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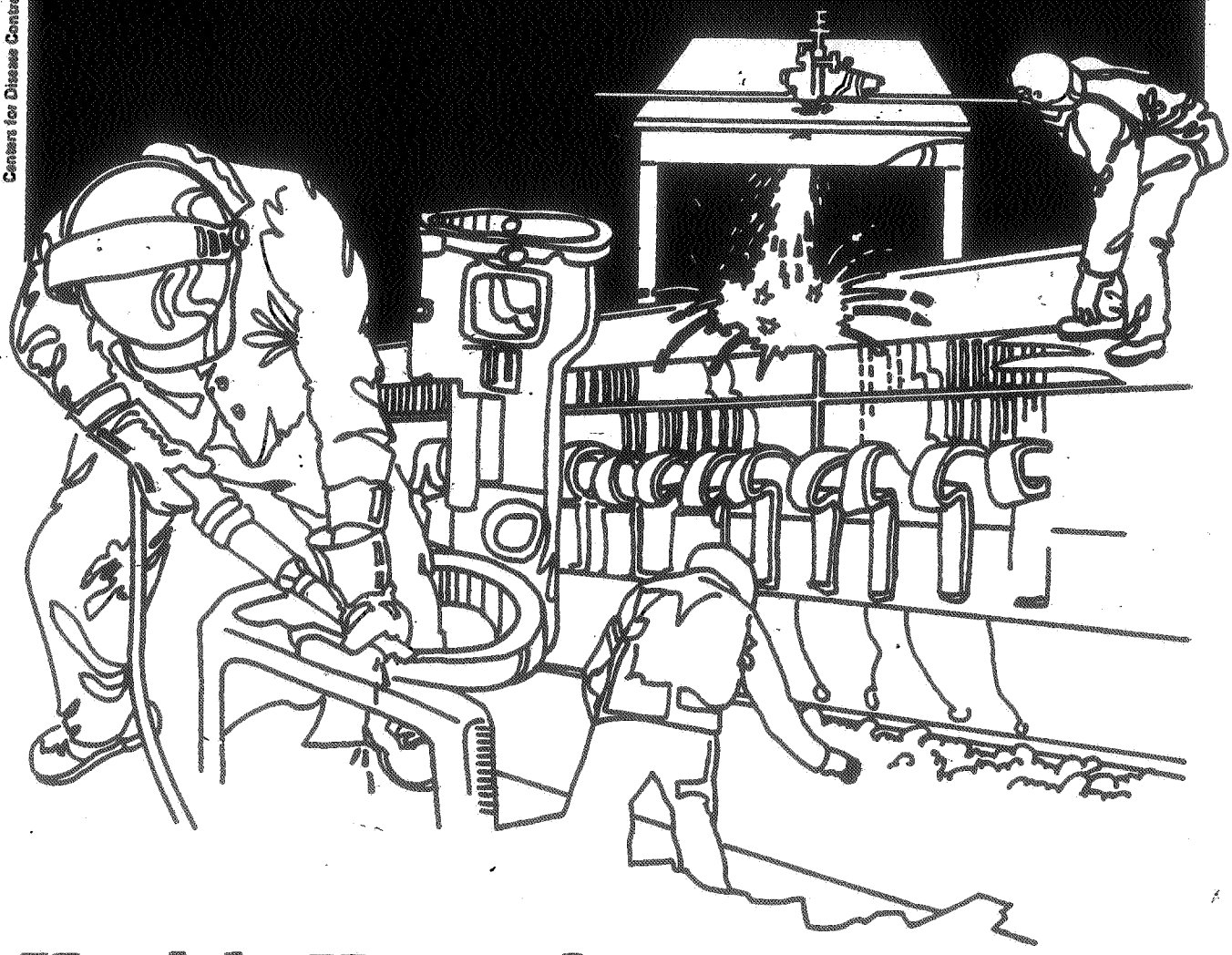

Health Hazard Evaluation Report

HETA 85-256-1716
AMF HEAD DIVISION
BOULDER, COLORADO

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 hygiene 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.

HETA 85-256-1716
July, 1986
AMF HEAD DIVISION
BOULDER, COLORADO

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I. SUMMARY

In March 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request from a representative of the AMF Head Division, Boulder, Colorado, to evaluate exposures to methylene bisphenyl isocyanate (MDI), methylene chloride, 1,1,1, trichloroethane, naphtha, sodium hydroxide, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK). After the initial investigation it was also determined that noise would be evaluated.

On August 15-16, and November 26, 1985, NIOSH investigators conducted an environmental survey at AMF Head. The survey consisted of collecting breathing zone and general area samples for the chemicals listed above and also performing a noise survey. Work practices and techniques were observed and employees were informally interviewed.

Personal and area samples for all the chemicals listed were below their respective standards and/or criteria. That is, MDI levels (all non-detectable/ND) were less than 0.05 mg/M^3 (NIOSH); 1,1,1, Trichloroethane levels (range 58-390 mg/M^3) were less than 1900 mg/M^3 (OSHA/ACGIH-TLV); Naphtha levels (range 113-293 mg/M^3) were less than 400 mg/M^3 (OSHA/ACGIH-TLV); Sodium hydroxide levels (range 0.02-0.05 mg/M^3) were less than 2.0 mg/M^3 (OSHA/NIOSH); MEK levels (range 18-36 mg/M^3) were less than 590 mg/M^3 (OSHA/NIOSH); MIBK levels (range 2.0-7.5 mg/M^3) were less than 200 mg/M^3 (NIOSH). Methylene chloride levels (range 3.7-16.8 mg/M^3) were less than 350 mg/M^3 (ACGIH-TLV). Animal experimentation data, however, suggest that methylene choride may have carcinogenic potential, and therefore, these exposures levels should be reduced to the Lowest Feasible Level (LFL). It was also determined that the lack of proper personal protective clothing could contribute to skin expsoure and irritations while performing certain processes.

During the study period, personal noise levels (range 83.6 to 92.5 dBA) were above the NIOSH recommended limit of 85 dBA TWA in the Stripping, Refill, and Fill/Sand areas. Peak noise levels for the various locations and jobs performed around this area ranged from 85 to 94 dBA.

On the basis of the environmental data collected, it is determined that a health hazard from excessive noise levels did exist for the workers evaluated in the Stripping, Refill, and Fill/Sand departments. It was also determined that methylene chloride may be a potential health hazard. Other employees who work with MDI, 1,1,1 trichloroethane, naphtha, sodium hydroxide, MEK, and MIBK were not overexposed to these chemicals during the NIOSH study. Recommendations to assist in reducing the exposures found in this investigation are included in this report.

KEYWORDS: SIC 3949 (Sporting and Athletic Goods), Tennis racket, racketball, other racket production; MDI, methylene chloride, 1,1,1 trichloroethane, naphtha, sodium hydroxide, MEK, MIBK, and noise.

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request in March 1985 from a representative of AMF Head Division, Boulder, Colorado. The request was to determine if there was a health hazard associated with various chemicals used during the production of sport rackets. The chemicals evaluated included methylene bisphenyl isocyanate (MDI), methylene chloride, 1,1,1, trichloroethane, naphtha, sodium hydroxide, MEK, MIBK, and noise. Environmental surveys were conducted on August 15 and 16, 1985 and November 26, 1985 to evaluate the potential exposures. In February, 1985, the results of this study were presented to the company with recommendations to further reduce and/or eliminate the exposures.

III. BACKGROUND

AMF Head Division, Boulder, Colorado manufactures various sports rackets (e.g., tennis, raquetball, squash, etc.). The chemicals used in the production of these rackets are numerous. The chemicals considered potentially hazardous to the employees were MDI, methylene chloride, 1,1,1, trichloroethane, naphtha, sodium hydroxide, MEK, and MIBK. Noise was also considered a potential health problem for a portion of the employees. The areas evaluated during the study period included the Spray Paint and Finishing, Mold Release, Degreasing, Refill, Fill/Sand, and Stripping departments.

IV. ENVIRONMENTAL DESIGN AND METHODS

A variety of sampling techniques were used to evaluate the suspected contaminants in these departments. Personal samples were taken on the majority of the employees who work at these locations. The following is a description of the sampling techniques used:

A. MDI

Fourteen area samples were collected for methylene bisphenyl isocyanates in impingers. Vaccumm pumps drew air through the impinger solution at approximately 1.0 liter per miniute (lpm). These samples were analyzed according to NIOSH Method 5505 with modifications.

B. Methylene Chloride

Three area samples were collected for methylene chloride using charcoal tubes. Vaccumm pumps drew air through the tubes at approximately 50 cubic centimeters per minute (cc/min). These samples were analyzed using NIOSH Method 1005 with modifications.

C. 1,1,1, Trichloroethane

Four personal breathing zone samples were taken for 1,1,1, trichloroethane using charcoal tubes. Vaccumm pumps drew air through the tubes at approximately 100 cc/min. These samples were analyzed using NIOSH Method 1003 (3rd Edition) with modifications.

D. Naphtha

Two personal breathing zone samples were taken for naphtha using charcoal tubes. Vaccumm pumps drew air through the tubes at approximately 100 cc/min. These samples were analyzed using NIOSH Method P&CAM 127 with modifications.

E. Sodium Hydroxide

Two personal breathing zone and four general area samples were collected for sodium hydroxide using AA filters. Vaccumm pumps drew air through the tubes at approximately 1.5 lpm. These samples were analyzed using NIOSH Method P&CAM 173.

F. MEK and MIBK

Four personal breathing zone samples were collected for methyl ethyl ketone and methyl isobutyl ketone using charcoal tubes. Vaccumm pumps drew air through the tubes at approximately 50 cc/min. These samples were analyzed using NIOSH Method 1300 with modifications.

G. Noise

Six personal noise level measurements were taken using Metrosonic noise dosimeters which register on a memory cell the dose or noise level received during the exposure period. The data can then be displayed as a read-out (hard copy) for each minute at the end of the exposure period. The read-out describes the accumulated exposure for each hour and is described as the average noise exposure for each hour evaluated.

Noise levels and sound pressure levels were also evaluated around the work sites using a Bruel & Kjoeré (B&K) Precision Sound Level Meter equipped with an octave band analyzer.

V. EVALUATION CRITERIA AND TOXICOLOGY

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 for time weighted averages (TWA) exposures to which most workers may be exposed to average airborne concentrations of a substance during a normal 8 to 10 hour day, 40 hour week for a working lifetime without experiencing adverse health effects. 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.

It is important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure.

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. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH recommended exposure limits, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard. However, it should be recognized that evaluation criteria may change over the years as new information on the toxic effects of an agent become available. Both NIOSH criteria and recommendations and the ACGIH TLV's usually are based on more recent information than are the OSHA standards.

Therefore, the NIOSH criteria and ACGIH TLV's for some chemical and physical agents may be lower than the corresponding OSHA standards. Except for noise, which is discussed later, the following is the list of standards/criteria and toxicology for those chemicals evaluated:

		Permissible Exposure 8-Hour Time Weighted Exposures (mg/M3)	
Substances	TLV	OSHA Standard	NIOSH Criteria
MDI	0.2	0.2	0.05
Methylene Chloride	700	700	LFL
1,1,1, trichloroethane	1900	1900	700*
Naphtha	-----	400	----
Sodium Hydroxide	2.0	2.0	2.0
MEK	590	590	590
MIBK	205	410	200

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mg/M^3 = milligrams of substance per cubic meter of air.

LFL = Lowest Feasible Limit which NIOSH believes should be obtained due to the potential carcinogencity of this chemical.

* = Refers to chemicals which are designated with a Ceiling (C) value or chemical levels which should not be exceeded even instantaneously.

B. Toxicology

Methylene Bisphenyl Isocyanate (MDI): Exposures to MDI may produce irritation of the eyes, dehydration of tissues, corneal damage, irritation of skin, and burns; darkening and hardening may occur after repeated exposures. MDI causes angioneurotic edema, irritation of the pharynx, dyspnea, headaches, cough, chest tightness, asthma, bronchitis, plumonary edema, nausea and vomiting. Allergic respiratory sensitization may occur.

Methylene Chloride: Methylene chloride is a general irritant, it depresses the central nervous system and can elevate carboxyhemoglobin levels. The signs and symptoms of exposure include: irritation of eyes and respiratory tract, headache, dizziness, nausea and vomiting. Maintaining exposures below 360 mg/M^3 should eliminate metabolic injury. Recently the National Toxicology Program has reported that methylene chloride showed

"clear evidence of carcinogencity" in laboratory test using mice. On the basis of these results and other recent literature, NIOSH has recommended that methylene chloride be considered a potential occupational carcinogen.

1,1,1 Trichloroethane (Methyl Chloroform): Methyl chloroform can effect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if ingested. Acute exposure effects include: headache, dizziness, drowsiness, unconsciousness, irregular heart beat, and death. Eye contact usually causes irritation. Chronic exposures may cause skin irritation. Reproductive abnormalities have been noted in animals chronically exposed to high concentrations.

Naphtha: Extremely high concentrations of naphtha, above 1000 parts per million, will cause narcosis. Naphtha is a central nervous system depressant. Naphtha is used to describe a variety of solvents. The aliphatic naphthas are relatively non-toxic. Severe exposures may produce light-headedness, drowsiness, and possibly irritation of the eyes, nose, and throat. Skin contact may cause drying and cracking due to defatting action.

Sodium Hydroxide: Sodium hydroxide is a severe irritant of the eyes, mucous membranes, and skin. The effects from the dust or mist will vary from mild irritation of the nose at 2 mg/M^3 to severe pneumonitis, depending on the severity of exposure.

Methyl Ethyl Ketone (MEK): MEK is an irritant of the eyes, mucous membranes, and skin. At high concentrations it causes narcosis in animals, and it is expected that severe exposure in humans will produce the same effect. In humans, short-term exposure to 300 ppm was "objectionable," causing headache and throat irritation; 200 ppm caused mild irritation of the eyes; 100 ppm caused slight nose and throat irritation. MEK can be recognized at 25 ppm by its odor, which is similar to acetone but more irritating.

Methyl Isobutyl Ketone (MIBK): MIBK has a amphor-like odor detectable at 100 ppm. In humans, at levels of 400 ppm, it is quite objectionable causing eye and nasal irritation. Eye irritation is noted at a level of 200 ppm. Workers exposed to about 100 ppm complained of nausea and headache, but developed a tolerance after several days of repeated exposure.

C. Noise

Exposure to high levels of noise may cause temporary and/or permanent hearing loss. The extent of damage depends primarily upon the intensity of the noise and the duration of the exposure. There is abundant epidemiological and laboratory evidence that protracted noise exposure above 90 decibels (dBA) causes hearing loss in a portion of the exposed population.

OSHA's existing standard for occupational exposure to noise (29 CFR 1910.95) specifies a maximum permissible noise exposure level of 90 dBA for a duration of 8 hours, with higher levels allowed for shorter durations. NIOSH, in its Criteria for a Recommended Standard, proposed a limit of 5 dB less than the OSHA standard.

Time-weighted average noise limits as a function of exposure duration are shown below:

Duration of Exposure (hours/day)	Sound Level, dBA	
	NIOSH	OSHA
16	80	---
8	85	90
4	90	95
2	95	100
1	100	105
1/2	105	110
1/4	110	115*
1/8	115*	---
	---	140 dB**

* No exposure to continuous noise above 115 dBA.

** No exposure to impact or impulse noise above 140 dB peak sound pressure level (SPL).

When workers are exposed to sound levels exceeding the OSHA standard, feasible engineering or administrative controls must be implemented to reduce levels to permissible limits. OSHA has issued a hearing conservation amendment to its noise standard. For workers exposed at or above a TWA of 85 dB, the amendment will require noise exposure monitoring, employee education, and audiometric testing. Review of audiograms have to be made by an audiologist or otolaryngologist or a qualified physician in their absence. Employees also must be notified of monitoring results within 21 days. Employee records must be kept by the employer for up to five years after termination of employment. Finally, for those employees exposed to noise levels exceeding 90 dBA for eight hours and/or where audiometric testing results indicate a hearing loss, ear protection must be worn.

Noise, commonly defined as unwanted sound, covers the frequency range of sound which is implicated in harmful effects (4000-6000 Hz). Noise can be classified into many different types, including wide-band noise, narrowband noise, and impulse noise. To describe the spectrum of anoise the audible frequency range is usually divided into eight frequency bands, each one-octave wide, and sound pressure level (SPL) measurements are made in each band using a special sound level meter. A wide-band noise is one where the acoustical energy is distributed over a large range of frequencies. Examples of wide-band noise can be found in the weaving room of a textile mill and in jet aircraft operations.

Exposure to intense noise causes hearing losses which may be temporary, permanent, or a combination of the two. These impairments are reflected by elevated thresholds of audibility for discrete frequency sounds, with the increase in dB required to hear such sounds being used as a measure of the loss. Temporary hearing losses, also called auditory fatigue, represent threshold losses which are recoverable after a period of time away from the noise. Such losses may occur after only a few minutes of exposure to intense noise. With prolonged and repeated exposures (months or years) to the same noise level, there may be only partial recovery of the threshold losses, the residual loss being indicative of a developing permanent hearing impairment.

Temporary hearing impairment has been extensively studied in relation to various conditions of noise exposure. Typical industrial noise exposures produce the largest temporary hearing losses at test frequencies of 4,000 and 6,000 Hertz (Hz).

The actual pattern of loss depends upon the spectrum of the noise itself. The greatest portion of the loss occurs within the first two hours of exposure. Recovery from such losses is greatest within one or two hours after exposure.

The amount of temporary hearing loss from a given amount of noise varies considerably from individual to individual. For example, losses at a given frequency due to noise intensities of 100 dBA may range from 0 to more than 30 dB.

Low frequency noise, below 300 Hz, must be considerably more intense than middle or high frequency noise to produce significant threshold losses.

Considerably fewer temporary hearing losses result from intermittent than from continuous noise exposure, even though the total amount of noise exposure is the same in both instances.

Physiologic reactions to a noise of sudden onset represent a typical startle pattern. There is a rise in blood pressure, an increase in sweating, an increase in heart rate, changes in breathing, and sharp contractions of the muscles over the whole body. These changes are often regarded as an emergency reaction of the body, increasing the effectiveness of any muscular exertion which may be required. However desirable in emergencies, these changes are not desirable for long periods since they could interfere with other necessary activities. Fortunately, these physiologic reactions subside with repeated presentations of the noise.

For performance on a task to remain unimpaired by noise, man must exert greater effort than would be necessary under quiet conditions. When measures of energy expenditure--for example, oxygen consumption and heart rate--are made during the early stages of work under noisy conditions, they show variations which are indicative of increased effort. Measurements in later stages under continued exposure, however, show responses return to their normal level.

VI. ENVIRONMENTAL RESULTS AND DISCUSSION

Employee exposures to suspected airborne concentrations of MDI, methylene chloride, 1,1,1, trichloroethane, naphtha, sodium hydroxide, MEK, and MIBK were evaluated. Potential noise exposures were also evaluated during the survey period. The following are the results of NIOSH's evaluation:

A. MDI

A total of 14 area samples were collected for methylene bisphenyl isocyanate in the Foam In Place department. All of these samples were non-detectable (ND) for the processes evaluated.

2. Methylene Chloride

A total of three area samples were collected for methylene chloride in the Foam In Place department. The results ranged from 3.7 to 16.8 mg/M^3 which is well below the ACGIH criteria of 350 mg/M^3. Based on recent information concerning the potential carcinogencity of methylene chloride, NIOSH believes that methylene chloride exposures should be reduced to the Lowest Feasible Level.

3. 1,1,1 Trichloroethane

A total of four breathing zone samples were collected for 1,1,1, trichloroethane. The results ranged from 58 to 390 mg/M^3 which is well below the OSHA Standard or NIOSH recommended level of 1900 mg/M^3.

4. Naphtha

A total of two personal breathing zone samples were taken for naphtha. The results ranged from 113 to 293 mg/M^3 and these were below the OSHA standard of 400 mg/M^3.

5. Sodium Hydroxide

A total of six samples, two personal and four area samples, were taken for sodium hydroxide. Each of the samples (range 0.02 to 0.05 mg/M^3) were well below the 2 mg/M^3 OSHA/NIOSH levels used in the study.

6. MEK and MIBK

A total of four personal breathing zone samples were collected for MEK and MIBK. Each of the results for MEK (range 18 to 36 mg/M^3) and MIBK (range 2.0 to 7.5 mg/M^3) were below NIOSH criteria of 590 and 200 mg/M^3 respectively.

7. Noise

A total of five personal noise samples were taken in the Cut to Fit and Finishing areas. Numerous area noise level measurements were also taken during the survey period. Only one of the five personal noise levels taken was below the NIOSH criteria of 85 dBA (refer to Table 1). The area noise level measurements taken ranged from 85-94 dBA for the sand and fill operations evaluated.

VII. CONCLUSIONS

It is concluded that a health hazard from noise did exist for those employees evaluated in the racket Stripping, Refill, and Fill/Sand finishing areas at the time of this study. It was also determined, based on methylene chloride's potential carcinogencity that it may be a health hazard to those employees who work with this chemical. The other employees evaluated, however, were not exposed to excessive levels of the remaining contaminants evaluated.

VIII. RECOMMENDATIONS

In view of the results of this study, as well as personal communications with individuals at AMF Head, Boulder, Colorado, the following recommendations are made to assist in providing a better work environment for the concerned employees:

A. 1,1,1 Trichloroethane and Soduim Hydroxide

The air sampling results for these contaminates were below their respective standards and/or criteria. It was noted during the survey period, however, that the employees who work with these chemicals were not wearing the proper personal protective clothing necessary to protect themselves during the work process.

Therefore, these employees should wear proper clothing to prevent direct contact and/or splashing onto the skin. This would include clothing to be worn only at work or disposable clothing. Proper gloves to prevent skin contact, and face shields should be worn.

B. Methylene Chloride

Although the air sampling results for methylene chloride were low, it is recommended that exposures should be kept to the lowest feasible level. Therefore, all contact with this chemical should be reduced and/or eliminated. Proper personal protective clothing to prevent exposures, especially during maintenance operations should also be used.

C. Hearing Protection

A hearing protection program is necessary at the AMF Head Division, in Boulder, Colorado. Since the company does provide hearing protection to its employees the following recommendations should be considered in those areas where excessive noise levels were found:

1. Noise monitoring should be performed annually, especially if additional operations and/or an increase in production should occur. This information will then identify for management and the employees noise levels in these areas. Also, those areas which are considered high noise areas should have warning signs posted accordingly.

2. To insure that full personal protection is being provided during those periods of suspected high exposure the Environmental Protection Agency's Noise Reduction Ratings (NRR) should be consulted and understood when selecting hearing protection in order to provide the most effective device. Each protective device (ear plugs or muffs) has a NRR rating which, for that particular type and model, describes what percent of noise attenuation may be obtained when using a particular device. Therefore, a complete evaluation of the noise levels and frequencies must be fully documented in each of the areas of concern.

TABLE 1

Personal Noise Dosimeter Levels

AMF HEAD, Division

Boulder, Colorado

June, 1986

Job/Task Description	Sampling Time (hours)	8-Hour TWA Noise (dBA)
Cut to Fit Operator	7	92.5
Grinder Finish Operator	7	86.0
Sand and Fill Operator	7	86.2
Sand and Fill Operator	7	86.5
Sand and Fill Operator	7	86.5
Sand and Fill Operator	7	83.6

EVALUATION CRITERIA	NIOSH 8-hour TWA	85 dBA
	OSHA 8-hour TWA	90 dBA
	OSHA 8-hour TWA*	85 dBA

* OSHA Revised Hearing Conservation Regulation requires the employer to institute a hearing protection program if TWA noise levels exceed 85 dBA.