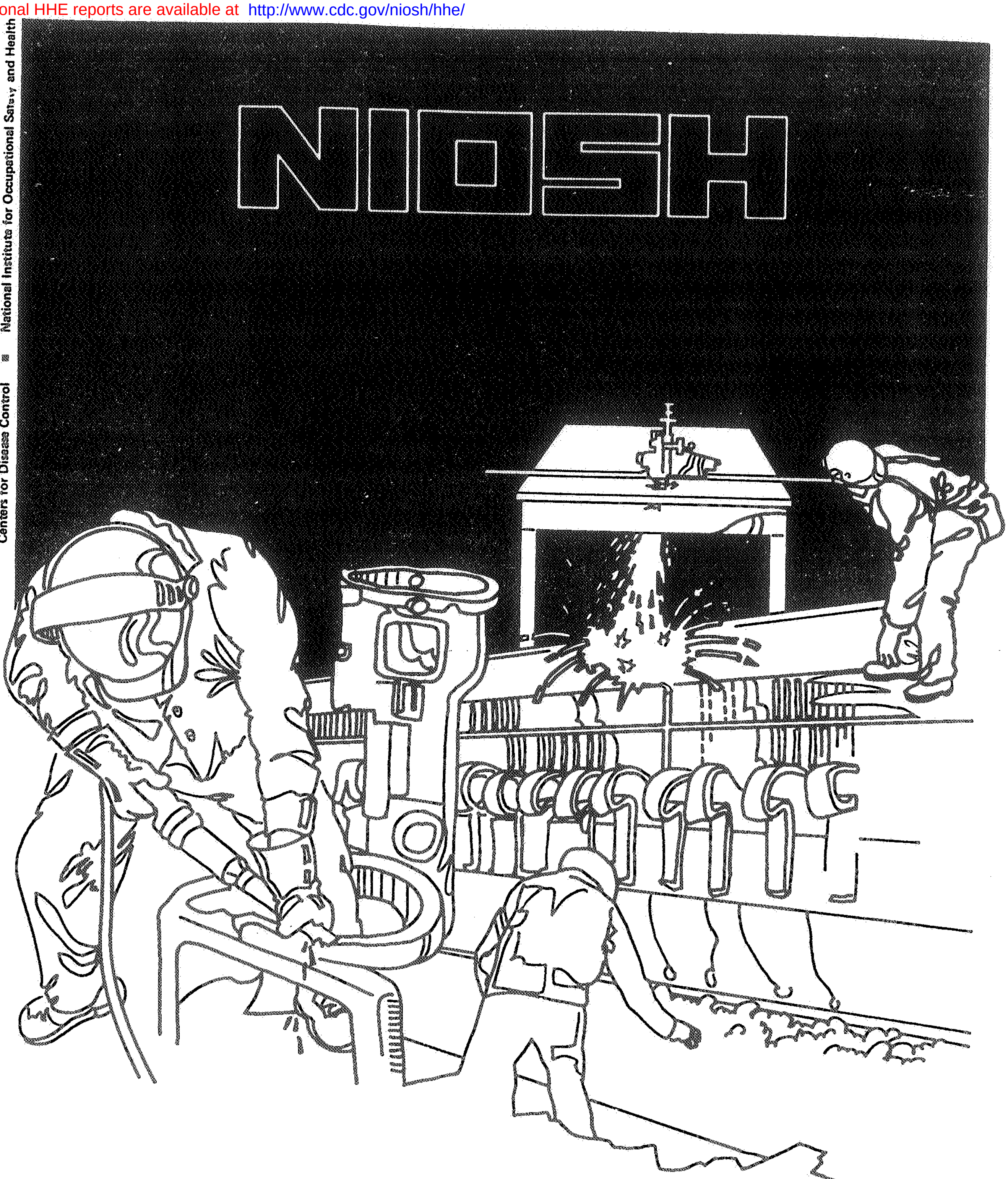
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ▪ Public Health Service
Centers for Disease Control ▪ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 82-037-1120
INDUSTRIAL AND AUTOMOTIVE FASTENERS INC.
ROYAL OAK, MICHIGAN

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.

May 1982
Industrial and Automotive Fasteners Inc.
Royal Oak, Michigan

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I. SUMMARY

On November 9, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the management of Industrial and Automotive Fasteners Incorporated of Royal Oak, Michigan. The request expressed concern over potential thermal decomposition products generated from the use of mineral oil based coolants in the cold forming process of automotive wheel nuts.

The company manufactures unthreaded fasteners (including lug nuts) from coils of carbon steel bar stock in the cold process area. Heat generated during the process results from intermolecular and mechanical friction associated with the physical formation of fasteners. Mineral oil based coolants are poured over the dies and parts during the process. Five operators worked in the area over two shifts.

On January 12-13, 1982 NIOSH investigators conducted a survey involving a walk-through survey of the facility, the collection of environmental air samples and bulk oil samples for the evaluation of thermal decomposition products, and the administration of occupational health questionnaires.

Analyses of bulk oil samples for thermal decomposition products indicated that in addition to a wide range of aliphatic hydrocarbons (containing 9 to 20 carbons), 2-butoxy ethanol (butyl cellosolve), tetrachloroethylene, toluene, and xylene were given off. These last four were present in very small quantities compared to the aliphatic group. Air samples were not quantifiable for 2-butoxy ethanol. Total n-alkanes (straight chain C_9 - C_{20}) had a maximum value of 6.4 mg/m^3. The maximum level of tetrachloroethylene was 1.5 mg/m^3; toluene 0.27 mg/m^3; and xylene 0.81 mg/m^3. NIOSH recommended evaluation criteria are 376 mg/m^3 for toluene; and 435 mg/m^3 for xylene. NIOSH recommends that tetrachloroethylene, considered a potential human carcinogen, should be kept at the lowest levels possible. Detector tube readings for formaldehyde, hydrogen chloride, and sulfur dioxide were all below detection limits. Carbon monoxide concentrations were 7 ppm or less (NIOSH recommended standard is 35 ppm).

Occupational health questionnaire results did not reveal any problems with the process other than occasional burning of the eyes from the "smoke" generated during operation of the cold forming machines.

Based on the results of data obtained during the investigation NIOSH does not consider a health hazard to exist from thermal decomposition products associated with the use of coolants in the cold forming process. Precautions are noted concerning small amounts of tetrachloroethylene found in the more concentrated smoke discharges. No significant health problems were identified. Recommendations for reducing the release of airborne contaminants in the cold process area are presented in Section VII.

KEYWORDS: SIC 3452 (bolts, nuts, screws, rivets, and washers), cold working process, mineral oil, thermal decomposition products, tetrachloroethylene.

II. INTRODUCTION

On November 9, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the management of Industrial and Automotive Fasteners Incorporated in Royal Oak, Michigan to conduct a health hazard evaluation. Specifically, the request addressed concern over potential thermal decomposition products generated from the use of coolants in the cold forming process.

The company had previously requested the Michigan Department of Public Health, Bureau of Environmental and Occupational Health to evaluate oil mists and fumes associated with the cold nut forming process. Sampling results were reported as total particulates. Values for total dust were below 2 milligrams per cubic meter or mg/m^3 (OSHA Standard: 15 mg/m^3).

NIOSH representatives conducted a survey at the plant on January 12-13, 1982 focusing mainly on the cold nut forming area. Employee representation was provided by Local 408 of the United Auto Workers. A letter presenting preliminary results of the analyses of bulk oil samples was transmitted to management and union representatives February 26, 1982.

III. BACKGROUND

Industrial and Automotive Fasteners Inc., a subsidiary of Key Industries, began operating at their present location in 1976. The single story concrete block building was originally built about 1940 and previously had been a tractor assembly plant. The company employs 42 hourly workers, five of which are operators in the cold nut forming area with three on the first (day) shift and two on the second shift.

Industrial and Automotive Fasteners manufactures 17 different wheel nuts for the transportation and automobile industry. Sizes range from 5/16 inch up to 3/4 inch in diameter and include both metric and english system sizes.

The unthreaded nuts or parts are formed from coiled carbon steel bar stock by a process known as cold working. Cold working is defined as the plastic deformation of metals below the metal's recrystallization temperature. The only heat generated in the process results from the intermolecular and frictional heating which occurs from physically forming the nut by passing a cut section of solid bar stock through a series of dies until an unthreaded, pierced part is produced. The parts are then dispensed into a bin either directly or by conveyor. From this point the parts will go to a detergent wash, subsequently will be tapped, and then can be sent out for either plating or heat treating or both. Once the parts are returned to the plant they may be combined with an optional cap (depending on the end use) to produce a more decorative nut. All parts are boxed and shipped from the plant to the purchaser.

The materials used in the cold forming process are coiled bar stock; a mineral oil based cutting oil and a mineral oil based extrusion oil - either of which is poured over the parts and dies as a coolant and lubricant during the forming process; and stoddard solvent for machine and die cleaning.

Four Smog-Hog® electronic air cleaners are present in the cold forming area. Six of the twelve cold forming machines are connected by ductwork to the air cleaners. Cold-nut-formers #4 and #2 each are connected to separate Smog-Hogs® while cold-nut-former #10 and part former #9 share one unit as do part-former #14 and nut-former #11. The difference between the nut and part formers is the number of dies they use and their capabilities. The remaining six cold forming machines do not have any local exhaust. There are also three large man-cooler fans in the area and one large ceiling fan located between nut-formers #3 and #6.

IV. METHODS AND MATERIALS

A. Industrial Hygiene

A walk-through survey of the process was conducted with an emphasis on the cold forming area. Air samples for collection of airborne contaminants associated with the thermal decomposition of coolants were obtained using charcoal and porous polymer sorbent tubes. These samples were compared with thermal decomposition products generated in the laboratory from bulk oil samples of the fresh extrusion and cutting oils.

The air samples were obtained in three locations with both sorbent tubes located side by side. One set of samples was obtained on machines using extrusion oil as a coolant; one set on a machine using cutting oil; and one set located between the two operating units using the two oils. The first two sets of samples were taken directly in the mist plume coming off of the machines and parts.

The discharge temperatures of parts as they were ejected from the units were obtained with the use of digital thermometer with a beaded wire probe, reading from the 0-2000°F scale. This was undertaken to determine the temperature range of interest for the bulk oil analyses. The probe was placed directly in contact with the parts at the nearest accessible discharge point after being ejected from the dies.

Following discussions with laboratory chemists a decision was made to limit the thermal decomposition analyses to the fresh bulk oil samples. Analysis of these samples instead of the used oil samples permitted evaluation of additional compounds coming off of the oils during their initial heating which may not appear in previously heated oil samples due to the elimination of the more volatile initial components.

1. Bulk Oils

Approximately 100 microliters (uL) of bulk oil was put into a glass U-tube and immersed in a hot wax bath heated at 170°-200°C (338-392°F). Air was passed into the U-tube at one end (100-300 cubic centimeters/minute), over the heating oil, and through a solid sorbent (2 charcoal or porous polymer tubes in series) positioned at the opposite end to trap organics. The generated charcoal samples were desorbed with carbon disulfide (CS_2) and the porous polymer tubes with acetone and then screened by gas chromatography (Flame Ionization Detector). Twenty-five meter methyl silicone fused silica capillary columns were used for all gas chromatography (GC) and GC/mass spectroscopy (MS) analyses. Since the same components were detected on both sorbents, only the CS_2 desorbed charcoal samples were further analyzed by GC/MS. The acetone desorbed porous polymer samples were later reanalyzed using the GC/microwave plasma detector, monitoring the carbon, hydrogen, oxygen, chlorine, and sulfur channels. No oxygen, sulfur, or chlorine compounds (other then perchloroethylene) were indicated by this technique.

2. Solid Sorbents-Air Samples

Charcoal samples were desorbed with 1 milliliter (mL) CS_2 spiked with 0.1% n-propyl benzene as an internal standard. Porous polymer samples were desorbed with 1 mL of acetone spiked with 0.1% n-propyl benzene. Both were analyzed by GC (FID) using the same column as described above.

3. Detector Tubes-Air Samples

Direct reading indicator tube measurements for formaldehyde, sulfur dioxide (SO_2), hydrogen chloride (HCl), and carbon monoxide (CO) were obtained at the sorbent tube sampling locations.

B. Medical

Non-directed occupational health questionnaires regarding whether workers had any current or past health problem they considered to be related to their work along with a description were administered to 12 employees; five of which were the current operators in the cold-nut forming area and seven employees from other areas in the plant.

V. EVALUATION CRITERIA

The criteria used in evaluating the documented environmental levels of chemical contaminants are obtained from the following sources: NIOSH recommended occupational exposure criteria; the American Conference of Governmental Industrial Hygienists (ACGIH) recommended Threshold Limit Values; and the Occupational Safety and Health Administration's (OSHA) General Industry Standards 26 CFR 1910:1000. Table I presents in summary form the applicable environmental criteria and the health effects associated with overexposures.

VI. RESULTS

A. Industrial Hygiene

The laboratory analyses of the emissions generated by heating both the extrusion oil and the cutting oil resulted in a large collection of straight chain aliphatic hydrocarbon peaks ranging from a chain length of nine to twenty. Other components identified were toluene, tetrachloroethylene, xylene, and butyl cellosolve (2-butoxy ethanol). No oxygen, sulfur, or chlorine were indicated as being present (other than tetrachloroethylene).

Values for toluene, tetrachloroethylene, xylene, and butyl cellosolve on the charcoal and porous polymer tube process samples were very low. Detector tube readings for formaldehyde, sulfur dioxide and hydrogen chloride were below the tubes limits of detection. Carbon monoxide values were detectable but low.

Representative gas chromatograms identifying the components of emissions coming off of Cadco 360 Cutting Oil, containing mineral oil and sulfurized fat; and Cadco Extrusion Oil 03A-164B, reported to contain mineral oil, chlorinated paraffins, and sulfurized fat are presented in Figure 1. Figure 2 presents a gas chromatogram representative of all the charcoal tube air samples. The two figures demonstrate the difference between controlled laboratory sampling directly over the heated oils and conditions at the machines. Other aliphatics and branched alkanes which may be present but could not be identified are cycloalkanes and/or olefins and alkyl substituted benzenes having three and four carbon chain substituents (aromatic compounds having a molecular weight 120 and 134). Below is a summary of the air sample results for both charcoal tubes and detector tubes:

Contaminant	Maximum Concentration*	Sample Type**	Notes
2-Butoxy ethanol	< 2.1 mg/m^3 (10ppm).	CT	Detected but not quantifiable
Carbon monoxide	8 mg/m^3 (7ppm)	DT	Grab sample in emission plume
Formaldehyde	< 0.6 mg/m^3 (0.5ppm)	DT	Grab sample in emission plume

Hydrogen chloride	< 0.8 mg/m^3 (0.5ppm)	DT	Grab sample in emission plume
Sulfur dioxide	< 2.6 mg/m^3 (1ppm)	DT	Grab sample in emission plume
Tetrachloroethylene	1.5 mg/m^3 (0.2ppm)	CT	Sampling emission plume at machine
Toluene	0.27 mg/m^3 (0.07ppm)	CT	Sampling emission plume at machine
Xylene	0.87 mg/m^3 (0.2ppm)	CT	Sampling emission plume at machine
Total n-alkanes	6.4 mg/m^3***	CT	Sampling emission plume at machine

* Values given in milligrams per cubic meter (mg/m^3) with parts per million (ppm) given in parentheses. Less than values (<) are given as environmental limits of detection for the specified samples.

** CT is a charcoal tube sample several hours in duration; DT is detector tube grab sampling. See Table II for specific sample data.

*** No specific molecular weight for conversion to ppm as entry represents all straight chain aliphatics.

The results of samples by location are presented in Table II and III.

An additional source of workers exposure to solvents and solvent vapors in the cold process area was the presence of open pails containing stoddard solvent adjacent to each machine. These were used for degreasing parts during maintenance and die setting. Workers were observed to place their unprotected arms and hands into the buckets to clean or retrieve parts. Use of gloves or barrier creams was not observed.

B. Medical

There were no consistent abnormalities reported for the group as a whole, however, two persons reported slight hearing losses. Additionally, two persons reported occassionally experiencing burning eyes from the "smoke" associated with operating the cold nut forming machines.

Ten of the twelve persons interviewed expressed concern about the excess amount of smoke that is frequently in the plant and questioned whether they would develop ill health effects from long-term exposure.

VII. DISCUSSION AND CONCLUSIONS

The bulk oil analyses reflect the basic mineral oil composition of the coolants in use in the cold forming process. A comparison of Figures 1 and 2 reflects the difference in sampling conditions. Essentially the two bulk oil chromatograms represent the contaminants generated and captured directly above an oil sample under controlled laboratory conditions at a temperature range of 338 to 392°F. While these temperatures are higher than those of the parts for which a temperature was obtained (maximum of 290°F) it must be noted that the distance and elapsed time from the point at which coolant oil is applied to the parts in the dies to the point at which parts are accessible for a temperature measurement permits cooling of the part. Figure 2 is a representative chromatogram of the air samples obtained on charcoal tubes placed in the mist and vapor coming off of the machines. The difference reflects both increased dilution of contaminants and decreasing temperatures of the residual oil which results in fewer and smaller peaks (due to less vaporization of the oils' components) on the air sample.

The conditions under which these samples were collected necessitates some discussion before stating that the work up done on thermal decomposition products associated with the coolants in use do not appear to be a problem. None of the cold forming machines sampled was connected to a Smog-Hog® oil mist collection system, thus one would consider the process samples as representative of the six units without local exhaust emission systems (other than enclosure) and potentially the units having the greatest amount of emissions into the work place. However, note that none of the machines on which samples were taken was in operation for the entire four hour sampling period. Additionally the sample obtained on a non-operating machine located between those that were operating demonstrates negligible levels of the contaminants evaluated. These values may be low if addressing thermal decomposition contaminant levels considered to represent the general cold process area, due to the fact that initially only four of the twelve machines in the area were operating at the time sampling began and only two units were in operation when sampling was terminated. Thus reduced operating levels, reflecting current market conditions, would not produce a situation which could be considered representative of a worst case situation for the entire area.

Workers reported that when a larger number of the cold forming machines were operating there would be a substantial amount of smoke in the area. This accumulation of smoke and vapor is considered very likely, especially when additional units not connected to the oil mist reclamation and suppression systems are operating. General ventilation is limited in the area to one ceiling fan and three man coolers. Windows located along the west side could be opened during warmer weather.

Observations of operators in the area revealed that a minimum amount of time was spent at the locations where process samples were taken. Operator's exposures would more reasonably resemble the general area sample (considering the previous discussion of the area sample).

The presence of tetrachloroethylene as a decomposition product released into the work area should be noted. The reason for its appearance in both oils (which includes the one without chlorinated hydrocarbons - Cadco 360®) is not apparent. NIOSH consideration of tetrachloroethylene as a potential human carcinogen, based on National Cancer Institute studies showing it to be a liver carcinogen in animals, recommends that exposure to this material be minimized as much as possible. Based on the information obtained from the process samples and bulk samples, the operators would not generally be considered as having exposure to tetrachloroethylene.

The results of process air and bulk oil samples do not present any serious or potentially serious health hazards due to heating of the oils (with the exception of tetrachloroethylene exposures). The issue of a build-up of contaminants in the area during higher levels of production could not be addressed due to the reduced level of operation, however, the question of what chemical compounds are coming off the oils upon heating has provided information on potential work place contaminants in the cold process area.

VIII. RECOMMENDATIONS

1. Machines connected to electrostatic precipitators released much less mist into the workroom than adjacent machines. The company's expressed intention of acquiring additional units for the remaining machines is encouraged. However, these units should not be considered applicable to gases or vapors generated by the process. Additionally, enclosure of discharge chutes and collection bins with appropriate access ports would help reduce the release of oil mist, especially for machine areas remotely located from the exhaust system takeoff.

2. Additional monitoring of operators during higher production levels is recommended, especially when addressing the presence or absence of worker exposure to the solvents mentioned, and specifically tetrachloroethylene. If significant worker exposures to tetrachloroethylene is found, investigation into possible substitutes for the oils currently in use may be undertaken. Substitute oils considered for use should be evaluated according to their application including an assessment of thermal decomposition products at operating temperatures. Some components to avoid in selecting substitute oils are nitrites and amines as well as chlorine. Caution in selection is necessary to avoid the unintentional replacement of one hazard with another.

3. Stoddard solvent used for degreasing parts and equipment in the cold process area should be contained in small safety cleaning tanks which can be covered to reduce solvent loss when not in use. They are also equipped with fusible-links permitting self extinguishing of contents if the solvent should ignite, and drain

baskets for cleaning small parts are available. This would eliminate the necessity of workers placing their unprotected hands and arms into the tanks to retrieve parts. Use of barrier creams by workers to protect against solvents and oils is not as effective as gloves but may offer some protection against solvents, providing the creams are properly selected and used correctly.

IX. REFERENCES

1. National Institute for Occupational Safety and Health (NIOSH)/Occupational Safety and Health Administration (OSHA) pocket guide to chemical hazards. Cincinnati; OH: National Institute for Occupational Safety and Health, 1978. (DHEW(NIOSH) publication no. 78-210).

2. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1981. Cincinnati, Ohio: ACGIH, 1981.

3. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.1000. Occupational Safety and Health Administration, revised 1980.

4. National Institute for Occupational Safety and Health (NIOSH) current intelligence bulletin 34: formaldehyde; evidence of carcinogenicity. Cincinnati; OH: National Institute for Occupational Safety and Health, April 25, 1981. (DHHS(NIOSH) publication no. 81-111).

5. National Institute for Occupational Safety and Health (NIOSH) current intelligence bulletin 20: tetrachloroethylene: Rockville, MD: National Institute for Occupational Safety and Health, January 20, 1978. (DHEW(NIOSH) publication no. 78-112).

6. National Institute for Occupational Safety and Health. Occupational diseases: a guide to their recognition. Revised ed. Cincinnati, OH: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) publication no. 77-181).

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, 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. Management, Industrial and Automotive Fasteners, Inc.
2. United Auto Workers - Local 408
3. International United Auto Workers Union
4. NIOSH, Region V
5. OSHA, Region V

For the purpose of informing the five 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 I

Evaluation Criteria and Health Effects Summary
Industrial and Automative Fasteners Incorporated
Royal Oak, Michigan
HETA 82-037

CONTAMINANT	RECOMMENDED EXPOSURE LIMIT mg/m³(ppm)[1]	SOURCE	OSHA STANDARD mg/m³(ppm)[1]	HEALTH EFFECTS[2] SYMPTOMS	TARGET ORGANS
2-Butoxy ethanol* (butyl cellosolve)	120(25)	ACGIH	240(50)	Eye, nose, throat irritant; hemolysis hemoglobinuria	Liver, kidneys, lymphoid system, skin, blood, eyes, respiratory system
Carbon monoxide	40(35)	NIOSH	55(50)	Headache, rapid breathing nausea, weakness, dizziness confusion; cyanosis; angina; syncope	Cardio vascular system, lungs, blood, central nervous system
Formaldehyde	See note 3	NIOSH	3.7(3)	Eye, nose, throat irritant; cough; pulmonary irritant; dermatitis; nausea	Respiratory system, eyes, skin. Animal carcinogen (nasal)
Hydrogen chloride	7(5)C[4]	ACGIH	7(5)C	Inflammation, ulceration of nose, throat; cough, burning throat, choking; burn eyes, skin; dermatitis	Respiratory system, skin, eyes
Stoddard solvent	350(60)	NIOSH	2950(500)	Eye, nose, throat irritation; dermatitis	Skin, eyes, respiratory system, central nervous system
Sulfur dioxide	1.3(0.5)	NIOSH	13(5)	Eye, nose, throat irritant; choking, cough, reflex bronchoconstriction, eye, skin burns	Respiratory system, skin, eyes
Tetrachloroethylene* (Perchloroethylene)	339(50) See note 5	NIOSH	678(100)	Eye, nose, throat irritation; nausea; flushing of face, neck; dizziness, incoherent, headache; somnolence, erythemia	Liver, kidneys, eyes upper respiratory system, central nervous system; [illegible]mal carcinogen (liv[illegible]

TABLE I (continued)

Evaluation Criteria and Health Effects Summary
Industrial and Automative Fasteners Incorporated
Royal Oak, Michigan
HETA 82-037

CONTAMINANT	RECOMMENDED EXPOSURE LIMIT mg/m^3(ppm)[1]	SOURCE	OSHA STANDARD mg/m^3(ppm)[1]	HEALTH EFFECTS[2] SYMPTOMS	TARGET ORGANS
Toluene*	376(100)	NISOH	751(200)	Fatigue, weakness; confusion, dizziness, headache; dilated pupils, lacrimation; nervousness, muscle fatigue; dermatitis	Central nervous system, liver, kidneys, skin
Xylene*	435(100)	NIOSH	435(100)	Dizziness, incoherent, staggering gait; eye, nose, throat irritation; anorexia nausea, abdominal pain;	Central nervous system, eyes, gastro intestinal tract, blood, liver, kidney skin
n-Alkanes, total	--	--	--	Narcosis; skin, mucous membrane irritant; dermatitis	Central nervous system, skin, respiratory system[6]

* Designates compounds having potential contribution to the overall exposure by the cutaneous (skin absorption) route including mucous membranes and eye.

Notes:
1. Concentrations given in milligrams per cubic meter (mg/m^3) and parts per million (ppm).
2. NIOSH/OSHA Pocket Guide to Chemical Hazards.
3. NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen, based on animal studies. No exposure level is recommended due to the absence of demonstrated safe levels of exposure to carcinogens. NIOSH Current Intelligence Bulletin 34, April 15, 1981.
4. C indicates value is a ceiling limit which should not be exceeded.
5. NIOSH recommends that tetrachloroethylene be handled in the workplace as a potential occupational carcinogen based on animal studies showing it to be a liver carcinogen. NIOSH Current Intelligence Bulletin 20, 1978.
6. Data for alkanes from Occupational Diseases; A guide to their recognition.

TABLE II

Long Term Process Sample Results in the Cold Process Area
Industrial and Automotive Fasteners Incorporated
Royal Oak, Michigan
HETA 82-037

January 12, 1982

SAMPLE LOCATION	MACHINE NO.	OIL COOLANT	MEASURED PART TEMP	SAMPLE DURATION	CONTAMINANT CONCENTRATION[1]				
					2-BUTOXY ETHANOL	TETRACHLOROETHYLENE	TOLUENE	XYLENE	TOTAL n-ALKANES[4]
In "smoke" plume coming off of parts	7(9)[2]	Extrusion oil 03A-164B	240-290°F (115-143°C)	261min	< 2.0[3] mg/m3	1.5 mg/m3	0.23 mg/m3	0.87 mg/m3	6.4 mg/m3
In "smoke" plume part discharge chute	3[5]	Cutting oil 360	340-360°F (171-182°C)	255min	< 2.1mg/m3	1.1 mg/m3	0.27 mg/m3	0.80 mg/m3	3.4 mg/m3
On non-operating	12	--	--	247 min	< 2.1 mg/m3	N.D.[6]	0.21 mg/m3	0.76 mg/m3	3.0 mg/m3
Calculated Environmental Limit of Detection:						1.0 mg/m3	0.21 mg/m3	0.21 mg/m3	0.52 mg/m3
Evaluation Criteria[7]					120 mg/m3	*6	376 mg/m3	435mg/m3	--

1. Concentrations given in mg/m3.
2. Samples moved from machine 7 to machine 9 after 164 minutes. Both machines used extrusion oil.
3. Values for 2-butoxy ethanol were not quantifiable at the amounts present in the samples. Values indicated are the environmental limit of detection.
4. Various other aliphatics (branched alkanes, cycloalkanes, etc.. and higher aromatics present are not included in these values.
5. Machine 3 did not operate during the last 90 minutes of the sampling period.
6. N.D. = none detected
7. See Table I. NIOSH recommends tetrachloroethylene levels be kept as low as possible and that it be treated as a potential human carcinogen.

TABLE III

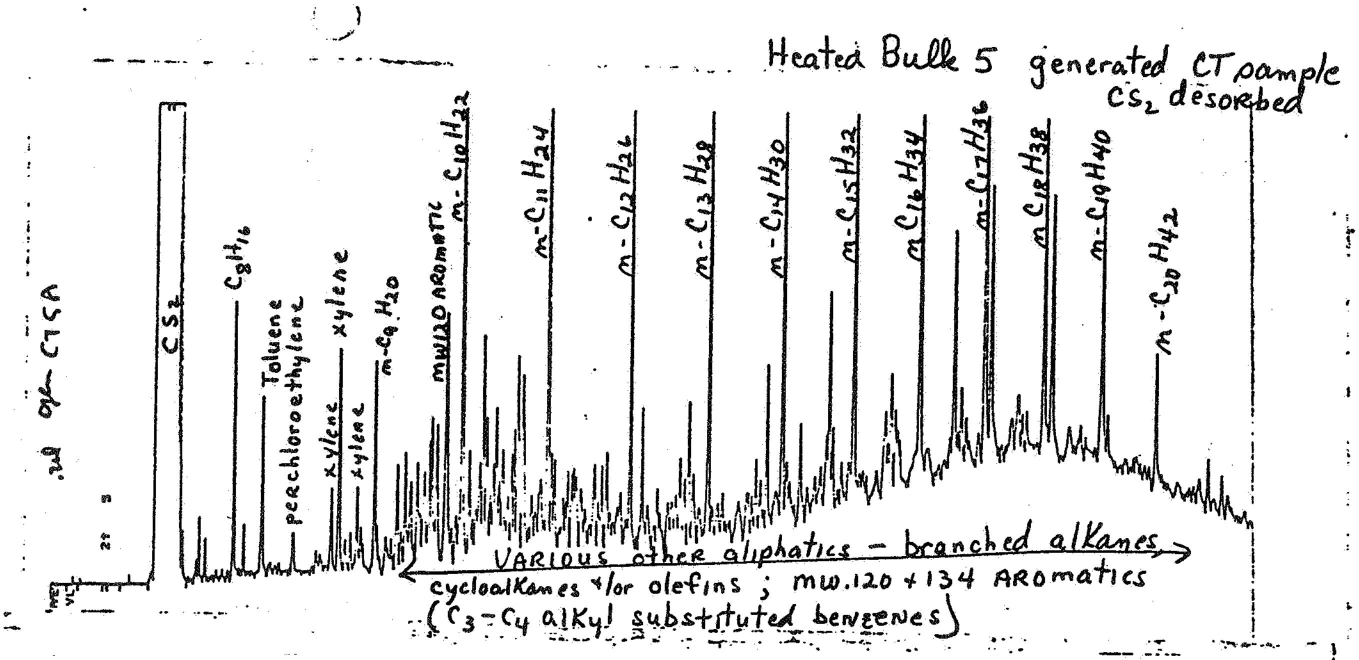
Grab Sample Indicator Tube Readings in the Cold Process Area
Industrial and Automotive Fasteners Incorporated
Royal Oak, Michigan
HETA 82-037

January 12, 1982

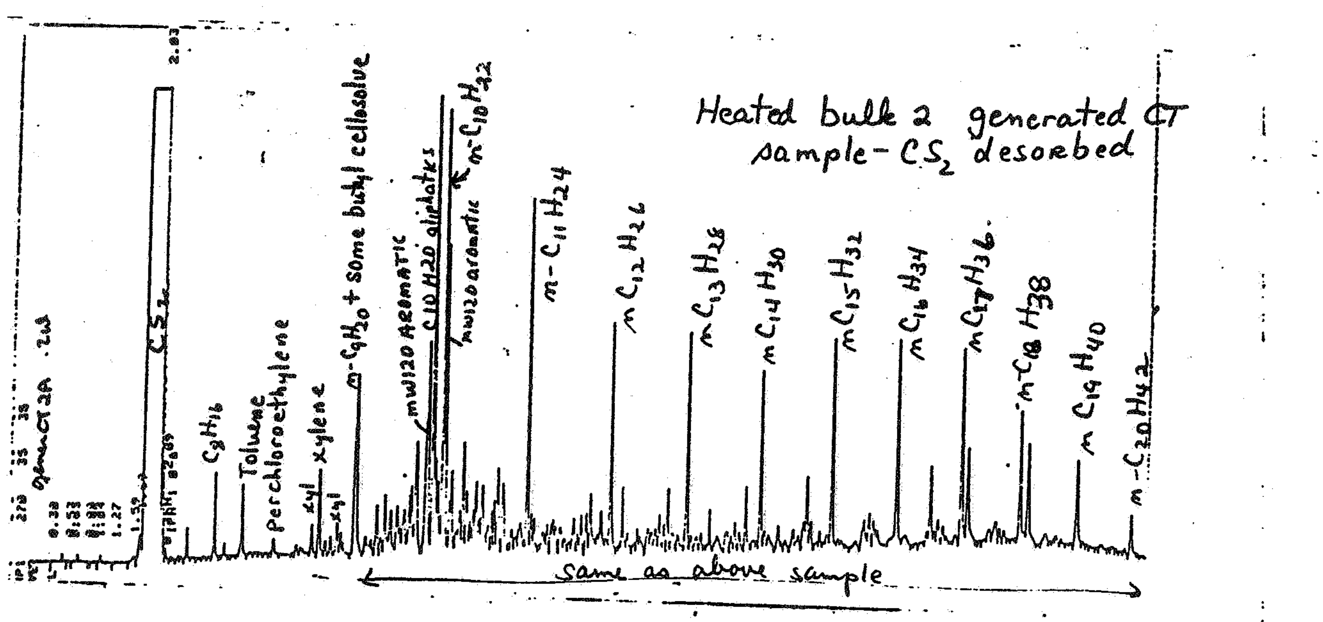
SAMPLE LOCATION	MACHINE NO.	OIL COOLANT	CONTAMINANT[1] CARBON MONOXIDE	FORMALDEHYDE	HYDROGEN CHLORIDE	SULFUR DIOXIDE
See "smoke" plume coming off of parts	9	Extrusion oil 03A-164B	7 ppm	< 0.5 ppm[2]	< 0.5 ppm	< 1 ppm
In "smoke" plume at part discharge chute	3	Cutting oil 360	7 ppm	< 0.5 ppm	< 0.5 ppm	< 1 ppm
On non-operating machine between above two units	12	---	5 ppm	< 0.5 ppm	< 0.5 ppm	< 1 ppm
Evaluation Criteria[3]			35 ppm	---	5 ppm	0.5 ppm[4]

1. Concentrations given in parts per million (ppm).
2. For contaminant values with a less than sign (<), concentrations of the compound, if present, were below the detectable limits of the indicator tube used.
3. See Table I.
4. No sulfur containing compounds coming off of the oils were detected using the GC/microwave plasma detector (See Section V.)

GAS CHROMATOGRAMS FOR THERMAL DECOMPOSITION
PRODUCTS FROM HEATING OF MINERAL OIL BASED LUBRICANTS
Industrial and Automotive Fasteners
Royal Oak, Michigan
HETA 82-037



Cadco 360 Cutting Oil



Cadco Extrusion Oil 03A-164B

REPRESENTATIVE GAS CHROMATOGRAM FOR COLD NUT FORMING
PROCESS SAMPLES OBTAINED ON CHARCOAL TUBES
Industrial and Automotive Fasteners
Royal Oak, Michigan
HETA 82-037

January 12, 1982