NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2001-0381-2932
Smurfit-Stone Container Corporation
Missoula, Montana

March 2004

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluation and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (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 (OSHA) 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 employers 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.

HETAB also provides, upon request, technical and consultative assistance 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 NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Boris Lushniak of the Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS) and Dino Mattorano of HETAB, DSHEFS. Field assistance was provided by Debra Feldman, Loren Tapp, and Duane Hammond from NIOSH, and Paula Vance from Microbiology Specialists, Inc. Analytical support was provided by NIOSH laboratories and two contract laboratories: Microbiology Specialists Inc. in Houston, Texas, and Data Chem Laboratories in Salt Lake City, Utah. Desktop publishing was performed by Shawna Watts. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of Smurfit Stone Container

On June 13, 2001, NIOSH received a health hazard evaluation (HHE) request from the Paper, Allied Industrial, Chemical and Energy Workers Local 8-0885 to evaluate exposures possibly related to skin ailments among employees at Smurfit Stone Container Pulp and Paper Mill.

What NIOSH Did

We talked to employees in all areas of the plant including the OCC, paper mill, paper laboratory, and office area.

NIOSH physicians examined the skin of affected employees.

We surveyed the employees about skin problems, job tasks, work history, and work environment.

We collected several pulp, paper, and white water samples and analyzed them for chemicals, metals, and biological organisms (mold/fungi and bacteria).

What NIOSH Found

We found that 11% of the workers had dermatitis or folliculitis (potential work-related skin problems) on the day of the skin exams.

Workers were exposed to pulp, white water, and paper.

We identified several irritants and allergens that were used by workers in the normal working process.

No specific agent was thought to be responsible for the skin ailments.

Only small amounts of resin acids (naturally occur in pine trees) which can cause skin problems were found in the pulp.

Microorganisms found in the pulp may make existing skin problems worse or cause a secondary bacterial infection.

What Smurfit-Stone Container Managers Can Do

Continue with the Health Issues Task Force which was developed to address skin problems at Smurfit.

Provide appropriate gloves, aprons, and/or gloves to workers.

Screen recycled materials to minimize biological contamination.

Educate workers about factors that affect skin health: temperature, humidity, ultraviolet light, water, good personal hygiene, and good skin care.

What the Smurfit-Stone Container Employees Can Do

Report <u>any</u> skin rashes immediately to your supervisor or the nurse.

Wear gloves, aprons, and/or goggles to minimize exposures to pulp, paper, and white water.

Get involved with the Health Issues Task Force.

Take care of your skin especially during winter months when it is dry

What To Do For More Information:

We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2001-0381-2932

Health Hazard Evaluation Report 2001-0381-2932
Smurfit-Stone Container Corporation
Missoula, Montana
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Boris Lushniak
Dino Mattorano

SUMMARY

In March 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance (HETA 2001-0209) from the Occupational Safety and Health Administration (OSHA) regarding dermatitis among employees at Smurfit-Stone Container Corporation ("Smurfit"), a paper-production plant in Missoula, Montana. During an OSHA inspection at the plant, the OSHA inspector learned that over 60 employees had experienced a "skin ailment" over the previous two years. A NIOSH site visit was conducted in April 2001 to assist OSHA in determining the role of occupational exposures in the skin diseases. At that time, 14 of 25 employees interviewed and examined had rashes; at least nine of these appeared consistent with occupational contact dermatitis. HETA 2001-0209 was closed with a letter to OSHA (Appendix A) on July 11, 2001, concluding that there was evidence of work-related dermatitis among Smurfit workers. On June 13, 2001, NIOSH received a health hazard evaluation (HHE) request from the Paper, Allied Industrial, Chemical and Energy Workers Local 8-0885 to further evaluate specific exposures at the Smurfit paper mill to determine the source of the dermatitis. To assess workers' exposures, bulk samples of pulp, paper, and white-water were collected from various locations throughout the paper manufacturing process. Samples were analyzed for various chemicals (biocide and naturally occurring compounds), metals, and biological organisms (mold/fungi and bacteria) that could possibly account for the rash.

A self-administered questionnaire was used to obtain information on demographics, skin problems, job tasks, work history, and the work environment for all employees. Workers who indicated they had a rash on the day they completed the questionnaire and agreed to have their skin examined were examined by the NIOSH dermatologist. Three hundred fifty-four out of four hundred seven employees (89%) completed the questionnaire. Forty-three workers fit the case definition of having a chronic rash (i.e., having a high recurrence or continual rash). Forty workers fit the case definition of having work-related current rashes which were clinically consistent with either dermatitis and/or folliculitis. The questionnaire and skin examinations did not reveal a single type of skin problem but rather a variety of problems. Analysis of the questionnaire data showed a weak but statistically significant association between chronic rash and not always laundering work clothes (prevalence ratio 2.0 [confidence interval1.1-3.8]) and washing hands more than four times per day (prevalence ratio 1.9 [confidence interval1.1-3.2]). Most areas of the plant had workers with chronic rash, which was not associated with any specific area of the plant. There was a statistically significant association of a previous history of eczema and chronic rash

(prevalence ratio 4.4 [confidence interval 2.5 to 7.9]) although the number of workers with previous eczema was relatively small.

Chemical and metal analysis of the bulk materials did not identify any single compound in any substantial amount which we suspect would account for the reported dermal ailments. Mostly, trace amounts of typical biocide by-products and natural occurring compounds (e.g., pinene and resin acids) were found. Metals found in the pulp, paper, and white-water samples were found in the source water in similar concentrations and not of concern regarding skin problems. Results of the microbial analyses were unremarkable except in one sample, which contained *Pseudomonas aeruginosa* a secondary infectious agent of the skin. Coliforms, however, were present in some samples which indicate that pathogens (some are associated with skin ailments) may be present in the pulp even though they were not found in the NIOSH evaluation. In addition, during the initial site visit, a potential heat stress problem was identified in the rewinder area which could lead to excessive sweating and ultimately cause skin damage. Also, glass fibers were found in two bulk samples collected from the same area which is associated with dermatitis.

A health hazard was identified at the Smurfit pulp and paper plant in Missoula, Montana. Approximately 11% of the workers had dermatitis or folliculitis. A single definitive etiologic agent was not identified. However, exposure to pulp, white-water, and/or finished paper alone or in combination with resin acids, dust, biocides, glass fibers, and heat may play a role in the skin problems.

Based on the information gathered during multiple site visits, we recommend decreasing workers' exposures to the pulp and white-water. Controls such as elimination of potential sources of pathogens, administrative changes, and personal protective equipment are recommended.

Keywords: SIC 2621 (paper mills) pulp and paper, dermatitis, skin rash, biocide, white-water, biological contamination, aerobic bacteria, chemical analysis, resin acids, metals, volatile organic compounds, recycled paper, Kraft pulping

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INTRODUCTION

In March 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance (HETA 2001-0209) from the Occupational Safety and Health Administration (OSHA) regarding dermatitis among employees at Smurfit-Stone Container Corporation ("Smurfit"), a paper-production plant in Missoula, Montana. During an OSHA inspection at the plant the OSHA inspector learned that over 60 employees out of a total of over 400 had experienced a "skin ailment" over the previous two years. A NIOSH site visit was conducted in April 2001 to assist OSHA inspectors in determining the role of occupational exposures in the skin diseases among the affected workers. At that time, 14 of 25 employees interviewed and examined had rashes, at least nine of which appeared consistent with occupational contact dermatitis. HETA 2001-0209 was closed with a letter to OSHA on July 11, 2001 (Appendix A), concluding that some of the dermatitis among the Smurfit workers was work-related. On June 13, 2001, NIOSH received a health hazard evaluation (HHE) request from the Paper, Allied Industrial, Chemical and Energy Workers Local 8-0885 to further evaluate specific exposures at the paper mill to determine the source of the dermatitis.

BACKGROUND

Summary of HETA 2001-0209

In HETA 2001-0209, NIOSH investigators concluded that the dermatitis observed at Smurfit did not seem to be a single type of skin problem. The skin problems described involved multiple body parts and workers reported multiple causes. A number of potential workplace compounds or agents that could explain the skin problems were identified, but no single etiologic agent was found. Workers were exposed to pulp, paper, and paper dust, mostly on the hands and arms and to a lesser extent on the face, torso, and legs. Paper dust sampled in the rewinder area contained fibrous glass, likely from ventilation ductwork or building insulation, which is known to cause dermatitis.[1] Temperature and relative humidity measured during the NIOSH site visit indicated a potential heat stress problem, especially for workers in the rewinder area. Excessive sweating has been associated with skin ailments such as skin maceration, especially in the groin and armpit areas where skin surfaces are opposed to each other.[2] Lastly, OSHA collected bulk samples in which phenanthrene carboxylic acid derivatives such as dehydroabietic acid (resin acid) were identified. Such derivatives are naturally found in pine trees and are known skin sensitizers.[3]

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The Smurfit facility consists of two main production areas which are located in separate buildings **B** the Old Corrugated Cardboard Plant (OCC) and the Pulp Paper Production Facility (PPP). The OCC is a recycling facility. Three machines in the PPP produce thick paper from wood chips for use as liner paper in corrugated cardboard boxes. The plant utilizes a chemical pulping process commonly referred to as the Kraft pulping process. In this process, wood chips are chemically digested (under caustic conditions) to form a slurry (the primary pulp) used to form the final paper product. Paper machine # 3 was the focus of this HHE because it produces a majority of the paper and it was the focus of the previous HHE. In the OCC, used corrugated cardboard containers are pulverized into a slurry (the secondary pulp) in a hydropulper using white-water (water removed from the pulp which is recycled) and a large spinning blade. In 1999, the plant converted from a bleaching to a non-bleaching process, which required the use of biocides to reduce the number of pigment-producing bacteria in the pulp slurry (primary and secondary) that were previously controlled with bleach. Descriptions of the observed work areas follow.

Paper Machine #3

The paper machine is separated into two ends **B** wet and dry. At the wet end, primary and secondary pulps are spread onto a rapid moving wire (Fourdrinier wire) via the primary and secondary head-boxes to form a two-layered

paper. White-water is removed from the Fourdrinier wire by vacuum boxes located directly below the wire. White-water is recycled and a portion is piped to OCC for use during hydropulping. Material on the Fourdrinier wire is pressed and dried through a series of steam drier cams. The final paper product is wound onto a large reel at the dry end of the paper machine. The reel is moved via a crane a short distance to the rewinder area where paper is cut and rewound into small rolls. Rolls are moved by gravity and a conveyor belt to a scale for weighing. Paper samples are collected for analysis and sent to the paper testing laboratory adjacent to the paper machine.

Several compounds are added to the pulp at different locations during the paper making process. Prior to the pulp reaching the headboxes, alum, sulfuric acid, starch, wet strength resin, and barium sulfate dispersant may be added automatically depending on pulp characteristics. At the primary and secondary headboxes, pulp temperature, and pH are between 120-130^{N}F and 4.8-5.2, respectively. Biocides are added throughout the process. In general, Hercules biocide RX 4700® (active ingredients **B** N-alkyl dimethyl benzyl ammonium chloride and dodecylguanidine hydrochloride) is added to the pulp at the primary machine chest three times per day. Hercules biocide RX 3600® (active ingredients **B** Bis (trichloromethyl) sulfone and N-alkyl dimethyl benzyl ammonium chloride) is continuously added at three locations within the pulp material flow including the OCC HiD tank at the decker feed pump, after the thin brokens tank before screening, and in the wet-end starch storage tank. Sodium hypochlorite is continuously added to white-water at the white-water excess tank.

OCC

Old corrugated cardboard containers are pulverized into pulp (secondary pulp) in a hydropulper through the use of recycled white-water from a paper machine and a large spinning blade. Excess waste and large foreign materials which are brought in with the previously used containers are removed from the hydropulper by a rope mechanism and by settling. After cardboard boxes are pulverized, the pulp is removed from the hydropulper and filtered through a series of screens and cyclones. Filtered pulp is transported up to the decker where excess water is removed via a large cylindrical screen. The remaining pulp is dumped into a large holding tank (HiD tank) where biocide RX 3600® is automatically added. When necessary, pulp is piped to the paper machine.

METHODS

On May 9, 2002, NIOSH medical officers and industrial hygienists conducted an opening conference to explain the HHE program as well as the specific purposes for the visit. This was attended by plant management and a union representative. We then conducted a walk-through survey of the facility including the chip yard, pulp mill, the PPP area, the OCC building, paper machines, and the paper laboratory. The site visit also included a questionnaire survey of employees, a dermatologic evaluation of workers currently reporting skin problems, and an industrial hygiene evaluation of pulp, white-water, and paper. In September 2002, NIOSH industrial hygienists returned to Smurfit to re-evaluate the pulp, white-water, and paper after management decided to decrease the overall microorganism counts and changed to a different biocide.

Medical

Questionnaires

On May 9-10, 2002, a self-administered questionnaire was used to obtain information (demographics, skin problems, job tasks, work history and the work environment) from all employees. The questionnaire was completed in groups of employees (20 to 60 workers at a time) in a common meeting area. NIOSH personnel were available in the meeting area to answer any questions regarding the questionnaire. The questionnaire included questions about skin problems experienced in the two years prior to the survey, the period during which skin problems reportedly

increased. Questions about recurrences or chronicity of the skin problem, seeing a health care provider, treatment, missing work, and job changes were asked as indirect indications of severity. Persons with a "history of rash" included those persons who reported having a "skin rash, dermatitis, or red inflamed skin" in the previous two years. The following information was also collected: the number of recurrences of the rash, how long the rashes lasted, treatment of the rashes with medications, and the effect of the rashes on workers' lives (for example, lost days from work, change of jobs, or change of work habits because of the rash).

Skin Exams

Employees who indicated that they had a skin rash on the day they completed the questionnaire and who agreed to have their skin examined were seen by the NIOSH dermatologist. Fifty-six workers were examined on May 9-10. Digital images of some of the skin problems were taken and diagnostic impressions were recorded on a physical exam form based upon history and physical examination of the skin. Diagnoses were made by the dermatologist at the time of the examination and shared with the workers examined.

Statistical Analysis

Two skin ailments were selected for analysis. A chronic skin rash was defined as a rash reported in the questionnaire to have frequent recurrences ("many, frequently, continuous, ongoing, several, weekly, often, a lot, chronic, daily" to describe occurrences) or a continual rash. For the purposes of this HHE, a work-related current rash was defined as a current rash seen by the dermatologist on May 9-10 and determined to meet all of the following criteria: (1) on physical exam the rash has the clinical appearance of dermatitis or folliculitis, (2) on physical exam the rash is in an anatomic distribution consistent with reported exposures in the job task (the latter obtained by worker history), (3) the rash effects a worker reporting workplace exposures to irritants or allergens (obtained by worker history), and (4) the rash's onset has a temporal relationship with workplace exposures (obtained by worker history). It is important to note that other commonly used criteria to establish work-relatedness were not able to be evaluated including: (1) nonoccupational exposures excluded as possible causes, (2) clinical improvement of the condition away from the exposure, and (3) skin patch tests or use tests identifying a probable causal agent.

Since a primary concern of the HHE requestors was that unidentified exposures in the production areas of the plant were causing the skin problems, the questionnaires were initially analyzed by comparing the prevalence of these conditions among workers in the paper production areas with that among office workers. Other potential risk factors for the skin problems were also evaluated, including use of unlaundered work clothing, washing of hands, and use of personal protective equipment (PPE) (including gloves).

Questionnaire data were analyzed using a statistical program (Epi Info 2002, Centers for Disease Control and Prevention, Atlanta, GA). The magnitude of relationships between potential exposures/risk factors and symptoms or illness was assessed by the prevalence ratio (PR). The PR represents the prevalence of the symptom in one group (e.g., those with certain exposures or practices) relative to the prevalence in the comparison group (e.g., those without those exposures or practices). A PR of 1.0 means there is no association between the symptom/illness and an exposure. A PR of greater than 1.0 indicates that there is evidence of an association. A PR of two would mean that a person in an exposed group may be two times more likely to have reported the symptom than a person in an unexposed group. A 95 percent confidence interval (95% CI) which excluded 1.0, or a significance level of $p \leq 0.05$, was considered to indicate a statistically significant finding. If the number of workers in a group or subgroup was small (i.e., less than 5), the Fisher exact test was used to test for statistical significance.

Industrial Hygiene

Industrial hygiene site visits were conducted in April 2001, May 2002, and September 2002. Based on observations made during these site

visits, dermal exposures were mostly to pulp and white-water on the hands and arms and to a lesser extent the face, neck, torso, and legs, depending on which activities were performed. Other potential exposures were to hydropulper waste material which some workers contacted as they removed foreign materials.

Bulk samples were collected and analyzed for agents that could be responsible for the reported skin ailments, including fungi, bacteria, organic compounds, and metals. Bulk samples of pulp, paper, and water were collected in amber glass vials with a Teflon[7] cap insert at 19 sites during the May 10, 2002, site visit and 23 sites during the September 5, 2002, site visit. At each site, three separate samples were collected for different analyses.

Fungi and Bacteria

Bulk samples for fungi and bacteria were weighed and the original volume recorded. Samples were then diluted with a known amount of sterile 0.02% polyoxyethylene sorbitan monolaureate solution in water. Microscopic examination of the specimen was done to semi-quantitate the presence of organisms for appropriate serial dilutions. Samples were then plated using a serological pipette (0.1 mls of specimen) onto various agars including inhibitory mold agar with chloramphenicol and gentamicin, malt yeast extract, buffered-charcoal yeast extract, Tryptic soy with polysorbate 80 and lecithin, MacConkey, Cellulose Czapek, Rose Bengal, and/or Littman Oxgall. Plated agar was then incubated at either 25 or 50°C and read at five, seven, and ten days.

Organic Compounds

Bulk samples were split and a portion was analyzed using a gas chromatograph equipped with a mass spectrometer (GC/MS) for identification of organic compounds. Except for the two solid samples (dry paper/final product), an aliquot of the liquid of each sample was decanted into a small vial and analyzed. The dry paper samples were extracted with carbon disulfide and concentrated prior to analysis. A portion of the aqueous layers was also extracted with methylene chloride and analyzed. Each sample was evaluated two ways: direct injection of the sample and headspace analysis of compounds off-gassing from the sample. A separate analysis was performed on the split samples to determine if resin acids were present. Bulk samples were analyzed by a high performance liquid chromatography (HPLC) procedure developed in the NIOSH laboratory for analysis of abietic and dehydroabietic acid which are resin acids naturally found in pine trees and which are known sensitizers. The dry samples were extracted with methanol before HPLC analysis.

Metals

Approximately 5.0 grams of each sample was weighed into a 150-ml beaker and wet ashed using NIOSH method, NMAM 7300.[4] The residues were redissolved in 10.0 ml of 4% nitric acid and 1% perchloric acid and analyzed.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff 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 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 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 increases 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),[5] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[6] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[7] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

The above occupational exposure criteria generally pertain to air sample results and in few cases to bulk material samples. The bulk samples collected at Smurfit do not have exposure criteria with which to compare results. Samples were collected from various locations throughout the pulp and paper manufacturing process so the results could be compared to each other. If one particular area contained increased concentrations of a chemical, metal, or biological organism or had very different types of compounds or microbes, it indicates that a closer look at that area was needed. Also the simple detection of certain compounds or microbes (*i.e., Pseudomonas aeruginosa*) in bulk samples was enough to warrant action since they have been associated with skin ailments.

RESULTS

Medical

Questionnaire

Three hundred fifty-four of four hundred seven employees (87%) completed the questionnaire. Descriptive statistics for questionnaire participants are included in Table 1. Eighty-eight percent of the respondents were male, ninety-five percent were white, the mean age was fifty years, and the mean years worked at Smurfit was twenty-one.

Workplace Habits/Hygiene

Results from questions dealing with workplace practices, including washing of hands, laundering of work clothing, and use of PPE are shown in Table 2. Of 348 respondents, 119 (34%) washed hands four to six times per shift at work, 141 (41%) one to three times, and 88 (25%) never washed their hands at work. Of 350 respondents, 167 (48%) always launder work clothing before rewearing. Of 345 respondents, 330 (96%) said they use some type of PPE such as gloves, safety glasses, barrier creams, and/or long sleeved shirts. Of 350 respondents, 234 (67%) use gloves always/most of the time and 116 (33%) used gloves occasionally, rarely, or never. Of 354 respondents, 33 (9%) used barrier creams always/most of the time and 209 (59%) wore long sleeves always/most of time.

Medical History

As for past medical history of the respondents, 20 (6%) had a history of eczema, 11 (3%) of psoriasis, 20 (6%) of acne, 17 (5%) of other rashes, and 11 (3%) of other skin diseases.

Reported Skin Problems

Overall, 129/354 (36%) reported a "history of rash" in the previous two years and went on to complete the full questionnaire. Those without a "history of rash" were not asked to complete the detailed part of the questionnaire dealing with rashes. Of those with a history of rash, 121 answered the question on first onset of the rash. Of these 42 (35%) had first noted a rash more than two years prior to the survey, 25 (21%) one to two years prior, and 54 (45%) within the

previous year. Of the 129, 119 answered the question about duration of the rash. Of these, 36 (30%) described the duration in terms of days, 19 (16%) in weeks, 18 (15%) in months, and 46 (39%) as continual. Of the 129, 113 described the number of occurrences of the rash in the previous two years. Of these, 28 (25%) had a single occurrence, 30 (27%) had two to four occurrences, and 12 (10%) had over five occurrences. The rash was always the same (same location, size, and characteristics) in 79 (64%) of the 124 who answered this question. Forty four of one hundred twenty-seven (35%) reported having allergies.

Of the 129, 127 answered the question about taking medications for the rash. Of these 54 (42%) were taking a medication to treat the rash. Of the 125 workers answering the question about having a current rash, 53 (42%) had noted a rash on the day of the survey.

Of those workers with a history of rash, the impact of the rash was as follows: 60 of 129 (47%) had seen a doctor, 22 of 111 (20%) changed work habits, 11 of 110 (10%) changed jobs and one of 106 (1%) had stayed home because of the rash. Of 129 workers with a history of rash, 54 (42%) listed something in the workplace which they felt causes the rash or makes the rash worse. The exposures/areas listed by these workers which they felt caused or worsened the skin condition included paper (10 workers), the wet end of the PPP (9), heat/humidity/moisture (9), dust (7), pulp (3), paper machine (2), friction/pressure (2), oil (2), and one each with the following causes: steam, coolant, hand washing, handling materials, hard hat, green liquor, dry end of plant, protective equipment, and wrist watch.

The parts of the body affected by the rash were as follows: 39 of 124 (32%) hands, [128 answered all of the following questions] arms 60 (47%), legs/feet 54 (42%), chest/back/abdomen 44 (34%), face 34 (27%), scalp 31 (24%), wrists 28 (22%), and groin/buttocks 23 (18%).

Forty-three workers fit the case definition of having a chronic skin problem and had used the terms "many, frequently, continuous, ongoing, several, weekly, often, a lot, chronic, daily" to describe occurrences. The prevalence of chronic skin problems by work area is shown in Table 3. The highest percentage of workers reporting chronic rash was found in the paper lab, workers working in multiple areas of the plant, maintenance, recovery, PPP, and office.

Skin Exams

Although 53 workers had noted that they had a rash on the day of the questionnaire, 56 requested or agreed to be seen by the NIOSH dermatologist. Clinical diagnoses made by the dermatologist at the time of the examination included 25 workers with dermatitis, 10 with folliculitis, five with both dermatitis and folliculitis, four with atopic dermatitis (eczema), four with no evident skin disease, three with seborrheic dermatitis, and one each with actinic keratosis (sun-induced lesions), post-inflammatory hyperpigmentation, rosacea, nail disease, and lichen planus. Of the skin conditions seen, only the dermatitis and folliculitis would be considered potential work-related diseases. Forty workers fit the case definition of having a work-related current rash (dermatitis and/or folliculitis). The body part most affected for these 40 workers included 14 on the lower extremities (35% of the total), nine on the hands (22%), seven on the trunk (18%), and five each on the face/scalp/neck and the upper extremities (12% each). The results of the skin exams by work area are shown in Table 4. Workers with a diagnosis of dermatitis and/or follicultis was found in the paper lab, recovery, workers working in multiple areas of the plant, maintenance, and PPP.

Evaluation of Skin Problems by Area and Evaluation of Risk Factors

Table 5 shows the risk of chronic rash and work-related current rash by potential exposure variables including production work, gender, unlaundered work clothing, washing of hands, and use of PPE, and separately gloves. Reporting a past history of eczema was associated with chronic rash and work-related current rash. There was also an association between not always laundering clothes and washing hands over four times per day and

chronic rash. None of the other work practices were associated with rash. Further analyses by specific work area are shown in Table 6. No specific work area was strongly associated with skin problems when comparing a specific work area with the rest of the plant.

Industrial Hygiene

Tables 7 and 8 describe the bulk sample collection locations from May 10 and September 5, respectively. Table 9 includes bacterial and fungal bulk sample results reported as total colony forming units per gram of sample (cfu/g). Included with the bacterial results are samples in which coliforms (*i.e., E. Coli*) were present. Coliforms are generally used as indicator organisms for monitoring water quality. Total coliforms are natural, generally harmless organisms commonly found in surface water (but not ground water). Coliforms are inactivated by standard water treatment or die off naturally in a manner similar to most bacterial pathogens. Therefore, if total coliforms are found in the water, this indicates that pathogens may also be present. Figure 1 illustrates the total aerobic counts for bacteria. Only samples collected during both site visits were included in Figure 1 for comparison purposes. From Table 9 and Figure 1 we can see an overall decrease in aerobic bacteria and fungi concentrations. This was expected since the company made a decision subsequent to the first NIOSH site visit to actively reduce aerobic bacteria and fungi counts through the use of different biocides and modified biocide application procedures.

Human pathogens such as *Pseudomonas aeruginosa, Staphylococcus aureus, and Streptopcoccus pyogenes,* which have been associated with skin ailments, were not found in any of the bulk samples except one: *Pseudomonas aeruginosa* was found in sample #18, the antiskid silicon dioxide spray system located near the top dryer of the steam drum line. It should be noted that this antiskid solution was not used during the NIOSH evaluation and is only used sparingly for certain types of paper.

Coliforms were found in five samples with sample #18 (described above) having the highest percentage (40% coliforms). Although pathogens were not found in most of the samples, the presence of coliforms in the pulp indicates that the presence of pathogens is possible. Since the only commonality of these samples (except #18) is the OCC recycling, the likely source of these organisms is the recycled material.

Evaluation of samples for organic compounds by the direct injection method produced no significant GC/MS peak identifications. Compounds were detected using the headspace method but only in trace concentrations. Most samples contained methanol, ethanol, alkyl benzenes (i.e., trimethyl benzene), and terpenes (i.e., a-pinene). Other compounds found in only a few samples included propylene and ethylene glycols. From a chemical perspective it is not unusual or unexpected to find trace amounts of the above mentioned compounds in pulp, white-water, and paper samples. All were major components or breakdown products of the biocides used at the plant except for pinene which is naturally found in pine trees.

Samples were evaluated for two resin acids, abietic and dehydroabietic acid (known skin sensitizers), which are typically found in pine trees. Results indicate that resin acids were not detected in most samples (concentrations were below the analytical limit of detection). Low concentrations (ppm range) were found in samples C-12, C-16, C-17, and C-20 which were the solid samples. For abietic acid the mean concentration was 48 μg/g and ranged from 14 to 100 μg/g. For dehydroabietic acid the mean concentration was 250 μg/g and ranged from 150 to 400 μg/g. The analytical limit of detection for abietic acid and dehydroabietic acid were 4 and 40 μg/g, respectively. It is not unusual to find resin acids in bulk paper since they are naturally occurring in pine trees; the concentrations measured at Smurfit are consistent with those reported in the scientific literature.[8]

Bulk samples of pulp, paper, and water were analyzed for 31 elements (metals). Only trace concentrations were identified in samples, similar to the concentrations found in sample #8,

the primary water supply for the plant. Major elements identified included (listed in order of abundance) sodium, potassium, magnesium, aluminum, and iron.

DISCUSSION

Dermatitis and Folliculitis

A general overview of occupational skin diseases is included in Appendix B. Because many workers had skin diagnoses related to a variety of forms of dermatitis and folliculitis, these two conditions will be emphasized here.

Contact dermatitis is the most common occupational skin disease. Epidemiologic data show that contact dermatitis makes up 90-95% of all occupational skin diseases.[9,10,11] Contact dermatitis (both irritant and allergic) is an inflammatory skin condition caused by skin contact with an exogenous agent or agents, with or without a concurrent exposure to a contributory physical agent (e.g., ultraviolet light). It is widely accepted that of all contact dermatitis, 80% is due to a nonimmunologic reaction to chemical irritants (irritant contact dermatitis) and 20% to allergic reactions (allergic contact dermatitis). Only certain chemicals are allergens, and only a small proportion of people are susceptible to them. Complete reviews of both irritant and allergic contact dermatitis are available in other sources.[12,13]

In dermatitis, the skin initially turns red and can develop small, oozing blisters (vesicles), and bumps (papules). After several days, crusts and scales form. Stinging, burning, and itching may accompany the rash. With no further contact the rash usually disappears in one to three weeks. With chronic exposure, deep cracking (fissures), scaling, and discoloration of the skin (hyperpigmentation) can occur. Exposed areas of the skin, such as hands and forearms, which have the greatest contact with irritants or allergens, are most commonly affected. If the chemical gets on clothing, it can produce rashes at areas of greatest contact, such as thighs, upper back, armpits, and feet. Dusts can produce rashes at areas where the dust accumulates and is held in contact with the skin, such as under the collar and belt line, at the tops of socks or shoes, and in flexural areas (e.g., front of the elbow, back of the knee). Mists can produce dermatitis on the face and anterior neck. Irritants and allergens can be transferred to remote areas of the body (such as the trunk or genitalia) by unwashed hands or from areas of accumulation (such as under rings or in between fingers). It is often not possible to clinically distinguish irritant from allergic contact dermatitis, as both can have a similar appearance and both can be clinically evident as an acute, subacute, or chronic condition. Workers with previous atopic dermatitis (eczema) may be at higher risk for developing occupational skin diseases, usually of an irritant nature.[1]

Extensive lists of irritants and allergens are available in reference books.[1,12,13] The most frequent causes of irritant contact dermatitis include soaps/detergents, glass fibers (fiberglass) and particulate dusts, food products, cleaning agents, solvents, plastics and resins, petroleum products and lubricants, metals, and machine oils and coolants.[11,14] Causes of allergic contact dermatitis include metallic salts, organic dyes, plants, plastic resins, rubber additives, and germicides/biocides.[11,14]

Folliculitis is defined as an inflammatory reaction in follicles resulting in skin lesions which may be papules (small bumps) or pustules (small pus-filled bumps). Folliculitis has a variety of causes, including infectious agents and occupational and environmental factors. *Staphylococcus aureus* is the most frequent cause of superficial pustular follicultis and this organism also causes furuncles (boils) which also begin in hair follicles.[15] Infections by other organisms (gram-negative bacteria) such as *Pseudomonas aeruginosa* (usually from hot tubs, whirlpools, or swimming pools), *Enterobacteriaceae*, *Klebsiella*, *Esherichia*, *Proteus*, or *Serratia* can also cause folliculitis.[15] Most infectious causes of folliculitis would not be considered work-related. But, various occupational and environmental factors can cause folliculitis, including mechanical and chemical effects.[1] Certain chlorinated

hydrocarbons, oils, greases, friction, and heat can produce folliculitis at sites of contact, especially when there is occlusion by clothing.[1]

In some cases, a contact dermatitis may appear to affect only the hair follicles resulting in a follicular contact dermatitis, which would appear clinically as a papular folliculitis. Formaldehyde, nickel, chrome, copper, fluoride, and a variety of chemicals found in cosmetics can produce a follicular contact dermatitis.[16]

The work-relatedness of skin diseases may be difficult to prove. The accuracy of the diagnosis is related to the skill level, experience, and knowledge of the medical professional who makes the diagnosis and confirms the relationship with a workplace exposure. Guidelines are available for assessing the work-relatedness of dermatitis and include the following criteria: (1) clinical appearance is consistent with a dermatitis, (2) workplace exposures to irritants/allergens, (3) an anatomic distribution consistent with reported exposures in the job task, (4) a consistent temporal relationship of exposure and disease, (5) nonoccupational exposures excluded as possible causes, (6) clinical improvement of the condition away from the exposure, and (7) skin patch tests or use tests identifying a probable causal agent.[17] Only some of these criteria were able to be evaluated in this HHE in defining the epidemiologic case definition of a work-related current rash. Further followup and diagnostic testing of effected employees would be necessary to meet all of the criteria listed above.

Even with guidelines the diagnosis may be difficult. The diagnosis is based on the medical and occupational histories and physical findings. The importance of the patient's history of exposures and disease onset is clear. In irritant contact dermatitis there are no additional confirmatory tests. Patch tests or provocation tests for irritants are discouraged because of a high false-positive rate. In many instances, allergic contact dermatitis can be confirmed by skin patch tests using specific standardized allergens or, in some circumstances, by provocation tests with nonirritating dilutions of industrial contactants.[12] Because people with contact dermatitis can develop long-term dermatologic problems, prevention is key. Strategies in the prevention of contact dermatitis include identifying allergens and irritants, substituting chemicals that are less irritating/allergenic, establishing engineering controls to reduce exposure, utilizing PPE such as gloves and special clothing appropriately, emphasizing personal and occupational hygiene, establishing educational programs to increase awareness in the workplace, and providing health screening.[14,18] The introduction of PPE must be considered carefully since it may actually create problems by occluding allergens or irritants or by directly irritating the skin. Similarly, the excessive pursuit of personal hygiene in the workplace may actually lead to misuse of soaps and detergents, which can result in irritant contact dermatitis.[19] The effectiveness of gloves depends on the specific exposures and the types of gloves used. The effectiveness of barrier creams is controversial,[20] and at times workers using barrier creams may have higher prevalence rates of contact dermatitis compared to those who do not use the creams.[21]

Potential Causes of Skin Problems at Smurfit

According to the Bureau of Labor Statistics, 15% of all recordable occupational injuries and illnesses in the paper and allied products industry are skin diseases.[22] These skin diseases can be caused by many agents, some of which Smurfit workers are exposed to. These include biocides, resin acids, and pathogens. We could not identify any specific exposure or area at work that was associated with the rashes among Smurfit employees.

Biocides, also referred to as slimicides or germicides, have been used in pulp and paper mills for decades to control the growth of microorganisms, especially the slime-producing molds. If these molds are allowed to amplify and build-up on equipment, the paper can be affected in different ways including causing "paper breaks." The biocides used at Smurfit are considered "quick-kill" types. The biocide is automatically pumped into the pulp or white-water at a specific time, at a specific rate, for a

specific amount of time. This causes a large killing of microbes. However, as the active ingredient(s) is used up, the numbers of microbes will then start to increase until the next addition of biocide. The goal is to control microbe growth below certain levels to keep equipment clean and to assure the quality of the paper. The quick-kill nature of these biocides is the likely reason no biocide active ingredients were identified in the air or bulk samples.

Biocides can cause both allergic and irritant contact dermatitis.[23,24,25,26,27] However, most skin rashes from biocides reported in the medical literature were from exposures to concentrated biocide. At Smurfit, a representative from the biocide supplier is located on site and is responsible for the biocide equipment and application. Therefore, no Smurfit workers should now be directly working with concentrated biocides. The only biocide exposure concern is for the wet end utility worker when collecting pulp samples from the headboxes. If pulp samples are collected at the time biocide is added then a biocide exposure may occur. However, it should be noted that only small amounts of biocide (tens of gallons) are added at any given time to large amounts of pulp (hundreds of thousands of gallons) and biocide exposure should be to only very dilute solutions.

Colophony (rosin), a natural component of pine trees, is composed mostly of resin acids (abietic and dehydroabietic acids) and fatty acids and is considered a skin sensitizer.[1,28] In the Kraft pulping process, these resin acids are mostly converted to sodium soaps and are dissolved in the residual cooking liquors.[29] However, trace amounts are still found in the paper. Even though resin acids were not found in most samples, they are most likely present but in concentrations below the analytical limit of detection. The concentrations that can cause skin problems are not known. The reason resin acids were detected in the solid (non-liquid) samples and not the others was because resin acids are not water soluble and during the paper making process when water is removed from the pulp (Fourdinier table) the resin acids are concentrated in the solid material.

As indicated from the fungal and bacterial sample results, Smurfit-Stone Container has reached its goal to reduce the overall aerobic bacterial and fungal counts in the pulp and white-water. However, the continued presence of coliforms in the pulp indicates that pathogens may be present in the pulp even though they were not found at the time of the NIOSH evaluation. From a dermal perspective, this is important not so much as a primary cause of dermatitis but as a secondary cause. For example, those who have a primary dermatitis due to other causes with dry, cracked skin (or other conditions which comprise the integrity of the skin) are susceptible to secondary bacterial infection if they contact pulp-containing pathogens. Also, pathogens such as *Pseudomonas aeruginos,* and *Staphylococcus aureus* may cause an infection of the hair follicles (folliculitis).

In general, our measurements of the chemicals and metals did not identify any one single compound in any significant amount which could account for the dermal ailments. Mostly, trace amounts of biocide by-products and natural occurring compounds (e.g., pinene and resin acids) were found in the bulk samples which are not unusual. However, it is important to note that resin acids are known skin sensitizers and can cause allergic contact dermatitis.[1] Finally, metals found in the pulp, paper, and white-water samples were found in the source water in similar concentrations and not of concern regarding skin problems.

CONCLUSIONS

Many exposures are present in the Smurfit workplace that could cause or exacerbate the skin problems experienced by employees. However, no single agent has been identified to be the cause of the skin problems. The skin problems described have varied characteristics, involve different body parts, and have different worker-reported causes or exacerbators. Some workers had skin conditions consistent with dermatitis and/or folliculitis, which in some circumstances can be work-related. Exposure to the pulp and/or finished paper B either of which

may serve as an irritant or allergen, alone or in combination with resin acids, dust, biocides, glass fibers, and heat (see Appendix A) **B** may well play a role. Not always laundering work clothes and washing hands more than four times per day appear to increase the risk for skin ailments. Most areas of the plant had workers with chronic rash and chronic rash was not associated with any specific area of the plant. Workers reporting chronic rash were found in the paper lab, workers working in multiple areas of the plant, maintenance, recovery, PPP, and office. A lower percentage of workers reporting chronic rash worked in the OCC, loading dock, chip dock, and the pulpmill. Although a history of eczema was associated with chronic rash, this could not explain the rash for most workers since relative few reported eczema.

RECOMMENDATIONS

Based on the above information and good occupational health practices, we recommend decreasing workers' exposures to the pulp and white-water due to the possible presence of bacteria and its potential for causing folliculitis or exacerbating existing skin conditions leading to a secondary bacterial infection. Review of the process and work practices revealed that engineering controls will not readily reduce workers' exposures to pulp and white-water. Therefore controls, such as elimination of potential sources of pathogens, administrative changes and personal protective equipment are recommended.

1. Based on bacterial results, it appears that OCC is a source of coliforms and possibly pathogens in the pulp. Therefore, controlling the quality of corrugated cardboard going into the OCC by screening for potential sources of coliforms (e.g., organic material, blood, and fecal material) before processing seems prudent and should eliminate or at least reduce the amount of coliforms in the pulp.

2. Periodically clean the antiskid spray system. The spray system operation manual may suggest a schedule but it is usually best determined by experience.

3. Personal protective equipment

   a. Use appropriate gloves, goggles, and aprons to minimize exposures to pulp and white-water. Appropriate protective clothing materials include butyl rubber, neoprene, or nitrile rubber. Exactly which PPE and when it should be used should be determined by the company and through discussions with employees. OSHA standard 29 CFR, part 1910, subpart I – Personal Protective Equipment provides good guidance.[30] Establish a comprehensive personal protective program which includes written procedures, proper selection, inspection and maintenance, and factors affecting quality of PPE.

      i. Written Procedures. Define the necessary PPE and ensure it is properly and consistently used and maintained. The use of PPE should be mandatory.

      ii. Proper Selection and Use. Specific task assessments should be conducted to define the potential hazard(s), and evaluate the potential for contact. PPE selection should be based on factors that include chemical resistance, comfort, and dexterity necessary for the task.

      iii. Inspection and Maintenance. Employees should be instructed how to inspect (before and after each use), use, and maintain their PPE. Chemical resistant gloves, aprons, eye protection, and footwear should be thoroughly rinsed with water whenever contact with pulp and white-water is suspected. Gloves should be rinsed prior to removal and replaced frequently. After cleaning, PPE should be stored properly.

4. Employees should take immediate action whenever there is skin contact with pulp and white-water. Exposed skin should be flushed with large amounts of running water or washed with soap and water as soon as possible. Residual soap should be washed off the skin surface. Clothing contaminated with pulp and white-water should be removed and laundered

prior to re-use. Special attention should be directed toward soaps and skin cleansers since they themselves can serve as irritants. Certain components of the soaps or moisturizers (e.g., lanolin and fragrances) are known allergens and may cause allergic contact dermatitis in sensitive individuals. Information regarding moisturizers, soaps, and skin cleaners should be included in the safety training curriculum.

5. Workers should be encouraged to report all potential work-related skin problems. These should be investigated on an individual basis by the company or consulting health care providers. Because the work-relatedness of skin diseases may be difficult to prove, each person with possible work-related skin problems needs to be fully evaluated by a physician, preferably one familiar with occupational/dermatological conditions. A complete evaluation would include a full medical and occupational history, a medical exam, a review of exposures, possibly diagnostic tests (such as skin patch tests to detect causes of allergic contact dermatitis), and complete follow-up to note the progress of the affected worker. Individuals with definite or possible occupational skin diseases should be protected from exposures to presumed causes or exacerbators of the disease. In some cases of allergic contact dermatitis, workers may have to be reassigned with retention of pay and employment status to areas where exposure is minimized or nonexistent.

6. Workers should be educated about factors affecting skin integrity as part of more comprehensive training on the prevention of work-related skin disease.

a. Temperature: too hot (excessive sweating) or too cold

b. Humidity: too much or not enough (dry skin)

c. Ultraviolet light: sunburn

d. Water: too much washing or not enough washing

e. Good personal hygiene

f. Emphasize good skin care

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Table 1
Description of Survey Participants
HETA 2001-0381-2932, Smurfit Stone
May 9-10, 2002 (n=354)

Sex No. (%)	Race No. (%)	Mean Age Years (Range)	Mean years at Smurfit (Range)	Shift (%)	Work Area No. (%)
Male 305 (88%)	White 330 (95%)	50 (21-74)	21 (1-43)	1st 179 (51%)	PPP 87 (25%)
Female 41 (12%)	Black 7 (2%)	Missing 1	Missing 1	Rotating/multiple 162 (46%)	Maintenance 86 (24%)
Missing info 8	Native American 5 (1%)			2nd 4 (1%)	Multiple work areas 41 (12%)
	Other 4 (1%)			3rd 5 (1%)	Office 40 (11%)
	Missing info 8			Missing 4	Recovery 37 (11%)
					OCC 13 (4%)
					Loading Dock 11 (3%)
					Chipdock 11 (3%)
					Paper Lab 9 (3%)
					Pulpmill 4 (1%)
					Other 14 (4%)
					Missing info 1

Table 2
Workplace Practices in Questionnaire Participants
HETA 2001-0381-2932, Smurfit Stone May 9-10, 2002 (n=354)

Workplace Practice	Number of respondents (% of total respondents)		
Handwashing (times per shift) (n=348)	119 (34%) 4-6 x	141 (40%) 1-3x	88 (25%) never
Type of soap used (n=183)	133 (52%) soap in restrooms	33 (11%) borax/boraxo	17 (5%) antibacterial soap
Laundering of work clothes (n=350)	167 (48%) always launder before rewearing	183 (52%) do not always launder before rewearing	
Use PPE (gloves, safety glasses, barrier creams, and/or sleeved shirts) (n=345)	330 (96%) Yes	15 (4%) No	
Use gloves (n=350)	234 (67%) always/most of the time	116 (33%) occasionally/rarely/ never	
Use barrier creams (n=354)	33 (9%) always/most of the time	321 (91%) occasionally/rarely/ never	
Use long sleeves (n=354)	209 (59%) always/most of the time	145 (41%) occasionally/rarely/ never	

Table 3
Number and Percentage of Workers with Chronic Rash* by Work Area
HETA 2001-0381-2932, Smurfit Stone
May 9-10, 2002 (n=354)

Work area (Number of respondents)	Chronic rash * (%)
Paper Lab (9)	3 (33%)
Multiple (41)	6 (15%)
Maintenance (86)	12 (14%)
Office (40)	4 (10%)
PPP (87)	9 (10%)
Recovery (37)	5 (14%)
Other (14)	2 (14%)
OCC (13)	1 (8%)
Loading Dock (11)	0
Chip Dock (11)	1 (9%)
Pulpmill (4)	0
Missing Info (1)	0
TOTAL (354)	**43 (12%)**

* Frequent recurrence of skin problems defined as "many, frequently, continuous, ongoing, several, weekly, often, a lot, chronic, or daily" occurrences.

Table 4
Number and Percentage of Workers with Dermatitis / Folliculitis by Work Area
HETA 2001-0381-2932, Smurfit Stone
May 9-10, 2002 (n=354)

Work area (Number of respondents)	Work-related current rash* (%)
Paper Lab (9)	2 (22%)
Multiple (41)	6 (15%)
Maintenance (86)	12 (14%)
Office (40)	2 (5%)
PPP (87)	11 (13%)
Recovery (37)	6 (16%)
Other (14)	0
OCC (13)	1 (8%)
Loading Dock (11)	0
Chip Dock (11)	0
Pulpmill (4)	0
Missing Info (1)	0
TOTAL (354)	**40 (11%)**

* A worker with a work-related current rash was defined as a worker with a current rash seen by the dermatologist on May 9-10 and meeting all of the following criteria: (1) a diagnosis of dermatitis or folliculitis, (2) an anatomic distribution consistent with reported exposures, (3) occurring in a worker reporting workplace exposures to irritants or allergens, and (4) the rash's onset reported to have a temporal relationship with workplace exposures.

Table 5
Exposure Variables Associated with Rash
(Prevalence Ratios and 95% Confidence Intervals)
HETA 2001-0381-2932, Smurfit Stone
May 9-10, 2002 (n=354)

	Chronic rash *	Work-related current rash†
Production workers compared to office workers	1.2 [0.5-3.3]	2.4 [0.6-9.6]
Males compared to females	0.6 [0.3-1.2]	2.6 [0.6-10.2]
Not always laundering work clothes before rewearing compared to always laundering	2.0 [1.1-3.8]‡	1.5 [0.8-2.7]
Washing hands >=4x per day at work compared to 0-3x per day	1.9 [1.1-3.2]‡	1.1 [0.6-1.9]
Not using any personal protective equipment (PPE) compared to using any PPE	0.5 [0.1-3.6]	0.6 [0.1-3.9]
"Occasional/rare/never" wearing gloves compared to "most of the time/always" wearing gloves	1.4 [0.8-2.5]	0.7 [0.4-1.4]
Past medical history of eczema compared to no history of eczema	4.4 [2.5-7.9]‡	3.0 [1.4-6.2]‡

* Frequent recurrence of skin problems defined as "many, frequently, continuous, ongoing, several, weekly, often, a lot, chronic, or daily" occurrences.

† A worker with a work-related current rash was defined as a worker with a current rash seen by the dermatologist on May 9-10 and meeting all of the following criteria: 1) a diagnosis of dermatitis or folliculitis, 2) an anatomic distribution consistent with reported exposures, 3) occurring in a worker reporting workplace exposures to irritants or allergens, and 4) the rash's onset reported to have a temporal relationship with workplace exposures.

‡ Statistically significant

Table 6
Prevalence Ratios and 95% Confidence Intervals of
Rash and Specific Work Areas Compared to the Rest of the Plant
HETA 2001-0381-2932, Smurfit Stone
May 9-10, 2002 (n=354)

	Chronic rash *	Work-related current rash†
Paper Lab	2.9 p = 0.08‡	2.0 p = 0.3‡
Multiple	1.2 (0.6-2.8)	1.3 (0.6-3.0)
Maintenance	1.2 (0.6-2.2)	1.3 (0.7-2.5)
Office	0.8 p = 0.4‡	0.4 p = 0.1‡
PPP	0.8 (0.4-1.6)	1.2 (0.6-2.2)
Recovery	1.1 (0.5-2.7)	1.5 (0.7-3.4)
Other	1.2 p = 0.5‡	0 p = 0.2‡
OCC	0.6 p = 0.5‡	0.7 p = 0.5‡
Loading Dock	0 p = 0.2	0 p = 0.3‡
Chip Dock	0.7 p = 0.6‡	0 p = 0.3‡
Pulp Mill	0 p = 0.6‡	0 p = 0.6‡

* Frequent recurrence of skin problems defined as "many, frequently, continuous, ongoing, several, weekly, often, a lot, chronic, or daily" occurrences.

† A worker with a work-related current rash was defined as a worker with a current rash seen by the dermatologist on May 9-10 and meeting all of the following criteria: 1) a diagnosis of dermatitis or folliculitis, 2) an anatomic distribution consistent with reported exposures, 3) occurring in a worker reporting workplace exposures to irritants or allergens, and 4) the rash's onset reported to have a temporal relationship with workplace exposures.

‡ Fisher Exact test for significance is used if the cell number of persons in a cell is <5; none of the results are statistically significant.

Table 7
Description of Bulk Sample Collection Locations (Initial Survey)
HETA 2001-0381-2932, Smurfit Stone
May 10, 2002

Sample Number	Sample Description	Note
1	OCC - Stock sample collected between dump chest and course screen #1; Old Corrugated Cardboard Recycling (OCC)	Stock = pulp. Stock made by hydropulping used cardboard with a huge blend-type machine and recycled white water.
2	OCC - waste water collected from #1 secondary cyclones; waste water removed from stock which is sent to sewer	Up until 1.5 years ago used to recycle this waste water, now it is no longer done.
3	OCC - recycled white water collected from decker area wash hose	Used to clean decker apparatus
4	OCC - stock collected from mixing tanks after AMA 160 added	AMA 160 is an n-alkyl dimethyl benzyl ammonium chloride quaternry ammonium compound
5	OCC - stock collected from OCC High Density (Hi D) tanks before AMA 160 added	
6	Machine # 3 - stock collected from secondary Machine Chest which includes primary stock (virgin) and brokens before AMA 160 added	Top layer of paper
7	Machine # 3 - stock collected from primary machine chest which includes OCC and primary stock	Bottom layer of paper
8	Machine # 3 - primary hot water/service water from onsite well before used in any process. Primary water supply.	Makeup water for Cloudy water chest and excess white water chest
9	Machine # 1&2 - water from Cloudy water chest which includes water from Fourdinier table	Used as dilution water for Hi D stock and OCC hydropulper
10	Machine # 3 - stock collected from Primary Buffer chest which includes primary and brokens	Stock then goes through refiners and white water is added for dilution
11	Machine # 3 - stock collected just before Primary machine chest. Stock includes primary and brokens	Sample collected after refiners which is where white water is added, this location is where workers collected and test stock for freeness, etc.
12	Machine # 3 - stock collected from Fourdinier table on side of vacuum box after secondary headbox just before dryer	Secondary headbox applies primary stock onto secondary stock to form the top layer of 2 layer board
13	Machine # 3 - white water from wire pit below Fourdinier table	Water very foamy, may include alum, acid, biocides, etc. because of of these are added at the headbox which is right at the head boxes, before fourdinier table
14	White water from excess tank, biocide is sodium hypochlorite	Used as dilution water for Hi D stock and OCC hydropulper
15	Sample collected from wet-end starch storage tank after AMA 110 is added	AMA 110 - Methylene bis (thiocyanate) biocide
16	Final product collected in the rewinder area	
17	Paper dust collected in rewinder area near paper slitters	
18	Sample of amorphous silica/service water spray system near top dryer at end of steam drum line	This solution is used on 69 and 72 lbs. paper to prevent large rolls from sliding during shipping
19	Service water sample collected from paper lab HVAC system	Service water used for humidification of paper lab

Table 8
Description of Bulk Sample Collection Locations (Follow-up Survey)
HETA 2001-0381-2932, Smurfit Stone
September 5, 2002

Sample Number	Sample Description	Note
1	OCC - Stock sample collected between dump chest and course screen #1; Old Corrugated Cardboard Recycling (OCC)	Stock = pulp. Stock made by hydropulping used cardboard with a huge blend-type machine and recycled white water.
2	OCC - waste water collected from #1 secondary x-cyclones; waste water removed from stock which is sent to sewer	Up until 1.5 years ago used to recycle this waste water, now it is no longer done.
3	OCC - recycled white water collected from decker area wash hose	Used to clean decker apparatus
4	OCC - stock collected from mixing tanks, on suction side of tank	OCC mixing tank is near tank farm and feeds all 3 primary machine chests
5	OCC - stock collected from OCC High Density (Hi D) tanks on suction side	Sample collected after biocide addition
6	Machine # 3 - stock collected from secondary Machine Chest which includes primary stock (virgin)	Top layer of paper. No biocide added to primary stock except through treatment of white water (dilution water)
7	Machine # 3 - stock collected from primary machine chest which includes OCC, primary stock and broke	Bottom layer of paper. RX4700 is added to prim. machine chest on top of tank. RX 4700 added 3X per day at 6am, 2pm and 10pm. Target conc. is 20 ppm.
8	Machine # 3 - primary hot water/service water from onsite well before used	Makeup water for Cloudy water chest and excess white water chest
9	Machine # 1&2 - water from Cloudy water chest which includes water from Fourdinier table	Used as dilution water for Hi D stock and OCC hydropulper
10	Machine # 3 - stock collected from Primary Buffer chest which includes primary and brokens	Stock then goes through refiners and white water is added for dilution
11	Machine # 3 - stock collected just before Primary machine chest. Stock includes primary and brokens	Sample collected after refiners which is where white water is added, this location is where workers collected and test stock for freeness, etc.
12	Machine # 3 - stock collected from Fourdinier table on side of vacuum box after secondary headbox just before dryer	Secondary headbox applies primary stock onto secondary stock to form the top layer of 2 layer board
13	Machine # 3 - white water from wire pit below Fourdinier table	Water very foamy, may include alum, acid, biocides, etc. because of of these are added at the headbox which is right at the head boxes, before fourdinier table
14	White water from excess tank, biocide is sodium hypochlorite	Used as dilution water for Hi D stock and OCC hydropulper
15	Sample collected from wet-end starch storage tank after RX 3600 is added	RX 3600 biocide contains dimethyl benzyl ammonium chloride, bis(trichloromethyl) sulfone, trimethylbenzene, and solvent naphthalene
16	Final product collected in the rewinder area	
17	Paper dust collected in rewinder area near paper slitters	
18	Sample of amorphous silica/service water spray system near top dryer at end of steam drum line	This solution is used on 69 and 72 lbs paper to prevent large rolls from sliding during shipping
20	OCC stock sample collected from decker after biocide is added and water is removed	Stock then goes to OCC HiD tank, biocide is RX3600 and is added continuously at the decker feed pump, target concentration is 2-4 ppm
21	Stock sample collected from Secondary buffer chest on suction side	Stock is virgin; no biocides are added
22	Stock sample collected from thin broke tank on suction side	Sample collected before biocide added, RX3600 is added after thin broke tank before screening
23	Stock sample collected from thick broken tank on suction side	Sample collected after water removal, biocide input and screening

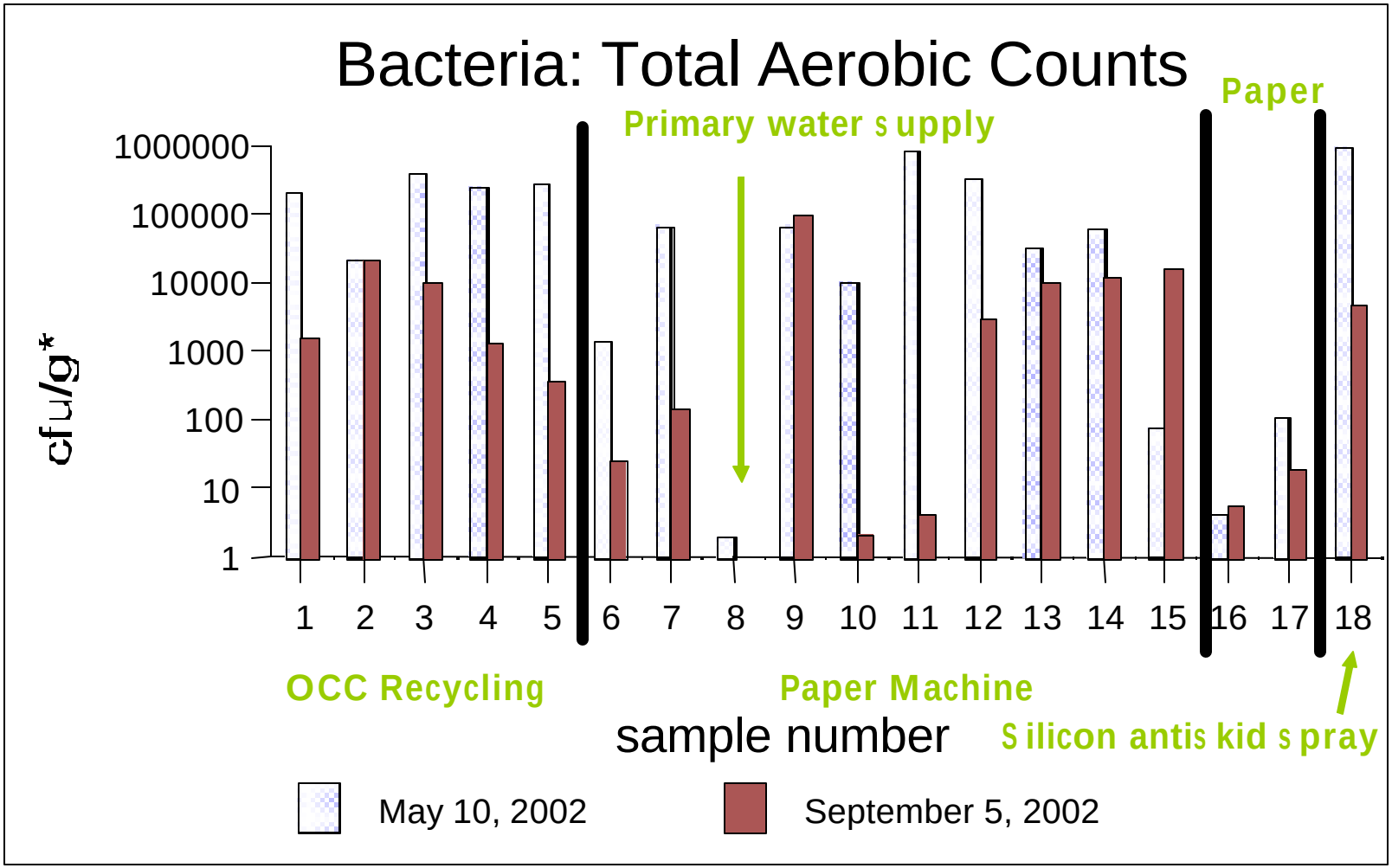
Note: No sample number 19

Table 9
Bacteria and Fungal Sample Results
HETA 2001-0381-2932, Smurfit Stone

Sample Number	Samples Collected May 10, 2002		Samples Collected September 5, 2002	
	Total Aerobic Count	**Total Fungal Count**	**Total Aerobic Count**	**Total Fungal Count**
1*	1.9×10^6	1.3×10^3	1.5×10^4	no fungus isolated
2	2.0×10^5	1.5×10^2	2.1×10^5	no fungus isolated
3	3.8×10^6	3.0×10^1	1.0×10^5	no fungus isolated
4	2.4×10^6	5.4×10^1	1.3×10^4 (1% Coliform)	no fungus isolated
5	2.6×10^6 (2% Coliform)	2.2×10^2	3.7×10^3 (<1% Coliform)	no fungus isolated
6	1.4×10^4	no fungus isolated	2.5×10^2	no fungus isolated
7	6.4×10^5	9.1×10^2	1.5×10^3	no fungus isolated
8	2.0×10^1	no fungus isolated	no bacteria isolated	no fungus isolated
9	6.5×10^5	2.1×10^3	9.1×10^5	7.2×10^1
10	1.0×10^5	no fungus isolated	2.1×10^1	no fungus isolated
11	8.1×10^6	2.3×10^1	4.1×10^1	no fungus isolated
12	3.0×10^6	2.8×10^3	2.8×10^4 (<1% Coliform)	1.0×10^0
13	3.0×10^5	9.6×10^3	1.0×10^5	1.1×10^1
14	6.0×10^5	no fungus isolated	1.2×10^5	no fungus isolated
15	7.8×10^2	no fungus isolated	1.5×10^5	no fungus isolated
16	4.0×10^1	no fungus isolated	5.6×10^1	no fungus isolated
17	1.1×10^3	no fungus isolated	1.9×10^2	1.9×10^1
18	8.8×10^6 (40% Coliform)	5.0×10^1	4.7×10^4	no fungus isolated
19	5.1×10^2	no fungus isolated	no sample collected	no sample collected
20	no sample collected	no sample collected	6.1×10^3	no fungus isolated
21	no sample collected	no sample collected	1.1×10^1	no fungus isolated
22	no sample collected	no sample collected	7.7×10^3	no fungus isolated
23	no sample collected	no sample collected	2.4×10^4	3.0×10^0

* Samples are reported as colony forming units per gram of material (cfu/g) collected.

Figure 1
Bacteria: Total Aerobic Counts
HETA 2001-0381-2932, Smurfit Stone



APPENDIX A

July 11, 2001
HETA 2001-0209

David DiTommaso
Montana Area Director
U.S. Department of Labor
Occupational Safety and Health Administration
2900 4th Ave North, Suite 303
Billings, Montana 59101

Dear Mr. DiTommaso:

On March 14, 2001, the National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance from the Occupational Safety and Health Administration (OSHA) regarding dermatitis among employees at Smurfit-Stone Container Corporation (hereinafter referred to as Smurfit), a paper-production plant in Missoula, Montana. During an OSHA inspection at the plant it was noted (through informal interviews with workers) that over 60 employees of the plant had suffered a "skin ailment" over the previous 1-2 years. On April 10-12, 2001, we conducted an initial site visit as well as confidential directed interviews of 25 employees. During the 3 weeks prior to our arrival, the OSHA representatives conducted employee interviews, obtained medical records, and conducted both bulk pulp and raw material sampling as well as air sampling. This letter contains final observations, results, and recommendations from the site visit and subsequent chart review.

BACKGROUND and PROCESS DESCRIPTION

Smurfit consists of two main areas of production which are located in separate buildings B the Old Corrugated Cardboard Plant (OCC) and the Pulp Paper Production Facility (PPP). The OCC is a recycling facility. Three machines in the PPP produce thick paper from wood chips for use as liner paper in corrugated cardboard boxes. The paper produced on-site is shipped elsewhere for incorporation into cardboard boxes. The plant utilizes a chemical pulping process commonly referred to as the Kraft pulping process. In this process, wood chips are chemically digested (under caustic conditions) to form a slurry (the primary pulp) used to form the final paper product. Because of high electricity prices (due to power shortage on the west coast), only paper machine #3 was in operation during this site visit. In the OCC, the used corrugated cardboard containers are pulverized into a slurry (the secondary pulp) in a hydropulper through the use of recycled white-water (from the paper machine) and a large spinning blade. Approximately 24 months ago, the plant converted from a bleaching to a non-bleaching process, which required different biocides to reduce the number of pigment-producing bacteria in the pulp slurry that were previously controlled with the bleach. Descriptions of the observed work areas follows.

Paper machine #3

The paper machine is separated into two ends B wet and dry. At the wet end, primary and secondary pulp are spread onto a rapid moving wire (Fourdrinier wire) via the primary and secondary head-boxes to form a two layered paper. The liquid portion of the pulp, "white-water", is removed from the Fourdrinier wire by vacuum boxes located directly below the wire. White-water is recycled and a portion is piped to OCC for use during hydropulping. Material on the Fourdrinier wire is then pressed and dried through a series of steam drier cams. The final paper product is wound onto a large reel at the dry end of the paper machine. The reel is moved via a crane a short distance to the rewinder area where paper is cut and rewound into

small rolls. Rolls are moved by gravity and a conveyor belt to a scale for weighing. Paper samples are collected and sent to the paper testing laboratory adjacent to the paper machine for analysis.

Several compounds are added to the pulp at different locations during the paper making process. Prior to the pulp reaching the headboxes, alum, sulfuric acid, starch, wet strength resin, and barium sulfate dispersant may be added automatically depending on pulp characteristics. At the primary and secondary headboxes, pulp temperature and pH are between 120-130^{N}F and 4.8-5.2, respectively. Biocides are added throughout the process. For the most part, biocide AMA 160 (active ingredient **B** N-alkyl dimethyl benzyl ammonium chloride) is added to the pulp prior to the primary headboxes. Biocide AMA 150 (active ingredient **B** 2,2-dibromo-3-nitrilopropionamide) is typically added to the white-water just after the excess white-water chest. Because these biocides are considered "quick kill" types, they are automatically applied every few hours at a specific rate for a specific amount of time depending on microbial growth.

OCC

Old corrugated cardboard containers are pulverized into pulp (secondary pulp) in a hydropulper through the use of recycled white-water (from paper machine) and a large spinning blade. Excess waste and large foreign materials which are brought in with the previously used containers are removed from the hydropulper by a rope mechanism and by settling. After cardboard boxes are pulverized, the pulp is removed from the hydropulper and filtered through a series of screens and cyclones. Filtered pulp is transported up to the "decker" where excess water is removed via a large cylindrical screen. The remaining pulp is dumped into a large holding tank where biocide AMA 150 is automatically added. When necessary, pulp is piped to the paper machine to make paper.

METHODS

On Tuesday, April 10, 2001, we conducted an opening conference to review the HHE program as well as the specific purposes for the visit. This was attended by plant management, a union representative, and OSHA and NIOSH personnel. We then conducted a walk-through survey of the facility including the chip yard, pulp mill, OCC building, paper machines and the paper laboratory. Subsequently, NIOSH personnel conducted employee interviews and observed worker activities.

Medical

NIOSH physicians conducted confidential interviews with employees. Employees had been made aware of the NIOSH visit and volunteered to be interviewed. Those with current rash were examined and photographs were taken. Initial general diagnostic impressions were recorded based upon history and physical examination. Conversations also occurred with management representatives including the human resources director and the plant nurse. A local occupational physician, who had seen several patients from Smurfit with rash, was also interviewed. We also reviewed available medical records for 23 employees as well as the OSHA 200 logs for the previous two years.

Industrial Hygiene

On paper machine #3, worker activities were observed to determine potential dermal exposures. Due to low paper production, OCC activities were intermittent and actual operations were not observed by NIOSH personnel. Information about potential exposures was obtained through individual interviews and a walk-through inspection lead by OCC personnel. Air and bulk samples (except settled dust in rewinder area) were not collected during this survey since OSHA had previously collected samples.

Because of the hot and humid conditions observed in the PPP facility during the initial walk-through survey, temperature and relative humidity measurements were collected at various locations on paper machine #3 including the rewinder area. These measurements were collected with a Fischer Scientific[8] temperature and relative humidity monitor. Temperature range of the instrument is 32 to 122^{N}F with 0.1^{N}F resolution and accuracy of $\pm$1.8^{N}F. Relative humidity range is from 2 to 98% with 1% resolution and accuracy of $\pm$2%. It should be noted that heat stress in an occupational setting is usually evaluated with

wet bulb global temperature (WBGT) measurements. But, NIOSH personnel did not have prior knowledge of a potential heat stress problem and the equipment required to collected WBGT measurements was not obtained for the NIOSH site visit. Therefore only temperature and relative humidity measurements were collected.

Bulk samples of settled dust were obtained from stationary surfaces, and from a worker=s arm in the rewinder area for identification and characterization. Samples were collected with a commercially available clear tape. The NIOSH industrial hygienist applied the tape to the surface of concern, slowly removed it, then placed in a plastic vial, capped, and labeled. A sample of the final paper product was also obtained for evaluation identification and characterization. Samples were submitted to a NIOSH microscopist. Preparation and analysis of samples was done using NIOSH analytical method NMAM 9002.

EXPOSURE EVALUATION CRITERIA

Heat Stress

Heat stress guidelines have been developed to protect people against heat-related illnesses such as heat cramps, heat syncope, heat exhaustion, and heat stroke. The objective of any heat stress index is to prevent a person's core body temperature from rising excessively. The World Health Organization concluded that "it is inadvisable for deep body temperature to exceed 38°C (100.4°F) in prolonged daily exposure to heavy work."[31] Many heat stress guidelines, including those of NIOSH and the American Conference of Governmental Industrial Hygienists (ACGIH[7]), also use a maximum core body temperature of 38°C as the basis for their environmental criteria.[32,33]

Because measuring deep body temperature is impractical, environmental factors most nearly correlating with deep body temperature and other physiological responses to heat are measured instead. The two most commonly used indexes of heat stress are the apparent temperature and the WBGT.[34] Since temperature and relative humidity measurements were collected at Smurfit, only apparent temperature will be used as evaluation criteria.

Apparent Temperature

Apparent temperature is a function of dry bulb air temperature and relative humidity. Four categories of apparent temperature are used to evaluate heat stress risk. Category I (caution) has an apparent temperature range of 80°F to 90°F and represents conditions for which fatigue is possible with prolonged exposure and physical activity. Category II (extreme caution) has an apparent temperature range of 90°F to 105°F and represents conditions for which heat cramps and heat exhaustion are possible with prolonged exposure and physical activity. Category III (danger) has an apparent temperature range of 105°F to 130°F. This category represents conditions for which heat cramps or heat exhaustion is likely and for which heat stroke is possible with prolonged exposure and physical activity. Category IV (extreme danger) is any apparent temperature that exceeds 130°F and represents conditions for which heatstroke is imminent.[4] Please refer to Figure 1 in the appendix for apparent temperature determination.

RESULTS

The results of this survey are based on our observations and examination of a sample of workers who volunteered to meet with NIOSH investigators. The results may not reflect what is occurring in the total Smurfit workforce, as the selection of workers was not based on a scientific sample.

Descriptive Statistics

The following information was collected solely though interviews with workers, all of whom work in either the OCC or PPP:

1. A total of 25 employees were interviewed. All reported a history of skin problems. Of these, 19 were male and 6 were female.
2. Fourteen of twenty-five had a skin rash at the time of the interview.
3. Of those with current rash, clinical impressions were as follows:
   - Dermatitis/Eczema: 9
   - Folliculitis: 4
   - Others:
     Lichen planus (1)
     xerosis(1),
     psoriasis(1)
     carbuncles(1)
     rosacea(1)

   Clinical impression based upon history alone were as follows:

   - Dermatitis/Eczema: 5
   - Folliculitis: 1
   - Urticaria: 4
   - Others: psoriasis(1), lupus(1), and nonspecific itch leading to rash (1)

NOTE: The total above in both categories is >14 because some workers displayed or described more than one concurrent diagnosis.

4. Time of onset since the workers noted a skin problem ranged from 4 months to 40 years; however, most (15 of 25) began within the past 2 years, with 18 of the 25 developing rash within the previous 3 years.

5. Additional personal protective equipment (PPE) such as gloves, rain-suit and eye protection, was used by 24 of 25; however, 18 of the 24 described this PPE use as occasional, intermittent, or rare.

6. With regard to workers= personal knowledge of the chemicals they use in the course of their work:
   - 10 had no idea of specific exposures
   - 7 had a vague/unsure sense of exposure
   - 4 were certain of their exposure
   - 4 were certain they had no exposure

7. The change in the use of chemical biocide within the past 2 years was a concern by the workers as a possible precipitating factor contributing to their skin problems.

Medical Records

We reviewed medical records from local physicians for 23 workers with skin problems. They revealed the following information:

1. Possible/definite work-relatedness was noted the within the clinical impression for 13 of 23 charts. Five of the thirteen were categorized as definite in this chart review. "Definite" here refers to the physician stating, for example, "work-related contact dermatitis." "Possible" refers to the physician stating in the chart that the problem, for instance, "...may be associated with exposure to chemicals at work."

2. In addition, 3 of the 23 charts reflected only a Registered Nurse or First-aider evaluation for rash which implied work-relatedness but no physician evaluation was available.

Observations of Work Activities

Paper machine #3 B wet end

As previously described, the paper machine is separated into two ends **B** wet and dry. At the wet end were two workers **B** a tender (operator) and a utility. The tender controls the paper machine and monitors all functions from an adjacent, enclosed control room. Approximately once per hour the tender goes to the Fourdrinier table and removes excess pulp from the sides of the Fourdrinier wire with a plastic hand-held device.

The tenders may have dermal exposures to small amounts of pulp and white-water periodically throughout the day. Pulp can be splashed onto the hands, arms, face, and torso while removing excess pulp from the Fourdrinier table. White-water exposure is usually in the form of a mist that is generated as the liquid portion of pulp is removed and falls into a large open pit beneath the paper machine. PPE used during this activity included safety glasses, hearing protection, and safety shoes.

The utility workers= main task included collecting and testing pulp samples every hour. Samples were collected from the primary and secondary machine chests and the primary and secondary head boxes using a plastic cup. Other tasks included changing biocide bins, mixing starch and assisting the tender. During these tasks a hard hat, safety glasses, hearing protection, and safety shoes were worn.

The main dermal exposure for utility workers was to the pulp. Exposure was primarily to the hands and forearms and to a lesser extent the torso and legs from continual splashing throughout the day while collecting pulp samples. According to the workers, in most cases they do not immediately wash skin that has been exposed to pulp.

Temperature and relative humidity on the Fourdrinier table were approximately 84^{N}F and 82%, respectively. Adjacent to the table where the utility mostly works, temperature and relative humidity measurements were 80^{N}F and 65%, respectively. In the wet end control room temperature and relative humidity were 76^{N}F and 31%, respectively.

Paper machine #3 B dry end

The dry end was operated by one worker, the dry end tender. All functions were monitored and controlled from an adjacent, enclosed control room. Tasks included changing paper reels (the reel is what the finished paper product is wound on) when full and cutting paper samples with a knife for testing. PPE worn during these activities, were a hard hat, safety glasses, hearing protection, safety shoes, and kevlar gloves.

The dry end tender had dermal exposure to paper and paper dust. Exposure was mostly to the forearms during cutting activities, and in some cases, to the hands when gloves were not worn.

Temperature and relative humidity at the dry end were approximately 88^{N}F and 43%, respectively. The dry end control room conditions were the same as the wet end.

Paper machine #3 B rewinder

The rewinder is operated by 4 workers, "3rd through 6th hands." The 3rd hand operates the rewinder from an adjacent, open control panel and helps feed paper into the rewinder. The 4th hand operates the overhead crane which moves paper reels from the paper machine to the rewinder and helps feed paper into the rewinder. The 4th hand also removes all excess paper with a knife from the reel before it is moved back to the paper machine. The 5th hand stencils production information onto paper rolls using a roller, weighs the rolls, moves excess paper to the re-pulper, and assists with feeding paper into the rewinder. The 6th hand assists with all activities. In addition, all workers participate in cleaning the rewinder. Cleaning consists of blowing down equipment with pressurized air especially the safety eyes. PPE worn during these activities were a hard hat, safety glasses, hearing protection, safety shoes, and kevlar gloves. It should be noted that not all workers use kevlar gloves when using a knife.

Rewinder workers were continuously exposed to paper mostly on the forearms and hands. Likewise, exposure to paper dust was mostly on the forearms and hands as well as the neck, face and on clothing. Pressurized air was used to blow paper dust from clothing and skin. Temperature and relative humidity at the rewinder were approximately 84°F and 41%, respectively.

Due to the concern of paper dust exposure, samples were collected (with clear tape) for characterization from two stationary objects in the rewinder area (T1 **B** settled dust on man cooler next to lunch room and T2 **B** settled dust on compensator roll support) and one worker (T3 **B** left outer forearm and T4 **B** right inner forearm). A bulk sample of the final product was also collected for characterization. Results indicate that samples T1 and T2 were mostly cellulose (paper) with a small amount of glass fibers. Sample T3 was mostly cellulose with small amount of synthetic fibers (i.e., clothing), hair, and skin cells. Sample T4 was similar to T3 but without hair.

OCC

Two workers were responsible for operation of the OCC hydropulper **B** an operator and an assistant. The operator controlled functions from an enclosed control room located adjacent to the hydropulper. The assistant was responsible for maintaining the rope mechanism on the hydropulper, and cleaning the "decker" water removal system. Both workers were responsible for cleaning the x-cyclones when they became clogged which occurred at least 4-5 times per day. PPE worn during these activities were a hard hat, safety glasses, hearing protection, safety shoes, and gloves (either leather or neoprene-coated cotton).

Dermal exposures were mostly to pulp and white-water on the hands and arms and to a lesser extent the face, neck, torso, and legs, depending on which activities were performed. For example, when unclogging an x-cyclone, workers would remove the x-cyclone by hand and blow into one end. Pulp exposure could be to the hands (if gloves were not worn) the mouth, and possibly the face if material splashed back at the worker. When cleaning the "decker", done on a weekly basis, exposure to recycled white-water would occur over most of the body since cleaning entails spraying the large cylindrical water removal screen with recycled white-water. Other potential exposures were to waste material from the hydropulper. Apparently, some workers go through the waste and collect cans or any other items of value. According to the workers, if dermal exposures to pulp or white-water occur, they immediately wash with soap and water.

Review of Air and Bulk Sampling Results from OSHA Site Visit:

We reviewed bulk and air sample results obtained by OSHA. Samples were taken at several different locations in the plant. For the fungal samples, the results primarily indicated common environmental contaminants. *Aspergillus fumigatus*, an opportunistic respiratory pathogen, was identified in some bulk samples. However, *A. fumigatus* will impact only those individuals whose immune systems have been severely compromised. Although interviewees were not specifically queried regarding respiratory symptoms, they were asked to report any other health problems in addition to the skin rash. No worker reported respiratory problems. Likewise, the bacterial cultures revealed that the vast majority of the

bacteria recovered were expected environmental contaminants. Of note is the presence of *Thermophillic Bacillus* and *Thermophillic Bacteria* as well as *Thermoactinomyces vulgaris* in several of the air samples. These have been associated with a respiratory condition called hypersensitivity pneumonitis. However, once again, respiratory complaints were not a component of this HHE. No primary dermal pathogens were revealed in the samples reported. Based on these results, it appears highly unlikely that work-related skin problems experienced by exposed workers at Smurfit are due to a microbial pathogen.

We reviewed results of the chemical analysis of air and bulk samples collected near paper machine #3. Personal breathing zone and/or area air samples were collected for ammonium chloride (as a marker of exposure to AMA 160), formaldehyde, and paper dust (gravimetric analysis). Results indicate that ammonium chloride and formaldehyde were not detected. Airborne paper dust concentrations ranged from 0.15 to 0.20 milligrams per cubic meter (mg/m^3) with the average concentration of 0.17 mg/m^3. Airborne paper dust concentrations were below all relevant limits. Bulk samples of pulp (primary and secondary), the final paper product, and settled dust were collected. Pulp samples contained only trace amounts of ethanol and methanol. Paper samples yielded little extractable material and only heavy aliphatic hydrocarbons were detected. Settled dust samples contained mostly phenanthrene carboxylic acid derivatives, such as dehydroabietic acid. Also trace amounts of dipropylene glycol dibenzoate isomers, heavy aliphatic hydrocarbons, and phthalate esters were found in the settled dust.

DISCUSSION

Because of the multiple dermatologic diagnoses and the multiple exposures at this worksite, this discussion will emphasize a general overview of occupational skin diseases. In addition, because many workers had skin diagnoses related to a variety of forms of dermatitis, dermatitis will be emphasized here.

Occupational skin diseases can manifest themselves in a variety of ways. These include contact dermatitis (which includes irritant contact dermatitis and allergic contact dermatitis), skin cancers, skin infections, skin injuries, and a large group of miscellaneous skin diseases [such as folliculitis/furuncles, acneform dermatoses (chloracne), urticaria (systemic and contact), benign neoplasias, photodermatitis, pigmentary disorders, connective tissue disorders, climatic disorders (miliaria rubra/prickly heat, asteatotic eczema/winter eczema), granulomatous dermatoses, ulcerative lesions, alopecia, and discoloration of hair, skin, and nails.] Many references on occupational skin disorders are available.[35,36,37]

Not all skin diseases have an identified environmental or occupational cause. For many skin diseases the exact factors causing the disease are unknown (e.g., psoriasis, lichen planus). Some diseases such as contact dermatitis and contact urticaria are known to be caused by exposures in the work and/or non-work setting (e.g., contact dermatitis to household products, perfumes, creams). Other skin diseases may not be caused by these environmental exposures, but may be exacerbated by such exposures (e.g., lesions of psoriasis produced at sites of skin friction or injury, heat exacerbating rosacea, wet work initiating dyshidrotic eczema).

In general, the causes of occupational skin disorders can be grouped into the following categories:

1. Physical insults (friction, pressure, trauma, vibration, heat, cold, variations in humidity, ultraviolet/visible/infrared radiation, ionizing radiation, and electric current).
2. Biologic causes (plants, bacteria, fungi, protozoa, and arthropods).

3. Chemical insults (water, inorganic acids, alkalis, salts of heavy metals, aliphatic acids, aldehydes, alcohols, esters, hydrocarbons, solvents, metalloorganic compounds, lipids, aromatic and polycyclic compounds, resin monomers, and proteins).

Contact dermatitis is the most common occupational skin disease. Epidemiologic data show that contact dermatitis makes up 90-95% of all occupational skin diseases.[38,39,40] Contact dermatitis (both irritant and allergic) is an inflammatory skin condition caused by skin contact with an exogenous agent or agents, with or without a concurrent exposure to a contributory physical agent (e.g., ultraviolet light). It is widely accepted that of all contact dermatitis, 80% is due to a nonimmunologic reaction to chemical irritants (irritant contact dermatitis) and 20% to allergic reactions (allergic contact dermatitis). Only certain chemicals are allergens, and only a small proportion of people are susceptible to them. Complete reviews of both irritant and allergic contact dermatitis are available in other sources.[5,7,41,42]

In dermatitis, the skin initially turns red and can develop small, oozing blisters (vesicles), and bumps (papules). After several days, crusts and scales form. Stinging, burning, and itching may accompany the rash. With no further contact the rash usually disappears in one to three weeks. With chronic exposure, deep cracking (fissures), scaling, and discoloration of the skin (hyperpigmentation) can occur. Exposed areas of the skin, such as hands and forearms, which have the greatest contact with irritants or allergens, are most commonly affected. If the chemical gets on clothing, it can produce rashes at areas of greatest contact, such as thighs, upper back, armpits, and feet. Dusts can produce rashes at areas where the dust accumulates and is held in contact with the skin, such as under the collar and belt line, at the tops of socks or shoes, and in flexural areas (e.g., front of the elbow, back of the knee). Mists can produce a dermatitis on the face and anterior neck. Irritants and allergens can be transferred to remote areas of the body (such as the trunk or genitalia) by unwashed hands or from areas of accumulation (such as under rings or in between fingers). It is often impossible to clinically distinguish irritant from allergic contact dermatitis, as both can have a similar appearance and both can be clinically evident as an acute, subacute, or chronic condition.

Extensive lists of irritants and allergens are available in reference books.[5,11] The most frequent causes of irritant contact dermatitis include soaps/detergents, fiberglass and particulate dusts, food products, cleaning agents, solvents, plastics and resins, petroleum products and lubricants, metals, and machine oils and coolants.[10,43] Causes of allergic contact dermatitis include metallic salts, organic dyes, plants, plastic resins, rubber additives, and germicides.[13]

The work-relatedness of skin diseases may be difficult to prove. The accuracy of the diagnosis is related to the skill level, experience, and knowledge of the medical professional who makes the diagnosis and confirms the relationship with a workplace exposure. Guidelines are available for assessing the work-relatedness of dermatitis,[44] but even with guidelines the diagnosis may be difficult. The diagnosis is based on the medical and occupational histories and physical findings. The importance of the patient's history of exposures and disease onset is clear. In irritant contact dermatitis there are no additional confirmatory tests. Patch tests or provocation tests are discouraged because of a high false-positive rate. In many instances, allergic contact dermatitis can be confirmed by skin patch tests using specific standardized allergens or, in some circumstances, by provocation tests with nonirritating dilutions of industrial contactants.[11]

Because people with contact dermatitis can develop long-term dermatologic problems, prevention is key. Strategies in the prevention of contact dermatitis include identifying allergens and irritants, substituting chemicals that are less irritating/allergenic, establishing engineering controls to reduce exposure, utilizing personal protective equipment (PPE) such as gloves and special clothing appropriately, emphasizing personal and occupational hygiene, establishing educational programs to increase awareness in the workplace, and providing health screening.[10,13,45] The introduction of PPE must be considered carefully since it may actually create problems by occluding allergens or irritants or by directly irritating the skin. Similarly, the excessive pursuit of personal hygiene in the workplace may actually lead to misuse of soaps and detergents, which can result in irritant contact dermatitis.[46] The effectiveness of gloves depends on the specific exposures and the types of gloves used. The effectiveness of barrier creams is controversial,[47]

and at times workers using barrier creams may have higher prevalence rates of contact dermatitis compared to those who do not use the creams.[48]

Workers= dermal exposures at Smurfit were to pulp, paper, and paper dust mostly on the hands and arms and to a lesser extent the face, torso, and legs. From the results of this evaluation and OSHA samples, paper dust collected in the rewinder area contained glass fibers and phenanthrene carboxylic acid derivatives (i.e. dehydroabietic acid). Glass fiber exposures have been associated with various skin ailments including irritant contact dermatitis.[49] Although glass fibers were not found in the paper, their likely source is ventilation ductwork or building insulation. In addition phenanthrene carboxylic acid derivatives such as dehydroabietic acid (resin acid) are considered skin sensitizers.[50] Resin acids are what make up colophony (rosin) which is a natural product of pine trees. Although the resin acids were not found in the paper and pulp bulk samples, they are likely there but in smaller amounts. Different analytic methods, such as fluoresceine techniques, are more sensitive for detecting phenanthrene derivatives than the gas chromatography/mass spectrometry technique used by OSHA.

Temperature and relative humidity measurements collected during the NIOSH site visit indicated a potential heat stress problem especially for workers in the rewinder area. These workers spend most of the time around the rewinder and not in a climate controlled control room except during lunch. For the rewinder workers the temperature and relative humidity measurements were 84^{N}F and 41%, respectively. The apparent temperature is 86^{N}F which, according to the heat stress index, means that caution should be taken because fatigue is possible with prolonged exposures and physical activity. Furthermore, excessive sweating has been associated with skin ailments such as skin maceration (intertrigo), especially in the groin and armpit areas where skin surfaces are opposed to each other.[51]

Biocides, also referred to as slimicides or germicides, have been used in pulp and paper mills for decades to control the growth of microorganisms, especially the slime-producing molds. If these molds are allowed to amplify and build-up on equipment, the paper can be affected in different ways including causing "paper breaks." The biocides used at Smurfit are considered "quick-kill" types. The biocide is automatically pumped into the pulp or white-water at a specific time, at a specific rate, for a specific amount of time. This causes a large killing of microbes. However, as the active ingredient(s) is used up, the numbers of microbes will then start to increase until the next addition of biocide. Again, the goal is to control microbe growth below certain levels to keep equipment clean and to assure the quality of the paper. The quick-kill nature of these biocides is the likely reason no biocide active ingredients were identified in the air or bulk samples.

Biocides are potent contact sensitizers.[52,53] However, most previously reported skin ailments were from exposures to concentrated biocide. At Smurfit a representative from the biocide supplier is located on site and is responsible for the biocide equipment and application. Therefore, no workers should be directly working with concentrated biocides. The only biocide exposure concern is for the wet end utility worker when collecting pulp samples from the headboxes. If pulp samples are collected at the time biocide is added then a biocide exposure may occur. However, it should be noted that only small amounts of biocide (tens of gallons) are added at any given time to large amounts of pulp (hundreds of thousands of gallons) and biocide exposure should be very dilute.

CONCLUSIONS

There are a number of potential workplace environmental explanations for the skin problems experienced by some Smurfit employees. In summary, (1) Conditions in some workers are consistent with dermatitis; (2) based on our assessment of workplace exposures and practices, interviews, examinations and review of medical records, several workers were found to have work-related dermatitis; (3) no definitive etiologic agent has been identified at this point. However, exposure to the pulp and/or finished paper B

either of which may serve as an irritant or allergen, alone or in combination with resin acids, dust, glass fibers, and heat **B** may well be complicit in the skin problems noted at Smurfit.

RECOMMENDATIONS

1. In general, a combination of the following strategies should be used to prevent occupational skin diseases at worksites:

   a. Identify irritants and allergens in the workplace.

   b. When feasible, consider systemic as well as dermatologic toxicity, substituting chemicals that are less irritating/allergenic.

   c. Establish engineering controls to reduce skin exposure.

   d. Utilize PPE such as gloves and special clothing (item 2 below).

   e. Emphasize personal and occupational hygiene (items 4-6 below).

   f. Establish educational programs to increase employee awareness of irritants and allergens in the workplace (item 7 below).

   g. Provide a system for the evaluation, reporting, and surveillance of dermatologic diseases (item 12 below).

2. Establish a comprehensive personal protective equipment (PPE) program. Elements of a good PPE program include:

   ! **Written Procedures**. Define the necessary PPE and ensure it is properly and consistently used and maintained. The use of PPE should be mandatory.

   ! **Proper Selection and Use**. Specific task assessments should be conducted to define the potential hazard(s), and evaluate the potential for contact. PPE selection should be based on factors that include chemical resistance, comfort, and dexterity necessary for the task.

   ! **Inspection and Maintenance**. Employees should be instructed how to inspect (before and after each use), use, and maintain their PPE. Chemical resistant gloves, aprons, eye protection, and footwear should be thoroughly rinsed with water whenever contact with a chemical is suspected. Gloves should be rinsed prior to removal and replaced frequently. After cleaning, PPE should be stored properly.

   Whether irritating due to an acidic pH, sensitization properties of the chemicals or mechanical irritation due to the physical properties of the substance, the pulp stock should be considered and handled as an irritant. For this reason, workers need to be protected from this substance. To that end, PPE such as gloves, aprons and splash shields should be better utilized when handling pulp. Based on our observations it does not appear that PPE is being adequately used for this purpose. Exactly which PPE and when they should be used should be determined by the company. A good starting point for this is the OSHA standard 29 CFR, part 1910, subpart I - personal protective equipment.[54]

3. At the dry end, the rewinder safety eyes are cleaned using a blower with compressed air. This practice should be eliminated and the cleaning process accomplished with the use of a vacuum

system. This will minimize the dust and particulate matter in the air that may act as a primary or secondary irritant or allergen for some workers.

4. The practice of digging through the waste from the hydropulper claw in the OCC is hazardous and should be abandoned. Warning signs should be posted in the OCC. The biohazard potential from exposure to blood-borne pathogens on medical waste materials such as scalpels and needles represent a tremendous risk to these workers.

5. In the OCC, the worker practice of blowing on the x-cyclone tips is another hazardous practice. Exposure to raw pulp is significantly increased by this practice.

6. The practice of re-wearing unlaundered work clothes should also be discouraged. Irritants can build up in the fabric when re-wearing clothing day after day and exacerbate any skin irritation.

7. Several issues were raised with regard to communication between the management and the workers at this plant. For example, we were informed by several workers that the new biocide supplier representative provides less information compared with the previous company=s representative which has generated some concern. This problem may be remedied by a more visible and active role on the part of the new chemical company=s representative to educate the workers regarding the products currently used at Smurfit.

8. Through our evaluation of work practices and exposures in the plant, there is definitely dermal exposure to chemicals and the presence of dermatitis in the workforce. Accordingly, a study should be conducted, utilizing patch testing if indicated, to attempt to identify the specific chemical sensitizers/allergens among the exposed workers. We feel that such a study is warranted. The chemicals utilized at Smurfit are not unique to this plant but are utilized in other paper plants and industries. If these chemicals were identified and not yet recognized as hazardous to workers, this study could lead to a significant improvement in working conditions beyond Smurfit.

9. When feasible, engineering controls should be implemented to reduce exposure to heat. A heat stress evaluation involving Wet Bulb Global Temperature measurements should be conducted, especially for the rewinder workers since they spend most of their time in the production environment, in contrast with other workers who spend a large portion of the work day in a climate controlled room. Recommendations for engineering controls, as well as other methods of controlling heat exposure are described in the NIOSH Criteria for a Recommended Standard: Occupational Exposure to Hot Environments.[55]

10. Smurfit personnel should take immediate action whenever there is skin contact with chemicals. Irritants and allergens that have come in contact with exposed skin should be flushed off with large amounts of running water or washed off with soap and water as soon as possible. Residual soap should be washed off the skin surface. Clothing contaminated with irritants or allergens should be removed and laundered prior to re-use. Special attention should be directed toward soaps and skin cleansers since they themselves can serve as irritants. Certain components of the soaps or moisturizers (e.g., lanolin and fragrances) are known allergens and may cause allergic contact dermatitis in sensitive individuals. Incorporate this item in the safety training curriculum.

11. Topical creams, ointments, and lotions containing neomycin sulfate, a common antibiotic, and lanolin, a wool wax alcohol, should be used with caution since neomycin and lanolin are potent skin sensitizers.

12. For yard workers, being outdoors creates an increased risk for excessive exposure to non-ionizing ultraviolet radiation from sunlight which can lead to skin cancers. Workers, especially those who need to work outdoors between 10 A.M. and 4 P.M., should be provided with information about sun exposure, should be encouraged to wear sun protective clothing and hats, work in shaded areas, and should liberally apply sunscreens with a sun protection factor (SPF) of at least 30.

13. Workers should be encouraged to report all potential work-related skin problems. These should be investigated on an individual basis by the company or consulting health care providers. Because the work-relatedness of skin diseases may be difficult to prove, each person with possible work-related skin problems needs to be fully evaluated by a physician, preferably one familiar with occupational/ dermatological conditions. A complete evaluation would include a full medical and occupational history, a medical exam, a review of exposures, possibly diagnostic tests (such as skin patch tests to detect causes of allergic contact dermatitis), and complete follow-up to note the progress of the affected worker. Individuals with definite or possible occupational skin diseases should be protected from exposures to presumed causes or exacerbators of the disease. In some cases of allergic contact dermatitis, workers may have to be reassigned to areas where exposure is minimized or nonexistent.

This letter completes our investigation. If you have any questions regarding the issues raised in this correspondence, please contact me at (513) 458-7153.

Sincerely yours,

Dino Mattorano, M.S.
Industrial Hygienist
Industrial Hygiene Section

Debra M Feldman, MD EIS Officer
Medical Officer
Medical Section

Boris D. Lushniak, M.D., M.P.H.
Medical Officer
Division of Surveillance, Hazard Evaluations
and Field Studies
4676 Columbia Parkway, Mail Stop R-12,
Cincinnati, Ohio 45226

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APPENDIX B

General Dermatological Issues

Occupational skin diseases can manifest themselves in a variety of ways. These include contact dermatitis (which includes irritant contact dermatitis and allergic contact dermatitis), skin cancers, skin infections, skin injuries, and a large group of miscellaneous skin diseases [such as folliculitis/furuncles, acneform dermatoses (chloracne), urticaria (systemic and contact), benign neoplasias, photodermatitis, pigmentary disorders, connective tissue disorders, climatic disorders (miliaria rubra/prickly heat, asteatotic eczema/winter eczema), granulomatous dermatoses, ulcerative lesions, alopecia, and discoloration of hair, skin, and nails]. Many references on occupational skin disorders are available.[56,57,58]

Not all skin diseases have an identified environmental or occupational cause. For many skin diseases the exact factors causing the disease are unknown (e.g., psoriasis, lichen planus). Some diseases such as contact dermatitis and contact urticaria are known to be caused by environmental exposures in the work and/or non-work setting (e.g., contact dermatitis to household products, perfumes, creams). Other skin diseases may not be caused by these environmental exposures, but may be exacerbated by such exposures (e.g., lesions of psoriasis produced at sites of skin friction or injury, heat exacerbating rosacea, wet work initiating dyshidrotic eczema).

In general, the causes of occupational skin disorders can be grouped into the following categories:

1. Physical insults (friction, pressure, trauma, vibration, heat, cold, variations in humidity, ultraviolet/visible/infrared radiation, ionizing radiation, and electric current).

2. Biologic causes (plants, bacteria, viruses, fungi, protozoa, and arthropods).

3. Chemical insults (water, inorganic acids, alkalis, salts of heavy metals, aliphatic acids, aldehydes, alcohols, esters, hydrocarbons, solvents, metalloorganic compounds, lipids, aromatic and polycyclic compounds, resin monomers, and proteins).

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DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
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