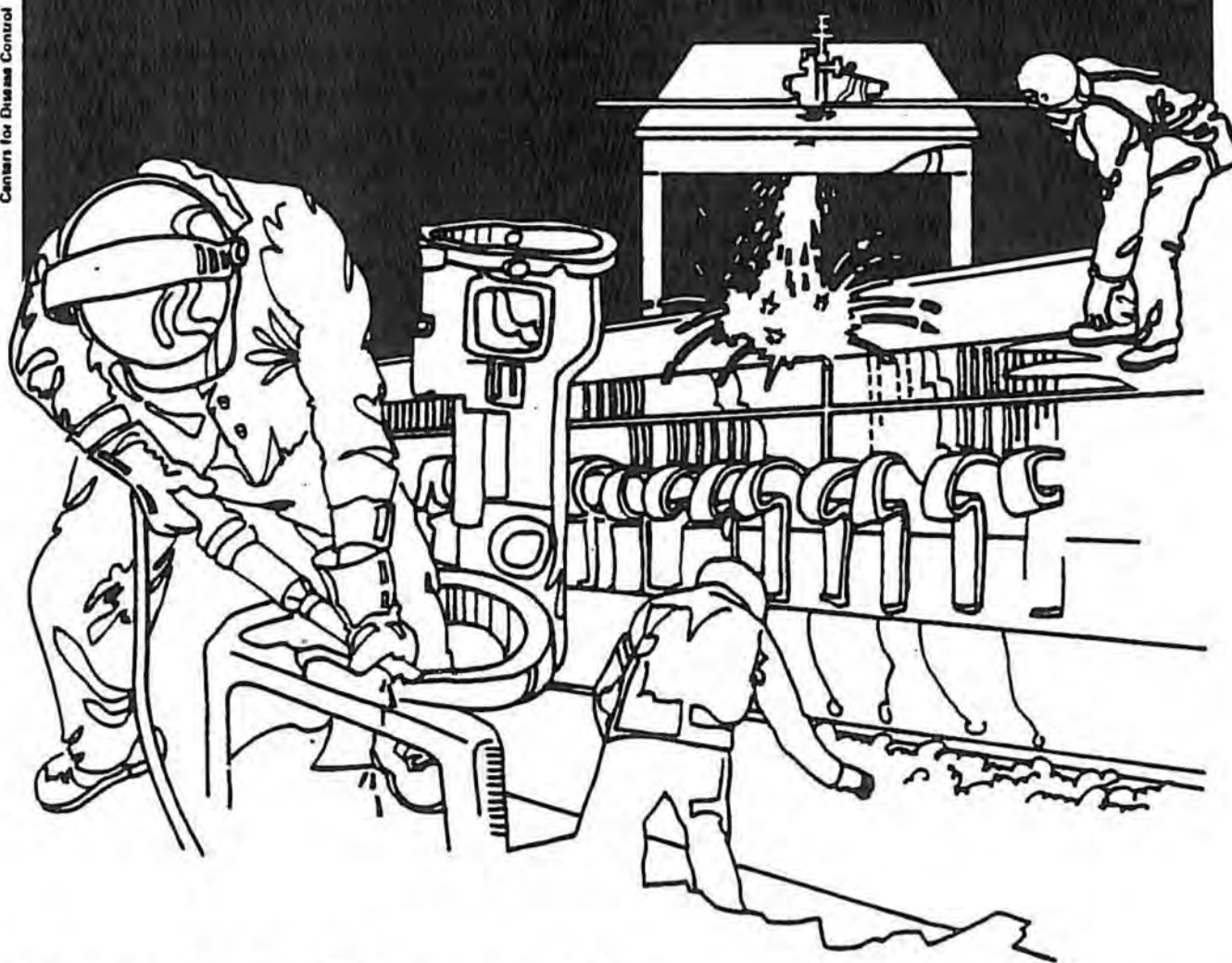


NIOSH



Health Hazard Evaluation Report

HETA 85-306-1753
TIMKEN, INC.
CANTON, OHIO

HETA 85-306-1753
December 1986
TIMKEN, INC.
CANTON, OHIO

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I. SUMMARY

In April 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate upper respiratory irritation among machinists exposed to oil mist at Timken Corporation, Canton, Ohio.

On July 30, 1985, NIOSH investigators conducted a walk-through of the roller bearing grinding departments and collected bulk samples of the grinding fluid for developing air sampling and analytical methods. On March 6, 1986, NIOSH investigators conducted an environmental and medical survey of the grinding area. Attempts to develop an analytical method for the "highly refined base oil" were unsuccessful, as was the attempted development of an analytical method for a surfactant dispersant additive (Gulf Agent 1688) consisting of a mixture of C₉-C₁₁ alcohol ethoxylates. Most workers associated their symptoms with exposure to this additive, particularly during the first few weeks after it was introduced in December 1984. As a result, the method of adding it to the grinding fluid was changed from rapid pouring to a slower, continuous "drip", method.

No nitrosamines were detected in bulk samples of the grinding fluid.

Total particulate exposure results were used to estimate workers' exposures to oil mist. Particulate air concentrations in the grinding area ranged from 1.6 to 2.6 milligrams per cubic meter (mg/m³), with a mean of 2.2 mg/m³. The inspection department, which is adjacent to the grinding area, had 0.3 mg/m³ of particulates in the air. The OSHA permissible exposure limit for mineral oil mist is 5 mg/m³.

A self-administered medical and occupational history questionnaire was completed by 174 employees. Commonly reported work-related symptoms included throat dryness (38% of participants); nose irritation (36%); dry nose (34%); headache (31%); itchy, runny nose (27%); stuffy nose (25%); eye watering (24%); eye redness (22%); and sore throat (21%).

The 82 participants from the two grinding departments did not differ significantly from the 52 inspection department participants with respect to the prevalence of any of 23 symptoms. Ten symptoms were numerically more prevalent among grinding department participants, and 13 were more prevalent among inspection department participants.

The company discontinued the use of Gulf Agent 1688 in April 1986.

The findings from the medical survey provided no evidence that exposure to machining fluids was the primary cause of the reported symptoms among the participants at the time of our survey. However, exposures to Gulf Agent 1688 were potentially different when it was introduced and the survey findings might not apply to that time. Recommendations for minimizing exposures are presented in Section VIII of this report.

KEYWORDS: SIC 3562 (Ball and Roller Bearings) Grinding fluid, Cutting oil, Oil mist, Alcohol ethoxylates, Nitrosamines, Upper respiratory irritation, Gulf Agent 1688, Gulf cut Soluble Oil B, Chevron Soluble Oil.

II. INTRODUCTION

In April 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request from workers at Timken Corporation, Canton, Ohio, to evaluate respiratory irritation, skin rashes, and headaches among machinists in the roller-bearing grinding area of the plant. Exposure to a grinding fluid additive, Gulf Agent 1688, was suspected to be the cause of the health problems.

On July 30, 1985, NIOSH investigators conducted a walk-through of the grinding area. Bulk samples of grinding fluid and Agent 1688 were collected in an attempt to develop air sampling and analytical methods.

On March 6, 1986, NIOSH investigators conducted an environmental and medical survey of the grinding area. The company was given the environmental results on June 23, 1986, at which time they reported that the use of Agent 1688 had been discontinued in April 1986.

III. BACKGROUND

The roller-bearing grinding area is located in an 18-year-old building and occupies about 1,600,000 ft.³ It has about 140 grinding machines and is divided into two departments. Dept. 40 employs 43 workers and Dept. 74 employs 83 workers. The major difference between the two departments is the degree of automation of their grinding machines. Dept. 40 requires one worker to operate 10-12 machines whereas Dept. 74 has one operator for every 1-2 machines.

The grinding fluid consists of a 50,000-gallon water-based recirculating system. The company started using Gulfcut Soluble Oil B and Gulf Agent 1688 in December 1984. About 300 gallons of oil per day are added to the system to maintain an 8-10% concentration. When the company first started using these products, the bulk quantity of Agent 1688 needed to achieve its desired concentration in the grinding fluid was poured rapidly into the system. Immediately, however, workers complained of throat irritation, nose bleeds, and nausea. Afterwards, Agent 1688 was continuously "dripped" into the system at a rate of 15 to 25 milliliters per minute to maintain the desired daily concentration of 0.2%. Union and management representatives agreed that health complaints were greatly diminished, probably due to the slower introduction of the additive. However, the union was not sure to what extent that natural ventilation during warm weather may have helped alleviate the problems. They expressed concern that harmful exposures to Gulf 1688 may recur when windows are closed during cold weather.

The material safety data sheet (MSDS) refers to Soluble Oil B as a "highly refined base oil" (CAS 64742-52-5, 64741-96-4) with additives including antihaze, emulsifying and oiliness agents, and diethylene glycol. The MSDS for Gulf Agent 1688 defines the product as a "mixture of C₉ to C₁₁ alcohol ethoxylates" (CAS 68439-45-3) and warns that trace amounts of ethylene oxide may be present. Agent 1688 is used as a surfactant dispersant, which is designed to prevent the "gumming-up" of the grinding machines.

After the NIOSH investigation, the company discontinued the use of Soluble Oil B and Agent 1688 and replaced them with Chevron "Soluble Oil", which requires no additives except water.

IV. METHODS

A. Environmental

On March 6, 1986, five full-shift personal breathing-zone air samples were collected from Grinder Operators and four area air samples from in and near the grinding area were collected. The samples were collected by battery-powered pumps on preweighed membrane filters at a flow rate of 1.5 liters per minute. They were then weighed and analyzed for oil mist according to NIOSH Method P & CAM 283.

Five bulk samples of grinding fluid were analyzed for nitrosamines by high pressure liquid chromatography.

Direct-reading colorimetric detector tubes were used for ethylene oxide near a grinding machine, near the Gulf Agent 1688 drip system, and in the air space inside of a drum of Agent 1688.

B. Medical

All workers in department 82 (inspection) and in departments 74 and 40 (both grinding) were invited to participate in the medical survey which consisted of a self-administered questionnaire addressing work history at Timken, smoking history, and a variety of skin, eye, nose, throat, respiratory, and systemic symptoms. We defined a symptom as work-related if it occurred at least once per week, began after the start of employment at Timken, and occurred mostly at work.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation

criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if 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 evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The specific environmental criteria used for assessing oil mist are described in the following section.

B. Oil Mist

The ACGIH Documentation of Threshold Limit Values cites a "striking lack of reported cases of illness" related to mineral oil mist inhalation at concentrations up to 15 mg/m³. ACGIH concluded that a 5 mg/m³ limit would provide a considerable margin of safety against even relatively minor changes in the lungs.

The MSDS for Gulfcut Soluble Oil states that there are no exposure limits for the product, since it is not a mineral oil. However, based on "information reviewed to date", the manufacturer recommended an exposure limit of 5 mg/m³ to prevent respiratory discomfort or irritation.

The MSDS for Gulf Agent 1688 does not recommend any exposure limits. It warns that contact with the liquid causes severe eye irritation and moderate to severe skin irritation; and that inhalation of high vapor concentrations may cause central nervous system depression. A NIOSH computerized literature search for toxicity data on C₉ - C₁₁ alcohol ethoxylates found no additional information.

VI. RESULTS AND DISCUSSION

A. Environmental

Grinder operators were exposed to total airborne particulate concentrations ranging from 1.6 to 2.6 milligrams per cubic meter (mg/m³) with a mean of 2.2 mg/m³ (Table I). The general area of Department 40 had a mean airborne particulate concentration of 2.1 mg/m³. The inspection department, which lies adjacent to the grinding area, had 0.3 mg/m³ of particulates in the air.

Method P & CAM 283 was found to be unsuitable for quantitating "Soluble Oil B". 1,1,2-trichlorotrifluoroethane was substituted for carbon tetrachloride as the extraction solvent, but it performed poorly. Evaluation of the quality control samples (both blind and analyst spikes) indicated that recovery was biased and erratic, most likely due to incomplete solubility of the samples.

Also, attempts to develop a suitable analytical method for Agent 1688 were unsuccessful due to the large number of compounds present in the product. Using gas chromatography with flame ionization detection, the lower limit of detection was found to be too high for quantitating the air concentrations likely to be present at Timken.

No nitrosamines were detected in any of the bulk samples. The limit of detection for dimethylnitrosamine is 12 nanograms per milliliter.

No ethylene oxide was detected (<1 ppm).

The grinding area is supplied with dilution ventilation by ceiling exhaust fans and return air fans. The company reports the ventilation rate to be about one air change every 10 minutes.

B. Medical

One hundred seventy-four workers answered the questionnaire; this included 134 (67%) of the 200 workers in the three target departments. (Not everyone answered every question.) Of those answering the respective questions, 52 (30%) were women and 30 (18%) were Black. Participants ranged in age from 29 to 61 years, with a mean and median age of 45. They had worked at the plant from less <1 to 43-1/2 years, with a mean of 22 and a median of 20, and had been in their current department from <1 to 43 years, with a mean of 15 and a median of 16. They had held their current job title from <1 to 42 years, with a mean of 13 and a median of 15. Fifty-eight (35%) were current smokers, 44 (26%) were former smokers, and 65 (39%) had never smoked.

Nose and throat symptoms and headache were the most prevalent, occurring at least three times per week in at least 1/3 of participants (Table II). Eye, sinus, and lower respiratory tract symptoms were somewhat less common. For specific symptoms, 24-61% (median 45%) were reported as work-related (Table III). Nose and throat symptoms and headache were again the most prevalent, followed by symptoms of eye irritation. The median time since onset of individual work-related symptoms ranged from 4 to 12 months.

Fifty-seven participants worked in department 74, 25 in department 40, 52 in department 82, and the rest in other, multiple or unspecified departments. Participation rates for the three target departments were comparable (Table IV). Participants in the grinding departments (departments 74 and 40) included only two women and two Blacks, whereas the participants from the inspection department (department 82) were 65% women and 36% Black. Department 74 participants appeared to be older and to have been in their current department and job title longer than department 40 participants. Combined, however, participants from these departments did not differ substantially from department 82 participants with respect to these characteristics.

Department 40 participants had numerically higher prevalences than department 74 participants for 16 of the 23 symptoms, but none of the individual differences was statistically significant ($p > 0.1$ in all cases, chi-square or Fishers exact test, as appropriate) (Table V). Furthermore, the trend for department 40 participants to have higher symptom prevalences was not statistically significant ($p > 0.05$, Wilcoxon matched pairs test). Comparing department 82 to departments 74 and 40 combined, there was no statistically significant difference in the prevalence of any individual symptom. The grinding departments combined had a numerically greater prevalence for 10 of the 23 symptoms, the inspection department for 13.

VII. CONCLUSIONS

Exposure to oil mist was found to be well below the manufacturer's recommended exposure limit of 5 mg/m^3 . However, the potential health effects from exposure to the newer types of machining fluids have not been studied thoroughly enough to conclude that it is appropriate to apply the "old mineral oil" exposure limit of 5 mg/m^3 to these products.

Workers in the grinding and inspection departments reported the frequent occurrence of headache and eye, nose, throat, and skin symptoms temporally related to work. Although in individual cases, some of the symptoms could have been caused by constituents or contaminants of the machining fluids, the lack of any significant difference in symptom prevalence between grinding and inspection departments suggests that exposure to machining fluids was not the primary cause of the reported symptoms among the survey participants at the time of our survey. Because exposures to Gulf Agent 1688 were potentially different when it was introduced, the survey findings might not apply to that time.

VIII. RECOMMENDATIONS

The most effective control of any contaminant is at the source of generation, however, it seems unlikely that the company would consider applying local exhaust ventilation to each of their 140 grinders. Nevertheless, they should keep in mind that dilution ventilation is very limited in its ability to control oil mist levels and the following recommendations should be used to keep exposures as low as possible.

1. Substitution. Since many of the proprietary ingredients of cutting fluids have not undergone complete toxicological evaluation, caution should be used when contemplating any change from one cutting fluid formulation to another, giving full consideration to the potential hazards of the substitute. Also care should be taken to ensure that the substitute does not contain either nitrosamine contaminated amines, or the necessary ingredients (amines and nitrites) for nitrosamine formation.

2. Respirators. Personal respiratory protective devices should only be used as an interim measure while engineering controls are being installed, for non-routine use and during emergencies. Standard written operating procedures should be developed in accordance with OSHA 1910.134.
3. Protective clothing. Impervious clothing should be provided and should be replaced or repaired as necessary. Non-impervious clothing is not suggested, but if used, it should be removed and laundered frequently to remove all traces of cutting fluids before being reworn. (Laundry personnel should be made aware of the potential hazard from handling contaminated clothing.)
4. Personal cleanliness. All exposed areas of the body and any area that becomes wet with cutting fluids should be washed with soap or mild detergent. Frequent showering is recommended.
5. Isolation. Where possible, any operations involved with cutting fluids should be placed in an isolated area to reduce exposure to employees not directly concerned with the operations.
6. Barrier creams. Barrier creams may provide protection against dermal irritation and skin absorption, however, the barrier cream should not contain secondary or tertiary amines (which may react to form nitrosamines in the presence of nitrites).

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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1. Timken Corporation
2. Local 1123, Safety Committee
3. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I
 Exposure to Total Airborne Particulate
 Timken Co.
 HETA 85-306
 March 6, 1986

JOB/LOCATION	SAMPLE TIME	Total Particulate Concentration (mg/m ³)
Dept. 74 Operator - Gardner Grinders 848 & 125	723 - 1431	2.4
Dept. 74 Operator - Plunge Cut OD Grinders	726 - 1435	1.6
Dept. 74 Operator - Odd Lot Set-up	731 - 1433	2.5
Dept. 40 Operator - Line 33	733 - 1438	1.9
Dept. 40 Operator - Lines 18 & 19	738 - 1441	2.6
Area Sample - Inspection Dept.	1030 - 1444	0.3
Area Samples (triplicate side-by-side)		2.2
Dept. 40 Grapper Area	800 - 1433	2.0
		2.1

TABLE II

Symptoms Reported by 174 Survey Participants

Timken Company
Canton, Ohio
HETA 85-306

March 1986

<u>Symptom</u>	<u>Number responding to question</u>	<u>Symptom present at least once per week</u>		<u>Symptom present at least 3 times per week</u>	
		<u>Number</u>	<u>%</u>	<u>Number</u>	<u>%</u>
Throat dryness	174	118	68	82	47
Headache	173	115	66	65	38
Stuffy nose	174	106	61	63	36
Itchy, runny nose	174	104	60	65	37
Nose irritation	174	103	59	79	45
Dry nose	174	101	58	66	38
Cough	173	93	54	48	28
Sore throat	172	90	52	50	29
Sinus infections	174	84	48	48	28
Eye watering	174	82	47	39	22
Eye redness	174	73	42	29	17
Hoarseness	172	61	35	30	17
Skin rash	172	57	33	24	14
Chest tightness	173	56	32	28	16
Vision blurring	174	49	28	19	11
Shortness of breath	172	47	27	26	15
Dizziness	171	41	24	10	6
Vomiting/nausea	172	41	24	14	8
Wheezy or whistling breathing	172	38	22	23	13
Nose bleeds	174	35	20	7	4
Eye pain	174	34	20	15	9
Eye dryness	174	21	12	11	6
Eye infection	174	9	5	2	1

TABLE III

Work-Related¹ Symptoms Among Survey Participants

Timken Company
Canton, Ohio
HETA 85-306

March 1986

<u>Symptom</u>	<u>Number</u>	<u>%²</u>	<u>Prevalence (%)³</u>	<u>Months since onset</u>		
				<u>Range</u>	<u>Mean</u>	<u>Median</u>
Throat dryness	66	56	38	1-204	14	5
Nose irritation	63	61	36	1-204	14	10
Dry nose	59	58	34	1-204	14	9
Headache	54	47	31	1-233	16	5
Itchy, runny nose	47	45	27	1-204	19	7
Stuffy nose	44	42	25	1-204	14	10
Eye watering	42	51	24	1-50	9	9
Eye redness	38	52	22	1-50	10	10
Sore throat	36	40	21	1-204	13	5
Skin rash	28	49	16	1-83	10	7
Cough	25	27	14	1-204	14	4
Hoarseness	25	41	14	1-204	16	5
Vision blurring	25	51	14	1-26	10	10
Sinus infections	22	26	13	2-170	23	12
Chest tightness	22	39	13	1-50	9	5
Eye pain	20	59	11	1-228	18	5
Nose bleeds	19	54	11	1-204	22	12
Dizziness	18	44	10	1-26	8	8
Shortness of breath	16	34	9	1-14	6	5
Vomiting/nausea	16	39	9	2-26	10	10
Eye dryness	11	52	6	2-18	7	4
Wheezing or whistling breathing	9	24	5	1-14	7	6
Eye infection	3	33	2	4-14	9	10

1 - See text for definition.

2 - Percent of all participants having a given symptom at least once per week (See Table II).

3 - Denominator of 174 used for all symptoms.

Table IV

Questionnaire Responses by Department

Timken Company
Canton, Ohio
HETA 85-306

March 1986

	Department 74 (grinding)	Department 40 (grinding)	Department 82 (inspection)
Number in department	79	41	80
Number in survey	57	25	52
Participation rate	72%	61%	65%
Number and (%) women	1 (4) ^A	1 (4)	36 (69)
Number and (%) Black	1 (4) ^A	1 (4) ^A	18 (36) ^B
Age (years)			
Range	30-59	29-51	32-61
Median	46	42	46
Mean	47	41	45
Time at company (years)			
Range	12-38	7-27	11-44
Median	23	20	17
Mean	25	19	19
Time in department (years)			
Range	3-38	1-17	2-43
Median	20	8	16
Mean	19	10	15
Time in current job title (years)			
Range	2-34	1-24	2-21
Median	15	9	16
Mean	15	11	13
Number and (%) current smokers	21 (40) ^C	7 (29) ^A	19 (37) ^A
Number and (%) former smokers	14 (26)	9 (38)	10 (20)
Number and (%) who never smoked	18 (34)	8 (33)	22 (43)

A - Information not provided in one questionnaire.

B - Information not provided in two questionnaires.

C - Information not provided in four questionnaires.

Table y
Work-related¹ Symptoms by Department

Timken Company
Canton, Ohio
HETA 85-306

March 1986

Symptom	Department 74 (57 respondents)		Department 40 (25 respondents)		Department 82 (52 respondents)		Grinding (departments 74 and 40) vs. inspection (department 82)	
	Number	Prevalence ²	Number	Prevalence ²	Number	Prevalence ²	Chi-square	p
Throat dryness	20	35	8	32	24	46	1.46	0.23
Nose irritation	23	40	11	44	15	29	1.67	0.20
Dry nose	22	39	10	40	15	29	1.04	0.31
Headache	13	23	9	36	21	40	2.10	0.15
Itchy, runny nose	15	26	7	28	12	23	0.080	0.78
Stuffy nose	13	23	7	28	16	31	0.37	0.54
Eye watering	10	18	4	16	16	31	2.69	0.10
Eye redness	10	18	6	24	14	27	0.62	0.43
Sore throat	7	12	6	24	13	25	1.17	0.28
Skin rash	13	23	5	20	6	12	1.69	0.19
Cough	9	16	4	16	5	10	0.60	0.44
Hoarseness	8	14	4	16	9	17	0.029	0.86
Vision blurring	6	11	4	16	11	21	1.31	0.25
Sinus infections	5	9	4	16	10	19	1.17	0.28
Chest tightness	8	14	6	24	5	10	0.91	0.34
Eye pain	6	11	1	4	6	12	0.074	0.79
Nose bleeds	6	11	4	16	3	6	0.86	0.35
Dizziness	4	7	1	4	7	13	F ³	0.13
Shortness of breath	5	9	4	16	5	10	0.0015	0.97
Vomiting/nausea	5	9	3	12	7	13	0.15	0.70
Eye dryness	3	5	3	12	2	4	F	0.33
Wheezy or whistling breathing	5	9	1	4	2	4	F	0.33
Eye infection	1	2	1	4	0	0	F	0.37

1 - See text for definition.

2 - Percent of respondents in the department.

3 - Fisher's exact test, 1-tailed.