U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

# HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 74-19-227

THE TIMKEN COMPANY
COLUMBUS, OHIO

OCTOBER 1975

## I. TOXICITY DETERMINATION

It has been determined based upon an environmental-medical evaluation in the Grinding Room, Railway Division, of Plant 17, The Timken Company, Columbus, Ohio conducted on August 20, 1974 that skin irritation may result from direct contact with liquid Cimcool S23A coolant and respiratory irritation may develop from worker exposure to mists of Cimcool S23A coolant. This determination is based upon an evaluation of workers in the Grinding Room which included: breathing zone measurements of coolant mist exposure, pulmonary function tests, physical examinations, and medical questionnaires.

While significant acute obstructive airways disease was not demonstrated during the evaluation, a relatively large proportion of workers developed upper respiratory irritation during the shift. A smaller number of workers developed eye irritation. Cutaneous examination of workers revealed an incidence of dermatitis greater than would normally be expected in a worker population of the size studied. Recommendations to improve the conditions contributing to skin and respiratory irritation have been made in this report.

## II. DISTRIBUTION AND AVAILABILITY OF THE DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) The Timken Company, Columbus, Ohio
b) Authorized representative of employees
c) U. S. Department of Labor - Region V
d) NIOSH - Region V

For purposes of informing the approximately 100 "affected employees" the employer shall promptly "post" the Determination Report in prominent place(s) near where affected employees work for a period of 30 calendar days.

## III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees regarding the exposure of employees to Cimcool in Plant 17 Grinding Room, Railway Division, The Timken Company, Columbus, Ohio and alleged that exposed workers were experiencing skin irritation, irritation to the nose, throat, and chest, and a nauseating odor associated with the coolant.

## IV. HEALTH HAZARD EVALUATION

### A. Description of Process-Conditions of Use

The area in question at The Timken Company, Columbus, Ohio is a grinding area in the Columbus Railroad Bearing plant. Approximately 100 men work in this area in 3 shifts. The men are operator grinders, maintenance mechanics, process checkers, and inspectors. This survey is concerned with 30 operator grinders in shift two and 18 in shift three, seven maintenance mechanics in shift two and five in shift three, and 15 inspectors in shift two and 11 in shift three.

Tapered roller bearings are produced in this area by separate grinding operations for cups, cones and rollers. The machinery and methods used have been essentially the same since 1958. In the grinding area general room ventilation was in operation but not machine local exhaust ventilation. The grinders were furnished with gloves and aprons on a voluntary but free basis. Respirators were said to be available but were not used. Aprons were said to be changed several times a week. Maintenance men were furnished coveralls. Skin barrier creams (Kerodex and Silicote) were available for use but rarely used.

The coolant Cimcool-S23A was developed for this operation to reduce misting and promote a longer wheel life by the Cincinnati Milacron Company, Cincinnati, Ohio. This semi-synthetic coolant was introduced around September 1973. The coolant is kept in a central system below the floor with a central sump filter and tank. Approximately three to four 55 gallon drums a week are added. The coolant is changed by attrition. A 5% concentrate is diluted with water. Cimcool was described as a water soluble preformed chemical emulsion cutting fluid suggested for machining and grinding all ferrous and nonferrous metals, glasses and plastics. Data on the exact

constituents was requested from Cincinnati Milacron Company, but this data has not been made available. The coolant probably contains an emulsifier, an oil, a bactericide (hexa hydro-1,3,5 tris (2-hydroxyethyl)-S-triazine), a lubricant, a corrosion inhibitor, a fungicide (sodium 1 hydroxyl 2-(1H), pyridine thional), water and possibly other constituents. The bactericide is said to release formaldehyde in solution and apparently can be quantitatively estimated by analysis for formaldehyde. According to the manufacturers, Cimcool 23A does not contain a water-conditioner, anti-foam or dye. According to the safety data sheet protective gloves are not required for handling this coolant. A product safety sheet said that prolonged skin contact with the concentrate should be avoided and that in case of contact with eyes the concentrate should be flushed with running water. It is said that the coolant is non-corrosive and not a primary skin irritant. Quality testing on the coolant is done at The Timken Company, Columbus Railroad plant and additional samples are sent to the Cincinnati Milacron Company. The final concentration is determined by a titration method aimed at producing a 5% dilution of the concentrate in water. The desired pH is between 8.7-9.3. The pH tends to fall with time presumably because of the action of acid bacteria. Bactericide and fungicide are added if the pH falls. The oil content could become too high but this is usually not a problem, and oil can be centrifuged off the coolant. Twice a week samples of coolant are sent to Cincinnati Milacron where concentration, pH, dirt, oil, a bacterial plate count, a mold count and percent alkalinity are monitored. When the coolant was initially installed, bacterial counts were frequently up to 50 million per cc or more. It appeared that the bacterial count had been better controlled by the time of our visit. On reviewing the records no bacterial counts greater than 3 million per cc were observed for the preceding 2 months. It should be noted that although bacterial and fungal growth within coolants is often associated with unpleasant odor and may lead to an alteration in the properties of the coolant, the bacteria and fungi responsible are not known to cause skin disease. The pH appeared also to have been better controlled for the two months preceding our initial visit. Sodium hydroxide had been added relatively frequently when the coolant was first used but this had not been necessary around the times of our visits. According to the operators when the pH falls below 9 an offensive odor is noted. At times Cimclean 30, a highly alkaline machine cleaner is added in very small quantities (about 1 pint to 40,000 gallons) to the coolant to remove grease buildup. The ingredients of Cimclean 30 are unknown.

Hygienic facilities for employees include a wash and toilet area where a liquid soap (liquid Swift Bouquet), an abrasive powder soap (Dr. Kutol Monarch Hand Powdered) were used as well as a waterless cleaner (Hand waterless SBS30). Solvents were not permitted to be used for cleaning the hands.

The plant has its own medical facilities in building 198. A registered nurse is on duty on each shift, in addition two part-time physicians are employed. Preemployment medical examinations are performed, however there is no attempt to screen workers with any particular type of skin characteristics or a past history of skin disease from working in the grinding area.

B. Evaluation Design

On April 15, 1974, an initial environmental and medical survey of the grinding area was conducted by NIOSH investigators. A discussion of the process and organization of the plant took place with management and union representatives. A walk through survey was conducted including the area of the plant involved, the washing and showering facilities, the medical facilities and the laboratory concerned with quality control of the coolant. Records were inspected in the latter area.

A preliminary medical evaluation was conducted involving interviews with 18 grinders, two maintenance mechanics and one material handler and helper in the grinding area. These interviews revealed that 16 out of 21 employees complained of an objectionable odor at one time or another from the cutting oil; 7 complained of symptoms of eye irritation; 14 of symptoms of upper respiratory irritation; 7 of asthmatic symptoms or chest tightness and 6 employees of skin irritation or lesions. The medical records of these employees were inspected. Evidence or complaints of eye irritation were recorded for one employee, skin irritation in two, upper respiratory symptoms in two and asthmatic symptoms or chest tightness in three employees. In a number of the latter instances the employees had intimated that they felt that the problem was due to the new cutting oil. On a brief examination at this time only one of the examined employees had skin lesions which could possibly have been associated with cutting oil exposure.

Because of the high incidence of complaints and particularly the symptoms of respiratory irritation among workers exposed to the grinding operation and cutting oil, an in-depth evaluation was planned.

A second visit was accordingly made on August 20, 1974, by NIOSH investigators. Workers from both the second and third shifts were examined. Prior to the shift a brief symptom questionnaire was administered, an examination performed of the skin, eyes, nose, throat and chest, and pulmonary function testing was performed. The purpose of the shorter questionnaire was to allow better correlation of symptoms with exposure levels and pulmonary function data. During the shift a more detailed questionnaire eliciting identification data, occupational history and medical and other data was administered. At the end of the shift, the brief symptom questionnaire was again administered and a further examination of the skin, eyes, nose, throat and chest was made and respiratory function testing again performed. Voluntary consent was obtained from each employee who participated in the study. Twenty-four workers from the second (day) shift and 20 workers from the third (night) shift were examined according to the above schedule. Data from workers who failed to complete both the pre-and the post-shift examinations was not included in the final evaluation. The exposure to total coolant mist was determined with personal breathing zone samples for each worker medically evaluated.

C. Evaluation Methods

1. Environmental Sampling

The evaluation of worker exposure to airborne substances was hampered by the lack of definitive information concerning the composition of the coolant in use in the grinding area of the plant. Conversation with a representative of Cincinnati Milacron revealed that the Cimcool S23A product does not use a nitrite as a corrosion inhibitor although nitrites or amines are the typical corrosion inhibitors used in synthetic coolants such as Cimcool S23A. For this reason amine detector tubes were selected to obtain air samples to determine qualitatively if the corrosion inhibitor could be detected in the grinding area. The bactericide may release formaldehyde in the coolant and this substance was also considered as a potential contaminant which could be present in the grinding area. Formaldehyde and amine length of stain detector tubes were used to determine if formaldehyde might be present in the grinding area. The limits of detection for the detector tubes used in this evaluation were approximately 1 ppm formaldehyde and 2 ppm amine.

Individual time-weighted exposures to total coolant aerosol were evaluated by personal samples. Samples were obtained in the breathing zone of the workers by clipping a closed-face cassette containing a mixed esters of cellulose filter having an average pore size of 0.8$\mu$ to the lapel of the worker. Air was drawn through the filter by attaching the cassette to a personal sampling vacuum pump with Tygon® tubing sampling at 1.5 liters/minute. Flow was maintained at a constant value by monitoring the pumps and adjusting the flowrate as necessary. The filters were analyzed for total coolant by a fluorescent method.[1] The coolant was analyzed for water content and the calibration standards prepared were corrected for water content and based only upon ingredients of the coolant as well as the hydraulic fluid and lubricants which may leak into the system from grinding machinery.

Since the composition of the coolant was unknown, it was not possible to conduct environmental sampling for the individual substances which comprise it. However, the use of the fluorescent analytical method was used to quantitate worker exposure to the combined substances of the coolant. The proper excitation wavelength was determined using a solution prepared from a bulk sample obtained from the coolant system. The peak-height of the largest fluorescent peak observed from the fluorescense spectrum was used to prepare the standard calibration curve. Bulk samples obtained from the coolant system were used for the preparation of the standard calibration curves, and a separate calibration curve was prepared for each of the two shifts investigated during the follow-up evaluation.

2. Pulmonary Function Testing

Each pulmonary function test required the employee to make between 5 and 7 forced expiratory volume maneuvers of which the best three were selected

and recorded. A Medister Electralic Tor pulmonary function analyser with a strip chart recorder was used. The equipment was calibrated before and after the visit. A read out was provided on the instrument, the readouts were verified by the strip chart recorder. For each test a forced expiratory volume in 1 second ($FEV_1$), and a forced vital capacity (FVC) were calculated and these data were used for statistical analysis.

3. Medical Questionnaires

Both immediately before and immediately after the shift, employees completed a short questionnaire concerning current skin, eye, nose, throat and respiratory symptoms as well as the number of cigarettes smoked so far that day.

In addition during the shift employees completed a more detailed questionnaire including questions about their present and past occupations, previous illnesses, respiratory, eye and skin symptoms and smoking history.

4. Physical Examination

An examination of the skin, mouth, nose, throat, eyes and respiratory system was performed on each worker immediately before and immediately after the shift.

D. Evaluation Criteria

1. Environmental Criteria

A number of sources recommend airborne levels of substances below which toxic effects would not be expected to occur in most workers. Such air-borne levels are referred to as standards or threshold limit values, although such recommendations consider only the effect of the individual substances. Simultaneous exposure to two or more substances could result in additive or synergistic effects. In this evaluation only formaldehyde could be identified as a substance for which an environmental guide exists although other such substances may have been present. In the authors' opinion the most appropriate environmental guide for formaldehyde is the Threshold Limit Value (TLV) recommended by the American Conference of Governmental Industrial Hygienists (TLV's for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1974):

| Substance | Standard (ppm) |
|---|---|
| Formaldehyde | 2 ceiling |

The present Federal Standard is an 8-hour time weighted average of 3 ppm with a ceiling of 5 ppm not to be exceeded for 30 minutes and a maximum peak of 10 ppm (CFR 29,1910.93 dated June 27, 1974).

The existing TLV and Federal Standard for a mineral oil mist is not considered appropriate for comparison to the air-borne levels of semi-snythetic coolant measured in this evaluation. A semi-synthetic coolant

typically contains little or no mineral oil.[2] The TLV and Federal Standard are intended for evaluation of air-borne mists of mineral oil.

E. Evaluation Results

1. Environmental Evaluation

Amine and formaldehyde detector tube testing was performed in an inner aisle of the grinding area where any substances escaping from the coolant would be expected to be most concentrated. Five amine and five formaldehyde length of stain detector tube measurements were made during the mid-part of the second and third shifts. Neither amines nor formaldehyde were detected by any of these measurements.

A comparison was made between the excitation and peak-height wavelengths for the bulk samples collected during the initial and follow-up evaluations, and both wavelengths were observed to be unchanged since the initial visit. The pH of the coolant during the initial visit was 8.8 which during the follow-up evaluation the pH was 8.9. These results indicate the composition of the coolant was unchanged from the time of the initial visit compared to the conditions at the time of the follow-up evaluation.

Breathing zone samples to determine total coolant exposure were obtained for all workers who were medically evaluated. However, only one-half of the pulmonary function tests were performed on a properly functioning instrument. It was necessary to compare the average exposure of workers tested on the properly functioning instrument to the average exposure of workers tested on the malfunctioning machine to insure that the coolant mist exposures were representative for both groups of workers. The coolant mist exposure for workers tested on the properly functioning instrument averaged 6.07 mg/M$^3$ compared to an exposure of 5.49 mg/M3 for workers tested on the instrument which malfunctioned. These means were compared using the "t test" and there was no significant difference between them. It can be concluded that the coolant mist exposure for workers tested on the properly functioning instrument is comparable to the exposure of those workers tested on the malfunctioning instrument.

It was also necessary to determine if there was any significant difference in coolant exposure between the two shifts since pulmonary function tests from the two shifts were evaluated as one group. A possible difference in airborne coolant exposure between the two shifts could be hypothesized on the basis of differences in work activity, work practices, and a possible accumulation of coolant mist in the environment during the shift(s). The average coolant mist exposure was 5.73 mg/M$^3$ for the second shift and 5.83 mg/M$^3$ during the third shift. These averages were compared by the "t test" and there was no statistically significant difference between the average exposures occurring on the two shifts.

2. Medical Evaluation

a. Examination of the skin[3,4]

Twenty-four workers from the second shift and 20 from the third shift were examined. Twenty-six workers had no significant observable skin abnormality (2 of these workers complained of itch or paraesthesia). Eleven workers had clinical signs of hand or forearm dermatitis, including erythema, scaling, vesiculation or hyperkeratosis confined to areas contacted by coolant. In three of these workers there was no clear relationship between the dermatitis and work exposures to the coolant. In two of these three workers the eruption pre-dated the use of Cimcool 23A. The other worker attributed the dermatitis to the recent use of a sealing solution at home, although it was not clear that work exposures may not have contributed to his problem. Seven workers had non-occupational skin problems (a healing traumatic lesion, varicose eczema, nummular eczema, solar keratosis, tinea versicolor, miliaria crystallinia and an eczema of the legs of undertermined cause). Of the eight workers who apparently had hand dermatitis associated with coolant exposure, five were grinders (three roller grinders, two cone or cup) two were inspectors and one a process checker.

b. Examination of the eyes

Forty-one workers had an eye examination both before and after the shift. The examination on 31 workers was normal on both occasions. Four workers had symptoms and objective signs of conjunctival irritation present both before and after the work shift and not altered in intensity between the two examinations. No workers had abnormal eye examinations prior to the shift and a normal eye examination after the shift.

One worker who was asymptomatic at the start of the shift complained of burning eyes after the shift but examination of the eyes remained normal. Five of the 41 employees had no ocular symptoms or abnormal physical findings in the eyes before the shift but had abnormal findings after the shift. One of these workers who described himself as suffering from a seasonal allergy had other signs consistent with seasonal allergy and in addition developed conjunctival erythema in the left eye over the work period. The other four workers developed symptoms of burning eyes and excessive tearing over the work shift. In addition they showed signs of conjunctival irritation (injection) and had excessive tearing on the post shift examination. These men were all employed as cup or cone grinders.

c. Examination of the respiratory tract

Examination of the nose, throat and chest and a questionnaire about related symptoms was performed pre-shift and post-shift on 41 workers. Nine workers had no symptoms and no abnormal findings on examination either before or after the shift. None of these workers smoked more than 10 cigarettes over the shift although 11 out of the remaining 32 workers smoked more than 10 cigarettes over the shift. Eleven workers had symptoms both before and after the shift, often accompanied by physical findings but both were

essentially unchanged in severity over the period. A number of these workers complained of recent upper respiratory tract infections, hayfever or sinus allergies. Six workers complained of symptoms before but not after the shift. These workers complained of cough, stuffy nose, chest tightness, stuffy nose and hoarse voice, running nose, cough and wheezing. Two of these six workers attributed their symptoms to hayfever or sinus allergy. None of these workers had significant alterations in their physical examination either before or after the shift.

Fifteen workers had either symptoms, findings or a combination of symptoms and findings after but not before the shift. Three workers complained of dry throat or stuffy nose not accompanied by abnormal physical findings. Two of these three workers had smoked 18 cigarettes over the period of the shift, the third was a nonsmoker. Seven workers had abnormal findings confined to the upper respiratory tract after the shift. Four workers had asymptomatic pharangeal injection and in one case swelling of the uvula after the shift which had not been present before the shift. Three workers had similar findings and, in addition, complained of a dry throat post-shift. Of the latter three workers, two did not smoke, the other had smoked one cigar over the period of the shift. One worker complained of a stuffy nose, cough, chest tightness and shortness of breath post shift. He had complained of no symptoms before the shift. Physical examination, however, was normal on both occasions. Four workers had normal examinations and were asymptomatic prior to the shift but had signs and symptoms of more extensive respiratory tract abnormalities after the shift. One of these employees complained of a productive cough, injection of the mouth and pharynx was noted and rhonchi heard in the right lower lobe. A second employee complained of burning eyes, stuffy nose, coughing and slight chest tightness after the shift. On examination there were marginal irritation of the nose and throat and isolated coarse rales in the right lower lobe posteriorly. A third employee described a dry throat burning eyes, tearing of the eyes, coughing, chest tightness and wheezing, and he appeared to be uncomfortable with a moist cough, frequent nose blowing, increased tearing and injection of the conjunctiva and pharynx. His chest remained clear to examination. A fourth employee described a productive cough through the shift. On examination there was marginal injection of the pharynx and isolated pulmonary rhonchi.

d. Pulmonary function testing

The calibration of the two spirometers was checked at the conclusion of the study. One of the spirometers was found to be malfunctioning, it was not certain when the malfunction had occurred, however the measurements performed with this machine at all times were less than those with the other machine. There was a suggestion that a progressive worsening of the malfunction had occurred throughout the day. In the final analysis only the data for the 23 employees tested with the correctly functioning spirometer were used.

The mean value of Pre and Post groups for $FEV_1$ and FVC are recorded in Table 1. Pulmonary function test results were evaluated using "paired t test" analysis of the pre to post shift mean differences in $FEV_1$ and FVC's for each group. The mean values for the pre-shift $FEV_1$ and post shift $FEV_1$ were not significantly different. There was a statistically significantly small decrement of about 2% in the FVC post-shift compared with the pre-shift FVC. The employees were divided into second and third shift employees and additionally into light or non-smokers and moderate or heavy smokers the data were further examined (see Table 2). The only significant difference was observed in the FVC of second shift employees.

Three of the four employees who had complained of asthmatic symptoms had both pre and post shift respiratory function testing performed with the correctly functioning spirometer. The data from these three employees is given in Table 3. No significant differences between the pre and post shift spirometry was observed in any of these three employees singly, or in all three taken as a group.

e. Discussion and Conclusions

The objectionable odor which had been noted by a high percentage of the employees shortly after the Cimcool 23-A coolant was introduced was associated with high bacterial counts in the collant and was presumably due to rancidity. Better control of the bacterial and fungal growth in the coolant appears to have largely eliminated this problem.

On the second visit approximately 20% of the examined workers had dermatitis attributable to contact with the cutting oil. The product safety data sheet described this coolant as non-irritating to the skin on the basis of animal testing. However from the results of this survey this coolant appeared to be the cause of an eczematous dermatitis with prolonged and repeated exposures in humans. The extent to which other concomitant work exposures (soaps, cleaning agents, etc.) might contribute to this irritation could not be determined. It may be significant that the animal testing of the irritancy of this coolant to the skin was derived from standard tests which require only one application of the coolant to the skin. In this operation, however, workers skin was repeatedly exposed to the coolant, day after day. In these circumstances a cumulative insult dermatitis may be produced by a seemingly mild irritant. Eczematous contact dermatitis from water soluble coolants of this type is most commonly due to irritation from repeated immersion in the alkaline soap-like fluid. Allergic contact dermatitis may occur but it is rare and when it occurs is usually due to additives, corrosion inhibitors, bacteriacidal agents etc. To investigate the possibility of allergy to an additive, patch testing to suitable dilutions of all the components of the coolant should be performed. As the composition of this coolant was not known by the investigators, such testing could not be performed. In any case it is apparent that repeated exposures under work conditions to this coolant may result in a significant incidence of eczematous contact dermatitis.

More than half of the employees complained of respiratory symptoms. Some of these were attributable to a recent epidemic of upper respiratory tract infections and to seasonal allergies. There remained however 11 out of 41 workers who developed signs and 14 out of 41 who developed symptoms of respiratory tract irritation over the shift period. In most of these workers only the mucous membranes of the upper respiratory tract, especially the nose and throat, seemed affected. Four employees also developed symptoms and signs of ocular mucous membrane irritation over the same period. These symptoms and signs could not be fully explained by smoking by the employees. They were observed in workers in both shifts examined. A comparison of respiratory symptomatology and findings of physical examinations before and after the shift for these workers is contained in Table 4.

These results suggest that the coolant mist is irritant to the mucous membranes under conditions of use. As the composition of the coolant was not made available we are unable to determine which if any, particular ingredient was responsible for these effects. It is conceivable that an allergic response to one or more ingredients or contaminants could have produced these responses but the detailed immunologic testing necessary to prove or disprove this hypothesis could not be performed in the absence of more information as to the constituents of the coolant.

Four employees complained of asthmatic symptoms including shortness of breath and chest tightness. However the $FEV_1$ appeared unchanged over the shift for either these employees or for the 23 employees who were adequately evaluated in this way. The average coolant mist exposure of these four workers was compared to the average exposure of the remaining workers who did not report the development of asthmatic symptoms during the shift. The symptomatic workers had an average exposure of 4.95 $mg/M^3$ compared to an exposure of 5.85 $mg/M^3$ for the remaining workers. These averages were compared and there was no statistically significant difference in exposure of these symptomatic and non-symptomatic workers.

A statistically significant reduction was seen in the FVC for second shift, but not for third shift, employees. The actual reduction however was very small, being about 2%. Decrements of this degree have been observed over a daytime shift in the absence of any hazardous exposure. We must conclude that we were unable to substantiate any pronounced degree of reversible obstructive airways disease due to exposure to the coolant.

The coolant, Cimcool S23-A, appears to be irritant to the skin and mucous membranes with repeated industrial contact despite the fact that it is apparently not corrosive nor a primary skin irritant according to the techniques specified in the Regulations for the Enforcement of the Federal Hazardous Substances Act (Revised Federal Register, September, 1964).

## V. RECOMMENDATIONS

1. Frequent monitoring of the coolant for pH, alkalinity, bacterial count, fungal count, concentration of bactericide and fungicide and other appropriate tests should be continued.

2. Precautions should be taken to minimize exposure of the workers to mist and spray from the coolant. Thus, where possible, splash guards (including lucite shields), hooding of machines and eye and face shields should be used. In all cases maximum enclosure of the cutting processes should be maintained.

3. Where it can be used safely, protective clothing including impervious gloves, and protective sleeves and aprons should be used.

4. It is important that personal cleanliness be emphasized, in particular the prompt removal of coolant from the skin. To this end only a mild soap and lukewarm water is recommended. If a liquid cleanser is used it should be of either acid or neutral pH and should be mild to the skin. If possible abrasive soaps should not be used, if they are found to be necessary the use of a granulated vegetable abrasive is recommended.

5. The pre-employment examination should be used to screen potential employees with periodic or recurrent skin, eye or respiratory disease from working in this area.

6. Affected employees should see the plant nurse or doctor if there is evidence of a significant skin, eye or other reaction. If the reaction is of a significant degree the employee should be withdrawn from the exposure until the cause is determined and preventive measures provided.

7. Employees should avoid contaminating or polluting the coolant with any type of waste matter.

## VI. REFERENCES

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Table I

RESULTS OF PULMONARY FUNCTION TESTS FOR GRINDING AREA WORKERS
(August 20, 1974)

| | Number of Workers | Mean Pre | Mean Post | t | Prob | Comment |
|---|---|---|---|---|---|---|
| $FEV_1$ | 23 | 3.77 | 3.73 | 0.6712 | 0.5091 | Not Sign. |
| FVC | 23 | 4.63 | 4.52 | 0.4249 | 0.0024 | Sign. diff. |

Table 2

RESULTS OF PULMONARY FUNCTION TESTS FOR GRINDING AREA WORKERS
BY SMOKING HISTORY (August 20, 1974)

| | Mean Pre | Mean Post | Prob | Comment |
|---|---|---|---|---|
| 2nd Shift | | | | |
| $FEV_1$ - NS or light | 3.49 | 3.42 | 0.1211 | Not Significant |
| $FEV_1$ - Mod. or heavy | 3.39 | 3.31 | 0.1863 | Not Significant |
| FVC - NS or light | 4.59 | 4.44 | 0.0263 | Significant |
| FVC - Mod. or heavy | 4.31 | 4.15 | 0.036 | Significant |
| 3rd Shift | | | | |
| $FEV_1$ - NS or light | 3.88 | 4.00 | 0.456 | Not Significant |
| $FEV_1$ - Mod. or heavy | 4.53 | 4.41 | 0.706 | Not Significant |
| FVC - NS or light | 4.90 | 4.79 | 0.323 | Not Significant |
| FVC - Mod. or heavy | 4.85 | 4.85 | 0.98 | Not Significant |

Table 3

RESULTS OF PULMONARY FUNCTION TESTS FOR GRINDING AREA WORKERS WITH ASTHMATIC SYMPTOMS (August 20, 1974)

| Employee | Mean* FVC | | Mean* FEV | |
|---|---|---|---|---|
| | pre | post | pre | post |
| 1 | 5.06 | 5.03 | 4.29 | 4.26 |
| 2 | 4.27 | 4.28 | 3.82 | 3.83 |
| 3 | 5.32 | 5.38 | 4.21 | 4.29 |
| Combined mean | 4.88 | 4.90 | 4.11 | 4.13 |

*In each case this is the mean of the 3 best determinations from 5 attempts.

Table 4

COMPARISON OF RESPIRATORY SYMPTOMATOLOGY AND PHYSICAL FINDINGS BEFORE AND AFTER THE SHIFT IN FORTY ONE EMPLOYEES

| Category | Number of Employees |
|---|---|
| **No Change Over Shift** | |
| No symptoms or findings before or after | 9 |
| Similar symptoms and findings before and after | 11 |
| **Changes Before But Not After The Shift** | |
| Symptoms before, no symptoms after | 6 |
| Symptoms and findings before, none after | 0 |
| **Changes After But Not Before The Shift** | |
| Symptoms after, no symptoms before | 4 |
| Symptoms and findings after, but not before* | 11 |

*In seven employees these changes were confined to the upper respiratory tract, in four changes appeared to involve both upper and lower respiratory tracts.