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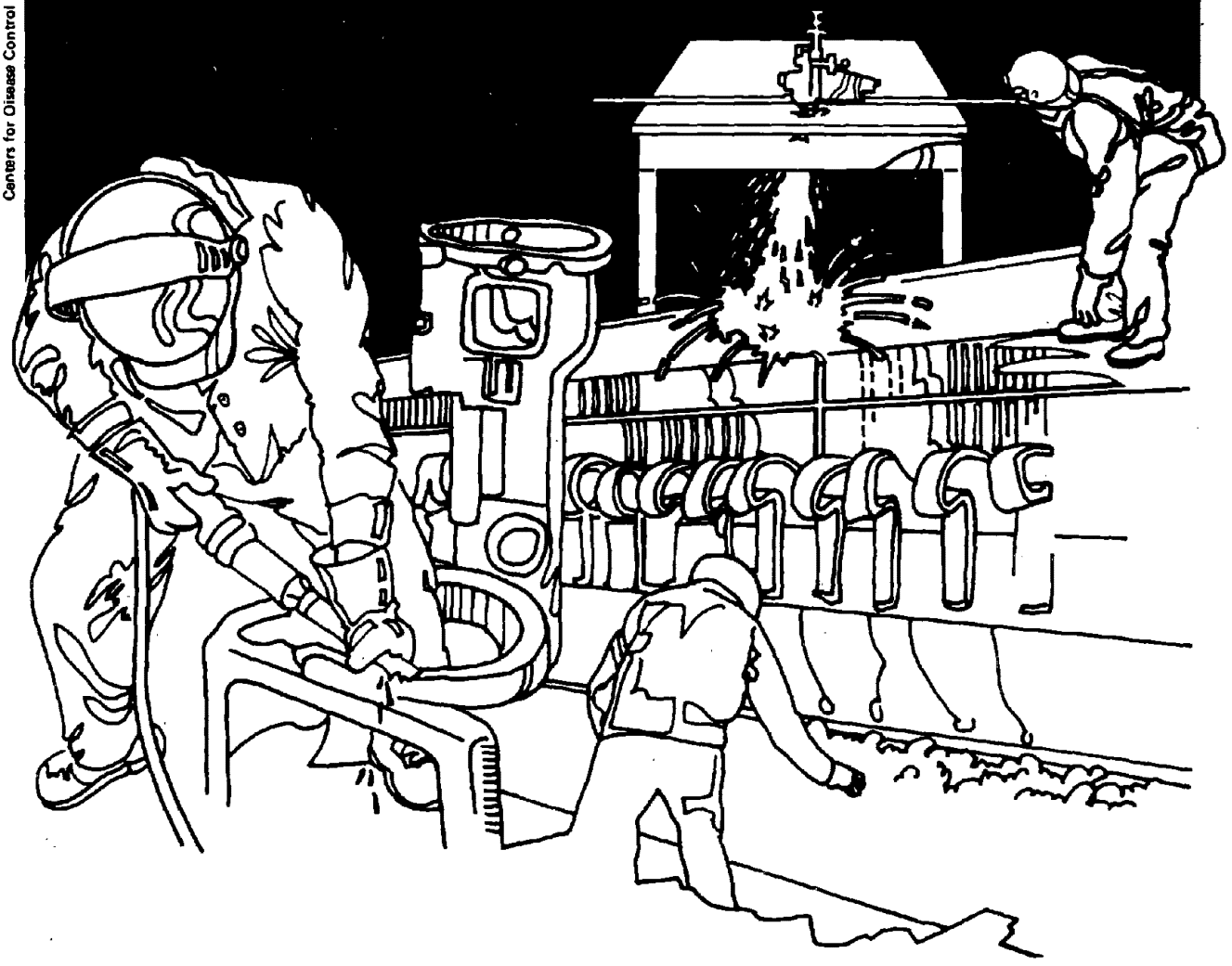

Health Hazard Evaluation Report

HETA 81-227-1408
MANVILLE CORPORATION
CORONA, CALIFORNIA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of 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 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 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 Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial nygiene technical and consultative assistance (TA) 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.

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SUMMARY

In April 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate employees' reported respiratory symptoms manifested by cough and wheezing which they believed may have been a result of their exposure to silane, phenol, ammonia and formaldehyde at Manville Corporation, Corona, California.

On July 27, 1981, the NIOSH investigators conducted an initial environmental and medical survey of the plant. On March 21-23, 1982, a follow-up medical evaluation was conducted to determine if there was an increased prevalence of respiratory symptoms within a sample of the working population. A respiratory questionnaire was administered to 71 of the 150 employees. There appears to be a general increase of all respiratory symptoms except for chronic phlegm when compared to the inplant control. This was particularly marked with the symptom of wheezing in the Cold End (70%) and Hot End (59%) of the production lines, breathlessness in all exposure groups, acute cough and phlegm in maintenance (41%), chest colds in all exposure groups, history of hay fever in the Cold End (22%), and lower respiratory illness in all groups.

On May 5-7, 1982, NIOSH conducted a follow-up environmental study. In this study thirty-two phenol and formaldehyde air samples (personal and area) were collected, but no air concentrations were found above the limit of detection. Seven personal and area air samples were collected along the lines for fibrous glass. The airborne concentrations ranged from 0.02 to 0.31 fibers per cubic centimeter of air (fibers/cc) which is below the NIOSH recommended criteria of 3.0 fibers/cc. Nine personal and area air samples were collected for total dust from the bailer and cutting area. The air concentrations ranged from 0.25-1.45 milligrams per cubic meter of air (mg/m^3). None exceeded the NIOSH recommended criterion of 5 mg/m^3. Two respirable dust air samples were collected from the same area; the air concentrations measured were 0.04 and 0.20 mg/m^3. These air concentrations were below the nuisance dust threshold limit value (TLV) of 5.0 mg/m^3. Four air samples were collected for total and respirable dust during clean out of the high efficiency air filter. The total dust air concentrations were 9.84 and 2.54 mg/m^3; neither exceeded the TLV of 10 mg/m^3. The respirable dust air concentrations were 0.18 and 0.11 mg/m^3; neither exceed the TLV of 5 mg/m^3. Eight personal and area air samples were collected for ammonia. The air concentrations ranged from none detected to 0.8 parts of a vapor or gas per million parts of air (ppm). Seven colorimetric detector tubes were used to measure peak exposures to ammonia. The air concentrations ranged from none detected to approximately 25 ppm. The NIOSH recommended criterion for peak exposure is 50 ppm.

Three bulk samples of a heat duct insulation material were analyzed for asbestos content. Two of the samples detected 40-50 percent chrysotile asbestos and one sample detected 5-10 percent crocidolite asbestos.

On December 6-8, 1982, a follow-up environmental survey was conducted to re-evaluate airborne formaldehyde exposures. Twenty-four formaldehyde area air samples were collected, and the air concentrations ranged from 0.01 to 0.55 ppm. In addition, The NIOSH Measurement Research Support Branch conducted a special study to determine whether the airborne glass fiber particulate may have an effect on the formaldehyde air sampling method or the analytical system. The study demonstrated consistent formaldehyde air concentrations ranging from 0.1 to 0.2 ppm. NIOSH recommends that formaldehyde exposures be maintained to the lowest feasible limit since it is a suspected human carcinogen.

On the basis of the environmental data, employees were not over-exposed to fibrous glass, fibrous glass dust, phenol or ammonia. However, a potential health hazard did exist based on the low airborne exposures to formaldehyde vapors. Based on the medical data, there appears to be an increased prevalence of upper and lower respiratory symptoms in the employees interviewed. Recommendatios are provided in Section IX of the report to reduce worker exposure.

KEYWORD: SIC 3296 (Mineral Wool), phenol, formaldehyde, ammonia, fibrous glass.

II. INTRODUCTION

In April, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from the Glass Bottle Blowers Association, local #192, at Manville Corporation, Corona, California. NIOSH was requested to investigate reported respiratory symptoms manifested by coughing and wheezing.

On July 27, 1981, the NIOSH regional industrial hygienist and the medical contractor conducted an initial walk-through survey of the plant.

On March 21-23, 1982, the medical investigator conducted a follow-up medical survey in which medical questionnaires were administered to employees.

On May 5-7, 1982, NIOSH conducted a follow-up environmental survey to measure the following airborne chemicals: formaldehyde, phenol, glass fibers, total and respirable fibrous glass dust and ammonia. In addition, several bulk samples of lagging material were analyzed for asbestos. On December 6-8, 1982, a follow-up environmental survey was conducted to re-evaluate the airborne formaldehyde concentrations. The environmental air sampling results were reported to the appropriate individuals as soon as they became available.

III. BACKGROUND

The Manville Plant in Corona, California was put into production in 1958. When running at capacity, the plant employs 220 hourly employees of whom 170 are directly involved in fibrous glass production and 40 are involved in maintenance. The other ten hourly employees work in the warehouse. There are four major crews. Three crews work 8-hour shifts and one crew is off in any 24-hour period. Employees rotate shifts every five days with up to four days off between shifts.

The Company has a yearly physical examination program that includes chest x-ray, spirometry, urinalysis, complete blood count, and audiometric examination. Some of these tests were started in 1980. Medical records are available for the past 20 years.

The Manville plant was working at half capacity in March, 1982; a large number of employees had been recently laid off. Three of the six production lines were shut down during the medical survey. Retention of employees (about 150) was apparently based on seniority. The number of individuals on permanent leave due to medical problems secondary to their occupation is unknown.

There have been no major process changes since initial production in 1958. Asbestos products have never been manufactured at the facility; however, asbestos products may have been stored within the warehouse facility.

The plant manufactures approximately 15 fibrous glass product groups (about 500 individual products which utilize approximately 27 individual chemical substances) from conventional glass making raw materials such as borosilicate and low alkaline silicate glasses. The average fiber diameter was reported to be 17 micrometers (um). The smallest fiber product has an average diameter of 3 to 5 um. The fibrous glass produced by melting and fiberizing silicate glass is called the pot marble process. This is similiar to the spin process seen with the manufacture of mineral wool. Once the glass marbles are melted, the fiber strands are pulled through to the gas burners and directed through the forming tubes. The glass fibers are sprayed at the binder header with a phenol-formaldehyde resin. Silicon, oil, dyes, pigments and adhesives may be used in the process. The sprayed glass is collected at the U-Chute on the collection chain after which the material is passed through the searing roll platform and the curing ovens. The glass is then cooled, cut and packaged.

IV. MATERIALS AND METHODS

1. Environmental:

Several sampling techniques were used to evaluate the suspected air contaminants which included: formaldehyde, phenol, total and respirable dust which contains fibrous glass, fibrous glass fibers, ammonia and asbestos. Personal and/or area air samples were collected to characterize worker exposure. Airborne samples were collected using Drager® colorimetric detector tubes and a sampling train (calibrated vacuum pump and appropriate collection media) through which a known volume of air is passed. In one instance, only bulk samples were collected and analyzed for asbestos.

The basis of the environmental sampling protocol was the medical complaints gleaned from workers while being interviewed. The following work areas and products were complained about by workers most often:

1) The bailing area (bagging operation); 2) Binder Room (ammonia); 3) Any Hot End of the lines including the collection chain (fumes); 4) Flotation Wool on line 66; 5) Trimming of Pipe Wool; 6) Thick bats (R/11-R/19); 7) Cleaning of high efficiency air filters (HEAF) by maintenance workers.

The following is a description of the sampling and analytical techniques used to characterize the airborne concentrations:

a) Formaldehyde

NIOSH presently uses two methods for measuring formaldehyde airborne concentrations. The methods are: Physical and Chemical Analytical Method (P&CAM) number 125 which uses an impinger containing 1% aqueous sodium bisulfite solution as the sampling medium with analysis by the colorimetric chromotropic acid procedure; and P&CAM 354 which uses XAD-2 resin tube coated with aminebenzlethanol as

the sampling medium with analyses of the benzloxazolidine reaction product by capillary column GC/FID. Some of the problems or limitations associated with each method are listed below.

P&CAM 125:

1. An impinger method; inconvenient and prone to error from loss of sample.

2. Not totally specific for formaldehyde.

3. Susceptible to interferences.

4. Possible sample storage stability problems.

P&CAM 354:

1. Prone to having a variable background of formaldehyde on the sampling medium.

2. Limited to a low flow and small sample volume by the kinetics of derivative formation.

3. Not as sensitive as Method 125; i.e., LOQ of 5 ug/sample for Method 354 (0.3 ppm in a 12 L sample) compared to a LOQ of 1 ug/sample for Method 125 (.007 ppm from a 120 L sample).

On May 5-7, 1982, environmental air samples were collected using a sampling train and a 150 mg XAD-2 resin coated tube. Subsequent analysis of the air samples revealed that in addition to possible problems in the analytical system, there are also those problems associated with the sampling procedure. One area of concern has been the possible effect that particulate material might have on formaldehyde monitoring. There is some speculation that formaldehyde might be absorbed on the particulate material and result in a low estimate of exposure if the sampling device is not able to compensate for this. Another potential problem is that resins or synthetic fibers might serve as formaldehyde sources through chemical degradation. Hypothetically, particulates of this type could enter a sampling system, decay with the resultant release of formaldehyde and give rise to data that would overestimate actual exposures.

Based on the potential problems mentioned above, a follow-up environmental study was scheduled December 6-8, 1982. Environmental air monitoring was conducted in the same areas previously monitored; however, a different sampling procedure was employed. Mixed cellulose ester membrane filters were used as particulate pre-filters for the impinger solutions and the XAD-2 resin tube. Also, the NIOSH Measurement Research Support Branch designed a special study which attempted to address both the similarities and/or differences in the two analytical techniques as well as determine any effects the different sampling configurations may have on the formadelyde concentrations.

The principle question posed in the follow-up study was how to address free gaseous formaldehyde versus particulate-bound or particulate generated formaldehyde. The potential existed for free formaldehyde from the resin system as it was sprayed onto the fiberglass, for particulate-bound formaldehyde-generating particulate from the resin system chemically degrading in the sampling systems. Monitoring methods used were NIOSH Method P&CAM 125, which uses midget impingers and a 1% sodium bisulfite absorbing solution, and P&CAM 354, which uses benzylethanol amine coated onto a XAD-2 resin tube as a chemical reaction absorbent (commercially available from Supelco). Impinger samples were shipped and stored in Nalgene polyethylene bottles. The various sample train configurations used are presented in Table #1, and Figure #1 shows the sampling manifold used in this study. The manifold can accommodate 12 samplers for each sampling period.

Cellulose ester membrane pre-filters were used on half of the samplers as a means of investigating the possible contribution from particulate material. With the two methods, 125 and 354, each being used with and without pre-filters there were four sampling configurations per manifold being used in triplicate. At the end of each sampling period the pre-filters were placed in sample bottles and treated with 10 mL of 1% sodium bisulfite solution. These samples were analyzed for formaldehyde by Method 125. As a check on sample stability and also as an indicator of formaldehyde generation all of the bisulfite solutions containing particulate material were analyzed immediately upon receipt as well as 10 days and 30 days following receipt. Samples suspected of showing a particulate material effect were the 300 series impingers that had no pre-filter and the 100 and 400 series pre-filter samples.

b) Phenol

A known volume of air is drawn through a midget bubbler containing 15 milliliters of 0.1 N sodium hydroxide to trap the phenol vapors. The resulting solution was acidified with sulfuric acid and analyzed by gas chromatography according to NIOSH method number S-330 with modifications.[17] The limit of detection was 0.02 milligram per sample.

c) Total and Respirable dust.

A known volume of air is drawn through a tared filter (M-5). The respirable dust air samples are collected using a cyclone which limits the particle size ($<$10u) collected on the filter. The total weights of the samples are determined by weighing the sample plus the filter on an electrobalance and subtracting the previously determined tare weight of the filter. The tare and gross weighings were done in duplicate.

d) Fibrous Glass

A known volume of air is drawn through an open face mixed cellulose ester membrane filter (AA). The filters were submitted for fiber counting. One-eighth of a 37-mm filter was prepared for Phase Contrast Microscopy via a procedure published in a 1977 Millipore Technical Service Brief. Counting was performed following the criterion set forth in Method Number P&CAM 239.[18]

e) Ammonia (NH_3)

A known volume of air was passed through a silica gel tube and analyzed using ion chromatography according to NIOSH P&CAM no. S-347.[19] A detection limit of four micrograms NH_3 per sample is estimated.

f) Asbestos

Portions of bulk samples of lagging material were each prepared for analyses by Polarized Light Microscopy Analysis at 100x magnification.[19]

Portions were also prepared for electron microscopy analysis at 10,000x magnification by ultrasonicating in ethyl alcohol and evaporating aliquots of this suspension onto 200 mesh carbon-coated copper girds.

2. Medical:

A modified American Thoracic Society respiratory questionnaire was administered to 71 of the 150 employees (47%) on payroll in March of 1982. The majority of these employees were from the A shift. Manville management and the local union fully cooperated with the questionnaire survey. Employee compliance from A shift was greater than 90 percent. All employees were given the opportunity to be interviewed. The respiratory questionnaire emphasized symptoms compatible with asthma. Because of the large number of job positions within the plant and the relatively small number interviewed in each job classification, an attempt was made to collapse the job positions into four main exposure groups. The rationale for selecting these exposure groups was a commonality of exposure in relationship to plant processes.

Maintenance: Chief maintenance electrician, chief maintenance mechanic, maintenance electrician I, maintenance mechanic I, maintenance electrician II, maintenance mechanic II, pot and burner mechanics, and painter.

Hot End: machine chief, operator, binder-marble operator, fabrication "B", fabrication "C".

Cold End: forktruck driver, machine attendant, production laborer, jacketing servicer, jacketer.

Control: truck and tractor driver, receiving and stores clerk, quality control inspector, warehouser, forktruck driver, material handler.

The maintenance exposure group had the potential for multiple types of occupational exposures due to the nature of the job position. The Hot End group most likely had the highest exposure to phenol-formaldehyde. The Cold End group most likely had the highest to fibrous glass fibers and dust. The "control" group represented job positions with the potential for the lowest exposure levels.

The questionnaire results were also collapsed into general symptom categories due to the small number of employees interviewed.

Upper Respiratory: Two or more episodes of respiratory symptoms of the eyes, nose, or throat irritation within one year.

Chronic Cough: Usually have a cough four to six times a day, four or more days out of the week for three continuous months for at least two years.

Chronic Phlegm: Phlegm production from the chest, twice a day, four or more days per week for three continuous months for at least two years.

Chronic Bronchitis: Symptoms of both chronic cough and chronic phlegm.

Wheezing: Wheezing included wheezing with a cold, apart from a cold, and/or associated with shortness of breath.

Breathlessness: Breathlessness included grade I (shortness of breath when hurrying up a slight hill), grade II (walks slower than people of your own age on the level because of breathlessness) or grade III (have to stop for breath when walking at your own pace on the level).

Acute Cough and Phlegm: Episode of acute cough and phlegm lasting three weeks or more each year for at least two years.

Chest Colds: A cold that usually goes to the chest (greater than half the time) usually associated with period of time off work, in-doors at home, or in bed during the past three years.

Hay Fever: History of hay fever confirmed by a doctor.

Lower Respiratory Illness: History of bronchitis, pneumonia, chronic bronchitis, or emphysema confirmed by a doctor.

V. EVALUATION CRITERIA

A. Environmental:

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 ten 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 exposure 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 standards, 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 only 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.

EVALUATION CRITERIA

CONCENTRATION/EXPOSURE PERIOD

Substance	8-Hour TWA	Ceiling	Source
Formaldehyde (ppm)	CA	--	NIOSH
	--	2 ppm	CAL-OSHA
	--	1 ppm (CA)	ACGIH
Phenol (skin)	5 ppm	15 ppm (15 min)	NIOSH
	5 ppm	--	CAL-OSHA
	3 ppm	10 ppm (30 min)	ACGIH
Ammonia	--	50 ppm (5 min)	NIOSH
	25 ppm	--	CAL-OSHA
	25 ppm	35 ppm	ACGIH
Fibrous Glass	fibers - 3 fiber/cc < 3.5 um diameter >10.0 um length		NIOSH
	dust - 5 mg/m^3		
As total Dust	- 10 mg/m^3 <7 um diameter	--	CAL-OSHA
	- 10 mg/m^3 <7 um diameter	--	ACGIH
As Respirable Dust	5 mg/m^3	--	ACGIH

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ppm - parts of a contaminant (vapor or gas) per million parts of air by volume.

mg/m^3 - milligrams of a contaminant per cubic meter of air.

CA - lowest feasible limit (suspected or confirmed carcinogen based on either (1) limited epidemilogical evidence excluding clinical reports of single cases, or (2) demonstration of carcinogenesis in one or more animal species by appropriate methods), use best control technology.

C - ceiling limit, maximum concentration to which an employee may be exposed based on a sampling interval which should not exceed 30 minutes unless otherwise specified.

B. Toxicological Effects:

1. Formaldehyde:

Formaldehyde has a sharp odor which can be smelled at very low levels (less than one ppm). The first signs or symptoms noticed on exposure to formaldehyde at concentrations ranging from 0.1 to 5.0 ppm are burning of the eyes, tearing (lacrimination), and general irritation to the upper respiratory passages. Low levels of 0.3 to 2.7 ppm have been found to disturb sleep and to be irritating to a smaller number of people.[1] Higher exposures (10 to 20 ppm) may produce coughing, tightness in the chest, a sense of pressure in the head, and palpitation of the heart.[3] Exposure of 50 to 1200 ppm and above can cause serious injury such as collection of fluid in the lungs (pulmonary edema), inflammation of the lungs (pneumonitis), or death.[2]

Dermatitis due to formaldehyde solutions or formaldehyde-containing resins is a well-recognized problem.[6] After a few days of exposure, a worker may develop a sudden inflammatory (eczematous) reaction of the skin of the eyelids, face, neck, scrotum, and flexor surfaces of the arms. An eczematous reaction also may appear on the fingers, back of the hands, wrists, forearms, and parts of the body that are exposed to the rubbing of clothing. Such rashes sometimes develop after years of asymptomatic exposures.

Recent review[7] of airborne formaldehyde as a factor in indoor air pollution problems suggest a wide spread in individual responses to various formaldehyde levels. A small percengage of the population show a hypersensitivity to even low levels of formaldehyde which can include both upper and lower airway symptoms. The exact mechanisms of this "allergy" are unclear.

Formaldehyde has been shown in a study conducted by the Chemical Industry Institute of Toxicology[8] to induce squamous cell cancer of the nasal sinuses in both Fischer 344 rats and B6C3F1 mice. In a study by New York University, formaldehyde appears to have induced the same type of cancer in Sprague-Dawley rats.[9] Although humans and animals may differ in their susceptibility to specific chemical compounds, any substance that produces cancer in experimental animals, particularly in more than one species, should be considered a cancer risk to humans. Formaldehyde also has demonstrated mutagenic activity in several test systems.[10]

Based on these results, NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen.[1] Safe levels of exposure to carcinogens have not been demonstrated, but the probability of developing cancer should be reduced by decreasing exposure. An estimate of the extent of the cancer risk

to workers exposed to various levels of formaldehyde at or below the current 3 ppm Occupational Safety and Health Administration (OSHA) standard[11] has not yet been determined. In the interim, NIOSH recommends that, as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit. The International Agency for Research on Cancer (IARC) concurs with the recommendations.[12]

2. Ammonia:

Ammonia is a severe irritant of the eyes, respiratory tract and skin. It may cause burning and tearing of the eyes, runny nose and cough.

In a human experimental study which exposed ten subjects to various vapor concentrations for five minutes, 134 ppm caused eyes, nose and throat irritation in most subjects and one person complained of chest irritation; at 72 ppm, several reported the same symptoms; at 50 ppm, two reported nasal dryness and at 32 ppm only one reported nasal dryness. Tolerance to usually irritating concentrations of ammonia may be acquired by adaptation, a phenomena frequently observed among workers who are subject to the effects of exposure. No data are available on concentrations that are irritating to workers who are periodically exposed to ammonia and who presumably have a higher irritation threshold.[15]

3. Phenol:

Phenol in a vapor form or in solution is an irritant to the eyes, mucous membranes, and skin; systemic absorption causes central nervous system effects as well as liver and kidney damage. Brief intermittent industrial exposures to vapor concentrations of 48 ppm of phenol (accompanied by 8 ppm of formaldehyde) caused marked irritation of eyes, nose and throat.[15]

4. Fibrous Glass:

Two categories of fibrous glass are identified for control purposes. The larger diameter fibers involve skin, eye and upper respiratory tract irritation, a relatively low incidence of fibrotic lung changes, and preliminary indications of a slight excess mortality risk due to nonmalignant respiratory diseases. Experimental animal studies demonstrated carcinogenic effects with long (greater than ten micrometers) thin fibers (usually less than one micrometer in diameter. However, these studies were performed by implanting fibrous glass in the pleural or peritoneal cavities. The data from these with these routes of exposure cannot be directly related to conditions of human exposure. On the basis of this information, NIOSH does not consider fibrous glass to be a substance that produces cancer as a result of occupational exposure.[16]

VI. RESULTS

A. Environmental:

On May 5-7, 1983, environmental air samples and bulk samples were collected along production lines 60, 63, 65 and 66, the binder room and the bailing area for one or more of the following chemicals: formaldehyde, phenol, fibrous glass, total and respirable fibrous glass dust, ammonia and asbestos. The environmental air samples collected during the follow-up survey were believed to be indicative of the typical work operation. The production output (pounds of finished product) during the dates of this study exceeded the average production rate for each product monitored.

Thirty-two formaldehyde and phenol air samples (personal and area) were collected during most of the workday at the hot end (platform, U-Chute) and near the searing roll or curing ovens. No formaldehyde or phenol vapors were detected on the dates of this survey.

Seven fibrous glass air samples (personal and area) were collected at the bailer area and along line 63 at the cutting area (Table 2). The airborne concentrations ranged from 0.02 to 0.31 fibers per cubic centimeter of air. None of these airborne concentrations exceeded the NIOSH recommended criterion of 3.0 fibers/cc of air.

Eleven personal and area air samples were collected for fibrous glass dust (Table 3). Of these, nine samples were total dust air samples. The concentrations ranged from 0.25 to 1.45 milligrams of dust per cubic meter of air (mg/m^3). These air samples were collected along the hot end of lines 60, 63, 65 and 66 and the cold end of the line 63 (fibrous glass cutting area). None of these air samples exceeded the NIOSH recommended criterion of 5.0 mg/m^3. Two of the eleven air samples were respirable dust air samples collected at line 63 (cutting area). The time-weighted average air concentrations were 0.04 and 0.20 mg/m^3. There is no NIOSH recommended criteria for respirable fibrous glass dust; however, the American Conference of Governmental Industrial Hygienist (ACGIH) considers fibrous glass to be a nuisance particulate. The ACGIH threshold limit value (TLV) for total and respirable nuisance dust is 10 and 5 mg/m^3 respectively, thus no excessive exposures were measured.

Four personal air samples (respirable and total) were collected for fibrous glass dust during clean out of the HEAF unit (Table 4). The total dust air sample concentrations were 9.84 and 2.54 mg/m^3. The respirable dust air sample concentrations were 0.18 and 0.11 mg/m^3. Only one sample exceeded the NIOSH recommended criterion of 5.0 mg/m^3. Employees wear NIOSH certified disposable respirators while working in the HEAF box, thus overexposures would not be anticipated. However, it should be noted that respirators were not being worn properly by two workers i.e. only one of the two elastic straps was used.

Eight ammonia air samples (Table 5) were collected from the binder room and line 66 during binder mixing. The time-weighted average air concentrations ranged from none detected to 0.8 ppm. In addition, seven drager tube air samples were collected at the same locations (Table 6).

These air concentrations ranged from none detectable to approximately 25 ppm. The NIOSH recommended criterion is 50 ppm.

Three bulk samples of lagging material were collected from lines 63, 65 and 66 (Table 7). The reason for analyzing the insulation was because the material was dry, cracking and slightly flaking in some locations. Whenever work is performed on the ducts, the workers must remove the lagging to make repairs. There was concern the material could contain asbestos. The bulk material analyzed asbestos, and the bulk sample collected along line 66 was reported to have 5-10 percent crocidolite asbestos.

Due to the potential sampling and analytical problems identified during the survey in May, 1982, a follow-up environmental survey was conducted on December 6-8, 1982. Twenty-four formaldehyde area air samples were collected from similiar locations (curing ovens and hot end of lines 60, 61 and 65) monitored earlier. The formaldehyde air concentrations ranged from 0.01 to 0.55 ppm.

The formaldehyde air measurement results, collected during the special follow-up study by the NIOSH Measurement Research Support Branch, are presented in tables 9 and 10. The data presents the 200 and 300 series impinger samples grouped by location. The sample data demonstrates a rather consistent ambient formaldehyde concentration ranging from 0.1 to 0.2 ppm. All sorbent tube samples, series 500 and 600, were less than the analytical limit of quantitation (5 ug/sample). All samples were analyzed within five days of collection in order to minimize any possible sample degradation. There was very good agreement between impingers with and without pre-filters. The amount of formaldehyde determined from the pre-filters was minimal. Table 11 presents the data from the series 300 impinger samples as a function of storage time. There was no significant increases due to particulate decay and release of formaldehyde; nor was there significant decreases due to possible sample degradation. A finding of interest was that the visible spectrum of a number of the desorbed filter samples was shifted. These samples exhibited a red color with an absorption maximum at 580 nm. This phenomenon could have several explanations. There could possibly be an extractable organic material

present in the MCEF filter which produces the red color on sample workup. Phenol from the resin system could also be responsible for the spectral shift. If phenol is the reason for the shift it is possible that the true amount of particulate-bound formaldehyde determined from the pre-filters is different from that reported. Phenol is a known negative interference in Method 125. It is also possible that the cured resin system itself might be degraded during sample analysis and produce the red color that was observed.

Based on discussions with employees and observation of employees work practices, the following conditions were noted: (1) Several machine attendants who clean out the HEAF units were not wearing the single use disposable respirators properly. Only one of the two elastic straps are used and the respirator was wet causing resistance to breathing. (2) Employees were observed using a ten percent sodium hydroxide solution to wash down equipment, but no protective equipment (gloves or eye protection) was worn.

B. Medical:

The results of the respiratory questionnaire were tabulated by job group, job group and length of employment, and latency of onset of symptoms after beginning employment. Demographic characteristics of the total work force, work force by job category, and job group and length of employment are also tabulated.

The data from the exposed groups is compared to the in-plant "control" group and to data recently published by G.J. Beck et al on respiratory symptoms in a rural community.[20] These control groups are only used for general comparison and are not meant to be valid epidemiological controls.

Statistical analysis was not done on the results of the survey because the data was not gathered in a sound, epidemiological manner and adequate control groups matched for age, race, sex, and smoking histories were not obtained. This was a preliminary survey to validate the initial health hazard evaluation request to NIOSH regarding the symptoms of cough and wheezing within the Manville Plant.

1) Respiratory Symptoms By Job Group

The objective of looking at the respiratory symptoms by job category was to establish if there is an increased prevalence of symptoms associated with a particular job group.

The demographic data of the total group and by job sub-groups is shown in Table 12. The majority of the employees were White or Hispanic surnamed males. The mean age of the total group was 39 with the maintenance group slightly older at a mean age of 45. The mean pack-years of cigarette smoking was similar for all groups (18 pack-years) except the in-plant "control" which was lower at ten mean pack-years.

There appears to be a general increase in all respiratory symptoms except chronic phlegm for the total group when compared to the in-plant "control". This was particularly marked with the symptom of wheezing in the Cold End (70%) and Hot End (59%), breathlessness in all exposure groups, acute cough and phlegm in Maintenance (41%), chest colds in all exposure groups, history of hay fever in the Cold End (22%), and lower respiratory illness in all groups. (Table 13) The in-plant "control" does have a markedly lower total pack-year of cigarette smoking which may account for some of these differences.

When compared to the "worst-case" situation from the rural community group data (males with highest percent abnormality from the 1972 or the 1978 S-S group), the Corona employees have an increased prevalence of wheezing and breathlessness. This is summarized in Table 14.

2) Respiratory Symptoms By Job Group and Length of Employment

The objective of looking at the respiratory symptoms by job group and length of employment was to establish if respiratory symptoms were more prevalent with longer duration of employment.

The demographic data by job group and length of employment is shown in Table 15. Employees were listed in two categories of length of employment, less than 11 years and equal to or greater than 11 years. This division represented the median length of employment of those employees interviewed. The mean age was increased for the Maintenance group. The control group had a definitely decreased smoking history manifested in both smoking categories and mean total pack-years.

Again, there appears to be a general increase in respiratory symptoms except chronic phlegm for the total group when compared to the in-plant "control". There did not appear to be any difference in respiratory symptoms within the total group when subdivided by less than 11 and equal to or greater than 11 years of employment. (Table 16)

When the four exposure groups are subdivided by duration of employment, it becomes difficult to evaluate trends because of the small numbers. There did not appear to be any trend, however, of increasing symptoms with duration of employment. The symptom of wheezing in the Cold End and Hot End, breathlessness in all exposure groups, acute cough and phlegm in Maintenance, chest colds in all exposure groups, hay fever in the Cold End and lower respiratory illness in all groups were increased in comparison to the in-plant "control".

3) Latency of Respiratory Symptoms After Beginning Work at the Plant by Job Group

The objective of looking at latency of symptoms after beginning work was to establish if there was a difference in onset of the various respiratory symptoms in relationship to job category. It also allowed an evaluation of symptomatology starting after onset of employment.

The demographical data for this information is similar to Table 12. Information of onset of symptoms for breathlessness and chest colds was not obtained. In some cases, the onset of symptoms was not available for each employee who had a specific respiratory symptom. For example, in Table 17, there were a total of 71 people interviewed. However, seven people who had upper respiratory symptoms did not give information concerning the time of onset of symptoms. These seven were not counted in the percent with symptoms or in calculation of the mean latency of upper respiratory symptoms. The number (n) with symptoms consists of only those who developed symptomatology after starting work. The mean latency is figured using those employees.

There was a general increase in the symptoms of upper respiratory irritation, chronic cough, and sneezing in comparison to the in-plant "control". There was an increase in wheezing in comparison to the rural community control.

The percent with symptoms would be higher if the employees with no onset of exposure data were included in the calculations.

The latency of onset of symptoms after beginning employment is generally consistent with those symptoms considered acute and chronic. The shortest latency periods in the total group were for upper respiratory irritation (2.8 years) and acute cough and phlegm (3.6 years). The longest were for wheezing (7.1 years) and chronic bronchitis (7.8 years). The total mean latency for the exposure groups for onset of all symptoms was shorter in the maintenance group in comparison to the other groups. There did not appear to be any significant trend for individual symptoms within specific exposure groups.

VII. DISCUSSION

The overall prevalence of upper and lower respiratory symptoms in the surveyed population was increased in comparison to the in-plant "control" and the symptoms in the rural community data. This was particularly apparent with wheezing and breathlessness in the Cold and Hot End job categories. The onset of respiratory symptoms after beginning employment was shortest in the Maintenance group.

A possible cause of the apparent increased prevalence of symptoms is the formaldehyde utilized within the fibrous glass production line and the fibrous glass given off during the cutting process in the Cold End of the production line.

The increased symptoms with the Cold End of the plant may be secondary to the irritant nature of fibrous glass in combination with formaldehyde exposure.

The chronic effects of formaldehyde exposure in relationship to upper and lower respiratory symptoms have been evaluated through several cross-sectional medical studies. A plant using phenol-formaldehyde resins in filter manufacturing either showed excess chronic cough or phlegm or both symptoms. Also, those employees with more than five years exposure had significantly lower FEV_1/FVC ratios than an in-plant control group. Exposure levels of formaldehyde were estimated to be in the range of 0.4 to 0.8 ppm.[23]

Workers exposed to urea-formaldehyde resins at two wood processing plants reported an increased incidence of chronic upper respiratory tract symptoms in comparison to a matched control group. The highest prevalence (58%) was in the hot press area of the plants where the formaldehyde concentration was 2.5 times the cold press plant area. The overall level was 0.4ppm.[26]

Asthma associated with formaldehyde exposure has been reported among workers in hemodialysis units and among embalmers in funeral homes. With a hemodialysis unit, eight of 28 employees had asthma. Inhalation provocation tests to formaldehyde were positive in two of five of these symptomatic individuals. The author suggested that formaldehyde may make certain individuals more susceptable to other agents. Similar findings were found in the embalmers exposed to concentrations of formaldehyde from 0.25 to 1.39ppm. The mechanism for the upper respiratory tract symptoms from formaldehyde exposure is most likely of an irritant nature. However, it is known that formaldehyde can act as a sensitizing agent with the development of delay-type hypersensitivity and immediate urticarial reactions.[26,27]

The effect of formaldehyde on the lower respiratory tract may be more complex. The mechanism of interaction with the respiratory tree is most likely multifactorial. The most common may be the induction of in flammatory bronchitis with secondary cough, increased sputum, and bronchospasm in certain individuals. An immunologic mechanism including IgE and/or IgG antibodies may also be a pathological mechanism in certain individuals. Formaldehyde may alter the bronchial mucosa with secondary increased bronchial permeability. This could lead to a reactive airway syndrome resulting in increased airway reactivity to non-specific agents.[26,27]

VIII. CONCLUSION

A. Environmental:

Based on the environmental air sampling results, no overexposure to phenol, fibrous glass, total or respirable glass fiber dust or ammonia was measured. Low level formaldehyde exposures ranging from 0.01-0.55 ppm were measured during the follow-up survey.

B. Special Formaldehyde Study:

In addition, the special study conducted by the NIOSH M.R.S.B. demonstrated the ability of the NIOSH P&CAM 125 to measure formaldehyde in the 0.1 to 0.2 ppm range with a high degree of precision. This study also further established one of the present limitations of P&CAM 354. A reported LOD of 5 ug/sample for these samples equates to an airborne concentration of 0.3 ppm from a 12L sample. The chronic formaldehyde level experienced in this situation would not be monitored adequately by Method 354 unless the method LOD were lowered to less than 2 ug/sample. At the present that is not possible. Therefore, P&CAM 125 should be the method of choice for this or any workplace environment suspected of having formaldehyde concentrations less than 0.4 to 0.3 ppm.

Situations where there might be airborne particulate, especially particulate that might potentially decay and release formaldehyde, warrant the use of a pre-filter when impinger samples are collected. If any attempts are made to desorb the filter in order to pursue the possibility of particulate-bound formaldehyde some additional filter types should be investigated. The cellulose ester filters used in this study, Millipore AA, gave rise to a measurable but not prohibitive blank value.

Shipping and storage of sodium bisulfite solution samples in Nalgene(R) CPE bottles resulted in good sample stability over a 30-day period.

C. Medical:

There appears to be an increased prevalance of upper and lower respiratory symptoms in the employees interviewed from the Manville Fibrous Glass Plant in Corona, California. A possible cause of these increased symptoms is the phenol-formaldehyde resin used as a binder for the fibrous glass.

IX. RECOMMENDATIONS

1) Employees should receive periodic training regarding the proper use of the disposable respirator. The employee should be instructed to replace his respirator whenever it becomes wet or if resistance to breathing occurs.

2) Employees should be instructed to wear proper protective equipment (gloves, goggles and/or apron) when handling sodium hydroxide or other potentially hazardous chemicals.

3) Whenever the exhaust fans in the binder room are turned off for maintenance, then industrial fans should be used to help dissipate the ammonia vapors.

4) The lagging material used to wrap the heating ducts along the various lines should be sprayed with a sealer if the lagging material is flaking. Furthermore, all maintenance personnel should be instructed to wear proper protective equipment (respirator and disposable coveralls) when removing any of the ducting insultation.

5) The plant's medical surveillance program should include possible assessment of respiratory symptoms and pulmonary function testing. This data should also be periodically assessed to evaluate any association between plant exposures and respiratory impairment.

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Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publication Office, at the Cincinnati address.

1. Glass Bottle Blowers Association, local 192.

2. Manville Corporation, Corona, California.

3. NIOSH - Region IX.

4. CAL-OSHA.

5. Federal OSHA

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

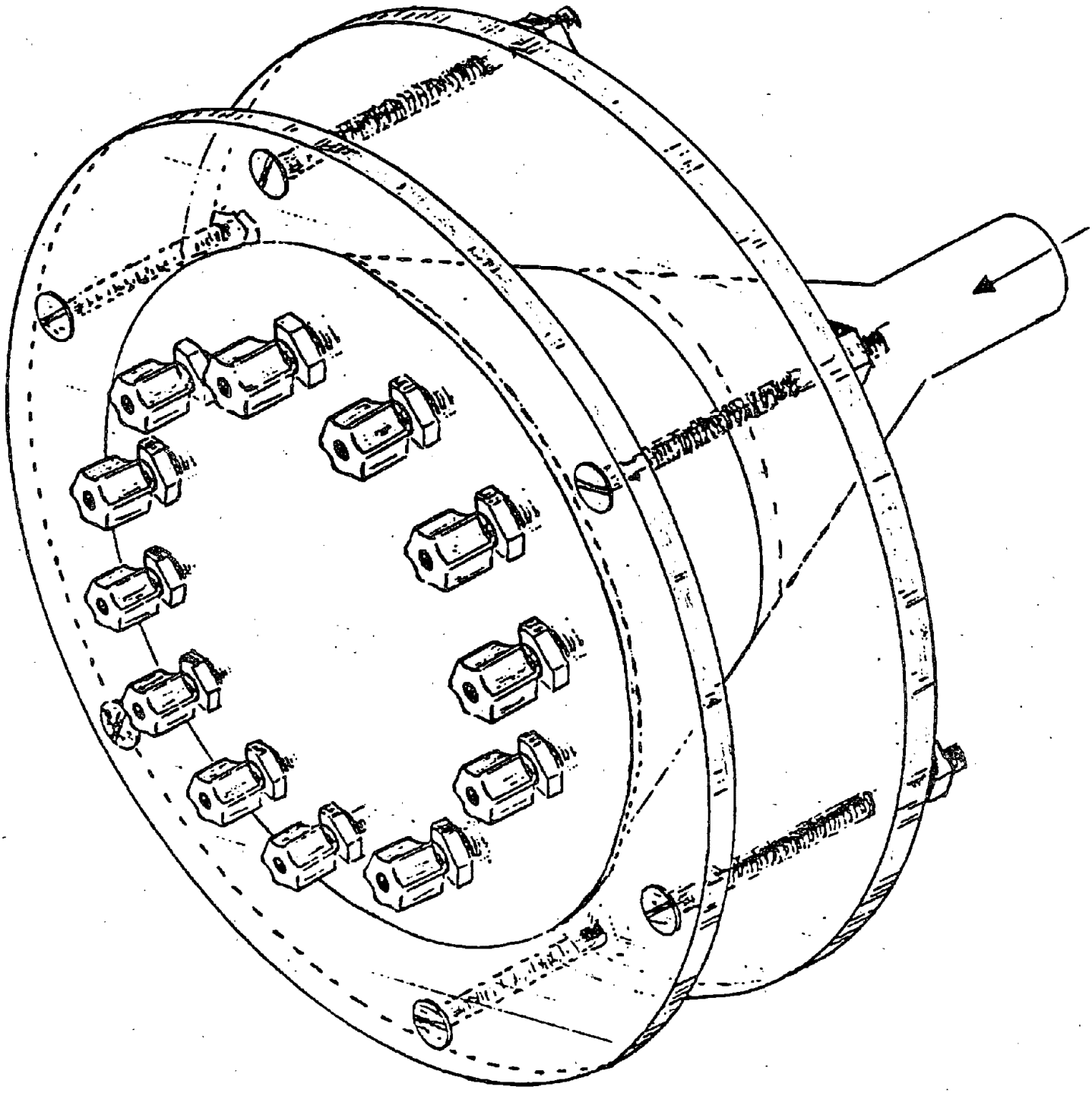

Figure 1 - Replicate Sampler

TABLE 1

HETA 81-227

Series	Sample Type	Sample Train
100	MCEF (AA) impinger prefilter	1
200	Impinger (1% $NaHSO_3$) following prefilter	
300	Impinger without prefilter	2
400	MCEF (AA) Sorbent tube prefilter	
500	Sorbent tube (354) following prefilter	3
600	Sorbent tube without prefilter	4

Each sampling manifold will accommodate 12 sampling trains all controlled by critical orifices. This allows a 3-fold replication of each of the four sampling trains for each sampling period. Sampling period was approximately 4 hours, 2 sampling periods per day for 2 days. Four locations were sampled allowing 1 sampling period per location.

Equipment: 2 sampling manifolds, A & B, 12 sampling parts each
2 critical orifice manifolds, 6 at 1 L/min and 6 aty 50 cc/min
1 large vacuum pump

TABLE #2

Environmental Air Samples
Collected for Fibrous Glass
Manville Corporation
Corona, California
May 5-7, 1983

HETA 81-227

Date	Field No.	Location	Type Sample	Time Period	Concentration (Fibers/cc)[1]
5/5	3	Bailer-Mach. Attentant	P[2]	0815-1240	0.25
5/5	19	Bailer-Mach. Attendant	P	1240-1445	0.17
5/5	4	Line 63, Cutting & Wrapping	A[3]	0820-1230	0.10
5/5	15	Line 63, Cutting & Wrapping	A	1230-1445	0.06
5/6	5	Bailer-Mach. Attendant	P	0900-1100	0.31
5/6	1	Bailer-Mach. Attendant	P	1100-1310	0.20
5/7	17	Line 63 - Cutting & Wrapping	A	0730-1400	0.02

1) Fibers/cc - Fibers of Fibrous glass per cubic centimeter of air.

2) P - Personnel air sample.

3) A - Area air sample.

TABLE #3

Area Air Samples
Collected for Fibrous Glass Dust
Manville Corporation
Corona, California
May 5-7, 1983

HETA 81-227

Date	Field Number	Location	Type Sample	Sample Period	Concentration (mg/m^3)[1]
5/5	8167	line 66 - Platform	T[2]	0750 - 1455	0.43
5/5	8161	line 63 - Platform	T.	0750 - 1450	0.40
5/5	8467	line 63 - Cutting & Wrapping	R.[3]	0820 - 1445	0.04
5/5	8166	line 63 - Cutting & Wrapping	T.	0820 - 1445	0.40
5/5	8163	line 60 - Platform	T.	0730 - 1445	0.44
5/6	8457	line 60 - Platform	T.	0700 - 1440	0.63
5/6	8464	line 65 - Platform	T.	0725 - 1500	0.63
5/6	8168	line 63 - Platform	T.	0700 - 1400	0.25
5/6	8157	line 63 - Cutting & Wrapping	R.	0720 - 1400	0.20
5/6	8461	line 63 - Cutting & Wrapping	T.	0720 - 1400	1.45
5/6	8158	line 65 - Platform	T.	0700 - 1400	0.40

1) mg/m^3 - milligrams of substance per cubic meter of air.
2) T - Total Dust air sample.
3) R - Respirable Dust air sample.

TABLE #4

Personnel Air Samples
Collected for Fibrous Glass Dust during
HEAF Unit Clean-out
Manville Corporation
Corona, California
May 6, 1983

HETA 81-227

Field Number	Location	Type Sample	Sample Period	Concentration (mg/m^3)[1]
8459	line 60-Mach. Attendant, suction box clean out bottom.	R.[2]	0745-1245	0.18
8465	line 60-Mach. Attendant, suction box clean out bottom.	T.[3]	0745-1200	9.84
8462	line 60-Mach. Attendant, suction box clean out top.	R.	0745-1305	0.11
8466	line 60-Mach. Attendant, suction box clean out top.	T.	0745-1305	2.54

1) mg/m^3 milligrams of a substance per cubic meter of air.

2) R - Respirable dust air sample.

3) T - Total dust air sample.

TABLE #5

Personnel and Area Air Samples
Collected for Ammonia
Manville Corporation
Corona, California
May 5-7, 1982

HETA 81-207

Date	Location	Type Sample	Sample Period	Concentration (ppm)[1]
5/5	Binder Room	P[2]	0805-1235	0.3
5/5	Binder Room	P	1235-1445	N.D.[3]
5/6	Binder Room	P	0725-1100	N.D.
5/6	Binder Room	P	1100-1435	N.D.
5/7	Line 66-Binder Mixing	P	0710-1100	0.5
5/7	Line 66-Binder Mixing	P	1105-1405	N.D.
5/7	Line 66-Binder Mixing	A[4]	0710-1045	0.8
5/7	Line 66-Binder Mixing	A	1300-1405	N.D.

1) ppm - parts of a vapor or gas per million parts of contaminated air by volume.

2) P - Personnel Air Sample.

3) N.D. - None detected.

4) A - Area Air Sample.

TABLE #6

Ammonia Ceiling Air Samples
Collected using Drager Tubes
Manville Corporation
Corona, California
May 5-7, 1982

HETA 81-227

Date	Location	Time	Concentration (ppm)[1]
5/5	Binder Room, Operator Control Area	1400	5*
5/5	Binder Room, Operator Control Area	1445	10*
5/6	Binder Room - Operator Control Area	0945	20*
5/6	Binder Room - Operator Control Area	1215	10*
5/6	Binder Room - Operator Control Area	1400	≈ 25*
5/7	Line 66, next to mixer-at end of batch mixing.	1045	N.D.[2]
5/7	Line 66, next to mixer-several minutes after ammonia addition.	1300	5

* - It was learned that the exhaust fan was down both days.

1) ppm - Parts of a vapor or gas per million pars of contaminated air by volume.
2) N.D. - None detected.

TABLE #7

Bulk Samples of
Pipe Insulation Analyzed for Asbestos
Manville Corporation
Corona, California
May 7, 1983

HETA 81-227

Field No.	Location	Asbestos Present Type	Asbestos Present Percentage
1A	Line 66 - Heat duct lagging	Crocidolite	5-10
2A	Line 65 - Heat duct lagging	Chrysotile	40-50
3A	Line 63 - Heat duct lagging	Chrysotile	40-50

TABLE #8

Environmental Air Samples
Collected for Formaldehyde
Manville Corporation
Corona, California
December 7-8, 1982

HETA 81-227

Date	Field Number	Location	Time Period	Concentration (ppm)[1]	
12/7	AA-1 I-1	Line 61, Middle of Platform	0739 - 1126	0.02 0.11	0.13
12/7	AA-5 T-1	Line 61, Middle of Platform	0739 - 1520	0.01[2] N.D.	0.01
12/7	AA-2 I-2	Line 61, Upper deck, U-Chute Box	0745 - 1129	N.D. 0.12	0.12
12/7	AA-6 T-2	Line 61, Upper deck, U-Chute Box	0753 - 1518	0.02 N.D.	0.02
12/7	AA-3 I-3	Line 65, Middle of Platform	0752 - 1132	0.02 0.12	0.14
12/7	AA-7 T-3	Line 65, Middle of Platform	0752 - 1522	0.02 N.D.	0.02
12/7	AA-4 I-4	Line 65, Upper deck, U-Chute Box	0803 - 1135	0.15 0.40	0.55
12/7	AA-8 T-4	Line 65, Upper deck, U-Chute Box	0803 - 1135	0.17 N.D.	0.17
12/7	AA-9 I-5	Line 61, Middle of Platform	1127 - 1520	0.01 0.07	0.08

* Series samplers were used to collect formaldehyde vapors and vapors bound to a particulate. Filters, impinger solution and resin tubes were used to conduct environmental air monitoring.

1) ppm - parts of a vapor or gas per million parts of air by volume.
2) N.D. - None detected.

TABLE #8 (continued)

Environmental Air Samples
Collected for Formaldehyde
Manville Corporation
Corona, California
December 7-8, 1982

HETA 81-227

Date	Field Number	Location	Time Period	Concentration (ppm)[1]	
12/7	AA-11 I-7	Line 61, Middle of Platform	1132-1523	0.01 0.09	0.10
12/7	AA-12 I-8	Line 65, lower level, U-Chute Box	1137-1526	0.02 0.12	0.14
12/7	AA-13 T-5	Line 65, lower level, U-Chute Box	1140-1525	0.04 N.D.	0.04
12/8	AA-14 I-9	Line 60, Middle of Platform	0800-1138	0.02 0.18	0.20
12/8	AA-15 T-6	Line 60, Middle of Platform	0801-1504	0.06 N.D.	0.06
12/8	AA-16 I-10	Line 60, Upper deck, U-Chute Box	0758-1135	0.02 0.18	0.20
12/8	AA-17 T-7	Line 60, Upper deck, U-Chute Box	0758-1501	0.08 N.D.	0.08
12/8	AA-18 I-11	Line 61, Middle of Platform	0802-1141	0.01 0.13	0.14
12/9	AA-19 T-8	Line 61, Middle of Platform	0803-1508	0.13 N.D.	0.13

TABLE #8 (continued)

Environmental Air Samples
Collected for Formaldehyde
Manville Corporation
Corona, California
December 7-8, 1982

HETA 81-227

Date	Field Number	Location	Time Period	Concentration (ppm)[1]	
12/8	AA-20 I-12	Line 61, Upper Deck, U-Chute Box	0805-1139	0.11 0.19	0.30
12/8	AA-21 T-9	Line 61, Upper Deck, U-Chute Box	0805-1139	0.01 N.D.	0.01
12/8	AA-22 I-13	Line 60, U-Chute Box	1138-1504	0.01 0.08	0.09
12/8	AA-23 I-14	Line 60, U-Chute Box	1136-1502	0.02 0.17	0.19
12/8	AA-24 I-15	Line 61, U-Chute Box	1141-1508	0.01 0.08	0.09
12/8	AA-25 I-16	Line 61, U-Chute Box	1139-1506	0.05 0.15	0.20

TABLE #9

Samples Grouped by Location for 12/7/82

AM - Line 66 Searing Roll

Sample No.	Formaldehyde, ug/m^3	PPM
201	249	0.2
202	228	0.2
203	229	0.2
301	231	0.2
302	239	0.2
303	249	0.2

Mean 237.5
S.D. 9.7
RSD 0.04

PM - Line 66 U-Chute

		Total	
204	119*(2)	121	0.1
205	123 (4)	127	0.1
206	124 (6)	130	0.1
304	126		0.1
305	-		-
306	130		0.1

Mean 124.4
S.D. 4.0
RSD .03

*Number in parentheses indicates amount determined from the desorbed prefilter.

TABLE #10

Samples Grouped by Location for 12/8/82

AM - LINE 60 SEARING ROLL

Sample No.	Formaldehyde, ug/m^3	Total	PPM
207	156*(7)	163	0.1
208	154 (1)	155	0.1
209	159 (2)	161	0.1
307	162		0.1
308	125		0.1
309	163		0 1

Mean 153.2
SD 14.2
RSD .09

PM - Line 60 U-Chute

210	157 (10	167	0.1
211	152 (26)	178	0.1
212	165 (13)	178	0.1
310	163		0.1
311	163		0.1
312	169		0.1

Mean 161.5
SD 6.1
RSD .04

*Number in parentheses indicates the amount determined from the desorbed prefilter.

TABLE #11

Quantitative Results for Series 300 Samples

as a Function of Storage Time

Sample No.	Formaldehyde, ug/sample, after indicated Storage Time				
	1d	10d	Recovery, %*	33d	Recovery, %*
300	< LOQ	< LOQ	-	< LOQ	-
301	49.7	49.9	100.5	48.6	97.8
302	48.6	48.1	99.0	46.4	95.4
303	42.0	41.0	97.5	35.5	84.5
304	30.3	30.6	100.9	29.7	98.0
305	21.2	20.6	97.1	16.2	76.4
306	29.8	30.2	101.3	24.2	81.2
307	41.5	40.6	97.7	39.2	94.5
308	29.9	29.1	97.4	24.4	81.6
309	31.6	30.2	95.6	26.1	82.6
310	29.7	29.1	98.0	30.2	101.7
311	27.3	25.9	94.8	24.0	87.9
312	29.4	28.7	97.6	27.9	94.9
313	< LOQ	< LOQ	-	< LOQ	
314	< LOQ	< LOQ	-	-	-
300-306 Blank	0.6	0.4	-	< LOQ	-
300-314 Blank	0.5	0.6	-	0.7	-

*Relative to the quantity of formaldehyde found on day 1.

TABLE #12

DEMOGRAPHIC CHARACTERISTICS OF TOTAL GROUP AND JOB SUBGROUPS

Characteristics	Total Group (n=71)		Control (n=14)		Maintenance (n=17)		Hot End (n=17)		Cold End (n=23)	
	N	%	N	%	N	%	N	%	N	%
Mean Age (years)	39	--	37	--	45	--	38	--	36	--
Sex										
Male	66	93	14	100	17	100	17	100	18	78
Female	5	7	0	0	0	0	0	0	5	22
Race										
White	38	54	8	57	9	53	7	41	14	61
Hispanic Surnamed	27	38	4	29	6	35	9	53	8	35
Other(1)	6	8	2	14	2	12	1	6	1	4
Smoking Status										
Nonsmokers	19	27	5	36	3	18	2	12	9	39
Ex-smokers	27	38	8	57	8	47	5	29	5	22
Current Smokers	25	35	1	7	6	35	10	59	9	39
Mean Pack-Years	18	--	10	--	22	--	18	--	20	--
Mean Number of Years at Current Usual Job	7	--	7	--	7	--	8	--	5	--
Mean Total Work-Years	11	--	12	--	11	--	15	--	9	--

(1) Includes Black (4), Asian (1), and American Indian (1)

TABLE #13

SUMMARY OF SYMPTOMS BY JOB GROUP

Symptoms and History	Total Group (n=71)		Control (n=14)		Maintenance (n=17)		Hot End (n=17)		Cold End (n=23)	
	N	%	N	%	N	%	N	%	N	%
Symptoms										
Upper Respiratory	42	59	7	50	12	71	7	41	16	70
Chronic Cough	13	18	0	0	5	29	4	24	4	17
Chronic Phlegm	10	14	3	21	3	18	3	18	1	4
Chronic Bronchitis	6	8	0	0	2	12	3	18	1	4
Wheezing	36	51	4	29	6	35	10	59	16	70
Breathlessness	23	32	2	14	6	35	7	41	8	35
Acute Cough & Phlegm	16	23	2	14	7	41	2	12	5	22
Chest Colds	26	37	2	14	7	41	9	53	8	35
History										
Hay Fever	9	13	0	0	2	12	2	12	5	22
Lower respiratory Illness	24	34	3	21	6	35	7	41	8	35

TABLE #14

PERCENTAGE COMPARISON OF RESPIRATORY SYMPTOM PREVALENCE IN THE MANVILLE PLANT POPULATION AND RURAL COMMUNITY POPULATION

Symptoms by History	Total Group %	Control[1] %	Rural Community[2] %	Maintenance %	Hot End %	Cold End %
Chronic Cough	18	0	23	29	24	17
Chronic Phlegm	14	21	26	18	18	4
Chronic Bronchitis	8	0	13	12	18	4
Wheezing	51	29	30	35	59	70
Breathlessness	32	14	18	35	41	35

(1) In-plant control

(2) Worst case situation, S-S group, males with highest % abnormality in 1972 or 1978. See Appendix C.

TABLE #15

DEMOGRAPHIC CHARACTERISTICS BY JOB GROUP AND LENGTH OF EMPLOYMENT

	Maintenance				Hot End				Cold End				Control			
	Length of Employment (Years)				Length of Employment (Years)				Length of Employment (Years)				Length of Employment (Years)			
	< 11 (n=10)		≥ 11 (n=7)		< 11 (n=2)		≥ 11 (N=15)		< 11 (n=15)		≥ 11 (n=8)		< 11 (n=8)		≥ 11 (n=6)	
Characteristics	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Mean Age (Years)	44	--	48	--	25	--	39	--	35	--	40	--	30	--	47	--
Sex																
Male	10	100	7	100	2	100	15	100	10	67	8	100	8	100	6	100
Female	0	0	0	0	0	0	0	0	5	33	0	0	0	0	0	0
Race																
White	6	60	3	43	1	50	6	40	8	53	6	75	5	63	3	50
Hispanic Surnamed	3	30	3	43	1	50	8	53	6	40	2	25	1	13	3	50
Other(1)	1	10	1	14	0	0	1	7	1	7	0	0	2	25	0	0
Smoking Status																
Nonsmokers	1	10	2	29	1	50	1	7	4	27	5	63	3	38	2	33
Ex-smokers	5	50	3	43	0	0	5	33	4	27	1	13	4	50	4	67
Current Smokers	4	40	2	29	1	50	9	60	7	47	2	25	1	13	0	0
Mean Total Pack-Years	20	--	25	--	--	--	18	--	16	--	37	--	6	--	14	--
Mean Total Work-Years	7	--	16	--	5	--	16	--	7	--	14	--	9	--	15	--

(1) Includes Black (4), Asian (1), and American Indian (1)

TABLE #16

SYMPTOMS AND HISTORY BY JOB GROUP AND LENGTH OF EMPLOYMENT

	Total Length of Employment (Years)				Control Length of Employment (Years)				Maintenance Length of Employment (Years)				Hot End Length of Employment (Years)				Cold End Length of Employment (Years)			
	< 11 n=35		≥ 11 n=36		< 11 n=8		≥ 11 n=6		< 11 n=10		≥ 11 n=7		< 11 n=2		≥ 11 n=15		< 11 n=15		≥ 11 n=8	
Symptoms and History	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Symptoms																				
Upper Respiratory	25	71	16	47	5	63	2	33	7	70	5	71	1	50	6	40	12	80	4	50
Chronic Cough	5	14	8	22	0	0	0	0	3	30	2	29	0	0	4	27	2	13	2	25
Chronic Phlegm	5	14	5	14	3	38	0	0	1	10	2	29	0	0	3	20	1	7	0	0
Chronic Bronchitis	2	6	4	11	0	0	0	0	1	10	1	14	0	0	3	20	1	7	0	0
Wheezing	17	48	19	53	2	25	2	33	5	50	1	14	1	50	9	60	9	60	7	88
Breathlessness	11	31	12	33	1	13	1	17	2	20	4	57	1	50	6	40	7	47	1	13
Acute Cough and Phlegm	11	31	5	14	2	25	0	0	5	50	2	29	0	0	2	13	4	27	1	13
Chest Colds	13	37	13	36	2	25	0	0	4	40	3	43	1	50	8	53	6	40	2	25
History																				
Hay Fever	4	11	5	14	0	0	0	0	1	10	1	14	1	50	1	7	2	13	3	38
Lower Respiratory Illness	9	26	15	42	2	25	1	17	3	30	3	43	0	0	7	47	4	27	4	50

TABLE #17

LATENCY OF SYMPTOMS AFTER BEGINNING WORK AT PLANT BY JOB GROUP

	Total Group (total=71)				Control (total=14)				Maintenance (total=17)				Hot End (total=17)				Cold End (total =23)			
	(1)	(2)		(3)																
Symptoms and History	N	n	%	$\bar{x}$	N	n	%	$\bar{x}$	N	n	%	$\bar{x}$	N	n	%	$\bar{x}$	N	n	%	$\bar{x}$
Symptoms																				
Upper Respiratory	64	32	50	2.8	12	4	33	3.0	15	10	67	4.0	15	5	33	1.8	22	13	59	2.
Chronic Cough	71	11	15	4.9	14	0	0	0.0	17	3	18	3.3	17	4	24	6.6	23	4	17	4.
Chronic Phlegm	71	8	11	4.4	14	3	21	4.0	17	1	6	5.5	17	3	18	4.3	23	1	4	4.
Chronic Bronchitis	71	8	11	7.8	14	3	21	11.0	17	1	6	5.5	17	3	18	6.0	23	1	4	5.
Wheezing	67	24	38	7.1	14	3	21	11.0	17	3	18	2.8	16	7	44	9.1	20	11	55	6.
Acute Cough and Phlegm	66	7	11	3.6	14	2	14	4.5	15	3	20	4.5	16	0	0	0.0	21	2	10	1.
History																				
Hay Fever	71	1	1	15.0	14	0	0	0.0	17	0	0	0.0	17	0	0	0.0	23	1	4	15.
Lower Respiratory Illness	71	11	15	6.7	14	3	21	6.7	17	2	12	3.5	17	4	24	9.3	23	2	10	5.
Mean Total Latency				4.3				6.6				3.9				8.4				8.

(1) N = the total number of people in each group minus the number for which this information was not given

(2) n = number with symptom

(3) $\bar{x}$ = mean latency (years)

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