of contaminant exhaust. Movement of the parts bin from one tank to another by hand may result in dermal contact with rust preventive oil and caustic sodium hydroxide solution.

HVAC Units The outside air intakes were free of debris and were drawing outside air into the units. However, the filters were in poor condition and heavily coated with an oily, tar-like matter. The coils were also contaminated with oil. Employees report that

smoke billows out of the HVAC units when the heating coils are activated. No mold, biological growth, or water accumulation in the condensate pans or coils was observed.

Medical

Medical Record Review The findings of the medical record review are summarized in Tables 6-8. Although the number of employees at the plant has decreased, the number of employees with reported skin conditions has decreased to a greater extent. The proportion of skin conditions reported from 1989 to 1991 declined from 11% to 5%. The data for 1992, although only reviewed through early December, 1992, appear similar to the data for 1991. The number of departments with employees reporting skin conditions has declined from 13 in 1989 to 7 in 1991 and 6 in 1992. In 1989 the highest proportions of skin conditions were found in the Cup Outside Diameter (27%), A & I (24%), and Roll Grind (18%) departments. In 1992, the highest proportions of skin conditions were in the Cup Inside Diameter (18%), Roll Grind (11%), and A & I (11%) departments.

Medical Interviews The medical histories of the eight employees out on medical leave were not consistent with any one unifying diagnosis. No one set of factors or exposures was identified as being involved in the etiology of the different employees' medical problems. Three of the eight employees did report a primary problem consistent with sensitization to petroleum products. These three all report significant angioedema-like symptoms (swelling) upon any exposure to petroleum products, and in two of the three such exposures were reported to cause diffuse urticarial wheals (hives). The symptoms of two of the three employees began while they were working in the A & I department, in 1985 and 1988. The third employee last worked in 1985, in a department no longer present at NTN Bower.

VII. DISCUSSION

Review of the medical records revealed that the proportion of employees with reported skin conditions decreased from 1989 to the present. This decrease could be a result of reduced exposures, or it could be secondary to workers who have skin problems having left work at this plant. Nevertheless, several departments (A & I, Roll Grind, Cup Outside Diameter) continue to have a large percentage of workers reporting dermatologic problems. In the A & I department, the type of glove may not be adequate to resist the rust preventive oil. In the Roll Grind department, most employees were not wearing gloves. Although steps have been taken to follow a number of the recommendations made in the previous HHE (see next section), efforts should continue to be made to decrease worker's exposures to *all* fluids (oils as well as cutting fluids) used in the manufacturing process. Avoiding exposure is key in controlling occupational skin disease.

The specific agent(s) causing the cases of dermatitis and urticarial reactions among employees at the NTN Bower plant remain unclear. The presence of detectable amounts of metals, including nickel and chromium, in bulk cutting fluid samples was not unexpected. As reported in the previous NIOSH investigation, metals are among a number of different substances used at this plant which are potential urticants, irritants, and sensitizers. In addition to the metal contaminants these include other contaminants, additives, a combination of ingredients, or their degradation products formed through heat or bacterial action.

Detectable concentrations of nickel were found in air samples from two different areas (one personal sample and one area sample). The concentrations in both samples were below the NIOSH REL; however, since nickel is a potential occupational carcinogen,

further air sampling should be conducted to better characterize employee exposures.

VIII. FOLLOW UP ON RECOMMENDATIONS FROM HETA 89-367

The following discussion refers to the recommendations made as part of HETA 89-367, found in Appendix A. The notation at the end of each paragraph refers to the section of Appendix A where the recommendation from HETA 89-367 can be found.

1. Efforts have been made to decrease the direct contact with cutting fluids. However, there are several areas of the plant in which skin protection is inadequate. Some employees in certain grinding areas, especially the Roll Grind department, were not wearing gloves because they could not manipulate small parts while wearing gloves. The physical/chemical properties of the cooling fluids used in the grinding areas are different than those of the oils used in assembly and inspection. Currently the same glove is used in both areas. (A.1.)

2. The importance of periodic hand-washing to remove oils and fluids from the skin should continue to be emphasized. We found adequate facilities available so that employees can wash with warm water and mild soap periodically and before breaks, at lunch time and at the end of the day. (A.2.)

3. Employees should shower at the end of the work shift. Employees in general are not showering at the end of the shift at the plant, although minimal shower facilities are available at the plant. Showering is not encouraged by management. The frequency of showering at the end of the day at home is unknown. (A.3.)

4. Barrier creams are available to the employees through the first aid department, and information regarding these creams is circulated to supervisors. (A.4.)
5. Our current survey of the plant revealed that most workers were wearing the proper short-sleeved clothing. Long-sleeved clothing could provide prolonged skin exposure to substances used in the plant. (A.5.)

6. Educational materials available to supervisors emphasize the need to report all skin conditions to the first aid department. (A.6.)

7. Management has been maintaining a log to track addition of biocide to the cutting fluids and has been following manufacturer's recommendations concerning periodic laboratory monitoring. (A.7., B.6.)

8. Additional mechanical exhaust in the form of a roof-mounted fan has recently been added in the roll grind area. Informal interviews revealed that this exhaust has significantly improved the air quality in that area. (A.8.)

9. The HVAC units reportedly bring 15-20% outside air into the plant. However, the filters and coils of several units were heavily coated with oil. (A.9.)

10. A new HVAC system, independent of the plant HVAC system, was installed in the break room, which reportedly has improved air quality in that area. (A.10.)

11. Pre-placement skin evaluation with the goal of limiting the ability of certain employees to work in certain areas of the plant can no longer be recommended. Engineering and administrative controls and personal protective equipment must be utilized to protect all workers from potential workplace hazards. (B.2.)

12. The educational program informing employees of potential skin problems which may

be associated with specific job duties appears to be inadequate when employees are transferred out of their usual departments to perform coverage duty. (B.3.)

13. The first aid department has the ability to refer employees directly to a dermatologist familiar with the substances used at the plant. This referral option is infrequently used because of difficulty scheduling appointments with the dermatologist. (B.4.)

14. No means of following trends in the occurrence of skin related complaints, such as a log devoted to skin complaints, has been established. Skin complaints are recorded in the general first aid department log or in the OSHA 200 log. (B.5.)

IX. RECOMMENDATIONS

Reducing employee skin contact with cutting fluids and oils is the best way to prevent occupational skin disease. The following recommendations are offered based on the current investigation and HETA 89-367:

1. The nitrile latex gloves used at NTN Bower have not been evaluated by the glove manufacturer for performance (degradation, break-through time, and permeation rates) against aliphatic hydrocarbons similar to the rust preventive oils.[11] Since these characteristics are useful in determining the reliability of a glove and the amount of time it can be worn, NTN Bower should consider a type of glove that has been evaluated. (The glove manufacturer could not provide this data to NIOSH.) Different glove manufacturers make gloves from similar materials but with different manufacturing techniques, resulting in significant variability in their ability to resist the same chemical. NTN Bower should also consider gloves having longer sleeves to reduce exposures to the arms. Employees should cuff the gloves to help prevent drips/residue from contacting the skin.

   The currently used glove has been evaluated for use with aqueous sodium hydroxide solutions and has been found to have good degradation characteristics.[11] Therefore, these gloves probably are adequate for protection against the alkaline cutting fluids. However, employees should conduct pre/post-use inspections of gloves to ensure that the integrity is maintained.

   NTN Bower should investigate other types of gloves for the roll grind area that might have greater worker acceptance. The currently-available surgical gloves were not used by workers during the NIOSH visit. NTN Bower should consider the type of glove used in the semiconductor industry, which permits a high level of dexterity and worker acceptance.

2. Educational programs should be continued to insure that all workers are informed of the possible health problems that may occur from frequent contact with cutting fluids, oils, and additives. Emphasis should be placed on personal hygiene and the reasons for using personal protective equipment. Special attention may be needed for employees who are assigned to temporary duties on short notice in their own or another department.

3. To monitor trends in the occurrence of urticaria and other skin conditions, a log of skin complaints should be maintained by the plant nurse. Cases of possible occupational dermatitis or urticaria should be recorded by department and job category so that any problem areas can be identified as early as possible. This information, minus personal identifiers, should be available to management and union representatives. Follow-up of high risk areas should include an industrial hygiene evaluation and a medical evaluation of similarly affected workers to determine work-relatedness. Based upon these evaluations, appropriate control measures (including engineering controls, product substitution, personal protective equipment, and personal hygiene procedures) should be implemented.

4. Puddles of cutting fluids or oils, from overflowing tanks or other equipment, were observed in several areas of the plant. These should be eliminated in work areas. As well as being a safety hazard (slips and falls), these fluids can saturate lower extremity clothing, leading to increased skin exposure. When required to work in an area where fluids are accumulating on the floor, employees should be provided with proper personal protective equipment.

5. NTN Bower should consider modifying the rust stripper in the A & I department so that the parts can move between tanks mechanically without direct worker interaction. Currently, this procedure is performed by hand, forcing the workers to stoop over the concentrated sodium hydroxide solution within the hood.

6. Communication between management and employees should be improved such that the results of all industrial hygiene sampling conducted by the company are made known to affected employees. OSHA regulations provide employees a right of access to relevant exposure and medical records.[12]

7. Maintenance of the roof HVAC units should be increased to prevent heavy oil accumulation on the filters and coils. This oil accumulation reduces air flow through the HVAC system and may pose a fire hazard. A log of preventive maintenance on the HVAC units should be kept.

8. Additional air sampling for nickel should be performed by NTN Bower to determine employee exposure for different job classifications.

XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

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2. UAW Local #1990
3. OSHA Region IV Office
4. PHS/NIOSH Region IV Office

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[1]
Numbers and Proportions of Skin Conditions by Department
for 1989 Using OSHA 200 log and Medical Department Records
NTN Bower Company
Hamilton, Alabama
HETA 92-280

Department	Number of Employees	OSHA 200[2]	Medical Dept.[3]	Total[4]	Proportion[5] (%)
Assembly and Inspection	75	5	17	18	24
Roll Grind	62	2	12	11	18
Cup O.D.	22	3	4	6	27
Cup I.D.[6]	17	0	1	1	6
Surface Grind	9	0	0	0	0
Cone Grind	57	2	10	9	16
Heat Treat	51	1	1	2	4
Press	21	0	1	1	5
Retainer	7	0	1	1	14
Automatics	19	0	3	3	16
Chuckers	56	0	2	2	4
Coldheaders	8	1	0	1	13
Roll Sort	10	0	0	0	0
Shipping	10	0	0	0	0
Tool Room	37	0	0	0	0
Tool Crib	8	0	1	1	13
Maintenance	75	1	6	7	9
Steel Gang	5	0	0	0	0
Press Tlspec	3	0	0	0	0
TOTALS	552	15	59	63	11

[1] Taken from a letter from NIOSH, Hazard Evaluations and Technical Assistance Branch, to NTN Bower and UAW Local 1990, dated 1/17/90, reporting preliminary findings for HETA 89-367
[2] # Skin conditions reported on OSHA 200 log
[3] # Medical visits for a skin condition
[4] # Employees from the OSHA 200 log and medical visits record; each person was counted only once.
[5] Total/Number of Employees x 100
[6] Formerly referred to as Race Grind

Table 2
Limits of Detection
NTN Bower Company
Hamilton, Alabama
HETA 92-280

Metal	Air Samples - Limits of Detection - micrograms per sample	Bulk Samples - Limits of Detection - micrograms per milliliter
Chromium	0.2	0.1
Copper	0.2	0.1
Iron	0.4	0.2
Magnesium	1.0	0.5
Manganese	0.2	0.05
Molybdenum	0.2	0.1
Nickel	0.4	0.2
Zinc	0.2	0.1

Table 3
Exposure Limits and Potential Health Effects
of Metals Found in Machining Operations
NTN Bower Company
Hamilton, Alabama
HETA 92-280

Element	Exposure Limit TWA ($\mu g/m^3$)†	Principle Health Effects[13,14]
Nickel	15 (NIOSH) 1,000 (OSHA) 1,000 (ACGIH)	dermatitis, nasal irritation, nasal and lung cancer
Chromium	500 (NIOSH)‡ 1,000 (OSHA) 500 (ACGIH)	severe skin and mucous membrane irritation, possible lung cancer
Copper	1,000 (NIOSH) 1,000 (OSHA) 1,000 (ACGIH)	upper respiratory irritation, dermatitis
Magnesium	NA (NIOSH)□ 10,000 (OSHA) 10,000 (ACGIH)	eye and nasal irritation
Manganese	1,000 (NIOSH) 3,000 STEL * 5,000 (OSHA) Ceiling 5,000 (ACGIH)	central nervous system effects, pneumonitis
Molybdenum	NA (NIOSH)□ 15,000 (OSHA) 10,000 (ACGIH)	eye irritation
Zinc	5,000 (NIOSH) 15,000 CEILING 15,000 (OSHA) 10,000 (ACGIH)	metallic taste, dry throat, cough; fresh fume can cause metal fume fever
Iron	5,000 (NIOSH) 10,000 (OSHA) 5,000 (ACGIH)	benign pneumoconiosis (siderosis)

† TWA ($\mu g/m^3$): 8-hour time-weighted average expressed in micrograms per cubic meter air.

‡ Chromium can occur in various oxidation states. Certain hexavalent chromium compounds (chromic acid and chromates) have been shown to be carcinogenic. NIOSH recommends controlling exposure to the lowest feasible concentration for these compounds. Chromium associated with grinding steel would not be expected to be hexavalent.[15]

□ NA: No NIOSH REL; NIOSH contends that health effects can occur below the PEL.

* STEL: 15 minute TWA exposure which should not be exceeded at any time during a work day.

Table 4
Bulk Sample Results
Metal Content of Cutting Fluids
NTN Bower Company
Hamilton, Alabama
HETA 92-280

Metal	Roll Grind High Speed Line (µg/mL)[1]	Roll Grind Conventional (µg/mL)	Cup Inside Diameter #224 (µg/mL)
Chromium[2]	0.4	ND	<0.2
Copper	<0.2	ND	<0.2
Iron	130	90	34
Magnesium	5.8	51	9.1
Manganese	1.9	2.7	4.0
Molybdenum	<0.2	0.1	<0.2
Nickel	<0.4	ND	<0.3
Zinc	<0.2	1.0	7.7

1 µg/mL: micrograms metal per milliliter of bulk solution.
2 < : metal was detected, but could not be accurately quantified at a concentration below indicated value.

Table 5
Air Sample Results
NTN Bower Company
Hamilton, Alabama
HETA 92-280

Metal REL/PEL[1] (µg/m³)	**Buffing Area (µg/m³)[2]**	**Tool and Die (µg/m³)**	**Cone Grind (µg/m³)**	**Roll Grind (µg/m³)**
Chromium 500/1000	2.4	2.9	0.7	0.5
Copper 1000/1000	0.4	0.4	1.6	ND[3]
Iron 5000/10000	390	72	123	68
Magnesium NA/10000[4]	3.2	1.3	2.7	1.3
Manganese 1000/5000[5]	0.6	0.7	2.0	0.6
Molybdenum NA/15000[4]	0.6	1.0	0.5	ND
Nickel 15/1000[6]	ND	13.1	1.3	ND
Zinc 5000/15000	0.6	1.8	4.3	1.6
Sample Type	Personal	Personal	Area	Area
Sample Volume (L)[7]	896	764	744	752

1 REL: NIOSH Recommended Exposure Limit as a time-weighted average for up to a 10-hour workday during a 40 hour week. PEL = OSHA Permissible exposure Limit as a time-weighted average concentration that must not be exceeded during any 8-hour work shift of a 40-hour workweek.
2 µg/m³: micrograms metal per cubic meter air sampled
3 ND: not detected.
4 NA: No NIOSH REL; NIOSH contends that health effects can occur at the PEL.
5 OSHA PEL is a ceiling value, not to be exceeded at any time.
6 NIOSH considers nickel metal a potential occupational carcinogen.
7 L: liters of air in sample.

Table 6
Numbers and Proportions of Skin Conditions by Department
for 1990 Using OSHA 200 log and Medical Department Records
NTN Bower Company
Hamilton, Alabama
HETA 92-280

Department	Number of Employees	OSHA 200[1]	Medical Dept.[2]	Total[3]	Proportion[4] (%)
Assembly and Inspection	60	4	10	14	23
Roll Grind	43	2	2	4	9
Cup O.D.	17	1	0	1	6
Cup I.D.[5]	18	1	3	4	22
Surface Grind	6	0	0	0	0
Cone Grind	40	0	0	0	0
Heat Treat	43	2	0	2	5
Press	15	0	1	1	7
Retainer	6	0	0	0	0
Automatics	8	0	0	0	0
Chuckers	35	0	3	3	9
Coldheaders	4	0	0	0	0
Roll Sort	5	0	2	2	40
Shipping	9	1	0	1	11
Tool Room	34	0	0	0	0
Tool Crib	8	1	0	1	13
Maintenance	61	1	3	4	7
Steel Gang	3	0	0	0	0
Press Tlspec	3	0	0	0	0
TOTALS	417	13	24	37	9

[1] # Skin conditions reported on OSHA 200 log
[2] # Medical visits for a skin condition
[3] # Employees from the OSHA 200 log and medical visits record; each person was counted only once. Employees with reported skin conditions from previous years were not excluded
[4] Total Cases/Number of Employees x 100
[5] Formerly referred to as Race Grind

Table 7
Numbers and Proportions of Skin Conditions by Department
for 1991 Using OSHA 200 log and Medical Department Records
NTN Bower Company
Hamilton, Alabama
HETA 92-280

Department	Number of Employees	OSHA 200[1]	Medical Dept.[2]	Total[3]	Proportion[4] (%)
Assembly and Inspection	57	6	2	8	14
Roll Grind	42	0	1	1	2
Cup O.D.	19	1	0	1	5
Cup I.D.[5]	15	1	1	2	13
Surface Grind	6	0	0	0	0
Cone Grind	34	0	0	0	0
Heat Treat	37	1	2	3	8
Press	18	0	0	0	0
Retainer	6	0	0	0	0
Automatics	4	0	0	0	0
Chuckers	36	2	0	2	6
Coldheaders	4	0	0	0	0
Roll Sort	4	0	0	0	0
Shipping	10	0	0	0	0
Tool Room	33	0	0	0	0
Tool Crib	8	0	0	0	0
Maintenance	58	1	0	1	2
Steel Gang	3	0	0	0	0
Press Tlspec	3	0	0	0	0
TOTALS	397	12	6	18	5

[1] # Skin conditions reported on OSHA 200 log
[2] # Medical visits for a skin condition
[3] # Employees from the OSHA 200 log and medical visits record; each person was counted only once. Employees with reported skin conditions from previous years were not excluded
[4] Total/Number of Employees x 100
[5] Formerly referred to as Race Grind

Table 8
Numbers and Proportions of Skin Conditions by Department
for 1992[1] Using OSHA 200 log and Medical Department Records
NTN Bower Company
Hamilton, Alabama
HETA 92-280

Department	Number of Employees	OSHA 200[2]	Medical Dept.[3]	Total[4]	Proportion[5] (%)
Assembly and Inspection	56	1	5	6	11
Roll Grind	44	1	4	5	11
Cup O.D.	15	0	1	1	7
Cup I.D.[6]	17	0	3	3	18
Surface Grind	8	0	0	0	0
Cone Grind	37	0	0	0	0
Heat Treat	42	0	1	1	2
Press	17	0	0	0	0
Retainer	5	0	0	0	0
Automatics	1	0	0	0	0
Chuckers	36	0	0	0	0
Coldheaders	5	0	0	0	0
Roll Sort	6	0	0	0	0
Shipping	5	0	0	0	0
Tool Room	34	0	0	0	0
Tool Crib	7	0	9	0	0
Maintenance	54	2	0	2	4
Steel Gang	2	0	0	0	0
Press Tlspec	2	0	0	0	0
TOTALS	393	4	14	18	5

[1] Through 12/4/92
[2] # Skin conditions reported on OSHA 200 log
[3] # Medical visits for a skin condition
[4] # Employees from the OSHA 200 log and medical visits record; each person was counted only once. Employees with reported skin conditions from previous years were not excluded
[5] Total/Number of Employees x 100
[6] Formerly referred to as Race Grind

APPENDIX A

A. HETA 89-367 recommendations from a letter from NIOSH, Hazard Evaluations and Technical Assistance Branch, to NTN Bower and UAW Local 1990, dated 1/17/90, reporting preliminary findings for HETA 89-367.

1. Direct contact with cutting oils should be avoided by wearing impermeable gloves and clean work clothing. Gloves should be lined, fit securely and cover at least one-third of the forearm. Torn or contaminated gloves should be replaced. Contamination occurs when employees allow their bare hands to contact oils and then place them inside the clean gloves.

2. It is important that oils be removed promptly from the skin with soap and water. Oil cloths for work purposes should not be used to wipe oil from the skin as metal particles present may cause skin abrasions. Conveniently located hand-washing facilities with an adequate supply of mild soap and clean towels should be available. Strong soaps, detergents, and abrasive-type cleaners should be avoided at work and at home. Solvents should not be used to clean the skin. Given adequate time for clean-up, warm water and mild soap should be sufficient for removing oils. Use of a skin moisturizer after washing helps to replace skin oils that are removed from the skin by exposure to oils and washing. Hand-washing should be required before breaks, lunchtime and at the end of the day.

3. Employees should shower at the end of the day in order to remove all traces of oil from the skin.

4. Barrier creams should be readily available to employees to reduce skin contact with oils. These creams do not prevent skin contact with oils, but may promote removal.

5. Short-sleeved overalls, rather than long sleeved clothing should be worn. Long-sleeves can become saturated with oils and metal which may increase the risk of skin problems by providing prolonged exposure to the oils.

6. Any skin injury or disorder should be immediately reported to the plant medical department.

7. A log should be kept of the dates and amounts of biocides or other additives added to cutting oil main reservoirs. A maintenance schedule for the additives should be established, rather than waiting for signs of bacterial overgrowth, such as noxious odors or loss of lubricity. Record keeping and periodic laboratory monitoring is needed to ensure that manufacturers' recommended concentrations for additives are not exceeded in working mixtures.

8. Eye and respiratory irritation was reported in the roll grind area. The one roof-mounted fan in this area should be supplemented with additional mechanical exhaust and a supply of tempered make-up air to provide more dilution ventilation and reduce oil mist concentrations. Additional or alternative controls that should be considered are electrostatic precipitators and wet centrifugal collectors, which may be directly mounted on grinding machines to collect and reuse oil.

9. In conjunction with the ventilation mentioned above, roof-mounted air handling units serving the grinding areas, which have been operated with 100% air recirculation, should be adjusted to provide outside air in sufficient volume to replace exhaust volume. A log should be kept of maintenance performed on these units, and air filter changes scheduled as necessary to prevent heavy oil accumulation (heavy accumulation was observed on two units).

10. Better housekeeping, maintenance, and ventilation is needed in the break room serving workers from the grind areas. The wall-mounted air conditioner filter and the wall vent filters should be replaced to improve ventilation efficiency and reduce oil mist infiltration into the break room. Both exhaust fan cowlings in the ceiling appeared to be dripping condensed oil.

B. HETA 89-367 recommendations from a letter from NIOSH, Hazard Evaluations and Technical Assistance Branch, to NTN Bower and UAW Local 1990, dated 5/24/90, reporting findings from HETA 89-367.

There is no one method that is known to prevent all skin exposures. The specific circumstances surrounding each case must be examined and different preventive measure tried till the best method is found. The following recommendations are offered:

1. Continue to implement the recommendations offered in our January 17, 1990 letter to reduce employee skin contact with cutting oils and lubricants.

2. 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 would be heavily exposed to cutting fluids.

3. The educational program informing new employees of the possible skin problems that may occur from frequent contact with cutting fluids and how to minimize exposure should be maintained. Current employees should also be encouraged to attend.

4. Because of the importance of early diagnosis and treatment of occupational dermatoses, all skin problems more severe than dry skin should be referred to a 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. A second medical opinion may sometimes be advisable because occupational dermatoses can be difficult to diagnose and treat.

5. To monitor trends in the occurrence of urticaria and other dermatologic conditions, a log of skin complaints should be maintained by the plant nurse. Cases of possible occupational dermatitis should be recorded by department and job category so that any problem areas can be identified as early as possible. This information, minus personal identifiers, should be available to management and union representatives. Follow-up of high risk areas should include an industrial hygiene evaluation and a medical evaluation of similarly affected workers to determine work-relatedness. Based upon these evaluations appropriate control measures (e.g., engineering controls, product substitution, personal protective equipment, personal hygiene procedures) should be implemented.

6. Isothiazolin-ones were not detected in any of the bulk liquids (except the undiluted biocide) or air samples. The biocide manufacturer recommends that a residual concentration of 5 to 17.5 ppm isothiazolin-ones be maintained at all times in the working cutting fluids to prevent excessive bacterial growth. Concentrations within this range, but below 12.1 ppm, would not have been detected by our analyses. Since there is no simple way to determine the concentration of isothiazolin-ones, careful monitoring of

bacterial levels, and maintenance of total bacteria counts at less than 10^5/ml is recommended by the manufacturer. Contact the biocide supplier for specific information on suggested schedules for addition of the product to cutting oils.

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