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Remington Arms Company, Inc.
Ilion, New York

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Douglas Trout, of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by John Decker and Patricia Sullivan. Desktop publishing by Pat McGraw.

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Health Hazard Evaluation Report 97-0118-2664
Remington Arms Company, Inc.
Ilion, New York
November 1997

Douglas Trout, M.D., M.H.S.

SUMMARY

In February 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) at the Remington Arms Company facility in Ilion, New York. The request regarded health complaints (headaches, sore throats, bloody noses, respiratory problems, skin irritation, and rashes) among machine operators potentially exposed to metalworking fluids (MWFs). Site visits were performed on March 17, and June 19-20, 1997, by NIOSH representatives. During the site visits safety and health procedures, hazard communication, personal protective equipment, and engineering controls were discussed, a symptoms questionnaire was distributed, and 12 bulk samples of MWF were collected to evaluate microbial contamination.

A total of 25 different MWFs were in use at Remington at the time of the follow-up visit; the fluids used in the greatest volume were semi-synthetic (water-based) fluids. The plant was in the midst of a change from the use of a central MWF system to the maintenance of fluids by individual sumps; the plant was also phasing out the use of one MWF, Cal-Lube 1705®. Air sampling results for oil mist conducted by Remington were reviewed; all were below the NIOSH Recommended Exposure Limit (REL) for mineral oil mist of 5 milligrams per cubic meter.

Nine hundred and eight of 946 (96%) non-supervisory employees took part in the questionnaire survey. All symptoms included in the questionnaire were reported more frequently among employees exposed to MWF. The most frequently reported symptom was 'sinus problems,' which was reported by 294 (31%) of the participants; 55 of the 294 (19%) reporting this symptom also reported that they felt it was related to work. The symptom groups most likely to be reported as work-related were irritation of the eyes, nose, or throat, which was reported as work-related by 85 (48%) of the 180 participants reporting this group of symptoms, and rash or skin irritation, reported by 33 (46%) of the 73 reporting this symptom. None of the physician-diagnosed medical conditions reported in the questionnaire (such as asthma) were reported more frequently in the MWF-exposed group.

Four of the 12 bulk samples yielded fungal growth (yeast, *Fusarium* species, and *Candida* species), and 10 of the 12 yielded bacterial growth. Bacteria identified in seven of the bulk samples included members of eight different bacterial genera (all gram-negative), including *Pseudomonas, Burkholderia, Shewanella, Acinetobacter, Citrobacter, Morganella, Psychrobacter,* and *Alcaligenes*. *Mycobacteria chelonae* alone was identified in three of the bulk samples.

Several aspects of Remington's program regarding maintenance and monitoring of MWFs are excellent. However, ongoing assessment of employee exposure to MWF will remain an important issue for Remington and deserves appropriate resources to provide engineering and administrative controls to minimize MWF exposure, and to monitor potential employee exposures. Employees should be encouraged to report all potential work-related health problems to appropriate health care personnel. Remington should monitor reported health complaints in a system designed to identify particular job duties, work materials (such as particular MWFs), machines, or areas of the plant which may be associated with particular health effects. Although it is not yet clear which component or components of MWFs are associated with the respiratory and irritant symptoms, exposure to aerosolized MWF should be minimized. Improved maintenance of the MWF in specific machines is needed to minimize employee exposure to microbial contaminants.

KEYWORDS: SIC 3484 (small arms manufacturing) metalworking fluids, bacteria, fungi, mycobacteria.

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INTRODUCTION

In February 1997, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Mine Workers of America (UMWA) international union for a health hazard evaluation (HHE) at the Remington Arms Company facility in Ilion, New York. The request regarded health complaints (headaches, sore throats, bloody noses, respiratory problems, skin irritation, and rashes) among machine operators, specifically those with potential exposure to a particular metalworking fluid (MWF), Cal-Lube 1705®, in use at that time. An initial plant evaluation was performed on March 17, 1997, by a NIOSH industrial hygienist; that evaluation was summarized in a letter dated April 28, 1997. NIOSH representatives made a return site visit on June 19-20, 1997, to administer a symptoms questionnaire and to collect bulk MWF samples to evaluate for microbial contamination. A letter describing the return site visit was distributed in July 1997.

BACKGROUND

Worksite

The Remington facility in Ilion employs approximately 1100 workers in a one-million-square foot facility which manufactures and assembles several models of firearms. Approximately 450 employees work with metalworking fluids, and roughly 300 of these employees worked with Cal-Lube 1705® at the time of the initial NIOSH visit. Remington introduced the Cal-Lube 1705® about 18 months prior to the initial visit to improve tooling life for certain operations. The metal machined at Remington consists primarily of various grades of carbon steel, along with some stainless steel.

Metalworking Fluids

MWFs are used to reduce friction between the work surfaces and cutting tools and to remove excessive heat and metal chips. They can be categorized into three major classes: straight (insoluble) oils, soluble (emulsified) oils, and synthetic fluids. The water-based fluids (soluble oils and synthetic fluids) are prone to high levels of microbial contamination. Most water-based fluids have low concentrations of fungi except when a bloom occurs (often caused by a dramatic decrease in bacterial contamination).[1,2] Bacterial concentrations in MWFs often range from 10^5 to 10^8 colony forming units per milliliter of fluid (CFU/mL), but they can be as high as 10^9 CFU/mL, with the predominant bacterial species typically being gram-negative bacteria.[2-7] High concentrations of microbes are generally an indicator of the need for improved fluid maintenance.

Industrial use of MWFs is known to produce respirable particulates,[8] and exposure to MWF aerosols has been associated with an increased prevalence of respiratory symptoms, decreases in airflow over a work shift, occupational asthma, and hypersensitivity pneumonitis.[9-13] The relationship between cultured microbes from a given sample of MWF and potential health effects among exposed workers is unknown.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH investigators employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small

percentage may experience adverse health effectsbecause 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 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 Recommended Exposure Limits (RELs),[14] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®)[15] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[16] In July 1992, the 11th Circuit Court of Appeals vacated the 1989 OSHA PEL Air Contaminants Standard. OSHA is currently enforcing the 1971 standards which are listed as transitional values in the current Code of Federal Regulations; however, some states operating their own OSHA approved job safety and health programs continue to enforce the 1989 limits. NIOSH encourages employers to follow the 1989 OSHA limits, the NIOSH RELs, the ACGIH® TLV®s, or whichever are the more protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard and that the OSHA PELs included in this report reflect the 1971 values.

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 (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Occupational Exposure Criteria for MWFs

Several factors can affect an employee's exposure to MWFs, including the type of ventilation controls, the distance from the source of contaminant generation, and several indoor environmental parameters.[17] Occupational exposure criteria for mineral oil mists have been established. OSHA has an 8-hour TWA PEL of 5 milligrams per cubic meter (mg/m^3).[16] The NIOSH REL is 5 mg/m^3 for a 10-hr TWA and a STEL of 10 mg/m^3.[14] The ACGIH® also has a TLV® for oil mist of 5 mg/m^3 for an 8-hr TWA.[15] ACGIH® has also published a notice of intended change which would establish an additional TLV® of 0.005 mg/m^3 (8-hr TWA) for mineral oil mist containing polynuclear aromatic hydrocarbons.[15]

Water-soluble MWFs cannot be accurately analyzed using the oil mist sampling method. Thus, total mass measurements are generally made, knowing that the water-soluble oil portion of the sample collected must be less than the total mass. This measurement is the same one that is used for particulates not otherwise regulated (PNOR), utilizing NIOSH Method 0500.[18] At this time, there is no generic occupational exposure standard or guideline for water-soluble MWFs. NIOSH has proposed a REL of 0.5 mg/m^3 of total particulate for these water-soluble MWFs, based primarily on respiratory health effects.[19] There are no occupational exposure criteria that address microbial contamination in MWFs.

METHODS

Initial Site Visit

The initial site visit consisted of an opening meeting attended by representatives from Remington, UMWA, and Calgon Corporation (MWF manufacturer) in which employee concerns with the Cal-Lube 1705®, safety and health procedures, hazard communication, personal protective equipment, and engineering controls were discussed. Following the opening meeting, the NIOSH representative conducted a walk-through inspection of the first- and third-floor machining areas, interviews with 14 employees, and a closing meeting.

Follow-up Site Visit

During the follow-up visit, a symptoms questionnaire was distributed to all Remington workers in the gun manufacturing and assembling areas of the plant who agreed to participate. This was done over the course of a 24-hour period by administering the questionnaire to groups of workers in a large room. The questionnaire asked for information regarding health effects mentioned in the HHE request and others potentially related to MWF exposure; the questionnaire specifically asked about symptoms occurring in the two months prior to the survey. Information was also collected about medical history and non-occupational factors which may affect the occurrence of symptoms. Two NIOSH representatives were available at all times during questionnaire administration to answer questions and to collect the completed questionnaires.

The questionnaires were analyzed using Epi Info software.[20] The magnitude of the association between reported symptoms and MWF exposure was assessed by the prevalence ratio; a 95% confidence interval which excluded 1 was used to indicate statistical significance. See Appendix A for a further discussion of prevalence ratios and confidence intervals as used in this evaluation. Exposure to MWF was determined based on the department in which the employees worked -- Remington provided a list of departments in which MWFs were used. Additionally, employees in non-MWF-using departments who reported exposure to MWF in another department within the two months prior to the survey were considered exposed to MWF.

During the site visit, NIOSH representatives reviewed information provided by Remington concerning the use of MWFs at the plant. In addition, other MWF-related records were provided after the site visit had been completed.

After the questionnaire administration had been completed, a walk-through inspection of the plant was conducted and 12 bulk samples of MWF were collected from machines in the machining areas. Five samples were taken of MWF that visually appeared to be contaminated with microbial growth (no other MWF was seen that appeared to be contaminated); the other seven bulk samples were taken randomly from among the other machines in the machining areas. The primary purpose of the bulk sample collection was to compare the types of microbes isolated from Remington with isolates from other MWF-using facilities which NIOSH has evaluated. The samples were collected in 20-milliliter scintillation vials with Teflon™-lined caps and shipped by overnight delivery to the NIOSH contract laboratory. Sequential dilutions from each bulk sample were made, and then plated on either R2A agar for bacterial analysis or malt extract agar (MEA) for fungal analysis. The plates were incubated at room temperature for four to seven days; then the colony forming units (CFUs) were counted and the species were identified. Plates inoculated specifically to look for the presence of *Mycobacteria* species were held for a longer time. Results are reported as CFU/mL. The limit of detection (LOD) for the samples was 1.0×10^1 CFU/mL.

RESULTS

Initial Site Visit

The Remington plant has approximately 500 machines using MWFs. The ventilation in the manufacturing areas is primarily general dilution ventilation; a few machines (primarily grinders and high-speed lathes) are equipped with local exhaust ventilation. At the time of the initial site visit, Remington was using MWF supplied to individual machines by a central piping system. In that central system, after several weeks or months (typically less than a year), the metalworking fluid was returned to a central reclamation system, where the fluid was tested and treated by a Calgon representative. Lubricating and hydraulic oil (tramp oil) were removed, the concentration, pH, and bioactivity (using a Difco HYcheck® contact slide) were checked, and the fluid was filtered with a 5-micron filter. The MWF was designed to operate at a pH between 9 and 11. Various changes were made to the fluid based on the test results. According to Calgon representatives, MWF with bacteria counts exceeding 10^5 per milliliter generally required maintenance. In addition to the central system, MWF in 30 individual machines (selected by supervisors in the departments) were audited twice weekly by Calgon for refractometer readings (to monitor concentration), pH, and bioactivity. Under the coolant management contract, Calgon was required to perform periodic laboratory analyses of coolant samples. In addition, the Calgon representative established pump-out and machine clean up schedules on an on-going basis.

Hazard communication training is provided annually (or whenever the process changes) at Remington by the employee's supervisor. The supervisors provide training on work practices, personal protective equipment, labeling, and Material Safety Data Sheets (MSDSs). Employees working with MWF use nitrile or neoprene gloves and vinyl coated Tyvek® aprons. Barrier cream (Stokoderm®) is also available. Respirators are not required in MWF areas, but a few employees were using particulate respirators. When assigned a respirator, the employees are included in the on-site respiratory protection program. Replacement personal protective equipment (PPE) was readily available in cabinets near the work areas. Clean-up areas for hand and arm washing were available and in good condition.

During the tour of the first and third floor areas, all the machinery observed was labeled with the type of coolant and its proper concentration. Charts were posted specifying recent refractometer readings. Log sheets were located at each machine for operators to record the refractometer concentration readings and what maintenance activities, if any, had been performed on the coolant. According to the log sheets, most MWFs were being monitored one or two times per day, although the policy at that time was to monitor three times a day. In some cases, machinery may not have been running for entire shifts, so monitoring was not conducted three times per day. MSDSs were available and kept with the MWF paperwork. No unusual odors or visually-deteriorated MWF were observed. Housekeeping in the plant was excellent. The floors were clean (not slippery) indicating that spills were cleaned promptly. The machinery was relatively clean and well-maintained, and the shields to prevent splattering were in place and being used.

Interviews

Interviews were conducted with nine employees selected at random. The employees had an average age of 46 (range: 30 to 57) and had worked at Remington for an average of 18 years (range: 3 to 26). All employees reported that they either currently worked with Cal-Lube 1705® or had done so in the past. Six employees reported no health symptoms they attributed to the work environment. Three employees reported upper respiratory symptoms that they associated with

working with Cal-Lube 1705® (two with throat irritation and one with excessive sneezing at the beginning of the shift). The employees reported that they first recognized their symptoms between a few months and one year prior to the interviews. Two of the three employees reported that their symptoms were worse toward the end of the work shift, but the other employee reported it was worse at the beginning of the shift. For all three, their symptoms reportedly resolve when they leave the work environment. None of the employees wore a respirator, and all reported that they used gloves and aprons. One employee reporting symptoms was a current smoker. None of the employees reported having dermatitis currently or in the past. None of the employees reporting symptoms were under the care of a physician for their symptoms or any other health problem.

Additional interviews were conducted with five employees selected by the UMWA. The employees had an average age of 48 (range: 43 to 53), and had worked at Remington for an average of 24 years (range: 16 to 32). Two were current smokers. Three of the five employees were currently working with the Cal-Lube 1705®. Two employees were belt sanders who worked in the vicinity of machinery using Cal-Lube 1705®. Four of the five employees reported upper respiratory symptoms (dry or sore throats, post-nasal drip, and/or stuffy nose), and three employees reported burning eyes; all attributed their symptoms to Cal-Lube 1705® exposure. None of the employees reported a history of dermatitis. One employee reported having a rash (now resolved) after being exposed to a cutting fluid that "foamed up."

Employees from both groups of interviewees indicated that maintaining the proper concentration ranges for the Cal-Lube 1705® was difficult, and that their symptoms in some cases may have been related to MWF concentrations above the recommended range. These problems reportedly occurred before implementation of the refractometer monitoring. All employees interviewed were well-informed regarding MWF and their responsibilities for maintaining the fluids.

Several employees indicated they did not feel comfortable reporting health problems to the medical clinic. They felt they would be labeled as "complainers," and would possibly be transferred to different job that would eventually be abolished.

Follow-up Site Visit

Record Review - A total of 25 different MWFs were in use at Remington at the time of the follow-up visit, although many of those were used in small quantities in a small number of machines. The fluids used in the greatest volume were semi-synthetic (water-based) fluids. Several changes had occurred in the use and management of MWF at Remington since the initial site visit of March 1997. As had been planned at that time, Cal-Lube 1705® was being phased out of use. As of the June site visit, Cal-Lube 1705® was being used in approximately 9% of the machines (as opposed to approximately 70% at the time of the initial site visit) and made up approximately 6% of the MWF used at the plant based on machine sump volumes. Remington representatives reported that the reason for the change in the MWF was primarily related to machine tool performance.

Maintenance of the MWFs is now primarily the responsibility of a Remington employee (formerly a contractor maintained the MWF). MWF records are being computerized to allow for access to data regarding use and maintenance. MWFs are used on an individual machine basis; use of the central system was discontinued. A battery of tests are performed by the MWF coordinator on a varying schedule (based on factors such as operator reports and machine performance) to determine fluid viability. Each machine is being equipped with a maintenance log and a tag describing fluid type in use.

Air sampling results for oil mist conducted in the past by Remington were reviewed. All results were below the NIOSH REL for mineral oil mist of 5 mg/m^3. Four personal breathing zone (PBZ) samples and one area sample collected in 1996 ranged from less than 0.2 mg/m^3 to less than 0.5 mg/m^3 as TWAs. Thirty-nine area and PBZ samples were collected in February and March 1997. The results ranged from 0.18 - 2.1 mg/m^3, with a mean of 0.66 mg/m^3 and a median of 0.53 mg/m^3. PBZ air concentrations for five machine operators thought to have the highest exposures were found to be 0.26, 0.28, 0.32, 0.39, and 0.99 mg/m^3 as TWAs. The air concentration in the first floor grinders area was 1.3 mg/m^3 as a TWA.

Questionnaire Survey

The Remington manufacturing areas are organized primarily by department; employees from 71 departments took part in the questionnaire survey. A total of 950 employees took part in the survey including 620 first shift employees, 229 second employees, and 94 third shift employees. Forty two (4%) of the 950 participants reported their job as supervisor. Nine hundred forty six non-supervisory workers were eligible to participate in the survey; therefore, the participation rate for non-supervisory workers was 96% (908/946). Exposure to MWF was determined based on the department in which the employees worked; 23 of the 71 departments use MWFs in their routine operations. Of the 950 participants, 441 currently worked in departments using MWF and 74 others reported using MWF in the two months prior to the survey, for a total of 515 (54%) employees exposed to MWF in the two months prior to the survey (these employees are considered 'MWF-exposed'). The mean age of all participants was 48 years (the mean age of MWF-exposed was 47; that of MWF-unexposed was 49); the mean time working in the current department for all participants was 90 months (mean for MWF-exposed was 81 months; that for MWF-unexposed was 100 months). Two hundred fifty one (26%) reported smoking cigarettes; 139 of 508 (27%) workers exposed to MWF reported smoking cigarettes, while 112 of 428 (26%) unexposed workers reported smoking cigarettes.

Table 1 presents the number of participants reporting symptoms. The most frequently reported symptom was 'sinus problems', which was reported by 294 (31%) of the participants; 55 (19%) of the 294 reporting this symptom also reported that they felt it was related to work. The symptom groups most likely to be reported as work-related were irritation of the eyes, nose, or throat, which was reported as work-related by 85 (48%) of the 180 participants reporting this group of symptoms, and rash or skin irritation, reported by 33 (46%) of the 73 reporting this symptom.

All symptoms included in the questionnaire were reported more frequently among those employees exposed to MWF (Table 2), with prevalence ratios ranging from 1.4 - 2.6. Confidence intervals for the prevalence ratios for two of the symptoms included 1. Episodes of 'flu' (defined as fever, coughs, and aches) and pneumonia in the two months prior to the survey were more common among the MWF-exposed workers, but the differences between the exposure groups were not statistically significant. Symptoms consistent with chronic bronchitis (defined as productive cough present at least three months out of a year for more than two years) were more common among the MWF-exposed.

Eight-four (9%) of the 950 participants reported that they had been diagnosed by a physician with some respiratory, upper respiratory, dermatologic, or infectious condition, including 42 (4%) reporting a history of being diagnosed with a sinus disorder, 16 (1.7%) with a non-specific infection, 14 (1%) with bronchitis, 10 (1%) with asthma, five (0.5%) with allergies, and 4 (0.4%) with a dermatologic problem. None of the reported physician-diagnosed conditions were reported more frequently in the MWF-exposed group.

Bulk Sampling

Bulk sampling results and locations are presented

in Tables 3 and 4, respectively. Four of the 12 samples had detectable fungi (yeast, *Fusarium* species, and *Candida* species), and ten of the 12 had detectable bacteria. Bacteria identified from seven of the ten bulk samples included members of eight different bacterial genera (all gram-negative): *Pseudomonas*, *Burkholderia*, *Shewanella*, *Acinetobacter*, *Citrobacter*, *Morganella*, *Psychrobacter*, and *Alcaligenes*. Four of the five bulk samples which were taken from visually-contaminated sumps had both fungal and bacterial organisms detected; one had no growth. *Mycobacteria chelonae* was identified in three samples; in those samples, the mycobacterium was the only organism detected. No *Legionella* species were identified.

DISCUSSION

Several aspects of Remington's program regarding maintenance and monitoring of MWFs are excellent. However, ongoing assessment of employee exposure to MWF will remain an important issue for Remington and deserves appropriate resources to provide engineering and administrative controls to minimize MWF exposure, and to monitor potential employee exposures. Reports from workers during both site visits indicated that employees have been hesitant to report health problems to the Remington health clinic. For the company to respond to emerging problems, there must be a mechanism where employees feel comfortable reporting health problems.

Exposure to MWF is known to be associated with increased prevalence of respiratory symptoms, decreases in airflow over a work shift, and the occurrence of occupational asthma and hypersensitivity pneumonitis.[9-13] This survey found a small but consistent increase in reporting of respiratory and irritant symptoms among those workers who worked with MWFs during the two months prior to the survey and is thus consistent with findings of previous studies. Our survey did not reveal an unusual number or pattern of reported medical diagnoses among participants. Although it is possible that medical conditions could be under-diagnosed in this group, or that more severely affected workers may have left the workplace, the questionnaire does not provide information helpful in evaluating those possibilities.

Anecdotal information from some employees indicated that many of the symptoms employees were experiencing in the past were related to the use of Cal Lube 1705®. It was not possible to accurately assess whether exposure to Cal Lube 1705® (as compared to other MWF) was associated with the symptoms reported in our survey. Nevertheless, Cal Lube 1705® is being phased out at the Remington plant, so irritant symptoms specifically related to exposure to that MWF should no longer be an issue.

Finding microbial growth in 10 of the 12 bulk samples was not surprising, as MWF is known to be contaminated by microbes and collection sites were selected, in part, based on observed contamination. Our testing indicates that the determination of which MWFs are contaminated with microorganisms can not reliably be made visually. Although the acid-fast organism *Mycobacteria chelonae* has been found to be present in MWF associated with outbreaks of hypersensitivity pneumonitis,[12] the significance of finding any particular fungal or bacterial species in MWF is not clear at this time. Elevated concentrations of microbes in the MWF of individual machine sumps at Remington is, however, an indicator that improved maintenance of the MWF for those machines is needed.

RECOMMENDATIONS

1. To provide an adequate health and safety program for all employees, Remington should address employee reluctance to report health problems. Employees should be encouraged to report all potential work-related health symptoms to appropriate health care personnel. Remington should monitor reported health complaints in a system designed to identify particular job duties, work materials (such as particular MWFs), machines, or areas of the plant which may be associated with particular health effects.

2. Although it is not yet clear which component or components of MWFs are associated with the respiratory and irritant symptoms reported at Remington, exposure to aerosolized MWF should be minimized.

   a. If particulate concentrations for particular machines are found to be difficult to control, and/or if employees continue to experience symptoms related to a specific machine or process, then local exhaust ventilation (LEV) should be considered for those operations that are not automated. Any LEV which is installed must be properly and routinely maintained, especially if the air is recirculated, so that it does not become the source of a health hazard itself. For example, a poorly maintained mist collector can become an amplification site for microbes and could aerosolize them and their metabolites.

   b. Monitoring of workplace exposures to water-based MWF should continue to be performed by monitoring total particulates, ideally with personal breathing zone sampling.[18] Although there is no established occupational exposure standard for water-based MWF, guidance is provided by the proposed NIOSH REL of 0.5 mg/m^3.[19]

3. Machines and machine sumps found to be contaminated with microbes should be appropriately cleaned. Appropriate precautions should be taken to protect the health of workers performing the cleaning. This should include personal protective equipment to minimize skin contact with MWF and contaminants. If there is the potential to generate aerosols during the cleaning process, respirators should be worn to minimize inhalation of those aerosols. Respirators which should be considered for use in this type of work include the R-series or P-series NIOSH certified particulate respirators. Increased levels of respiratory protection (e.g., half-face respirators equipped with HEPA filters powered air-purifying respirators equipped with HEPA filters, etc.) may be required, depending on the level of visible contamination and/or the nature of the microorganisms present. These respirators must fit properly in order to provide the intended protection. If respirators are worn, a complete respiratory protection program must also be implemented that meets the requirements of the OSHA respiratory protection standard (29 Code of Federal Regulations 1910.134).[21]

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TABLE 1
Self-Reported Symptoms and Illnesses
HETA 97-0118, Remington Arms, Inc.

Symptom/Illness	Number (% of 950 participants) who reported symptom/illness	Number (% of previous column) who reported symptom as work-related[1]
Sinus problems	294 (31)	55 (19)
Dry cough	180 (19)	39 (22)
Cough with phlegm	183 (19)	23 (13)
Irritation of eyes, nose, or throat	180 (19)	85 (48)
Unusual tiredness or fatigue	142 (15)	39 (28)
Ache all over	110 (12)	24 (22)
Wheezing or whistling in chest	112 (12)	12 (11)
Tightness in chest	81 (9)	13 (16)
Unusual shortness of breath	76 (8)	19 (25)
Rash or skin irritation	73 (8)	33 (46)
Fever or sweats	66 (7)	12 (19)
Chills or shivering	37 (4)	6 (16)
Chest flu[2]	118 (13)	NA[3]
Symptoms consistent with chronic bronchitis[4]	54 (6)	NA
Pneumonia	6 (1)	NA

[1] A positive answer to the question "Do you think it (the symptom) is related to work."
[2] Chest flu defined as fever, cough, and aches.
[3] Not applicable.
[4] Symptoms consistent with chronic bronchitis defined as a productive cough occurring more than three months out of the year for more than two consecutive years.

TABLE 2
Reported Symptoms/Illnesses Among Employees Exposed and Unexposed to MWF
HETA 97-0118, Remington Arms, Inc.

Symptom/Illness	Number of Exposed (% of 515) reporting symptom/illness	Number of Unexposed (% of 435) reporting symptom/illness	Prevalence Ratio[1] [95% Confidence Interval]
Irritation of eyes, nose, or throat	136 (26)	44 (10)	2.61 [1.91 - 3.58]
Unusual shortness of breath	56 (11)	20 (5)	2.37 [1.44 - 3.88]
Dry cough	132 (26)	48 (11)	2.32 [1.71 - 3.15]
Tightness in chest	57 (11)	24 (6)	2.01 [1.27 - 3.18]
Chills or shivering	26 (5)	11 (3)	2.0 [1.0 - 3.99]
Unusual tiredness or fatigue	98 (19)	44 (10)	1.88 [1.35 - 2.62]
Wheezing or whistling in chest	77 (15)	35 (8)	1.86 [1.27 - 2.71]
Rash or skin irritation	50 (10)	23 (5)	1.84 [1.14 - 2.96]
Cough with phlegm	124 (24)	59 (14)	1.78 [1.34 - 2.35]
Fever or sweats	43 (8)	23 (5)	1.58 [0.97 - 2.58]
Ache all over	71 (14)	39 (9)	1.54 [1.06 - 2.22]
Sinus problems	183 (36)	111 (26)	1.39 [1.14 - 1.70]
Symptoms consistent with chronic bronchitis[2]	38 (7)	16 (4)	2.01 [1.13 - 3.55]
Pneumonia	4 (0.8)	2 (0.5)	1.71 [0.31 - 9.28]
Chest flu[3]	72 (14)	46 (11)	1.32 [0.93 - 1.87]

[1] Prevalence ratio for the reporting of the symptom among the MWF-exposed group compared with the MWF-unexposed group.
[2] Symptoms consistent with chronic bronchitis defined as a productive cough occurring more than three months out of the year for more than two consecutive years.
[3] Chest flu defined as fever, cough, and aches.

TABLE 3
Results of Bulk Sampling of Metalworking Fluids
HETA 97-0118, Remington Arms, Inc.

Sample #[1,2]	Concentration (Colony-forming units per milliliter of sample)	Organisms
1	$< 10^{1}$	Fungi
1	$< 10^{1}$	Bacteria
2	$< 10^{1}$	Fungi
2	$> 3 \times 10^{3}$	*Mycobacteria chelonae*
3	$< 10^{1}$	Fungi
3	$> 3 \times 10^{3}$	*Mycobacteria chelonae*
4	$< 10^{1}$	Fungi
4	$> 3 \times 10^{7}$	Multiple (> 2) genera/species Gram (-) Bacteria
5[3]	$< 10^{1}$	Fungi
5[3]	$< 10^{1}$	Bacteria
6[3]	6×10^{3}	*Fusarium*-like Fungi
6[3]	$> 3 \times 10^{7}$	*Acinetobacter sp.*, *Citrobacter sp.*
7[3]	4.4×10^{4}	Yeast, *Candida*, *Fusarium*-like
7[3]	6.2×10^{6}	Multiple (> 2) genera/species Gram (-) Bacteria
8	$< 10^{1}$	Fungi
8	2.5×10^{6}	*Psychrobacter sp.*, *Pseudomonas sp.*
9	$< 10^{1}$	Fungi
9	3.1×10^{6}	*Pseudomonas sp.*
10[3]	2.3×10^{2}	*Fusarium*-like Fungi
10[3]	$> 3 \times 10^{7}$	Multiple (> 2) genera/species Gram (-) Bacteria
11[3]	8×10^{1}	*Fusarium*-like Fungi
11[3]	3×10^{7}	Multiple (> 2) genera/species Gram (-) Bacteria
12	$< 10^{1}$	Fungi
12	$> 3 \times 10^{3}$	*Mycobacteria chelonae*

[1] Chart includes separate rows for fungal and bacterial determinations for each bulk sample.
[2] See Table 4 for bulk sample locations. [3] Samples taken from machines with visible MWF contamination.

TABLE 4
Bulk Sampling Locations
HETA 97-0118, Remington Arms, Inc.

Sample #	Location
1	Machine # N2024
2	Machine # 32232
3	Machine # 41134
4	Machine # 41528
5	Machine # 28926
6	Machine # 32668
7	Machine # 40653
8	Machine # 32650
9	Machine # 41041
10	Machine # N1827
11	Machine # 32297
12	Machine #39667

APPENDIX A

Prevalence ratios may be calculated using a table referred to as a 2x2 table which can be set up as follows:

		Symptom Present (+)	Symptom Absent (-)
Exposure variable	Present (+)	a	b
	Absent (-)	c	d

The prevalence ratio represents the prevalence of the symptom among the exposed group relative to the its prevalence among the unexposed group. The equation used is:

(a/a+b)/(c/c+d)

A prevalence ratio of 1 means that no association between the two variables has been found.

A prevalence ratio of 2 would mean that a person in the exposed group is 2 times more likely to have reported the symptom than a person in the unexposed group.

Confidence intervals provide information concerning the value of the true prevalence ratio for the variables and the population being studied. A 95% confidence interval means that there is a 95% chance that the prevalence ratio for the population will be within that interval. If the number 1 (representing an equivalent risk of the symptom being present among the two group) is not included within the confidence interval, we conclude that an association between the variables is likely (the two variables being: 1) exposure to MWF; and 2) a reported symptom). Conversely, if 1 is included within the confidence interval, we conclude that the data do not demonstrate an association between the variables.