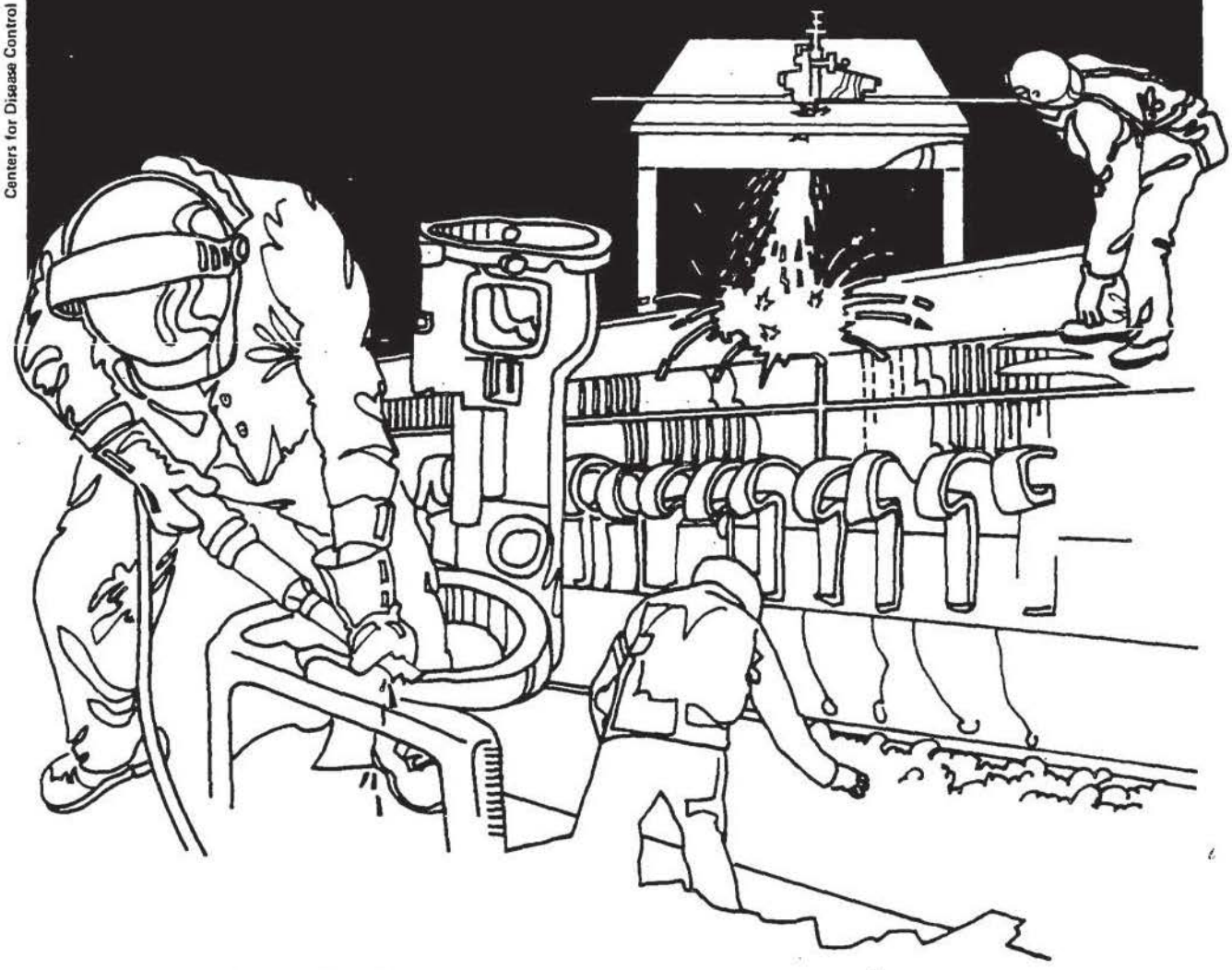
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 85-510-1937
JOHN DEERE
DUBUQUE, IOWA

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 85-510-1937
NOVEMBER 1988
JOHN DEERE
DUBUQUE, IOWA

NIOSH INVESTIGATORS:
Anne T. Nichting, CIH
Bobby J. Gunter, PhD
Thomas G. Wilcox, MD

I. SUMMARY

In August of 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request from Local 94 of the United Auto Workers Union, Dubuque, Iowa. The requestors were concerned about possible long-term adverse health effects of coolant exposures to machinists and other workers. They were especially concerned about the possibility of contamination of the cutting oils and other coolants with carcinogenic nitrosamine compounds.

On February 2-3, 1988, NIOSH conducted a walk-thru (initial) survey, and a followup environmental and medical investigation was conducted on March 15, and 16, 1988. The environmental investigation consisted of breathing zone and general room air samples for oil mist, nitrosamines, polynuclear aromatics (PNA), and aldehydes. Aldehydes and nitrosamines were not observed in any of the air samples. Oil mist concentrations ranged from 0.11 mg/M^3 to 1.57 mg/M^3 with a mean concentration of 0.38 mg/M^3; the OSHA standard and the ACGIH threshold limit value (TLV) is 5 mg/M^3 however, neither of these standards consider the possible carcongenic effects of lubricants. The PNA analytical screening showed trace quantities of acenaphthene, fluorene, phenanthrene, benzo (K) fluoranthene, dibenz (a,h) anthracene. Levels of these PNA's ranged from nondetectible to a high of 0.005 mg/M^3. NIOSH recommends the lowest feasible limit for these compounds and these levels represent extremely low levels and should not pose a significant health hazard.

The requestors felt that the plant work force may have experienced an excess of cancer, especially lung and brain cancers. The union had compiled a list of six persons who were believed to have succumbed to brain cancer in the years 1986 and 1987, and of eleven persons who were believed to have died from lung cancer during the same period. Review of death certificates provided by the company for these 17 employees revealed that 2 deaths due to brain cancer (both glioblastomas) and 7 deaths due to lung cancer had occurred in this group. One of the 2 employees with brain cancer was an engineer who worked in a research facility separate from the manufacturing building in which the other employee with brain cancer had worked as a production worker.

In the cohort of John Deere employees (estimated by the union to be about 4,500 men with average age above 45) about 4.5 lung cancer deaths and .35 deaths due to brain cancer would be expected each year. Thus, seven lung cancer deaths in a 2 year period are not in excess, however, no attempt to do additional case ascertainment was conducted. While the 2 brain cancer deaths are in excess, one of the two employees with brain cancer was not a production worker and the two cases of brain cancer are not necessarily epidemiologically linked through an occupational exposure.

Based on the environmental results and current exposure guidelines, a health hazard did not exist from an occupational exposure to oil mist, aldehydes, nitrosamines, and PNA's at the time of the environmental evaluation. However, the current oil mist exposure guidelines do not consider the possibility that some cutting oils and other coolants may have carcinogenic potential. Since there have been recent reports in the scientific literature suggesting a possible link between cancer (primarily digestive cancer)[12] and exposure to oil mists from cutting and coolant fluids, the union's marked concern about a possible excess of cancer in current and former John Deere workers is likely to continue until the union has access to reliable mortality information regarding production employees at the Dubuque facility. Recommendations are contained in Section VII.

KEYWORDS: SIC 3531, (Construction Machinery and Equipment), oil mist, polynuclear hydrocarbons, aldehydes, and nitrosamines.

II. INTRODUCTION

In August 1985, the National Institute for Occupational Safety and Health (NIOSH) received a request from Local 94 of the United Auto Workers Union, Dubuque, Iowa. The request was to determine if there was a health hazard from machinists' exposure to metalworking fluids at the John Deere Dubuque Works plant, Dubuque, Iowa. The request specifically addressed concerns about the possibility of exposure to N-Nitrosamine compounds. The John Deere Dubuque Works plant is a large facility which manufactures small industrial equipment (e.g., backhoes) and uses cutting oils, soluble oils, and synthetic fluids in machining operations.

The request was assigned to the Work Related Disease Program, Iowa Health Department under a co-operative agreement NIOSH had with the state. A preliminary draft protocol of study was prepared by the state and included an industrial hygiene survey, medical survey, and mortality study. NIOSH recommended: 1) proceeding on characterizing the physical environment, i.e., an industrial hygiene evaluation, 2) delaying the decision to conduct a medical survey until after the industrial hygiene survey was performed, and 3) not undertaking a NIOSH mortality study at this plant. NIOSH's Industry Wide Studies Branch was appraised of the Hazard Evaluation so that the plant might be considered for a future mortality study.

In July 1986 nineteen Thermosorb/N air sampling tubes and six bulk samples collected at the John Deere Dubuque Works plant were submitted to NIOSH for analysis of nitrosamines.(1) The samples were analyzed by gas chromatography with a Thermal Energy Analyzer (GC-TEA) according to a standard procedure for general nitrosamine analysis, Draft Method 2522. The bulk samples contained no nitrosamines but the presence of diethanolamine was confirmed in three bulk samples. On initial analysis by GC-TEA all of the Thermosorb/N tubes were found to contain a large peak for dimethysulfate, a potent carcinogen. Further work determined that if any nitrosamines were present on the Thermosorb/N tubes their detection would have been masked by the dimethylsulfate peak. Unused Thermosorb/N tubes from the same lot showed this same major peak. Blank Thermosorb/N tubes from another lot were also analyzed for dimethylsulfate. The presence of dimethylsulfate was confirmed but it was present in such a small amount that it would not be detected by the TEA. The lab report concluded further work was necessary to try and find the origin of the dimethylsulfate on the Thermosorb/N tubes.

A walk through survey of metalworking areas was conducted by two NIOSH industrial hygienists on February 2, 1988. A medical and industrial hygiene evaluation was conducted March 15 and March 16, 1988.

III. BACKGROUND

The John Deere Dubuque Works plant is a large facility which manufactures small industrial equipment (e.g., backhoes) and uses cutting oils, soluble oils, and synthetic fluids in machining operations. Several mineral and soluble oils and synethetic metal working fluids along with biocides were used at this plant. The plant at one time contained both a foundry and the metalworking plant. Total employment in the plant is approximately 3,000 employees. This facility has a large office complex for engineering and other management functions.

Coolant survey data obtained from the plant's Materials and Engineering Department and dated February 10, 1988 listed 45 manufacturing departments at the Dubuque Works. The data listed for each machine the department, equipment description (e.g., lathe, mill, etc.), type of metalworking fluid (e.g., cutting oil, soluble oil, or synthetic), fluid name and manufacturer, and plant location based on a plant-wide co-ordinate system. The survey listed over 1,000 machines. The coolant survey data was used to determine where air sampling was conducted because conducting air sampling in each department was not possible. The departments were categorized by size (small, medium, large) based on the number of machines and also by the type of metalworking fluid predominantly used in the department. Seven departments were selected for air sampling and represented medium to large departments using either synthetic metalworking fluid, cutting oils, soluble oils or a combination of cutting oils and soluble oils. Refer to Table 2. Material Safety Data Sheets for the metalworking fluids and biocides were obtained and reviewed. Refer to Table 1.

There were 3 eight hour production shifts with approximately 600 machinists employed. The day shift (7:00 AM to 3:30 PM) was the major production shift and the one chosen for air sampling on March 15 and March 16, 1988. Basic machine tools (lathes, drills, mills, etc.) and speciality machines (threading machines and gear cutting machines) were used in the departments sampled. Local exhaust ventilation, enclosures, and machine guards were observed on many of the machines.

MEDICAL BACKGROUND

The requestors were concerned about the effects of coolant exposures, both dermatitis and possible long term adverse health effects. The requestors felt that the plant work force may have experienced an excess of cancer, especially lung and brain cancers, because of occupational exposures received by plant workers. The Union had compiled a list of employees that were believed to have succumbed to various types of cancer in the past 7 to 8 years. This list contained the names of six persons who were believed to have succumbed to brain cancer in the years 1986 and 1987, and the names of eleven persons who were believed to have died from lung cancer during the same period.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

On March 15 and 16, 1988 an industrial hygiene evaluation was conducted by two NIOSH industrial hygienists in seven production departments. Refer to Table 1. Personal exposures and average area air concentrations of oil mist, polynuclear aromatic hydrocarbons (PNA's), polychlorinated biphenyls (PCB's), aldehydes, and N-Nitrosamine compounds. Bulk samples of metalworking fluids were also collected to aid in the oil mist analysis and to determine if PCB's were present. Twenty personal breathing zone (PBZ) and four general area air samples were collected for oil mist at a flowrate of 1.5 liters per minute (lpm) on mixed cellulose ester membrane filters and analyzed according to NIOSH P&CAM (Physical and Chemical Analytical Method) 283.(2) Ten bulk samples of cutting oils were collected to aid oil mist analyses. Eight general area air samples for polyaromatic hydrocarbons (PAH's) were collected at a flowrate of 1.5 lpm on teflon filters and washed XAD-2 sorbent tubes and analyzed according to NIOSH Method 5515.(3) Four general area air samples for polychlorinated biphenyls (PCB's) were collected at a flowrate of 100 cubic centimeters per minute (cc/minute) on Florisil sorbent tubes and analyzed according to NIOSH Method 5503.(3) One bulk sample of cutting oil was collected to determine presence of PCB's. Seven general area air samples and one PBZ air sample were collected for a qualitative aldehyde scan on Orbo-23 sorbent tubes and analyzed by gas chromatography (GC) and flame ionization detection (FID).(4) Seventeen general area air samples and one PBZ air sample were collected for Nitrosamines on Thermosorb/N tubes at a flowrate of 100 cc/minute and analyzed using gas chromatography with a Thermal Energy Analyzer (TEA) in the nitrosamine mode.

B. Medical

The Company was asked to provide death certificates and work histories for the former employees thought to have succumbed to brain or lung cancer by the requestor. In addition, the problem of coolant dermatitis at the Dubuque plant was discussed with the requestor, with five workers during private medical interviews, with the Director of Industrial Hygiene and Safety, and with the Plant Nurse.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is,

however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

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

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

	Environmental Exposure Limits 8-Hour Time-Weighted Average (TWA)	
Oil Mist	5 mg/m^3	(ACGIH)
	5 mg/m^3	(OSHA)
Nitrosamines	LFL	(NIOSH)
Total Aldehydes		(No Criteria)
	1.5 mg/M^3	(OSHA)
PNA's	LFL	(NIOSH)

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mg/M^3 = milligrams of substance per cubic meter of air.
S = Skin absorption can be a significant factor in toxicity.
LFL = Lowest Feasible Level.

Oil Mist

Oil mist (mineral) refers to airborne mist of petroleum-base cutting oils or white mineral petroleum oil. The ACGIH TLV for mineral oil mist is 5 mg/m^3. The OSHA PEL is also 5 mg/m^3. Oil mist lubricants are a common cause of skin rashes. The lighter oils cause defatting of the skin which leads to redness itching and a chronic eczematous rash. The thicker oils tend to block the pores of the skin leading to folliculitis and achne.(6) The ACGIH TLV was established to provide a margin of safety against minor changes in the lungs for the types of cutting and lubricating oils most frequently encountered and where there has been no altering of composition by heat and/or oxidation.(7)

Unfortunately, the current oil mist exposure guidelines do not consider the possibility that some cutting oils and other coolants may have carcinogenic potential. (There have been recent reports in the scientific literature suggesting a possible link between cancer (primarily digestive cancer) and exposure to oil mists from cutting and coolant fluids.[12])

Nitrosamines

Historically, nitrosamines have been regarded as one of the most potent families of animal carcinogens. Although nitrosamines are suspected to be human carcinogens, their carcinogenic potential in humans has not been documented. Commercial cutting fluids have the potential for formation of nitrosamines by the reaction of secondary and tertiary amines with nitrites or other oxides of nitrogen (both substances are present in some cutting fluids). N-nitroso compounds, including nitrosamines such as N-nitrosodiethanolamine, have been detected in bulk samples of synthetic metal working fluids. The N-nitroso compounds presumably result from the combination of ethanolamines and nitrite additives in solution. NIOSH recommends that exposure to nitrosamines be reduced to the lowest feasible level.(8)

Polycyclic Nuclear Aromatics

Polynuclear aromatics hydrocarbons (PNAs) including benz(a)pyrene have been measured in both new and used bulk samples of cutting (mineral) oils. Solvent refining of these oils in recent years is thought to have reduced the level of these contaminants below that historically found in acid refined oils. There are no specific criteria for individual PNAs, however, NIOSH recommends that exposures be limited to the extent feasible by the use of engineering or administrative controls and personal protective clothing and equipment.

Aldehydes

Biocides are typically added to all varieties of cutting fluids to reduce microbiologic growth. The most common are cyclic triazines which are condensates of formaldehyde with substituted alkylamines or ammonia. These presumably react by releasing formaldehyde at microbial cell membrames and that little free formaldehyde is released under normal conditions in alkaline cutting fluids. The primary acute health effects of exposure to formaldehyde are irritation of the respiratory tract, eyes, and skin. Eye and respiratory tract irritation has been reported in workers exposed to concentrations of less than 1.5 mg/m^3.(9) Recent studies have found that formaldehyde induced nasal cancer in rats exposed to high levels (23 mg/m^3) of formaldehyde over a long period of time.(10) NIOSH recommends that formaldehyde be handled in the work place as a potential occupational carcinogen.(11) Safe levels of exposure to carcinogens have not been demonstrated, but the probability of developing cancer should be reduced by decreasing exposure. NIOSH recommends that engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible level.

VI. RESULTS

A. Environmental

One bulk sample of cutting oil was collected to determine presence of PCB's. The analysis was performed on a gas chromatograph equipped with an electron capture detector. The presence of a PCB was determined by comparison with seven standard samples (Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260). The results of these analyses were below the laboratory limit of detection (10.0 micrograms per gram). The four general area air samples collected for polychlorinated biphenyls (PCB's) were therefore not analyzed.

Seven general area air samples and one personal breathing zone (PBZ) air sample were collected for a qualitative aldehyde scan on Orbo-23 sorbent tubes and analyzed by gas chromatography (GC) and flame ionization detection (FID).(4) No aldehydes above the formaldehyde limit of detection (0.8 micrograms per sample) were detected.

Twenty breathing zone and four general room air samples collected and analyzed for oil mist showed concentrations ranging from 0.11 mg/M^3 to 1.57 mg/M^3 the mean concentration was 0.38 mg/M^3, well below the OSHA standard and the ACGIH recommended level of 5 mg/M^3.

Sixteen breathing zone and general room air samples were taken for nitrosamines. Nitrosamines were not found in detectable amounts in any of the air samples.

B. Medical

Of the six employees thought to have succumbed to brain cancer during 1986-87, one was still living but had a non-malignant disease that affected the central nervous system. Two had lung cancer with brain metastases, one had melanoma with metastasis to the brain, and two had succumbed malignant brain tumors - both glioblastomas. One of the 2 employees with glioblastoma was a research engineer who worked in a research facility separate from the manufacturing building; the other was a production employee. Of the 11 former employees believed to have died from lung cancer during 1986-87, one person was still living and the death certificates indicated that five people had succumbed to conditions other than lung cancer (one renal carcinoma, one stomach carcinoma, one ventricular fibrillation, one chronic obstructive pulmonary disease, and one auto accident). Death certificates for five of the eleven did list lung carcinoma as the cause of the death and along with the two people succumbing to lung cancer who were thought to have had brain cancer by the union, there were seven lung cancer deaths for the period 1986 and 1987.

Regarding the possible dermatological problems associated with coolant contact, there was general agreement among all parties that skin problems due to contact with coolant had decreased markedly over the last 5 years after institution of a program conducted jointly by the union health and safety committee and the medical department. This program identified workers with incipient skin problems, determined the factors causing those skin problems and then intervened to prevent a worsening of the skin condition by decreasing the worker's exposure to coolant and providing medical treatment to hasten the healing of the skin lesions. Four of the current workers interviewed mentioned that they on occasion had spots of irritated skin on their hands and arms that were related to contact with various synthetic coolants, but that medication provided by the medical department along with increased efforts to avoid coolant exposure and to cleanse their skin should exposure occur, successfully treated these lesions before they became severely eczematous.

VII. DISCUSSION

No exposures exceeding current occupational exposure criteria were found for exposures to oil mist, aldehydes, nitrosamines, or PNA's at the time of the environmental evaluation . However, the current oil mist exposure guidelines do not consider the possibility that some cutting oils and other coolants may have carcinogenic potential.

The union estimated that the cohort consisting of male workers presently employed at the John Deere facility and living retired male workers approximated 4,500 people. In a population of that size and age distribution (average age exceeded 45 years of age), about 4.5 deaths per year due to lung cancer would be expected. Thus, the seven lung cancer deaths in a 2 year period are not of themselves excessive, however, no attempt to do additional case ascertainment was conducted.

For brain cancer deaths, about 0.35 deaths per year would be expected in such a population. It is of interest that the union also had four other employees who they thought had died from brain cancer during the years 1980 to 1985. Of these employees, the death certificates indicated that one died of small cell lung carcinoma metastatic to the brain, one died of squamous cell carcinoma of the lung metastatic to the brain, one died of a myocardial infarction with no mention of the presence of a brain tumor, and one died of sinus cancer. For the period from 1980 to 1987, the two documented deaths due to brain cancer would not be considered a statistical excess. In addition, since one of the two employees with brain cancer was not a production worker, the two cases of brain cancer are not necessarily epidemiologically linked through an occupational exposure.

It appears that some of the union concern regarding possible excess deaths due to brain and lung cancer has resulted from difficulties in obtaining accurate information as to the cause of death of deceased employees. In addition, there have been recent reports in the scientific literature suggesting a possible link between exposure to cutting fluids and cancer (primarily digestive cancer).[12] The union's marked concern about a possible excess of cancer is likely to continue until it has access to reliable information regarding the mortality experience of the production employees at the Dubuque facility.

The company, as part of its retirement program, routinely collects death certificates of deceased vested employees. It would be advisable for the company to make available to the union information regarding the cause of death of union members. This should end any confusion caused by misconceptions about causes of death. The union and company could also discuss the possibility of conducting a proper mortality analysis of production employees at the plant. Only by defining the true rate of mortality through proper epidemiologic study can there be any certainty as to whether there has or has not been excess cancer mortality. While this activity is well beyond the scope of a NIOSH Health Hazard Evaluation, we could offer technical assistance and review.

VIII. REFERENCES

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VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:

Bobby J. Gunter, Ph.D.
Regional Industrial Hygienist
NIOSH - Denver Region
Denver, Colorado

Thomas Wilcox, M.D.
Medical Officer
NIOSH Cincinnati Office
Cincinnati, Ohio

Anne T. Nichting, CIH
Industrial Hygienist
NIOSH - Denver Region
Denver, Colorado

Originating Office:

Hazard Evaluations and Technical Assistance Branch (HETAB)
Division of Surveillance, Hazard Evaluations, and Field Studies
Cincinnati, Ohio

Report Typed By:

Marile F. DiGiacomo
Secretary
NIOSH - Denver Region
Denver, Colorado

IX. DISTRIBUTION AND AVAILABILITY

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluation and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Port Royal Road, Springfield, Virginia 22161. 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. United Auto Workers Local 94, Dubuque, Iowa
2. John Deere Dubuque Iowa
3. U.S. Dept. of Labor/OSHA - Region VII
4. NIOSH - Denver Region
5. Iowa Department of Health

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

Metalworking Fluids and Biocides Used at the
John Deere Dubuque Plant
John Deere
Dubuque, Iowa
March 1988

Biocides

Name	Manufacturer
Busan 77	Buckman Laboratories, Inc. Memphis, TN
Groten	John & Fink Industrial Products Co. Montvale, NJ
Kathon 886 MW Biocide	Rohm and Haas Company Philadelphia, PA
Amine CS-1135	ANGUS Chemical Company Northbrook, IL
Compund Bioan	ANGUS Chemical Company Northbrook, IL

Synthetic Metalworking Fluids

Van Stroaten 39-144-F (Deersyn 100V)	Van Stroaten Chemical Company Chicago, IL
Chemtool Seersyn 100-C	Chemtool, Incorporated Crystal Lake, IL
Deersyn 100-C	Chemtool, Incorporated Crystal Lake, IL
Van Stroaten 902-C	Van Stroaten Corp. Crystal Lake, IL
B-9	Cutting & Grinding Fuids, Inc. Rockford, IL
Kool Kut 610	Cutting & Grinding Fuids, Inc. Rockford, IL
Deersyn 100-S	D.A. Stuart Oil Co. of America Willowbrook, IL

Table 1
(con't)

Metalworking Fluids and Biocides Used at the
John Deere Dubuque Plant
John Deere
Dubuque, Iowa
March 1988

Cutting Oils

Name	Manufacturer
Thredbut Cutting Oil	D.A. Stuart Oil Co. of America Willowbrook, IL
Superkool Base	D.A. Stuart Oil Co. of America Willowbrook, IL
Mineral Seal Oil	Rock Valley Oil & Chemical Co. Rockford, IL
Dascolene 3798	D.A. Stuart Oil Co. of America Willowbrook, IL
Dasco 1770	D.A. Stuart Oil Co. of America Willowbrook, IL
JDDW 434 Cutting Oil	John Deere Dubuque Works Dubuque, IA
02234 Clear tex D	Texaco Inc. Beacon, NY

Soluble Oil Fluids

Microcut 19-6m	Quaker Chemical Corp. Conshohocken, PA
Dasco 1198	D.A. Stuart Oil Co. of AMerica Willowbrook, IL
Densol	John Deere Dubuque Works Dubuque, IA
Trim SOL	Master Chemical Corp. Perrysburg, OH

Table 2

Departments Samples By Size and Tupe of Metalworking Fluid
John Deere Dubuque Works
John Deere
Dubuque, Iowa
March 1988

Department #	Size of Department	Type of Metalworking Fluid
9	Large	Cutting Oil and Soluble Oil
11	Medium	Soluble Oil
12	Large	Cutting Oil
15	Large	Cutting Oil and Soluble Oil
19	Large	Synthetic
20	Large	Synthetic
73	Large	Cutting Oil

Key:

Large Department: >50 machines
Medium Department: 15-50 machines
Small Department: <15 machines

Table 3

PBZ Air Samples for Oil Mist
John Deere Dubuque Plant
John Deere
Dubuque, Iowa
March 15 and 16, 1988

Sample #	Date	Location/ Job	Sampling Time	Sample Volume (Liters)	Concentration mg/M^3
1	March 15	Dept. 73/ Machinist	7:58am - 2:17pm	569	0.62
2	March 15	Dept. 73/ Machinist	7:59am - 2:16pm	566	0.34
3	March 15	Dept. 12/ Machinist	7:21am - 2:04pm	605	0.31
4	March 15	Dept. 73/ Machinist	7:55am - 2:15pm	570	0.28
6	March 15	Dept. 15/ Machinist	8:10am - 2:27pm	566	0.32
7	March 15	Dept. 12/ Machinist	7:15am - 2:01pm	609	0.32
8	March 15	Dept. 15/ Machinist	8:15am - 2:28pm	560	0.37
9	March 15	Dept. 15/ Machinist	8:12am - 2:26pm	561	0.28
10	March 15	Dept. 12/ Machinist	7:18am - 2:02pm	606	0.11
11	March 15	Dept. 9/ Machinist	7:46am - 1:46pm	540	0.36
12	March 15	Dept. 9/ Machinist	7:24am - 2:06pm	603	0.36
13	March 15	Dept. 9/ Machinist	7:33am - 2:06pm	590	0.13
14	March 15	Dept. 9/ Machinist	7:35am - 2:10pm	593	0.21
16	March 16	Dept. 12/ Machinist	7:24am - 2:03pm	599	0.30
17	March 16	Dept. 12/ Machinist	7:28am - 2:04pm	594	0.29
18	March 16	Dept. 12/ Machine setup	7:30am - 2:02pm	588	0.27
19	March 16	Dept. 73/ Machinist	7:55am - 2:16pm	572	0.31
20	March 16	Dept. 73/ Machinist	7:57am - 2:18pm	572	0.31
21	March 16	Dept. 73/ Machinist	7:58am - 2:17pm	569	0.17
22	March 16	Dept. 73/ Machinist	8:03am - 2:20pm	566	1.57

Table 3 (con't)

General Area Air Samples for Oil Mist
John Deere Dubuque Works
John Deere
Dubuque, Iowa
March 15 and 16, 1988

Sample #	Date	Location/ Job	Sampling Time	Sample Volume (Liters)	Concentration mg/M^3
5	March 15	Dept. 73/ Machine 14529	8:51am - 1:25pm	492	0.34
15	March 15	Dept. 73/ Machine 12336	8:56am - 1:22pm	489	0.9
23	March 16	Dept. 73/ Machine 12636	8:06am - 2:19pm	560	0.29
24	March 16	Dept. 73/ Machine 14020	8:08am - 2:21pm	560	0.57
Evaluation Criteria					5.0
Laboratory Limit of Detection = (.05 mg/filter)					

Table 4

General Area Air Samples for PNA's
John Deere Dubuque Works
John Deere
Dubuque, Iowa
March 15 and 16, 1988

Sample #	Date	Location/ Job	Sample Sampling Time	Volume (Liters)	Concentration mg/M^3 Acenaphthene	Fluorene	Phenanthrene	Benzo (K) Fluoranthene	Dibenz(a,h) Anthracene
1	March 15	Dept. 73/ Machine 12336	9:00am - 1:22pm	483	*	*	*	0.002	0.003
2	March 15	Dept. 73/ Machine 14529	9:00am - 1:23pm	485	0.003	0.001	*	*	0.001
3	March 15	Dept. 73/ Shaver Area	9:44am - 1:45pm	362	0.001	*	*	0.002	*
4	March 15	Dept. 12/ Hob Line	9:50am - 1:49pm	359	0.003	0.001	0.001	*	0.004
5	March 15	Dept. 12/ Hob Line	9:53am - 1:47pm	351	*	*	*	*	*
6	March 16	Dept. 12/Gleason Battery Area	7:26am - 2:03pm	596	0.001	0.001	0.001	*	*
7	March 16	Dept. 73/ Machine 12335	7:59am - 2:17pm	567	0.001	*	*	0.003	0.002
8	March 16	Dept. 73/ Machine 14529	8:01am - 2:22pm	572	0.005	0.002	0.001	*	*
Evaluation Criteria					LFL	LFL	LFL	LFL	LFL
Laboratory Limit of Detection ug/sample					0.3	0.3	0.3	0.6	0.5

Table 5

PBz and General Area Air Samples for Nitrosamines
John Deere Dubuque Works
John Deere
Dubuque, Iowa
March 15 and 16, 1988

Sample #	Date	Location/ Type/Area	Sampling Time	Sample Volume (Liters)	Concentration mg/M^3
CO 1	March 15	Area/Dept. 73/ Machine 12336	9:03am - 1:22pm	26	ND
CO 2	March 15	Area/Dept. 73/ Machine 14529	9:03am - 1:24pm	27	ND
SY 3	March 15	Area/Dept. 20/ Machine 13809	9:23am - 1:36pm	15	ND
SY 4	March 15	Area/Dept. 20/ Machine 13805	9:24am - 1:34pm	27	ND
SY 5	March 15	Area/Dept. 20/ Machine 13996	9:25am - 1:37pm	27	ND
SY 7	March 15	Area/Dept. 19/ Machine 13953	9:32am - 1:41pm	25	ND
SY 8	March 15	Area/Dept. 19/ Machine 14399	9:34am - 1:48pm	22	ND
SY 9	March 15	Area/Dept. 19/ Machine 14944	9:35am - 1:39pm	25	ND
SY 10	March 15	Area/Dept. 19/ Machine 13987	9:37am - 1:43pm	23	ND
SO 11	March 16	Area/Dept. 11/ Machine 14112	7:12am - 1:55pm	25	ND
SO 12	March 16	Area/Dept. 11/Machine 11768 & 11794	7:20am - 1:59pm	39	ND
SY 13	March 16	Area/Dept. 19/ Machine 13953	7:37am - 2:68pm	37	ND
SY 14	March 16	Area/Dept. 19/ Machine 13987	7:38am - 2:07pm	33	ND
SY 15	March 16	Area/Dept. 19/ Machine 10852	7:43am - 2:09pm	38	ND
SY 16	March 16	Area/Dept. 19/ Machine 14899	7:43am - 2:10pm	40	ND
SY 17	March 16	Area/Dept. 38/ Machine 11544	10:00am - 2:27pm	27	ND
SY 18	March 16	Area/Dept. 38/ Machine 12995	10:00am - 2:28pm	26	ND

Evaluation Criteria LFL
Laboratory Limit of Detection from .0064 to 0.1 mg/sample
LFL = Lowest Feasible Limit

Table 6

PBz and General Area Air Samples for Aldehydes
John Deere Dubuque Works
John Deere
Dubuque, Iowa
March 15 and 16, 1988

Sample #	Date	Location/ Type/Area	Sampling Time	Sample Volume (Liters)	Concentration mg/M^3
SY 1	March 15	Area/Dept. 20/ Machine 13809	9:17am - 1:35pm	20	None Detected
SY 2	March 15	Area/Dept. 20/ Machine 13805	9:18am - 1:34pm	16	None Detected
SY 3	March 15	Area/Dept. 20/ Machine 13996	9:20am - 1:37pm	18	None Detected
SY 4	March 15	Area/Dept. 19/ Machine 14449	9:38am - 1:42pm	18	None Detected
SY 5	March 15	Area/Dept. 19/ Machine 13953	9:39am - 1:41pm	19	None Detected
SY 6	March 16	Area/Dept. 11/ Machine 14112	7:12am - 1:55pm	25	None Detected
SY 7	March 16	Area/Dept. 11/ Machine 11768	7:19am - 1:59pm	28	None Detected
SY 8	March 16	Area/Dept. 19/ Machine 13953	7:41am - 2:08pm	31	None Detected

Evaluation Criteria — No Criteria
Laboratory Limit of Detection 0.5 ug/sample