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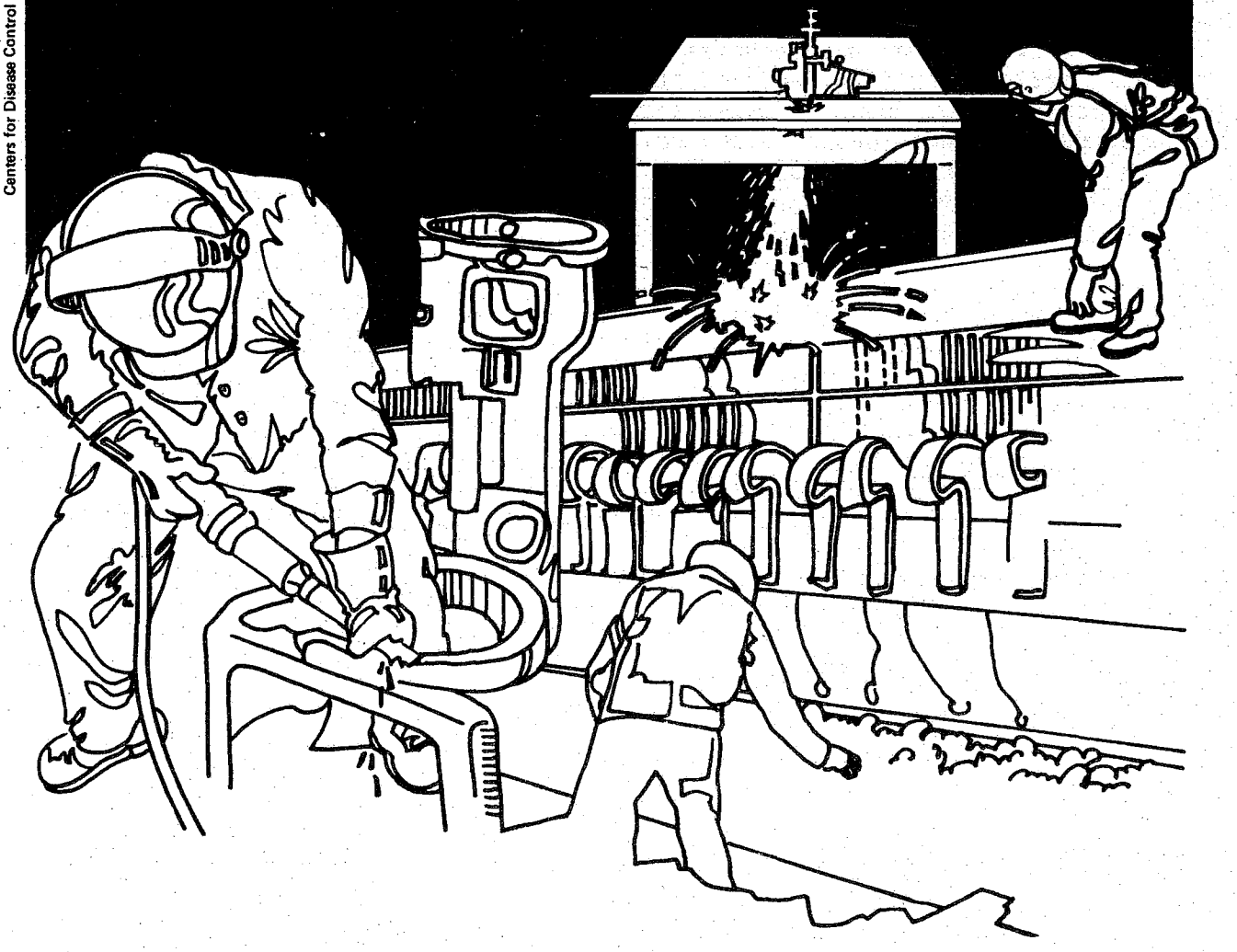

Health Hazard Evaluation Report

HETA 83-039-1305
DRIVE TRAIN INDUSTRIES, INC.
GRAND JUNCTION, 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 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.

HETA 83-039-1305
MAY 1983
DRIVE TRAIN INDUSTRIES, INC.
GRAND JUNCTION, COLORADO

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I. SUMMARY

In November 1982 the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a health hazard evaluation at Drive Train Industries, Inc., Grand Junction, Colorado. The company produces and refurbishes parts and equipment for both small and large motorized vehicles. The request concerned exposures to asbestos, sodium hydroxide, total welding fumes, nickel, manganese, copper, and noise which are found at various locations in the plant.

On November 30, 1982, NIOSH investigators conducted an industrial hygiene survey to determine airborne concentrations of the contaminants listed above.

The maximum 8-hour time-weighted average (TWA) exposure concentration of asbestos measured in the operator's breathing zone ranged from 0.02-0.37 fibers > 5 um/cc. These were less than the 2.0 fibers > 5 um/cc 8-hour TWA Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL). One of the asbestos results was above the NIOSH asbestos criteria of 0.10 fibers > 5 um/cc.

Personal samples for all other chemicals tested were below their respective criteria and/or standards. That is, sodium hydroxide levels (range 0.02-0.03 mg/M^3) were less than 2.0 mg/M^3 (OSHA/NIOSH); total welding fume levels (range 0.04-2.0 $mg/^3$) were less than 5.0 mg/M^3 (ACGIH); nickel levels (all non-detectable) were less than 1.0 mg/M^3 (OSHA); manganese levels (range non-detectable to 0.03 mg/M^3) were less than 5.0 mg/M^3 (OSHA); and copper levels (all non-detectable) were less than 0.1 mg/M^3 (OSHA).

At the time of the November survey, personal noise levels (range 77 to 83 dBA) were below the NIOSH recommended limit of 85 dBA TWA in the machine shop. Peak noise levels for the various locations and jobs performed around the machine shop ranged from 80 to 110 dBA.

On the basis of the environmental data collected, NIOSH determined that a potential health hazard to asbestos did exist during the November 1982 survey. Based on consultation with management on the asbestos problem, Drive Train and NIOSH developed engineering controls on the first day of the survey to reduce the suspected asbestos exposure. After the engineering controls were installed the asbestos exposures were reduced over 90% when comparing the first and second day's data. NIOSH also determined that a health hazard from excessive noise levels, sodium hydroxide, and welding contaminants did not exist to the workers evaluated in the machine shop. Recommendations to further assist in preventing asbestos exposures are included in this report.

KEYWORDS: SIC 3714 (Motor Vehicles and Motor Vehicle Equipment), brake drums, clutches, transmissions, drivelines, asbestos, noise, sodium hydroxide, nickel, manganese, copper, total welding fumes, welding, hot dipping, driveline components.

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request in November 1982 from a representative of the employees at Drive Train Industries, Inc., Grand Junction, Colorado. The request was to determine if there was a health hazard from asbestos during the reconditioning of truck brakes and clutches. Contaminants from welding operations, e.g., nickel, manganese, copper, total welding fumes; sodium hydroxide from hot dipping operations, and noise from various operations in the machining of metals were also evaluated. Environmental surveys were conducted on November 29 and 30, 1982, to evaluate the potential exposures to these contaminants. On February 9, 1983, the results of this study were presented to the company with recommendations to further reduce and/or eliminate the exposures found during the survey.

III. BACKGROUND

Drive Train Industries, Inc., Grand Junction, Colorado, remanufactures and rebuilds various truck parts such as brakes, clutches, drivelines, transmissions, and other mechanical parts used in truck driveline systems. A large percentage of brakes and clutches, as well as a portion of the other products produced at Drive Train, are refurbished and/or relined with some asbestos material.

Various operations and departments were evaluated by NIOSH. These included the brake, driveline, and clutch operations, as well as the transmission, and tear down operations.

The normal processes for remanufacturing any of these parts are similar. Once the old core is received it is then torn down, and the parts are cleaned. The old core is machined, and new parts are replaced as necessary.

Drive Train's main headquarters in Denver, Colorado, has been well aware of the potential for asbestos exposures to their employees for several years. Since 1977 they have had performed asbestos environmental monitoring, and medical screening for exposed workers since 1981 at their Denver plant. The environmental monitoring has been performed annually by either Drive Train's insurance carrier or by a local laboratory. As environmental results dictated, Drive Train altered their process to reduce the asbestos exposures. This included increased local exhaust ventilation, housekeeping (using vacuum cleaners) and improved personal hygiene, i.e., eating and smoking outside the work area, education on personal hygiene, and uniforms for work only.

The medical evaluation for asbestos exposure is performed by a local medical clinic and is available to those employees working in the area where asbestos work is performed. The medical evaluation includes exposure history, physical examinations, pulmonary function tests, and chest X-rays. Drive Train also gives pre-employment physicals to those employees who would be working in areas where asbestos is handled.

IV. ENVIRONMENTAL DESIGN AND METHODS

A variety of sampling techniques were used to evaluate the suspected contaminants in the shop. Personal samples were taken on the majority of the employees at this location. The following is a description of the techniques used:

A. Asbestos

Six personal air samples were collected for asbestos on AA filters (open faced) and counted on a phase contrast microscope (NIOSH Method P&CAM 239).

B. Sodium Hydroxide

Three personal breathing zone samples and one general area sample for sodium hydroxide were collected on AA filters and analyzed by atomic emission spectrophotometry (NIOSH Method No. S-381).

C. Welding Fumes

Six breathing zone samples were taken for nickel, manganese, copper, and total welding fumes. Metal analysis was performed by atomic absorption spectroscopy (NIOSH Method P&CAM 173). Total weights were performed on an electrobalance and taking the difference in pre/post-tare weights.

D. Noise

Nine 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 & Kjoer® (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 standards, by contrast, are based solely 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. 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 asbestos and noise which are discussed below, the environmental and medical (toxicological) evaluation criteria used for this investigation are presented in Table 1. Recommended environmental limits and general information concerning each substance are listed in this table, i.e., the source of the recommended limits, the present OSHA standard, and a brief description of the primary health effects known to date.

1. Asbestos

NIOSH recommends that occupational exposure to asbestos be controlled so that workers are not exposed to a workroom air concentration for an 8-hour time-weighted average (TWA) exposure exceeding 0.10 fibers per cubic centimeter greater than 5 microns in length and 0.5 fibers per cubic centimeter greater than 5 microns in length for a 15-minute Ceiling. The U.S. Department of Labor/Occupational Safety and Health Administration (OSHA) standard for asbestos for an 8-hour (TWA) exposure is 2 fibers per cubic centimeter greater than 5 microns in length, and a Ceiling concentration of 10 fibers per cubic

centimeter greater than 5 microns in length. The American Conference of Governmental Industrial Hygienists (ACGIH) TLV is 0.20 fibers per cubic centimeter greater than 5 microns in length.

Asbestos is a generic term applied to a number of hydrated mineral silicates, including chrysotile, amosite, crocidolite, tremolite, and anthophyllite. Asbestos consists of fibers of varying size, color, and texture. The uses of asbestos are numerous and include thermal and electrical insulation, fire blankets, safety garments, filler for plastics, and roofing materials. The most toxic route of entry is inhalation.

The most widely recognized disease caused by asbestos is asbestosis, followed by cancer of the lungs and digestive tract and mesothelioma.

Asbestosis is a lung disorder characterized by small irregular opacities which are often accompanied by pleural thickening and calcification that can be progressive even if exposure has stopped. Asbestos bodies may be found in the sputum, and the worker exhibits restrictive pulmonary function. Along with the clinical changes a worker may have fine rales, finger clubbing, dyspnea, dry cough, and cyanosis. Advanced asbestosis may also produce pulmonary hypertension and right sided heart failure.

Bronchogenic carcinoma and mesothelioma of the pleura and peritoneum are also caused by asbestos exposure. Excesses of cancer of the stomach, colon, and rectum have been found among asbestos workers.

The NIOSH recommendation and the TLV of 0.20 fibers/cubic centimeters greater than 5 microns in length were established to protect against asbestosis and reduce to an acceptably low risk the development of neoplasms.

Medical monitoring of asbestos workers should include preplacement and annual physical examinations with emphasis on the pulmonary system.

2. 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 recently 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 a noise 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 asbestos, sodium hydroxide, welding fumes (i.e., nickel, copper, manganese) were evaluated. Potential noise exposures were also evaluated during the survey period. The following are the results of NIOSH's evaluation.

1. Asbestos

The results received for asbestos are listed in Table 2. Two personal samples were taken (range below limit of detection [LOD] to 0.37 fibers > 5 um/cc) and three area type samples (range 0.04 to 0.06 fibers > 5 um/cc). Only one of these samples was above the NIOSH 0.10 fibers > 5 um/cc criteria established for this investigation.

2. Noise

A total of nine personal noise samples were taken (welding, miller, lathe, and horizontal boring operators). Numerous area noise level measurements were also taken during the survey period. All of the nine personal noise levels were below the NIOSH criteria of 85 dBA (refer to Table 3). The peak area noise level measurements taken ranged from 90-95 dBA for air compressed operations, 105-110 dBA for impact type noise, and 80-85 dBA background noise levels in the shop area.

3. Sodium Hydroxide

A total of four samples, three personal and one area sample, were taken for sodium hydroxide. Each of the samples (range 0.02 to 0.03 mg/M^3) were well below the 2.0 mg/M^3 criteria used in the study (refer to Table 4).

4. Welding Fumes

A total of six samples were collected for analysis of nickel (all non-detectable); manganese (non-detectable to 0.03 mg/M^3); copper (all non-detectable); and total welding fumes (range 0.04 to 2.0 mg/M^3). All of these samples were well below their respective criteria and/or standards. (Refer to Table 5.)

VII. CONCLUSIONS

NIOSH concluded that a health hazard did potentially exist to one employee evaluated for asbestos at the time of the NIOSH study. However, the other employees were not exposed to excessive concentrations of the other contaminants evaluated by NIOSH.

The personal samples taken for asbestos on the first day were suspected of being excessively contaminated. That is, this was suspected due to the type of work being performed, such as tearing down brake cores, blow down and cleaning cores which were know to contain asbestos. With this concern in mind, NIOSH and Drive Train officials developed an exhaust system to remove the major source of exposure during the tear down process. This was accomplished by adapting an industrial type

vacuum exhaust hose to the de-riveting machine. During the second day of sampling this adaptation proved to be very effective in exhausting the tremendous amount of dust generated by this operation.

When one compares the results in Table 2 to the reduction from the first day's sampling (0.37 fibers > 5 um/cc to 0.04 fibers > 5 um/cc), this difference would indicate a reduction of approximately 90 percent.

VIII. RECOMMENDATIONS

In view of the findings of NIOSH's environmental study, as well as personal communications with individuals at Drive Train Industries, Inc., Grand Junction, Colorado, the following recommendations are made to assist in providing a better work environment for the concerned employees:

A. Asbestos

The exhaust ventilation program designed by NIOSH and Drive Train in Grand Junction to protect the employees from asbestos exposure should be maintained and continued in order to further reduce the overall asbestos exposures to the employees who work around this contaminant.

B. Hearing Protection

A hearing protection program is not required at the Grand Junction operation. Since the company does provide hearing protection to its employees the following recommendations should be considered:

a. Noise monitoring should be performed 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 be posted accordingly.

b. 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. However, these ratings can be misunderstood, i.e., suppose a muff (X) has good attenuation at all frequencies except at 4000 Hertz where it has excellent attenuation and its overall NRR rating is 23. Another muff (Y) has great attenuation at all frequencies except 4000 where its attenuation is poor and its overall NRR rating is 26. Therefore, if one only knew that the higher the NRR the better the protection, it would be misleading if the greatest intensity noise in their workplace was at 4000 Hertz and they were using muff Y rather than muff X.

c. An educational program to instruct new employees on the hazards of noise exposures should be implemented, as well as an annual review of noise hazards for all concerned employees should also be implemented if it has not been already.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGMENTS

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XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standard 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, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Drive Train Industries, Inc., Grand Junction, Colorado
2. Drive Train Industries, Inc., Denver, Colorado
3. U.S. Department of Labor/OSHA - Region VIII.
4. NIOSH - Region VIII.
5. Colorado Department of Health.
6. State Designated Agency.

For the purpose of informing 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.

TABLE 1

EVALUATION CRITERIA AND TOXICOLOGY

Drive Train Industries, Inc.
Grand Junction, Colorado

Substance	Recommended Environmental Limit[A]	Reference Source	Primary Health Effects	OSHA Standard
Manganese	(C) 5 mg/M^3	ACGIH	Nervous disorder; loss of strength; metal fume fever; dry throat.	5 mg/M^3
Nickel	0.015 mg/M^3 10 hour TWA	NIOSH	Dermatological irritation; lung cancer; allergic asthma.	1 mg/M^3
Copper	1 mg/M^3	ACGIH	Irritation of mucous membrane, pharynx; nasal ulceration performation; eye irritation	1 mg/M^3
Welding Fumes	5 mg/M^3	ACGIH	ACGIH recommends evaluation of symptoms associated with each metal present in welding operation (refer to above).	----

[A] All air concentrations are expressed as time-weighted average (TWA) exposures for up to a 10 hour workday unless designated (C) for Ceiling which should not be exceeded.
[B] ACGIH = American Conference of Governmental Industrial Hygienists.
mg/M^3 = Approximate milligrams of substance per cubic meter of air.
(C) = Ceiling level which should not to be exceeded even instantaneously.

TABLE 2

Summary of Personal and Area Air Samples for Asbestos

Drive Train Industries, Inc.
Grand Junction, Colorado

November 1982

Job/Area Description	Sampling Time (minutes)	Asbestos (fibers > 5 um/cc)*
1st Day		
Tear Down Operator	120	0.37
Area	420	0.06
2nd Day		
Tear Down Operator	120	0.04
Area	420	0.02
Area	420	0.04

EVALUATION CRITERIA: OSHA -- 2.0 fibers > 5 um/cc
ACGIH -- 2.0 fibers > 5 um/cc
NIOSH -- 0.10 fibers > 5 um/cc

**LABORATORY LIMIT OF DETECTION: 0.03 fibers per field or 4500 fibers per filter.

* = fibers per cubic centimeter greater than 5 microns in length.

** = A detection limit is calculated by dividing the minimum observable fibers by the maximum number of fields specified by the method.

TABLE 3

Personal Noise Dosimeter Levels

Drive Train Industries, Inc.
Grand Junction, Colorado

November 1982

Job/Task Description	Sampling Time (hours)	8-Hour TWA Noise (dBA)
Foreman	7	77
Drive Line Mechanic	7	80
Drive Line Mechanic	7	83
Drive Line Mechanic	7	83
Drive Line Mechanic	7	81
Brake Reliner	7	81
Mechanic/All Over	7	80
Powershift Mechanic	7	80
Powershift Mechanic	7	79

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 employer to institute a hearing protection program if TWA noise exceeds 85 dBA.

TABLE 4

Summary of Personal and Area Samples for Sodium Hydroxide

Drive Train Industries, Inc.
Grand Junction, Colorado

November 1982

Job/Area Description	Sampling Time (minutes)		mg/M^3 Sodium Hydroxide
Mechanic	450		0.03
Mechanic	450		0.02
Mechanic	450		0.02
Tank	450		0.02
EVALUATION CRITERIA		OSHA	2.0
		NIOSH	2.0
LABORATORY LIMIT OF DETECTION (mg/sample)			0.007 mg

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

TABLE 5

Summary of Personal and Area Air Samples for
Nickel, Manganese, Copper, and Total Welding Fumes

Drive Train Industries, Inc.
Grand Junction, Colorado

November 1982

Job/Area Description	Sampling Time (minutes)	mg/M^3 Nickel	Manganese	Copper	Welding Fumes (total)
Drive Line Shop	630	ND	ND	ND	0.05
Drive Line Operator	630	ND	0.03	ND	2.0
Drive Line Operator	630	ND	0.03	ND	2.0
Drive Line Operator	630	ND	ND	ND	0.04
Drive Line Operator	630	ND	0.02	ND	0.05
Mechanic	630	ND	0.01	ND	0.73
EVALUATION CRITERIA	OSHA	1.0	5.0	0.1	---
	NIOSH	0.015	---	---	---
	ACGIH	---	---	0.2	5.0
LABORATORY LIMIT OF DETECTION mg/sample		0.005	0.003	0.001	0.002

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