HETA 91-0091-2418
MAY 1994
3M COMPANY
LITTLE ROCK, ARKANSAS

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SUMMARY

A health hazard evaluation (HHE) was conducted by the National Institute for Occupational Safety and Health (NIOSH) at the 3M Company in Little Rock, Arkansas. This investigation was performed in response to a request from the Oil, Chemical and Atomic Workers' union that listed heart problems, lung disease, and hearing loss as health concerns in workers involved in the manufacture of roofing granules. Specific exposures of concern were airborne dust and chemical products used in the coloring department. Hearing losses were reported to have been documented by company hearing tests, but the union reported that the losses were not addressed by the company.

On March 4, 1991, NIOSH investigators performed a walk-through inspection of the 3M plant. Medical records from both individual employees and the 3M medical department, and health survey questionnaires distributed by the local union were reviewed. Noise dosimeter measurements and area noise levels were determined in several areas of the plant. Personal and area air samples were collected to aid in characterizing worker exposure to respirable crystalline silica and trace metals. A return visit was conducted in July 1991, to collect bulk samples and additional personal and area air samples.

During the initial site visit, the air concentration of crystalline silica, determined from one personal sample, was above the NIOSH Recommended Exposure Limit (REL) of 50 micrograms per cubic meter of air (µg/m^3). Air concentrations of silica measured during the second visit were all within the NIOSH REL. The air concentrations of trace metals were below the NIOSH RELs. Personal noise dosimetry revealed that a majority of sampled employees had noise exposures in excess of the NIOSH REL of 85 dB(A) for an 8-hour time-weighted average.

Heart disease was reported by 10 (4%) of the 235 employees and documented by medical records in 4 (1.7%) of the employees. These employees had known personal risk factors for heart disease and none of the exposures found at the 3M facility are known to be associated with heart disorders. Lung problems, including "lung spot," bronchitis, and respiratory infections, were reported by 4 (1.7%) employees but were not documented in the medical records that were reviewed, and could not be conclusively related to occupational exposure.

Personal noise dosimetry revealed that a majority of the samples were in excess of the NIOSH REL of 85dB(A) for an 8-hour time-weighted average. The substances used in this workplace have not been associated with the development of heart disease. Reported lung diseases could not be conclusively related to occupational exposures. Recommendations for reducing exposures to dust, silica, and noise are included.

Keywords: SIC 3295 (Minerals and Earths, Ground or Otherwise Treated), silica, noise, hearing conservation, heart disease.

No. 91-0091-2418

INTRODUCTION

In January 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) at the 3M plant in Little Rock, Arkansas. The request was from the Oil, Chemical and Atomic Workers' union and listed heart problems, lung disease, and hearing loss as health concerns in workers involved in the manufacture of roofing granules. Specific exposures of concern were airborne dust and chemical products used in the coloring department. Hearing losses were reported to have been documented by company hearing tests but were not addressed by the company, according to the requestors.

BACKGROUND

NIOSH conducted a prior HHE at the plant in 1972 in response to employee concerns that workplace exposures in the coloring department were causing adverse health effects. During that investigation, environmental monitoring for total particulate matter (TPM), respirable particulate matter (RPM), and iron oxide fumes was conducted in the coloring department. NIOSH investigators determined that under the conditions at the time of the survey, concentrations of rock dust and iron oxide fume in the air did not constitute a hazard. Recommendations aimed at providing a more desirable work environment were made at that time.[1]

Process Description

The 3M plant in Little Rock, Arkansas, employs approximately 235 workers and produces roofing granules. The raw material, nepheline syenite, arrives by boxcar from a quarry owned by 3M and located four miles from the plant. Once the boxcar is unloaded, the rock is transported by conveyors to the crushing and screening (C&S) department where a uniform sized granule is produced. This is accomplished using two types of crushers in series and multiple beds of Rotex screens. Once the granules are sized, they are transported by conveyor from the C&S department to the coloring department where assorted slurries containing different color pigments are mixed with the granules and heat cured. The finished product, a uniform sized granule in one of a variety of colors, is stored in silos until being transported to customers by rail or truck. Appendix 1 shows a list of the job titles held by personnel in both departments and a summary of their duties.

METHODS

General

The NIOSH evaluation began with an opening meeting with employee, union, and management representatives to discuss the purpose and scope of the HHE. The visit included a walk-through survey of the plant, personal breathing zone, and area air sampling to assess workers' exposures to respirable crystalline silica and trace metals, noise level measurements, private interviews with employees, review of health questionnaires distributed by the union, review of medical records provided by workers and by the 3M corporate office, and a closing meeting during which the visit's findings were presented.

Medical

Prior to the NIOSH visit, union representatives informed employees of the date and time that NIOSH representatives would be available for private medical interviews. Employees who volunteered were interviewed during the NIOSH site visit. The union had also prepared and distributed to all employees a questionnaire regarding health concerns (Appendix 2). Those questionnaires that were returned were reviewed by the NIOSH medical officer. Medical records provided by individual employees and by the 3M corporate office were also reviewed for information pertinent to the hazard request.

Environmental

A descriptive summary of the industrial hygiene methods used by the NIOSH investigators is presented in this section. The methods used to collect and analyze the environmental samples are presented by their NIOSH method number, and a brief description of each method is presented in Appendix 3.

The following company records were reviewed by the NIOSH industrial hygienist: data for silica exposure, MSDS sheets for the products used in the coloring department, and a copy of the respirator program for the plant.

During the initial NIOSH survey, six full-shift personal air samples were collected from employees in the C&S department to characterize exposures to crystalline silica and RPM using NIOSH Methods 7500 and 0600.[2] Both RPM and silica content were determined for each sample. In addition to the personal samples, two area air samples were collected to measure TPM using NIOSH Method 0500. One area sample was collected near the waste product conveyor, and the other near the finished product conveyor. These locations were chosen because they were dusty. Using NIOSH Method 7300, eight personal full-shift air samples were also collected from workers in the coloring department during two shifts to determine their exposure to metals and metal oxides. A bulk sample of the raw material was collected to determine the percent silica content using NIOSH Method 7500.

Results from this survey suggested that more extensive sampling of workers for silica exposure was warranted. A NIOSH team of three industrial hygienists returned to conduct a follow-up survey in July, 1991. During this survey, 17 full-shift personal air samples were collected from employees in the C&S department, and five personal samples were collected in the coloring department. These samples were analyzed for silica and RPM. In addition, three area air samples were collected to measure TPM, and two area samples were collected to measure RPM. One of the area samples for TPM and one for RPM were collected side-by-side near the waste conveyor. Another set was collected side-by-side on the third floor of the C&S department. The side-by-side sampling was conducted to determine the percent of dust in the air that is of a respirable size. The third area sample for TPM was collected near the final product conveyor. Bulk samples of the raw material, the waste fines, and the raw sodium silicate used in making the slurry were collected to determine the percentage of crystalline silica in each. The methods used to collect and analyze the samples during the return survey were the same as those used during the initial survey.

Noise Monitoring

Prior to visiting the 3M Plant, a NIOSH investigator met with the corporate audiologist responsible for the hearing conservation program at the Little Rock facility. The NIOSH investigator was given a copy of the corporate hearing conservation program in effect at Little Rock, as well as copies of the training and education programs used at this plant. The Industrial Hygiene Department also furnished noise dosimeter measurements which had recently been collected at various locations in the facility.

The noise dosimeters used in the survey were Metrosonics Model dB301/26 Metrologgers, a small noise level recording device which is worn on the waist of the employee with a 1/4 inch microphone attached to the worker's shirt collar, or the shoulder area if the shirt has no collar. This dosimeter is designed to measure noise in decibels, A-weighted levels (dB[A]) four times per second. The noise measurements are integrated according to the Occupational Safety and Health Administration (OSHA) noise regulation (see Evaluation Criteria section of this report) for an entire minute and stored separately in the Metrologger for later analysis and final storage. Each dosimeter was calibrated according to the manufacturer's instructions before being placed on the worker. After the recording period was completed, the dosimeter was removed from the worker and placed in the standby mode of operation. The data was later transferred to a Metrosonics Model dt-390 Metroreader/Data Collector following the day's noise sampling. Prior to turning off the dosimeter, it was again calibrated to assure that the device had not changed during the sampling period. The dosimeter information was finally transferred to a personal computer with supporting Metrosonics Metrosoft computer software for permanent data storage and later analysis.

Area noise samples were collected with a Larson-Davis Laboratories Model 800B Precision Integrating Sound Level Meter. Octave band measurements at consecutive center frequencies of 31.5 Hertz (Hz) to 16 kilohertz (kHz) along with A-weighted and C-weighted scales were made at several locations in the plant. All measurements were made with the sound level meter integrating the sound energy over a 1-minute period with a 3 dB exchange rate. Values are reported as 1-minute equivalent levels (L_{eq}) at each measurement band or scale.

EVALUATION CRITERIA

General Guidelines

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 which most workers may be exposed to 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, even if the occupational exposures are controlled at the level set by the evaluation criteria, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of a specific worker to produce adverse health effects. 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, potentially increasing the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent becomes available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH criteria documents and recommendations, including Recommended Exposure Limits (RELs); (2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs); and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). The OSHA standards 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 this report's recommendations for reducing these levels, it should be noted that the Occupational Safety and Health Act of 1970 dictates 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 (STEL) or ceiling values, which are intended to supplement the TWA when there are recognized toxic effects from elevated short-term exposures.

Heart Disease

Heart disease is the leading cause of death in the United States. Personal risk factors that contribute to the likelihood of developing heart disease include smoking, high blood pressure, and elevated serum cholesterol level. Men have a greater risk than women for developing heart disease, and the risk increases with increasing age. Other personal risk factors, such as obesity, diabetes and lack of physical exercise, have also been associated with the development of heart disease.

While the association between the personal risk factors listed above and heart disease is well documented, knowledge of the role of occupational and environmental risk factors is more limited. Chronic exposure to carbon monoxide, carbon disulfide, and certain aliphatic nitrates (such as nitroglycerine) has been associated with heart disorders in workers. Other substances that have been suspected of being associated with heart disease include arsenic, lead, cadmium, and certain solvents (such as methylene chloride, 1,1,1-trichloroethane, fluorocarbons, and phenol).[3]

Silica

Exposure to crystalline silica is known to cause silicosis, a disabling, progressive and sometimes fatal pulmonary fibrosis. Symptoms include cough, shortness of breath, and wheezing. Clinically, silicosis is characterized by the presence of nodules in the lung tissue. Both the clinical signs and symptoms of silicosis tend to be progressive with continued silica exposure, advancing age, and smoking.[4] The NIOSH REL for respirable crystalline silica, for both quartz and cristobalite, is 0.05 mg/m^3 as an 8-hour TWA exposure.[5] In addition to causing silicosis, evidence indicates that crystalline silica is a potential occupational carcinogen, and NIOSH is currently reviewing the data on carcinogenicity.[6,7,8] ACGIH recommends a limit of 0.05 mg/m^3 for cristobalite and 0.1 mg/m^3 for quartz. The current OSHA PEL for crystalline silica is calculated specifically for each respirable dust sample based on the percentage of crystalline silica in that sample.[9] At the time of the NIOSH field surveys, the OSHA PELs were 0.05 mg/m^3 for cristobalite and 0.1 mg/m^3 for quartz. These PELs were adopted by OSHA in 1989 under the Air Contaminants Standard. In July 1992, the 11th Circuit Court of Appeals vacated this standard. The percentage of crystalline silica in each sample was not determined during the NIOSH field survey; therefore, PELs under the current standard cannot be provided in this report.

Particulate Matter

Evaluation criteria appropriate for the total and respirable particulate matter present at the 3M facility are not currently available. Permissible exposure limits exist for respirable particulate matter not otherwise regulated (RPNOR) and total particulate not otherwise regulated (TPNOR). However, they do not apply to particulate matter at this facility because it contains silica, which is regulated.

Trace Metals

The exposure criteria for those metals present in products used during the NIOSH survey are presented in Table 2. A summary of the primary health effects of these metals is presented below.

Aluminum Metallic aluminum is considered a relatively benign "inert dust."[10]

Cobalt The inhalation of cobalt (Co) can cause respiratory fibrosis and respiratory pneumonitis.

Chromium Chromium (Cr) exists in a variety of forms depending on the chemical compound in which it is present. The toxicity of Cr varies among these different forms. For example, elemental Cr (CrIII) is relatively non-toxic, whereas hexavalent Cr (CrVI)) is a suspected carcinogen. The Cr-containing product used in the coloring department is in the relatively non-toxic elemental form, CrIII.

Iron Oxide	Inhalation of iron oxide dust may cause a benign pneumoconiosis called siderosis.[11]
Titanium Dioxide	Titanium dioxide (TiO_2) has historically been considered a mild irritant and has generally been regarded as a nuisance dust.[1] Based on recent experimental evidence[12] however, NIOSH considers TiO_2 to be a potential occupational carcinogen.
Zinc Oxide	The ACGIH considers zinc oxide dust to be a nuisance dust.[13] Evidence from a recent animal study however, suggests that chronic exposure to 5 mg/m^3 of ZnO may cause respiratory disease.[14]

Noise

Occupational deafness was first documented among metalworkers in the sixteenth century.[15] Since then, it has been shown that workers have experienced excessive hearing loss in many occupations associated with noise. Noise-induced loss of hearing is an irreversible, sensorineural condition that progresses with exposure. Although hearing ability declines with age (presbycusis) in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This noise-induced loss is caused by damage to nerve cells of the inner ear (cochlea), and unlike some conductive hearing disorders, cannot be treated medically.[16]

While loss of hearing may result from a single exposure to a very brief impulse noise or explosion, such traumatic losses are rare. In most cases, noise-induced hearing loss is insidious. Typically, it begins to develop at 4000 or 6000 Hz (the hearing range is 20 Hz to 20,000 Hz) and spreads to lower and higher frequencies. Often, material impairment has occurred before the condition is clearly recognized. Such impairment is usually severe enough to permanently affect a person's ability to hear and understand speech under everyday conditions. Although the primary frequencies of human speech range from 200 Hz to 2000 Hz, research has shown that the consonant sounds, which enable people to distinguish words such as "fish" from "fist," have still higher frequency components.[17]

The OSHA standard for occupational exposure to noise (29 CFR 1910.95)[18] specifies a maximum PEL of 90 dB(A)-slow response for a duration of 8 hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship. This means that for a person to be exposed to noise levels of 95 dB(A), the amount of time allowed at this exposure level must be cut in half in order to be within OSHA's PEL. Conversely, a person exposed to 85 dB(A) is allowed twice as much time at this level (16 hours) and is within his daily PEL. Both NIOSH (in its Criteria for a Recommended Standard[19]) and the ACGIH (in their TLVs[20]) propose an exposure limit of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard. Both of these latter two criteria also use a 5 dB time/intensity trading relationship in calculating exposure limits.

Time-weighted average (TWA) noise limits as a function of exposure duration are shown as follows:

Duration of Exposure (hrs/day)	Sound Level (dB(A)) NIOSH/ACGIH	OSHA
16	80	85
8	85	90
4	90	95
2	95	100
1	100	105
1/2	105	110
1/4	110	115 *
1/8	115 *	- **

* No exposure to continuous or intermittent noise in excess of 115 dB(A).
** Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

The OSHA regulation has an additional action level (AL) of 85 dB(A) which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the AL. The program must include monitoring, employee notification, observation, an audiometric testing program, hearing protectors, training programs, and record keeping. All of these stipulations are included in 29 CFR 1910.95, paragraphs (c) through (o).

The OSHA noise standard also states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dB(A), feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels. Also, a continuing, effective hearing conservation program shall be implemented.

RESULTS

Medical

Nine (4%) of the 235 employees volunteered to be interviewed. All were male. Their job titles (some had more than one job) included electrician, painter, maintenance person, screen person, truck driver, car/tank cleaner, belt operator, bagger, bin operator, bin tender, C&S operator, and welder. Four of those interviewed reported histories of heart attacks and provided medical records for review. The medical records documented three of the heart attack histories. All were current or former smokers. The fourth medical record showed no history of heart disease. Other health concerns reported by those interviewed included throat and nose irritation (reported by three), nonspecific hearing problems (reported by two), and stress due to shift work (reported by two).

A total of eight employees provided copies of their medical records for review by NIOSH. Three (as noted above) had documented heart attacks, one had coronary artery disease, and four had no heart disease. Lung disease was not documented in any of the medical records provided.

The union provided NIOSH with copies of 41 completed questionnaires. Ten employees reported a heart problem that had been evaluated by a physician. These were all males whose ages ranged from 34-63 years and whose jobs included a variety of types and areas within the facility. Seven were current or former smokers.

Four questionnaire respondents (three of whom were current or former smokers) reported lung problems for which they had received care by a physician. These included a "spot on my lung," bronchitis, and respiratory infections.

The employee health program was reported by the 3M occupational physician to include a pre-employment physical exam with chest x-ray and pulmonary function tests, audiogram within six months of hire and then annually, and a voluntary physical exam every two years including chest x-ray and pulmonary function testing. In addition, a voluntary cardiac risk evaluation (including cholesterol testing, and an assessment of other risk factors such as family history of heart disease and obesity) was offered to the Little Rock employees.

Environmental

Chemical Monitoring

Environmental sample results for silica, collected during the initial survey, are presented in Table 1. During the initial survey, the air concentrations ranged from below the limit of detection (LOD) to 0.09 mg/m^3. Air concentrations of all silica samples collected during the follow-up survey were below the NIOSH REL of 0.05 mg/m^3, with most concentrations being below the minimal detectable concentration (MDC). (For a sample volume of 700 liters, the MDC was 0.02 mg/m^3.) The air concentrations of cristobalite reported in 3M's silica exposure records ranged from 0.03 mg/m^3 to 1.1 mg/m^3; quartz concentrations ranged from 0.02 mg/m^3 to 0.1 mg/m^3.

The results from air monitoring for trace metals conducted during the initial survey are presented in Table 2. All concentrations were below the NIOSH RELs and OSHA PELs.

The concentration of RPM for the collected samples ranged from 1.2 to 5.8 mg/m^3. The measured concentrations for the two area samples collected near the waste conveyor and product conveyor were 1924 mg/m^3 and 443 mg/m^3 respectively. These are considered minimal concentrations since particulate may have been lost due to overloading of the samples.

The concentration of RPM measured during the follow-up survey ranged from 0.1 to 2.6 mg/m^3. The air concentrations of TPM from the area samples measured 22.01, 34.79, and 68.87 mg/m^3 respectively, for samples collected on the third floor, near the finished product conveyor, and near the waste conveyor. The air concentrations of RPM were 2.69 and 8.64 mg/m^3 respectively for samples collected near the waste conveyor and on the third floor. The percent of total particulate measured near the waste conveyor that was respirable was 3.9%. The percent respirable measured on the third floor was 39.3%. These limited results suggest that although the first floor, where the waste conveyor is located, has a greater amount of total airborne dust than the third floor, the respirable fraction is much less.

The bulk sample collected of the raw material during the initial survey contained 1.4%

cristobalite. The bulk sample of raw material collected during the follow-up survey contained 1.7% cristobalite. The bulk sample collected from the waste conveyor contained 1.9% cristobalite. The bulk sample of sodium silicate did not contain detectable levels of cristobalite. Quartz was not detected in any of the bulk samples.

Noise Monitoring

The results of the NIOSH noise dosimeter survey in the Crushing and Screening (C & S), Coloring, and Maintenance Departments are summarized in Table 3. The majority of the 22 dosimeter samples were in excess of 85 dB(A) for an 8-hour TWA. The potential for high noise exposures was also seen in the maximum 1-minute periods measured during the survey. Values ranging up to 114 dB(A) were seen in the noise records of the employees tested. The results from the crushing and screening department were influenced by several power outages which occurred on the day of testing. The operations in this department were halted while the electricity was off. Also, the restarting of the operation was a unique event that does not occur often in a worker's daily noise exposure. Several of the workers in the C & S Department and Coloring Department were working 12-hour shifts during the NIOSH survey. Sampling was only done for approximately 8 hours of the shift because of time limitations inherent in the dosimeters. The TWA values in the table can be converted to a dose percentage, interpolated to 12 hours, and then converted back to 8-hour TWAs to represent the noise exposure for the 12-hour work shift. The individual noise records for the sampled employees are presented in Figures 1-22.

The attenuation characteristics of the control booths used in the C & S Department and Coloring Department reduced the noise levels by 31 and 21 dB(A), respectively. This is graphically shown in Figures 23 and 24. The octave band measurements taken inside and outside of the control rooms are given in the figures as well as the overall A- and C-weighted scales. The noise reduction of both booths is characterized by better attenuation in the high frequency region. Spectral measurements taken in other areas of the C & S and Coloring Departments are shown in Figures 25-29. Most of these plots show relatively flat spectra with a gradual noise reduction in the high frequency region. All areas except for the fourth floor in the Coloring Department had noise levels near 90 dB(A). The conveyors on the fourth floor were near 75 dB(A).

DISCUSSION

Environmental

Chemical

The results from the environmental monitoring indicate that the air concentration of silica varies within the plant and exposures to cristobalite at concentrations above the OSHA PEL of 0.05 mg/m^3 are possible on certain days. The environmental monitoring data collected during the HHE is limited in characterizing worker exposures to silica due to (1) during the initial survey, management reported that dust concentrations were higher than usual because of "upset conditions" caused by a power failure at the plant, and (2) during the follow-up survey, one of the three production lines in the C&S department was not operating due to mechanical problems. This may have caused concentrations of airborne silica to be less than usual.

3M management currently relies on respirators as one measure to control worker exposures to various compounds including silica. Although respirators can reduce exposures if worn properly, their use relies on employees being trained in their use and being physically able and willing to wear one. The 3M plant has a respirator policy which trains workers in wearing and maintaining respirators. This includes insuring that workers are aware of times when respirators must be worn. During the survey, NIOSH investigators observed that workers did not always wear a respirator during the times when it is required or recommended by 3M management.

NIOSH recommends that engineering controls be the primary method of reducing exposures; exhaust ventilation located at the source of the pollutant is an example. Local exhaust ventilation relies on total or partial enclosure of the source. Much of the processes in the C&S department are currently enclosed, however there are leaks in and around the enclosures. An example of this is the Rotex screens located on floors 3 and 4 of the C&S department. Dust is emitted from the sleeves which join the screens to the delivery/exhaust ductwork. Management is hopeful that a new screen system will greatly reduce the dust emissions; however, a prototype operating at the plant at the time of the survey emitted dust at several areas. The exhaust ducts above each of the Rotex screens have values on them which were reported by 3M management to be the measured air velocity and pressure measurements inside of the duct. The velocity written on the sides ranged from 1000 feet per minute (FPM) to 2600 FPM. The ACGIH recommends an air velocity of 3000 to 4000 FPM for transporting dry dusts and powders to prevent dust from settling in the ductwork and reducing the effectiveness of the exhaust system.[21]

Better enclosure of the conveyor belts located on the floors 1 and -1, would reduce the amount of dust emitted in this area. Conveyor #4 was observed to emit a large amount of dust through a hole in the enclosure which appeared to have been cut away. If maintenance operations require the removal of part of the enclosure, it should be replaced as soon as the work is completed.

Housekeeping issues at the plant which need to be addressed include the piles of dust located in many areas of the C&S department, and the methods which are used to clean up the dust; this was discussed in the NIOSH report of the 1972 survey. As pointed out at that time, dust on surfaces can be dispersed into the work environment. The NIOSH investigators recommended that air hoses not be used as a method of cleaning, and that the use of a vacuum system be evaluated to minimize re-entrainment of dust. During the 1991 surveys, the use of air hoses to clean up dust was not observed at the plant; however, sweeping with hand brooms did create noticeable clouds of dust. The use of a vacuum system is again recommended.

Floors 1 and -1 of the C & S department are particularly dusty. 3M management reported that workers generally do not spend more than a few minutes on these floors at any one time, except under unusual conditions or during maintenance. However, several workers reported that the employees responsible for operating the "guzzler," a mobile vacuum system, may spend most of their working day in these areas. Personal air monitoring is recommended for these workers to determine if they are being overexposed to silica. If these workers are being overexposed, engineering and administrative controls should be evaluated to control their exposure. As an interim measure, NIOSH-approved respirators are recommended.

Although nepheline syenite is reported to be a mineral that does not contain silica, the percent of silica found in the raw material was between 1 and 2% for both samples. As part of a hazard communication program, workers should be aware of hazardous chemicals or compounds in the workplace. Workers at the 3M plant should know that the raw material being used at the plant does contain silica, and should understand the potential health effects from overexposure.

Noise

The 3M Little Rock plant has a written hearing conservation program which appears to be consistent with current OSHA regulations, or more restrictive in some instances. The program consists of periodic sound surveys that use dosimeters for personal noise measurements and sound level meters for area measurements. The noise data provided by the company show workers with 8-hour TWA values up to 100 dB(A) in the noisiest areas of the plant. Employees are also given annual audiometric examinations as well as annual training on hearing conservation by the corporate audiological and medical departments' staff.

A variety of hearing protection devices (HPDs) are available for the employees to use in the noisy areas of the plant. During the survey, it was observed that employees generally wore HPDs in the posted noise areas. These employees included maintenance personnel and supervisory staff who were in noise areas for short periods of time. The types of HPDs offered to the employees, which include Bilsom ear plugs, E-A-R® foam plugs, Howard Leight ear plugs, QB2® sound bands, and Peltor ear muffs, should provide adequate protection if worn properly. The industrial hygiene department had a sufficient supply of these devices readily available for the employees. Finally, several engineering controls have been tried in the plant, including nonmetal straps on the Rotex screens, rubber doors over observation ports, noise attenuating control booths, and prototype equipment that has potential for noise reduction.

Medical

Risk factors for heart disease (male gender, smoking) were found to be present among those persons at the 3M facility who had reported heart disease risk. In addition, the substances used in this workplace have not been associated with the development of heart disease. Therefore, there is no basis for suspecting that chemical or dust exposures at this facility contributed to the occurrence of heart disease.

The respiratory health concerns reported by workers (bronchitis, infections and "lung spots") could be caused or exacerbated by some exposures found at this workplace (silica or titanium dioxide) but could also be a result of factors not related to the workplace, such as smoking.

RECOMMENDATIONS

1. Those employees concerned about their risk of heart disease should request periodic evaluation of their cardiac risk factors from the 3M medical department. Wherever possible, these employees should decrease or eliminate those risk factors that are under their behavioral control, such as smoking and fat intake.

2. There should be continued enforcement of the hearing conservation program's guidelines. The program contains all of the necessary components required by OSHA, and goes beyond these requirements in some instances. However, better communication between

the corporate medical department, the corporate and local industrial hygiene departments, and the union officers may help to alleviate the perception that the company is destroying workers' hearing and are doing nothing about it. The company has a very workable hearing conservation program and has put both monetary and personnel support behind it. The workers need to be better informed about the program.

3. The audiometric data collected by the company during the annual testing program is readily available for further analysis which will give feedback on the effectiveness of the hearing conservation program. New methods of audiometric database analysis are being developed in order to accomplish this kind of feedback on how well the program is working.[22,23,24,25] The American National Standards Institute currently has a working group (ANSI S12.12) preparing a consensus standard for the audiometric database analysis techniques.

4. A substitute procedure for emptying the rail cars of the mineral used in making the roofing granules has already been discussed with the supervisor of the C & S Department. It has been suggested that a rubber mallet or plastic mallet filled with metal shot be substituted for the metal sledgehammer used to hit the side of the rail car. New hammers should be tried until a quieter hammer is found that will still get the material out of the car efficiently.

5. A warning horn located at ear level in the staircase leading under a conveyor at the mineral pile was located during the survey. This horn should be moved to a location which will not directly impact a worker's ear who happens to be near the staircase opening when it is sounded. Placing the horn higher on the conveyor structure or further down the stairs will still warn workers that the conveyor is starting.

6. The company's program of engineering noise out of the production process should be continued. Several good examples of eliminating metal-to-metal contact between moving parts was seen during the survey. This kind of engineering solution should be encouraged in all areas of the plant.

7. Maintenance of the equipment used in the C & S department to control emissions from the Rotex screens on the third and fourth floors, should be improved to reduce particulate emissions. This could include the earlier replacement of worn sleeves and the monitoring of air velocities in the exhaust ducts to assure that they are appropriate.

8. Further enclosure of the conveyors used on floors 1 and -1 in the C & S department is recommended to reduce particulate emissions in this area.

9. The piles of particulate that are located throughout the C & S department should be cleaned-up to prevent the particulate from becoming airborne. The use of vacuum systems should be evaluated as a method of routine cleaning throughout the plant.

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Copies of this report have been sent to:

1. 3M Management
2. Union Requestors

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 1
Results from Air Sampling for Silica and Respirable Particulate Matter
Minnesota Mining and Manufacturing Company
Little Rock, Arkansas
HETA 91-091
March 5-6, 1991

Job Title	Sample Volume (liters)	Cristobalite Concentration (mg/m^3)	Quartz Concentration (mg/m^3)	RPM Concentration (mg/m^3)
Maintenance	719	(.03)	*	1.35
Screen man	775	(.04)	*	2.23
Bin Tender	767	(.04)	*	3.29
Helper	774	*	(.03)	1.22
Helper	772	(.03)	*	1.54
Helper	668	.09	*	5.79
Evaluation Criteria				
NIOSH REL		**	**	N/A ***
OSHA PEL		.05	.1	N/A ***
ACGIH TLV		.05	.1	N/A ***

* The amount of this analyte collected is below the limit of detection of the analytical method.

** This analyte is considered by NIOSH to be a potential human carcinogen, recommendation is to reduce the concentration to the lowest feasible level.

*** Appropriate evaluation criteria do not currently exist for this analyte.

( ) The numbers in parenthesis represent values between the limit of detection (LOD) and the limit of Quantitation (LOQ) for the analytical method. There is an uncertainty in the accuracy of these values, because they approach the sensitivity limit of the analytical method. The LOD and LOQ for a 700 liter sample is 0.02 mg/m^3 and 0.04 mg/m^3 respectively.

Table 2
<u>Results from Air Sampling for Trace Metals</u>
Minnesota Mining and Manufacturing Company
Little Rock, Arkansas
HETA 91-091
March 5-6, 1991

worker's title	date	Concentration mg/m^3					
		Aluminum	Cobalt	Chromium	Iron Oxide	Titanium Dioxide	Zinc Oxide
#1 mixer operator	3/5/91 3/6/91	.10 .02	*	* *	.10 .06	.02 *	* *
#2 mixer operator	3/5/91	.02	*	*	.07	.01	*
#3 mixer operator	3/5/91 3/6/91	.04 .05	*	* *	.06 .10	.01 .01	* *
chief operator	3/5/91	.02	*	*	.02	*	*
plant helper	3/5/91	.03	*	*	.03	.01	*
EVALUATION CRITERIA							
NIOSH REL		10	.05	.5 [1]	5	0.2[2]	5
OSHA PEL		15	.05	.5 [1]	10	10	10 [3]
ACGIH TLV		10	.05	.5 [1]	5	10	10 [3]

* The amount of this analyte collected is below the limit of detection of the analytical method. The LOD for aluminum is 0.025 mg/m^3, the LOD for the remaining metals is 0.0025 mg/m^3.

1 The evaluation criteria presented for chromium is for chromium (III) compounds measured as chromium.

2 NIOSH considers titanium dioxide to be a potential human carcinogen and recommends that exposures be reduced to the lowest feasible concentrations. The REL of 0.2 mg/m^3 is based on the lowest concentration that is reliably detectable over a single workshift.

3 OSHA and ACGIH criteria for zinc oxide are 10 mg/m^3 for dust, and 5 mg/m^3 for fume.

Table 3
Noise Dosimeter Results
Minnesota Mining and Manufacturing Company
Little Rock, Arkansas
HETA 91-091
March 5-6, 1991

Job Description	# Samples	Mean 8-hr TWA [dB(A)]	TWA Range [dB(A)]	Maximum 1-min Period [dB(A)]	Mean Sampling Period [hh:mm]
Maintenance Mechanic	6	88.3	84.1 - 93.6	110	07:38
Electrician	2	84.4	83.3 - 85.6	102	07:32
C & S Operator	2	84.1	81.7 - 86.5	111	07:37
C & S Screenmen	2	88.8	87.6 - 89.9	103	07:12
C & S Bin Tender	1	84.4	-	101	07:58
C & S Department Helper	2	92.6	91.0 - 94.3	114	07:56
C & S General Labor (2601)	1	86.6	-	108	06:33
Coloring: Mixer Operator	2	90.5	90.3 - 90.7	103	07:48
Coloring: Kiln Operator	2	89.6	88.9 - 90.4	111	07:50
Coloring: Bin Tender	2	84.0	83.2 - 84.7	102	07:37

Appendix 1
Job Titles and Duties
Minnesota Mining and Manufacturing Company
Little Rock, Arkansas
HETA 91-091

The following is a list of the job titles in the C&S and coloring departments and brief summary of their duties:

C&S Department

Job Title	Job Description
Operator	This employee operates crushers and Rotex screens, and performs quality control on the size of the product. Approximately 95% of his day is spent in an enclosed control room.
Bin Tender	Makes sure that mineral enters and exits into proper silos and assists in screen changing.
Screenman	Constructs screens for the Rotex, maintains screen inventories, assists in screen changing.
Helper	Assist in screen changing, general cleaning of all areas in the department.

Coloring Department

Job Title	Job Description
Dissolver	Dissolves sodium silicate used in the slurry, monitors operator transfer of this to the coloring department. Works in separate building.
Bin Tender	Operates equipment and conveyors for moving product through the Rotex screens and into storage silos.
Mixer	Mixes pigments with sodium silicate to produce slurry used by operator for coloring the granules.
Preheater	Monitors transfer of product from C&S department to and from preheat kiln, preheats product to the designated temperature.
Helper	Relieves the mixing operators, general cleaning of all areas in the department.

Appendix 2
Union Employee Health Survey Questions
Minnesota Mining and Manufacturing Company
Little Rock, Arkansas
HETA 91-091

1. Name ____

2. Social Security # ____

3. Address ____
(Street, P.O. or Box) (City) (State) (Zip)

4. Home Telephone # (or number where you can be reached) _____________________

5. Date of Birth ___________________________
(month) (day) (year)

6. When is the best time to contact you? _________________________________

7. How many years have you worked for 3-M? 0-5 _____ 6-10 _____ 11-15 _____
16-20 _____ 21-25 _____ 26-30 _____ 31-35 _____ over 35 _____

8. What is your present job title? ______________________________________
(example: welder, maintenance operator, etc.)

9. Please list any past job titles _______________________________________
____

10. Was your general state of health good _____ fair _____ or bad _____ before you began working at 3-M?

    Comments:

11. Do you smoke? yes _____ no _____ Have you ever smoked? yes _____ no ____
Approximate date you quit _________________

12. List any health problems you believe could be caused from your work at 3-M:

13. Do you have any heart problems for which you have received care by a doctor?
yes _____ no _____

    If so, did they start after you began employment with 3-M? yes _____ no _____

Table 3
Noise Dosimeter Results
Minnesota Mining and Manufacturing Company
Little Rock, Arkansas
HETA 91-091
March 5-6, 1991

Page 2 (Health Survey)

Give a brief description of your heart problems:

List the names of the doctors who have treated you for heart problems:

14. Do you believe you might be developing heart problems, but have not seen a doctor?
yes _____ no _____

15. Do you have lung problems for which you have received care by a doctor?
yes _____ no _____

If so, did they start after you began employment at 3-M? yes _____ no _____

Give a brief description of your lung problems:

List the names of the doctors who have treated you for lung problems:

16. Do you believe you might be developing lung problems, but have not seen a doctor?
yes _____ no _____

17. Do you have hearing problems for which you have received care by a doctor?
yes _____ no _____

If so, did they start after you began employment at 3-M? yes _____ no _____

Give a brief description of your hearing problems:

List the names of the doctors who have treated you for hearing problems:

18. Do you believe you might be developing hearing problems, but have not seen a doctor?
yes _____ no _____

19. Have you been given by 3-M any hearing protection devices? yes _____ no _____

If so, what kinds? ____

Appendix 3
Description of Methods Used During Survey
Minnesota Mining and Manufacturing Company
Little Rock, Arkansas
HETA 91-091

Crystalline Silica - NIOSH Method 7500

For air samples, air was drawn through a Dorr-Oliver cyclone and then through a polyvinyl chloride filter (37 millimeter diameter, 5 micron pore size) using a portable, battery-powered sampling pump at a flow rate of 1.7 liters per minute. The bulk samples were collected in plastic bags. The samples were analyzed by x-ray diffraction using the 7500 method with the following modifications: 1) Filters were dissolved in tetrahydrofuran rather than being ashed in a furnace. 2) Standards and samples were run concurrently and an external calibration curve was prepared from the integrated intensities rather than using the suggested normalization procedure.

Trace Metals - NIOSH Method 7300 (Elements)

Sample air was drawn through a mixed cellulose ester filter (37 millimeter diameter, 0.8 micron pore size) using a portable, battery-powered sampling pump at a flow rate of either 1 or 2 liters per minute; the total air volume sampled ranged from 417 to 878 liters. The samples were analyzed by inductively coupled plasma emission spectroscopy using NIOSH Method 7300.

Respirable Particulate - NIOSH Method 0600

Sample air was drawn through a Dorr-Oliver cyclone and then through a polyvinyl chloride filter (37 millimeter diameter, 5 micron pore size) using a portable, battery-powered sampling pump at a flow rate of 1.7 liters per minute. Filters were analyzed gravimetrically according to NIOSH method 0600 with the following modifications: 1) The time for stabilization between tare weighings is reduced from 8-16 hours to 5-10 minutes. 2) The filters and backup pads are not vacuum dessicated.

Total Particulate - NIOSH Method 0500

Sample air was drawn through a polyvinyl chloride filter (37 millimeter, 5 micron pore size) using a portable, battery-powered sampling pump at a flow rate of 2 liters per minute. Filters were analyzed gravimetrically according to NIOSH Method 0500 with the following modifications: 1) The time for stabilization between tare weighings is reduced from 8-16 hours to 5-10 minutes. 2) The filters and backup pads are not vacuum dessicated.