HEALTH HAZARD EVALUATION REPORT 72-35-34
HAZARD EVALUATION SERVICES BRANCH
DIVISION OF TECHNICAL SERVICES

Establishment : The Budd Company
Automotive Division
Clinton, Michigan

Report Prepared By : Raymond L. Hervin, Project Officer
Regional Industrial Hygienist
Region VII
Kansas City, Missouri

James Lucas, M.D., Medical Officer
Medical Services Branch
Cincinnati, Ohio

Other NIOSH Participants : Raymond L. Ruhe, Industrial Hygienist
Hazard Evaluation Services Branch
Division of Technical Services
Cincinnati, Ohio

Robert E. Rosensteel, Industrial Hygienist
Hazard Evaluation Services Branch
Division of Technical Services
Cincinnati, Ohio

Originating Office : Jerome P. Flesch
Chief, Hazard Evaluation Services Branch

March 1973

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION REPORT 72-35-34
THE BUDD COMPANY
AUTOMOTIVE DIVISION
CLINTON, MICHIGAN

MARCH 1973

I. SUMMARY DETERMINATION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees to evaluate the potential hazards associated with the use of cutting oil coolants (mineral oil/water based) which are utilized in drilling, milling, grinding, and other machining operations in the production of automobile and disc brakes at The Budd Company, Automotive Division Plant at 11700 Tecumseh Road, Clinton, Michigan.

A NIOSH investigator conducted an observational survey of this facility on June 27, 1972. It was concluded, based upon information obtained at that time that the potential hazards to which workers were exposed were primarily from direct contact with the mineral oil coolants, mineral oil mists from the machining operation, and noise; with secondary considerations concerning the use of organic solvents, ozone, total dust, iron, and heat. Hence, a more complete evaluation of the working environment and a medical evaluation of employees would be necessary to complete the investigation.

A medical evaluation and interviews with employees were conducted on August 29-30, 1972. Of those twenty-five (25) employees examined, 40% were noted to have varying degrees of dermatitis with 90% of these workers exhibiting typical lesions consistent with cutting oil dermatitis (oil acne and folliculitis). All cases of dermatitis were confined to those operations and areas which utilize the mineral oil coolant designated as MS-105. The medical-environmental team do not feel that the use of a different oil-based coolant would contribute to any significant reduction in the cutting oil dermatitis problem. A review of medical records confirmed a history of dermatitis within

the plant, although the frequency was less than found at the time of our evaluation. Reviews of records and interviews with employees concerning respiratory tract symptoms were also accomplished and no pattern suggesting an occupationally associated respiratory problem was ascertained. There was no evident symptomatology suggesting toxic exposure to the organic vapors, total dust, iron, ozone, or heat.

An environmental survey was conducted on August 29-31, 1972. All air sample results based on an estimated 8-hour time weighted exposure show that no airborne concentrations individually or combined exceeded the established health standards (Federal Register, Part II, §1910.93, Tables G-2, 2, and 3, Individual Standards, and Part II, §1910.93(d)(2)(i)-Combined Standards) promulgated by the U.S. Department of Labor to prevent toxic effects characteristic of such substances.

Eighty (80) air samples were collected and 230 analytical determinations made to complete the environmental survey. Of primary importance and consideration are the results obtained in the survey of those operations which involve the use of Budd Company's coolant Specification No. MS-105 which is a mineral oil emulsion in water. The sample results for the operations and areas where MS-105 are used show concentrations of oil mists collected by personal samples to vary from 10-80 percent of the Federal health standard of 5 mg/M^3 with an average of 40 percent. Such concentrations are not considered hazardous for inhalation. However, it is apparent that such concentrations do result in oil mists coating various surfaces (e.g. machines, metal, rafters, etc.) and hence, contributing to the dermatitis problem. The results of the air samples for mineral oil mists in other operations and areas were less than (about 50%) those where MS-105 coolants were in use. Sample results for other airborne contaminants did not show concentrations which could be considered hazardous to the employees and are summarized below.

1. All total dust concentrations were less than 30 percent of the health standard of 15 mg/M^3.

2. All iron concentrations were less than 1 percent of the health standard of 10 mg/M^3.

3. Operations involving organic solvents in the truck assembly paint booth operations and Dowclean or Visic-Tool operations involve health standards of 1,900 mg/M^3 for 1,1,1-Trichloroethane, 670 mg/M^3 for Tetrachloroethylene, 750 mg/M^3 for Toluene and 435 mg/M^3 for Xylene.

The effects are additive and the combined results for the paint spray booth operation were less than 2 percent of the health standard, and for the Dowclean operations less than 50 percent of the combined health standards.

4. Ozone concentrations in and around the Ozone Generator were less than 50 percent of the health standard of 0.2 mg/M^3.

Based upon the results of the medical-environmental study reported above, it is our determination that a hazard to the health of workers does exist from exposure to operations involving mineral oil coolant designated as MS-105 which results in varying degrees of dermatitis. A number of recommendations have been submitted to management to correct the observed and potential hazards to the approximately 170 exposed employees. It is also our determination that a hazard to the health of workers does not exist from the use of organic solvents in the paint booth operation and the organic cleaning solution; ozone and airborne total dust and iron.

Weighted exposures of employees to noise levels were not made during the survey. However, sound levels measured in several of the machining areas exceeded the Federal Standard for noise exposure of 90 dBA for 8-hour continuous exposure. Exposure to excessive noise levels can produce permanent hearing loss in man. Recommendations in the area of noise have been suggested to management to obviate the observed hazard to the affected employees. Heat measurements at the time of the survey did not indicate that exposure of employees to heat was a problem area.

Copies of this Summary Determination as well as the Full Report of the evaluation are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th & Walnut Streets, Cincinnati, Ohio 45202. Copies of both have been sent to:

a) The Budd Company - Automotive Division
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region V

For purposes of informing the approximately 170 exposed employees, the employer will promptly "post" the Summary Determination in a prominent place(s) near where affected employees work for a period of 30 calendar days.

II. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees of The Budd Company, Automotive Division, 11700 Tecumseh Road, Clinton, Michigan.

The request states that the primary hazard to be evaluated concerned the exposure of employees to Budd Company Specification MS-105 a mineral oil based coolant which is used in copious quantities in the machining of rough iron castings which are received and include various grinding, milling, boring, and drilling operations. These machining operations are highly automated and huge amounts of cutting oil coolants are utilized. The plant exclusively produces disc brakes for automotive and truck assemblies. Only the drum portion of the brake is produced. Subsequent discussions indicated that exposure of employees to total dust, iron, ozone, organic solvents, noise and heat are of substance but lesser significance from an employees standpoint.

There are a total of 336 employees at the plant of which about 290 are involved in the production areas. There are 3 shifts for 5 days a week, but only about 20 custodial employees are present during the graveyard shift.

III. BACKGROUND HAZARD INFORMATION

A. Standards

The Occupational Health Standards as promulgated by the U.S. Department of Labor (Title 29 Code of Federal Regulations, Chapter XVII, Part 1910, Subpart 1910.93, entitled "Air Contaminants") applicable to substances of this evaluation are as follow:

Substance	Eight Hour Time-Weighted Concentration	
	p.p.m.[a]	mg/M^3 [b]
Oil Mist, mineral	---	5[c]
Iron-Fe (as Iron Oxide)	---	10
Total Dust (Inert or Nuisance Dust)		15
1,1,1-Trichloroethane (Methyl Chloroform)	350	1,900
Tetrachloroethylene (Perchloroethylene)	100[d]	670
Toluene	200[e]	750
Xylene	100	435
Ozone	0.1	0.2

a. Parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm Hg pressure.

b. Approximate milligrams of compound per cubic meter of air.

c. As sampled by method that does not collect vapor.

d. Tetrachloroethylene also has a health standard of an acceptable ceiling concentration of 200 p.p.m., and acceptable maximum peak above acceptable ceiling concentration for an 8-hour shift of 300 p.p.m., for 5 minutes in any 3 hours.

e. Toluene also has a health standard of an acceptable ceiling concentration of 300 p.p.m., and acceptable maximum peak above acceptable ceiling concentration for an 8-hour shift of 500 p.p.m., for 10 minutes in any 8 hours.

B. Toxic Effects

Oil Mist, mineral: The primary effects of cutting oils and coolants are upon the skin and dermatitis remains a common problem among workers in machining operations. Oil acne and folliculitis result basically from mechanical blockage of the follicular openings in skin contact areas. This results in comedones (blackheads) and papular lesions (pimples) associated with varying degrees of inflammation. THUS, THE PROCESS IS PRIMARILY MECHANICAL IN NATURE AND NOT DUE TO THE PRESENCE OF BACTERIA IN COOLANT FLUIDS OR THE INFREQUENT CHANGING OF COOLANT FLUIDS. In fact, when oil acne occurs, it would occur even if the cutting oil and biocide were changed on a daily basis. While it is true that cutting oils and coolants may contain large numbers of micro-organisms which may cause oil rancidity, these organisms are nearly always non-pathogenic and incapable of causing infection. In occasional cases, secondary infection of the primary lesions of oil folliculitis have been observed and in such cases, the patient's own skin or nose is the source of the offending agent.

The health standard for oil mist (mineral) of 5 mg/M^3 refers to airborne mist of petroleum-base cutting oils or white mineral petroleum oil. Experimental findings indicate that heat-decomposed oil fumes are irritant but apparently do not result in even relatively minor changes in the lungs at 5 mg/M^3 . Theoretically, the inhalation of extremely high levels of oil mists could result in lipid pneumonitis. This has not been reported to be a problem in industry.

Iron-Fe (as Iron Oxide): Iron and iron salts are generally considered to be of low orders of toxicity and are essential constitutents of the human body. These needs are met by dietary intake. Excessive ingestion seldom results in toxicity since absorption from the gastrointestinal tract is limited to body needs. However, the inhalation of FeO3 particulates eventually result in a benign pneumoconiosis (siderosis) manifested solely by radiographic stippling of the lungs. This occurs most commonly in electric-arc welders, silver polishers and other rouge users. This condition results in few, if any, symptoms and causes no disability.

Total Dust (Inert or Nuisance Dust): Nuisance dusts have little adverse effects on the lungs and do not produce significant disease or toxicity when exposures are kept under reasonable control. These dusts are biologically inert in that when inhaled the architecture of the alveoli remains intact; little or no scar tissue

is formed; and any reaction provoked is potentially reversible. Excessive concentrations in workroom air may reduce visibility, cause unpleasant accumulations in the eyes, ears, or nose and secondarily cause injury to the skin due to the vigorous cleansing procedures necessary for their removal.

1,1,1-Trichloroethane (Methyl Chloroform): Methyl Chloroform is a widely used chemical intermediate and solvent. Physiologically it acts as an anesthetic and causes depression of the central nervous system (somnolence, incoordination, semiconsciousness, coma). It has essentially no capacity to produce chronic injury from either single or repeated exposures.

Tetrachloroethylene (Perchloroethylene): There have been relatively few instances of serious illness or death as a result of exposure to this substance. The most important effects of vapor inhalation are anesthesia and primary irritation of the eyes, nose, and skin. In common with many chlorinated solvents, overexposure to Perchloroethylene may sensitize the heart, predisposing it to the development of serious or even fatal rhythym disturbances. Furthermore, persons with definite liver, renal, cardiac, or neurologic disease should not be placed at work where there may be substantial repeated exposures. The anesthetic effects of the chemical begin at concentrations of around 200 p.p.m., and manifests itself as loss of judgment and mental acuity and as concentrations increase, feelings of lightheadedness, dizziness, and lack of coordination may be noticed. The chemical may cause irritation of the skin and mucous membrane by prolonged or repeated contact. The maximum exposure to Perchloroethylene is 200 p.p.m., and it is believed that the standard of 100 p.p.m., will prevent serious narcotic effects.

Toluene: Toxicity--this agent is well known for its powerful narcotic effects. Acute exposure to 200 p.p.m., for 8 hours produces mild fatigue, confusion, and paresthesias of the skin. At 300 p.p.m., for 8 hours, symptoms are more pronounced. At 600 p.p.m., for 3 hours, mental confustion is prominent and nausea, headache, dizziness occur, pupils dilate and accommodation is impaired. Effects at this concentration persisted for hours and subjects complain of insomnia, fatigue, and nervousness on the second day postexposure. Industrial experience fails to provide evidence for standard below 200 p.p.m., on the basis of irritative and narcotic effects in workers exposed at or near this concentration.

Xylene: Toxicity is similar to Toluene although it is more pronounced with symptoms including headache, fatigue, lassitude, irritability, and gastro-intestinal disturbances such as nausea, annorexia, and flatulence. The standard of 100 p.p.m., is recommended to prevent irritant and narcotic effects. It is believed that no significant chronic injuries will result from continued occupational exposure at this level.

Ozone: Ozone is a powerful irritant. The symptoms associated with exposure to ozone include eye, nasal and throat irritation, fatigue, headache, vertigo, and chest discomfort. Exposure to high concentrations may result in pulmonary edema and death.

Physical Agents:

Noise: Prolonged exposure to noise levels over 90 dBA encountered in industrial environments can produce permanent hearing loss. There is no known treatment for this type of injury. Hearing loss due to noise is insidious and generally requires an exposure over a period of years for damage to occur.

Heat: The physical effects of excessive exposure to environment heat are determined to a large extent by factors other than actual temperature. Work load, rest periods, water and salt supplementation, clothing, general physical fitness and acclimatization are all extremely important in determining levels at which effects can be expected to become manifest. In general, well adults performing continuous moderate work can easily tolerate a wet black globe temperature of 80°F. without developing heat disorders.

Heat fatigue is the mildest of the heat disorders and is characterized by decreased ability to concentrate, tiredness, and irritability. Heat prostration (heat collapse, exhaustion, or syncope) results in weakness, dizziness, vertigo, nausea, blurred or dim vision and mild muscular cramps which may progress to a listless, apprehensive semicomatose state. In severe cases unconsciousness may result due to complete circulatory collapse even though the body temperature remains normal. The prognosis is excellent and the condition is usually transient. Heat cramps are sudden, severe muscular cramps resulting from excessive physical exertion in high temperatures due to perspiration. This condition occurs mainly among unacclimated individuals performing extremely severe physical labor in very hot environments such as stokers, miners, firemen, etc. The most severe heat disorder is heat hyperpyrexia (sunstroke, heat stroke). In this condition a

profound disturbance of the heat-regulating mechanism occurs following prolonged exposure to excessively high temperatures leading to high fever and collapse. Convulsions, coma and death are not infrequent despite prompt medical attention. This heat disorder is largely a problem of the elderly non-working age population and the severity of the syndrome is usually related to an already compromised physical state due to heart, kidney or other underlying diseases.

IV. HEALTH HAZARD EVALUATION

A. Initial Visit - Observational Survey

An initial hazard evaluation survey of The Budd Company, Clinton, Michigan Plant was made on June 27, 1972, by Mr. Raymond L. Hervin. The function of the National Institute for Occupational Safety and Health and its relation to Section 20(a)(6) of the Occupational Safety and Health Act of 1970 and the purpose of the visit, was explained to Messrs. Employee Relations Manager; , Assistant Employee Relations Manager; , Superintendent of Maintenance; President of Local Union 39, United Auto Workers; and Union Representative on the Plant Safety Committee. The National Surveillance Part I Questionnaire Form was completed with their assistance. The following is a resume of the walk-through evaluation survey of the plant.

The plant is located 1 mile south of Clinton, Michigan, and has been in production for 6 years at this location. The main production work is carried out inside of a 97,000 square feet metal building (refer to Exhibit A attached) in a work area of about 80,000 square feet. The rough castings (75% cast iron, 20% malleable iron, and 5% steel forgings) are received from outside vendors and machined into hub and rotor assemblies as disc brakes for use in auto, truck, and large equipment. The machining operations involve various grinding, milling, boring, and drilling operations which use huge amounts of mineral/cutting oil coolants and are highly automated.

Area A, as discussed in this report, consists of, primarily, 8 automated machining lines of 12 cutting stations each and 2 lines of 6 cutting stations each. Each pair of lines is served by a 18,000 gallon reservoir of Cutting Oil Solution No. 1 which is a 5% solution of the oil as received plus minor amounts of biocide (prevent rancidity) mixed with water. Cutting Oil Solution No. 1

is designated by the Budd Company as MS-105 and manufactured by the Shell Oil Company as Shellcool Oil-L which is one of a class of products containing mineral oils which are readily emulsified in water. The 18,000 gallon reservoirs have a Henry Separator and Sludge Remover which are in rooms under the floor area in front of each pair of lines. The coolant is changed about every 3 years, and it is necessary to add about 500 gallons per day/unit to make up for loss of coolant due to the generating of oil mists, splashes, and evaporation. An Ozone Generator has been installed on a trial basis to study the effectiveness of ozone as a biocide. Coolant drains from the cutting edge into a metal basin which drains into a concrete trough and runs under a steel walkway between the lines to a reservoir. High speed cutting operations generate oil mists in addition to considerable splashing. Ventilation hoods are present at some stations and a number were noted not to be in working order. Lines 271, 272 and 281 through 288 are involved in the above operations. There are also about 14 stations consisting of various drilling and bullard operations which utilize a more concentrated (18%) solution of Cutting Oil Solution No. 1 plus biocide. This solution is changed upon demand which is normally every 2 weeks.

Area B consists of Lines 291 through 295 which are also automated for different machining operations plus test and assembly purposes. Each line has a grinding operation which uses a reservoir of 1,600 gallons of Cutting Oil Solution No. 2. This is a 2% solution in water of International Solution No. 321 which is manufactured by the International Chemical Company. This solution is changed every 6 weeks. Another operation just prior to the checker operation involves an Oil Emulsion Solution No. 3 used as a cleaner and rust inhibitor. This is a 4% solution in water of Jem Mulsion 400 and is manufactured by the Ajem Laboratories. This operation is in an enclosed system at the end of the line. Another operation in this area involves the use of an Organic Cleaning Solution No. 4 for cleaning small metal parts in a large metal feeding bin by the Visi-trol Operator (Lines 293 and 294). This solution is Dowclean E.C. Solvent and is manufactured by Dow Chemical Company. There are also similar machining operations conducted in the Truck Assembly Area which includes the use of Solution No. 2 and Solution No. 3.

Operations thought to be of lesser significance from a health hazard were: (1) use of a paint spray booth for minor spraying of part of truck disc; (2) use of an Ink Solution for paint spray marking of part of the disc; and (3) open painting of metal parts in Bullard/Drill Area which occurs perhaps once or twice a week.

On the initial walk-through evaluation survey, production on most lines appeared normal, if not above normal. Ventilation hoods are present at some stations and a number were noted not to be in working order and were non-existent at other locations. Oil mists appeared to be rather dense throughout the facility and extremely dense in the aisle of Assembly Lines 271 through 278. The metal aisle walkways and floors were very slippery from the oil mist. The density of the oil mist was less in Area B and the truck assembly area. Some of the employees complained about the extreme heat and humid conditions which exist a few days throughout the year. In addition, a few employees complained about the mists, smoke, phlegm, and cough. However, the main complaint elicited from employees concerned dermatitis which is the Nation's leading occupational disease. A few of the employees showed definite signs of dermatitis but it was not determined whether it was due to occupational exposure.

The operators normally work on the steel walkway adjusting the various operations and are continuously exposed to oil splashing and mists. The hands and forearms are frequently immersed in the coolant. Steel splash shields and guards extend upward on each side of the walkway to a height of approximately 30 inches. The shields are constantly wet with coolant and are leaned against when reaching into the machining area. Gloves and protective clothing were not evident. Rubber aprons apparently are available but not worn since coolant mists from the drain below the walkway are said to soon saturate clothing under the apron. Apparently gloves are not worn because of the delicate nature of the adjustment and the hazard imposed by the fast-moving machinery. Workmen are expected to provide their own working clothing and the company will provide laundry services for a small weekly fee. Showers are not provided, although restroom facilities appeared entirely adequate. Silicone protective barrier lotions and creams are made available but were also not observed in use.

Each pair of lines from Line 271 through 288 is serviced by a loader, 2 operators, a set man, and an unloader, Lines 291 through 295 have a Visi-trol operator, dry grinder operator, weight balance

station operator, grinding operator, checking operator, and a few other support personnel per pair of lines. The truck assembly area involves approximately 14 operators and helpers. The total number of production personnel involved in production operations considered as the primary affected employees is estimated at around 85 employees per shift or total of 170 employees. Production Lines 271 through 288 were considered as the main area of concern due to the oil mist problem.

A review of the findings on the initial visit was made with appropriate personnel of The Budd Company, Clinton, Michigan. As the result of this initial visit, it was determined that environmental measurements were necessary in order to evaluate the required determination of exposure levels to the alleged hazards. It was felt that mineral oil mists and noise were the prime potential hazards to be evaluated; with secondary considerations concerning the use of organic solvents, total dust, iron, ozone, and heat. In addition, it was determined that a physician should conduct a medical evaluation of the employees in order to ascertain whether any symptoms are due to occupational exposures.

B. Environmental Evaluation

1. Procedure

Bulk samples of solutions mentioned in A above were analyzed for major ingredients and the companies manufacturing the solutions were contacted concerning their formulation. Appropriate sampling and analytical procedures were obtained for those contaminants which may become airborne in concentrations which may present a potential hazard. On August 29-31, 1972, an environmental sampling survey was conducted by Messrs. Raymond L. Hervin, Raymond L. Ruhe, and Robert E. Rosensteel to determine environmental exposures of employees.

Samples for oil mists were collected on preweighed glass fiber filters (Gelman TypeA--no organic binder). Samples for total dust and iron were collected on preweighed HA 37 mm diameter esters of cellulose membrane filters. The air was drawn through the collection filters held in a Millipore Field Monitor by a MSA Model G, battery powered vacuum pumps operating at a rate of 2 liters per minute for 4-7 hours to simulate an 8-hour time weighted average exposure. Samples for organic solvents were collected in MSA Charcoal Sampling Tubes by a MSA Model G Vacuum Pump at 1 liter per minute for 10 minutes. Flow rates were maintained during sampling by periodically adjusting each pump's calibrated flow meter. Personal air samples were obtained by attaching the Monitor

to an employee's collar or lapel which was connected via Tygon Tubing to the pump which was attached to a belt at the waist. Breathing zone samples were hand-held to obtain air from the actual breathing zone of the employee and were limited to charcoal tube samples only. The general area zone samples were collected in specific fixed locations in the working environment. Procedures used for measurements of noise, heat, and ozone are discussed in other sections of this report.

2. Methods

All of the 79 air samples were analyzed by the Division Laboratories and Criteria Development, NIOSH, Cincinnati, and approximately 230 analytical determinations were made to evaluate the working environment. Twenty-eight (28) air samples were analyzed by both gravimetric (weight) and spectrophotofluorometric procedures for mineral oil mists. Sixteen (16) air samples were analyzed by gravimetric and atomic absorption procedures for total dusts and iron respectively. Thirty-five (35) air samples (charcoal tubes) were analyzed by gas chromatographic procedures for 1,1,1-trichloroethane, perchloroethylene, toluene, and xylene with a minimum detection level for these compounds of 1/20th of the appropriate health standard. Other minimum detection levels from an analytical standpoint are 0.1 milligrams for gravimetric analysis (oil mists and total dust) and 0.001 milligrams for spectrophotofluorometric (oil mists) and atomic absorption (iron) procedures.

3. Survey Results

a. General

The same observations as noted in the initial walk-through survey were also noted in the environmental survey. However, the oil mists although very visible and apparent throughout the production area, particularly lines 281-288, did not appear as dense as they were during the initial survey. This was probably due to some production lines not being operational and a lower ambient temperature. During the survey, we contacted Messrs. , Plant Manager; , Manager Safety and Industrial Hygiene; , Registered Nurse; and other various employees. An exit interview was held

with representatives from management and a separate exit interview was held with union representatives. The primary purpose of the meetings was to discuss survey findings from a health viewpoint. Several safety items were discussed during both meetings, although this was not the purpose of the evaluation or this report. In reviewing sample results discussed below, it should be noted that mineral oil is the primary ingredient and potential hazard involved in the use of Solutions 1,2, and 3 discussed previously in this report.

b. Oil Mists, Mineral

Exhibit B presents the results of 15 personal air samples and 3 general area samples from Area A. The results vary from 10 to 80 percent of the health standard for oil mists with an average of 40 percent using the spectrophotofluorometric procedure which is specific for oil mists. The old procedure using the gravimetric or weight methods measures oil mists plus other contaminants in the air and is not considered appropriate for evaluation of oil mists by the NIOSH investigators. However, it is noted that two sample results (maximum - 6.0 mg/M^3) exceeded the health standard for oil mists of 5 mg/M^3 if one considered the gravimetric method as appropriate. It is further noted that oil mists were visible and very dense between the production lines in this area.

Exhibit C presents the results of 9 personal air samples and 1 general air sample from Area B. The results vary from 8 to 40 percent of the health standard for oil mists. There is excellent correlation between the two analytical methods in Area B.

It may be questionable whether the two sample results mentioned above, were in fact, exceeding the health standard as the spectrophotofluorometric method used for oil mists shows the same sample results below the standard. However, it should be noted that in reviewing the sample results, the concentrations are greater for the operators working in the production lines. They are particularly elevated for those operators and set-up men working in Lines 271 through 272. The results do confirm visual observations of oil mists by the surveyors. Also, some lines were not operational during the environmental survey.

c. Total Dust and Iron

Exhibit D presents the results of 16 personal air samples collected in Areas A and B. All results for total dust were less than of the health standard. It is noted that the filters probably collected some oil mists which may account for a good portion of the total dust concentration. The total dust concentrations and the minimal concentrations of iron indicate adequate control of airborne particulate matter.

d. Organic Solvents

In considering two or more hazardous substances having similar pathophysiologic effects such as two organic solvents, their combined effect, rather than each individually, must be considered. Hence, in the absence of information to the contrary, the effects of different solvents, must be considered as additive, that is, if the sum of the concentration X compound divided by its health standard plus the sum of Y compound divided by its health standard exceeds unity (1), then the health standard for the mixture would be considered as being exceeded. E_m is used for the sum total and should not exceed 1. Please refer to Exhibit E for a more detailed explanation on this matter.

Exhibit F presents the results of the 21 samples concerning exposures of employees to organic vapors around the feeder bins (Lines 293/294) near Visi-trol area, from the use of Cleaning Solution 4. No health standard was exceeded on an individual basis, although the combined effects of three samples did exceed unity with a maximum E_m of 1.40, but the three sample results do not represent an 8-hour time weighted average. One may average the sample results to estimate the actual exposure of employees. In this regard, it is estimated that the average of personal air sample results is 32% and general area air sample results are about 50% of the health standard for the mixture of 1,1,1-trichloroethane and tetrachloroethylene. It is noted that the metal feeder bins are open and hence, it is apparent that the vapors from the Cleaning Solution #4 are dispersed in air in the immediate vicinity of the conveyor line and Visi-trol operations. No xylene or toluene were detected.

Results for other organic solvents are presented in Exhibit G. The number and results of air samples in and around the paint booth operation (Truck Assembly Line) are somewhat

minimal and all results are less than 2% of the health standard. No toluene, xylene, or tetrachloroethylene were detected. This operation appears adequately controlled. Only four samples were obtained concerning the use of an opaque green ink operation (by weight balance station line 291) and the results were less than 2% of the health standard and samples covered only a 10-minute operation. No xylene or tetrachloroethylene were detected. Open floor painting operations are also accomplished sporadically in the bullard/drill area but were not observed during our survey and no samples were obtained of this operation. Operations covered by this paragraph were not specifically part of the original request, and these operations are not a salient portion or consideration from a health viewpoint in this report by the surveyors.

e. Ozone

A MSA Universal Test Kit with MSA Detector Tubes were utilized to detect the presence of ozone in and around (e.g., inlet, outlet, etc.) the ozone generator. The detection range using this method is 0.05 to 5.0 ppm and no ozone was detected nor was there any apparent odor of ozone detected by the surveyors during the survey. Prior to the survey, the manufacturers of the equipment said that previous health surveys for ozone on the same type of installation did not show a problem concerning ozone. It is noted that an evaluation of ozone concentrations was not part of the original request.

f. Heat and Noise

It has been determined that "substances" as presently defined in Section 20(a)(6) of the Act do not include physical agents. However, for completeness of our overall responsibilities for acknowledging any occupational health hazards encountered during an evaluation of a place of employment, we conducted a cursory heat and noise survey.

The standards for occupational noise exposures as published in the Federal Register, Part II, §1910.95, Table G-16, are shown in Exhibit H. Sound levels were measured with a General Radio Company Permissible Sound Level Meter, Type 1565-B in dBA with a slow response and are summarized in Exhibit I of this report. The Sound Level Meter was calibrated prior to taking readings. The sound level results are at various locations, and no 8-hour evaluation of any employees' total integrated exposure to noise was accomplished. However, it is felt the noise levels measured

were of such a magnitude in certain operations that some or several employees may be exposed to noise levels exceeding the health standard on an 8-hour basis. During the survey, only two employees were observed actually using hearing protection devices. It is noted that the company has recently initiated a hearing conservation program at this plant which includes at least the use of hearing protection devices.

Please refer to Exhibit J for resume of heat measurements taken at time of survey. The peak wet bulb-globe temperature (WBGT) is seen to be slightly more than 77°F. According to the present criteria for heat stress, established by the American Conference of Governmental Industrial Hygienists (ACGIH), this level of environmental heat load would be acceptable on a continuous basis, at even a maximal continuous workload. The relatively small difference between the globe temperature and the dry bulb temperature at the measurement sites indicate that radiant heating is not an important factor in the total heat load. If worker complaints about hot conditions persist some amelioration of the environment (from a comfort standpoint) could be achieved by the usage of properly placed man-cooling fans. The air velocities measured at the worksites were relatively low, indicating that improved evaporative cooling could be effected by increasing the air movement. The survey although limited in scope and depth, was in accordance with appropriate methods for evaluating hot environments.

g. Ventilation

Ventilation measurements were taken with an Alnor, Jr., Velometer and are summarized in Exhibit K. The following is a brief resume of our findings.

Other than the ventilation systems (not all in working condition) for Stations 1, 2, 3, the ventilation on Lines 281-288 and Lines 271 and 272 was inadequate as these lines had little or no local ventilation. From the air sample results, it is noted that the concentrations of oil mists were also greater in this area than other areas. This is also expected as greater amounts of coolants are also used in this area or Area A. Improved local ventilation in this area would certainly help to lower the concentrations of oil mists in this area. The oil mists were more visually apparent and dense during the initial visit than the environmental survey as some of the lines were not operational during the survey and the ambient temperature was also lower.

The Motch Machines in Line 291 has local ventilation which is serviced by a central collection system on an open mezzanine floor above the production line. These Motch Machines were not operational during the survey. However, they were turned on for a few minutes to observe the Motch Machines in Line 291. This resulted in the Motch Operations (particularly in the walkway between lines) being sprayed with coarse ships from the central system above. In addition, the central collection system services other operations and provides filtration but is vented directly back into the building rather than to the outside atmosphere.

C. Medical Evaluation

The Medical Evaluation was conducted by James B. Lucas, M.D. The environmental conditions discussed in Section IV- were also observed by Dr. Lucas. The following is a brief resume of his medical findings obtained on August 29-30, 1972.

A full-time nurse staffs a small, modern clinic located immediately adjacent to the production area. A local physician is retained to provide pre-employment examinations and emergency care. Because of the proximity to Ann Arbor, patients with more chronic problems are frequently referred for consultation by University of Michigan specialists. The records kept per the requirements under the Occupational Safety and Health Act were reviewed and in 1971 there were 16 lost-time entries, 1 dermatitis, and the rest various injuries, mostly of a minor nature. A total of 166 workdays were lost, 38 of which were due to a case of dermatitis. Thirty-six entries not involving lost-time were noted, 35 being due to minor injuries and 1 due to dermatitis. A high percentage of injuries were ocular foreign bodies resulting from machine chips and swarf. Seven compensation claims were paid in 1971, 1 for chronic hand eczema and the rest for fractures. Three dermatitis cases were noted in this year's log entries. The patient involved in one of these cases was terminated since he had failed to disclose a pre-existing skin disability. One case appears to have been a cutting oil dermatitis, and the final patient is only described as having a "rash involving both hands and wrists".

Twenty-five production workers, working in representative areas of the factory, were interviewed while on the line. Ten were noted to have varying degrees of dermatitis. Nine exhibited typical lesions consistent with cutting oil dermatitis (oil acne and folliculitis). Cases ranged from very mild, exhibiting only a few scattered lesions, to a few men with relatively extensive involvement.

The main skin areas involved were the exterior surfaces of the forearms and anterior thighs. No pyoderma was noted in association with these lesions. Cases were largely confined to those men working on the walkways between the paired machining sections and maintenance personnel who repair the equipment. Drillers, Bullard Machine Operators, Grinding Operators, and other employees had a markedly lower incidence of complaints. Lines 291 through 295 plus the truck assembly area employees also appeared to have a lower incidence of involvement.

A single individual who works in a custodial capacity was found to have typical chronic hand eczema. While he normally wears gloves during the course of his work, they probably are not changed frequently enough. In addition, some exposure to primary irritants is probably nearly inevitable in the performance of his duties and is sufficient to cause a continuation of his dermatitis.

Individuals were also questioned about respiratory tract symptoms and although oil mists were apparent during the walk-through, no pattern suggesting an occupationally-associated respiratory problem was ascertained. A number of individuals obviously had pre-existing respiratory problems of diverse etiology (i.e., asthma, pneumothorax, pneumonia, possible silicosis, etc.). Several persons commented that minor respiratory tract infections tended to persist for inordinate periods of time. No symptoms suggestive of excessive exposure to organic solvents, dusts, iron, ozone, or heat were elicited.

V. CONCLUSIONS AND RECOMMENDATIONS

It is our conclusion that a hazardous exposure to the workers in the areas studied, particularly Assembly/Machining Lines 271 through 278, does exist. This conclusion is based upon: (1) a past history, and the current findings in this evaluation of several employees exhibiting typical lesions consistent with cutting oil dermatitis, and (2) the elevated but perhaps not excessive, concentrations of oil mists, and the splashing and direct contact with the cutting oil contributing to cutting oil dermatitis problem. In addition, a hazard to employees exists from exposure to noise. The other agents studied during the survey (organic solvents, dust, iron, ozone and heat) were determined to be non-hazardous as used in the facility.

The following recommendations are submitted to management to obviate observed and potential hazards and to provide a more desirable working environment for all personnel.

1. The company should improve the ventilation system to effectively reduce oil mists in the areas of highest concentrations and dermatitis incidence (Lines 271 through 278). Areas using cutting oil should be evaluated to ascertain if additional splash guards can be effectively used to avoid spraying of oil droplets on employees. All external surfaces of splash guards and shields should be frequently cleaned and wiped free of oil.

2. Long-sleeved shirts with close-fitting cuffs should be worn. Clothing soiled with cutting oil should not be worn, certainly not from one day to another. Since gloves cannot be worn for safety reasons, the hands should be protected by the frequent application of protective creams. The last line of defense is to remove the offending agent from the skin as quickly as possible.

3. It should be emphasized to each employee that personal cleanliness is the most effective method for avoiding and cutting dermatitis problems. Personal cleanliness is a must. Waterless hand cleaners are especially valuable in removing oil from the skin. Bacteriostatic soap should be provided for frequent hand and arm washing. Showers are highly desirable since many employees presently commute considerable distances wearing oil-saturated clothing.

4. The current hearing conservation program should be expanded to include any of the items below which may not now be part of the current program.

a. Pre-employment, periodic, and termination audiometric examinations for employees potentially exposed to high noise levels.

b. Identification of areas and periodic evaluation of noise levels where noise may be a problem.

c. Elimination of noise at its source, by engineering methods where feasible.

d. Provide and encourage workers to wear properly-fitted hearing protection devices until the high noise level is eliminated, or where it is not feasible to control the high noise levels by engineering methods.

5. As a matter of good industrial practice, the following suggestions are made for consideration by management.

a. The central ventilation system(s) servicing the Motch Machines utilized in Lines such as 291 should be evaluated for: (1) appropriate modifications (e.g., venting to outside atmosphere, etc.) and (2) appropriate periodic cleaning and inspection to assure there is no inordinate spraying of metal chips or dusts onto the employees on the ground floor.

b. Consideration should be given to the feasibility of providing a tight-fitting cover with an appropriate vent over the metal feeder bins containing the Organic Cleaning Solution No. 4 by the Visi-trol Area in Lines 293 and 294.

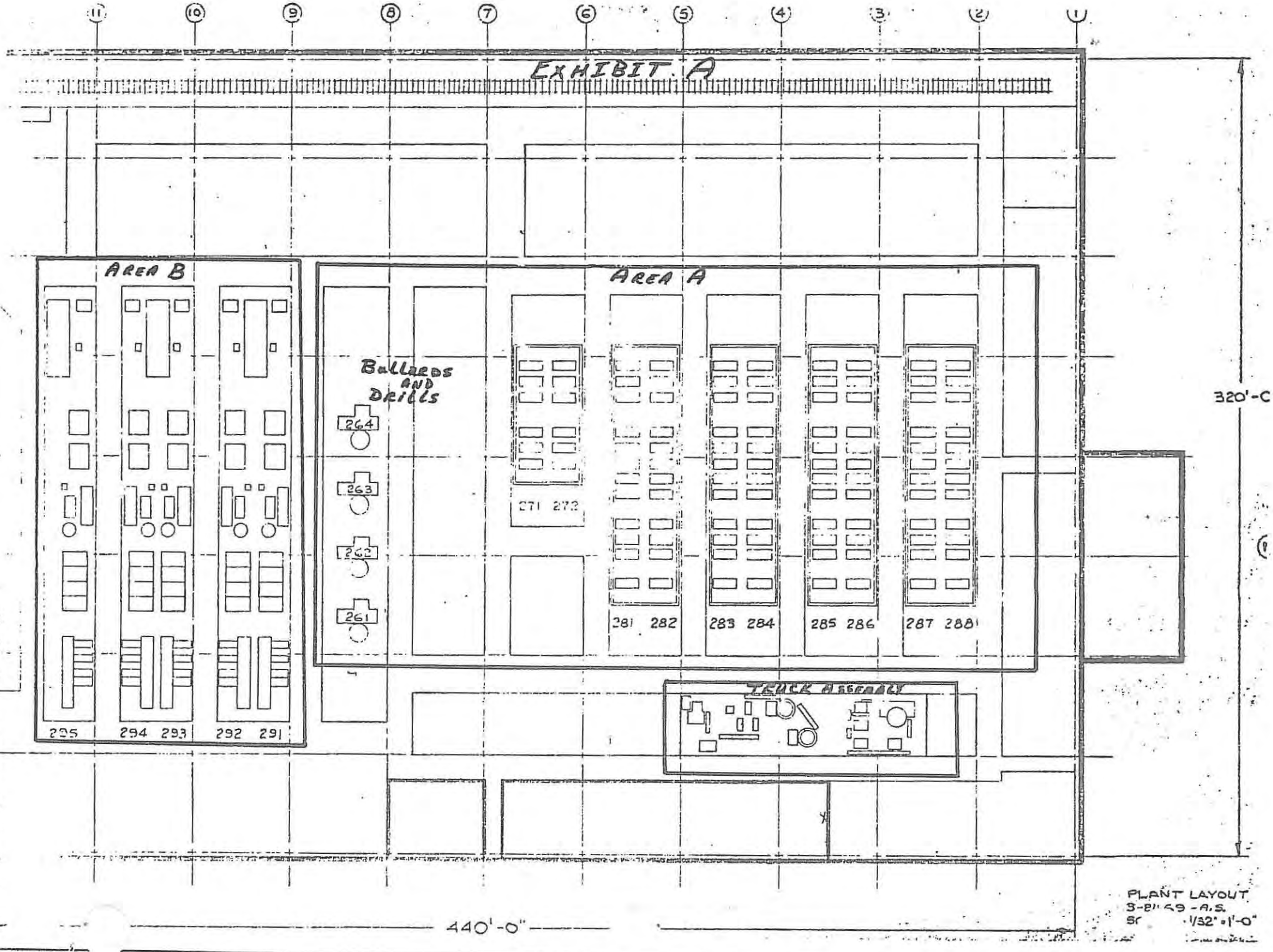
EXHIBIT A
AREA B
AREA A
Bollards AND Drills
264
263
262
261
271 272
281 282
283 284
285 286
287 288
295
294 293
292 291
TRUCK ASSEMBLY
320'-0
440'-0"
PLANT LAYOUT
3-21-49 - A.S.
1/32" = 1'-0"

EXHIBIT B - OIL MISTS

Air Sample Results on Various Operations in Area A

(All Results from Personal Air Samples unless Noted as General Area Sample)

mg/M_3 - milligrams of compound per cubic meter of air

Location	Operation	Sample No.	mg/M^3 Gravimetric	mg/M^3 Spectrophoto Fluorometric
Line 285/286	Set Up Man	46	2.8	1.0
Line 288	Operator	52	5.5	3.6
Line 284	Operator	41	4.1	3.9
Line 287/288	Line Unloader	42	1.8	1.1
Line 281/282/271/272	Line Loader	50	0.9	0.8
Line 281-282	Set Up Man	45	3.6	2.3
Line 281/282	Operator	11	1.9	1.6
Line 281/282/271/272	Unloader	5	1.8	1.8
Line 287/288	Set Up Man	21	4.2	2.3
Line 282-Station #5	General Area Sample	2	2.1	1.0
Line 285-Station 8-9	General Area Sample	55	2.7	1.2
Bullard #256	Operator	51	2.0	2.0
Drill	Operator	54	2.6	2.6
Bullard 263	Operator	48	1.3	1.3
Drill 302	Drill Operator	14	0.5	0.5
Bullard 263	Operator	16	6.0	3.2
Bullard 264	Operator	20	3.3	2.3
Bullard 262	General Area Sample	9	2.8	2.0
Average of Personal Air Sample Results			2.8	2.0

EXHIBIT C - OIL MISTS

Air Sample Results on Various Operations in Area B

(All Results from Personal Air Samples unless Noted as General Area Sample)
mg/M_3 - milligrams of compound per cubic meter of air

Location	Operation	Sample No.	mg/M^3 Gravimetric	mg/M^3 Spectrophoto Fluorometric
Line 293	Checker	49	0.4	0.0
Line 291/292	Checker	53	0.5	0.5
Line 291-292	Checker	25	0.4	0.4
Line 293/294	Grinding Operator	47	2.0	2.0
Line 291/292	Grinding Operator	43	2.0	2.0
Line 293-294	Grinding Operator	6	0.7	0.7
Line 292	Motch Operator	8	1.3	1.3
Line 294	General Area Sample	10	0.6	0.6
Truck Ass. 303	Grinding Operator	3	2.0	2.0
Truck Ass. 303	Grinding Operator	13	1.8	1.8
Average of Personal Air Sample Results			1.2	1.2

EXHIBIT D - TOTAL DUSTS AND IRON

Personal Air Sample Results on Various Operations in Areas A and B

$mg/_3$ - milligrams of compound per cubic meter of air

AREA A

Location	Operation	Sample No.	mg/M^3 Total Dust	mg/M^3 Iron
Line 283/284	Set Up Man	3HA	1.9	.024
Line 286	Operator	15HA	1.8	.003
Lines 283,284,285,286	Loader	20HA	0.5	.002
Line 283	Operator	1HA	3.8	.018
Line 283-284	Set Up Man	17HA	0.7	.038
Moh 302	Drill Operator	11HA	2.0	.014
Bullard 265	Operator	13HA	1.7	.008
Bullard 264	Operator	5HA	1.7	.005
Bullard 262	Operator	7HA	4.3	.010

AREA B

Line 292	Motch Operator	26HA	1.5	.002
Line 294	Motch Operator	14HA	1.5	.005
Line 294	Motch Operator	34HA	1.3	.002
Line 293	Checker	2HA	0.8	.002
Line 291-292	Grinder Operator	18HA	0.8	.007
Truck Ass. 300	Motch Operator	8HA	2.3	.010
Truck Ass. 300	Motch Operator	6HA	0.9	.004

EXHIBIT E

OCCUPATIONAL SAFETY AND HEALTH STANDARDS
SUBPART G - OCCUPATIONAL HEALTH AND ENVIRONMENTAL CONTROL
(Code of Federal REgulations, Title 29, Chapter XVII, Part 1910)

PART 1910 -- OCCUPATIONAL SAFETY AND HEALTH STANDARDS

1910.93 AIR CONTAMINANTS

Part B(2)(i) In case of a mixture of air contaminants an employer shall compute the equivalent exposure as follows:

$$Em = \frac{C_1}{L_1} + \frac{C_2}{L_2} + \ldots \frac{C_n}{L_n}$$

Where:

Em is the equivalent exposure for the mixture,

C is the concentration of a particular contaminant,

L is the exposure limit for that contaminant, from table G-1, G-2, or G-3,

The value of Em shall not exceed unity (1).

(ii) To illustrate the formula prescribed in subdivision (i) of this subparagraph, consider the following exposures:

Material	Actual concentration of 8-hour exposure	8-hour time weighted average exposure limit
Acetone (Table G-1)	500 ppm	1,000 ppm
2-Butanone (Table G-1)	45 ppm	200 ppm
Toluene (Table G-2)	40 ppm	200 ppm

Substituting in the formula, we have:

$$Em = \frac{500}{1{,}000} + \frac{45}{200} + \frac{40}{200}$$

$$Em = 0.500 + 0.225 + 0.200$$

$$Em = 0.925$$

Since Em is less than unity (1), the exposure combination is within acceptable limits.

EXHIBIT F

Air Sample Results - Organic Cleaning Solution #4 - Visi-trol Operator Area

mg/M^3 - milligrams of compound per cubic meter of air

Sample No.	Line	mg/M^3 1,1,1-Trichloroethane	mg/M^3 Tetrachlorethylene
I. Personal Air Sample Results - Visi-trol Operators			
1	293	210	110
6	293	270	110
10	293	350	190
15	293	420	160
19	293	360	140
3	294	30	10
7	294	30	10
11	294	50	30
14	294	30	10
17	294	1660	350
21	294	30	10
II. General Area Sample Results - Visi-trol Area Station			
2	293	370	180
5	293	520	170
9	293	450	170
8	294	90	40
4	294	50	10
12	294	180	40
22	294	1640	340
III. General Area Sample Results above Conveyor Line by Visi-trol Area Station			
13	294	1140	350
18	294	10	10
16	293	500	140
20	293	460	130

The E_m for the sample results of I above varied from .04 to 1.4 with an average E_m of 0.3.

The E_m for the sample results for II above varied from .05 to 1.4 with an average E_m of 0.5.

The E_m for the sample results of III above varied from .03 to 1.1 with an average E_m of 0.5.

Note: No xylene or toluene were detected.

EXHIBIT G

Air Sample Results - Miscellaneous Operations

(GA - General Area Air Sample; BZ - Breathing Zone Sample)

mg/M^3 - milligrams of compound per cubic meter of air

I. Paint Booth Operations (Truck Assembly Line)

Sample No. Line	mg/M^3 1,1,1-Trichloroethane
R-1-BZ	40
R-3-BZ	3
R-5-BZ	1
R-7-BZ	3
R-9-BZ	3
R-6-GA (outside booth)	10
R-4-GA (inside booth)	10
R-8-GA (inside booth)	3
R-2-GA (outside booth)	10

Note: No toluene, xylene or tetrachloroethylene were detected.

The above air sample results are less than 2% of the health standard for 1,1,1-Trichloroethane.

II. Spray Ink (Opaque Green Ink) Operation by Weight Balance Station-Line 291

Sample No. Line	mg/M^3 1,1,1-Trichloroethane	mg/M^3 Toluene
A-1-GA	30	1
A-2-GA	10	1
A-3-GA	10	1
A-4-GA	10	1

Note: No xylene or tetrachloroethylene were detected.

The above air sample results either individually or combined (E_m) did not exceed 2% of the appropriate health standard.

EXHIBIT H

PERMISSIBLE NOISE EXPOSURES*

Duration Per Day, Hours	Sound Level dBA Slow Response
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115 Ceiling Value

*When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: C1/T1+C2/T2+Cn/Tn exceeds unity, then the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

EXHIBIT I

SUMMARY NOISE MEASUREMENTS

Location	Sound Level dBA
Lines 287-288 - (not operating) - General Walkway	87
Lines 287-288 - Station 11	94
Lines 287-288 - Conveyor Drive Motor - Steps	93
Lines 285-286 - Drive Motor - Steps	94
Lines 285-286 - General - Walkway	91-95
Lines 285-286 - Stations 1-3	95-100
Lines 283-284 - Stations 1-3	93-100
Lines 283-284 - General Walkway	91-98
Lines 283-284 - Drive Motor - Steps	94
Lines 281-282 - (not operating) - General Walkway	90
Lines 281-282 - Stations 1-3	91
Lines 281-282 - Drive Motor - Steps	91
Lines 271-272 - Stations 1-3	91-102
Lines 271-272 - General Walkway	91
311 - Drills - General	90
Bullard 264 - General	90-93
Bullard 264 - Air Hose	110
Bullard 263 - General	90-93
Bullard 263 - Air Hose	105
Bullard 265 - General	90-92
Bullard 265 - Air Hose	102
Lines 291-292 - Walkway - Visitrol	95
Lines 291-292 - Balancer - General	95
Lines 291-292 - Balancer - Reject Impact on Metal	113
Lines 291-292 - Grinder	91
Lines 291-292 - Washer Blower	91
Lines 293-294 - RCA	91
Lines 293-294 - Washer Blower	93
Lines 293-294 - Balancer - General	94
Lines 293-294 - Balancer - Reject Impact on Pad	98
Lines 293-294 - Visitrol - Walkway	93
Line 294 - Station 1 Air Jet	95-103
Line 295 - Blower Washer	93
Line 295 - Load Station	91
Line 295 - Balancer - General	90
Truck Assembly - Paint Booth - General	92
Truck Assembly - Motch and Grinder	91
Truck Assembly - Min and Max on Air Hose - Jet and Wrench	90-103

Heat Measurements and Results, Line 284-Station 9

August 29, 1972

Time	11:00	12:30	2:15
Globe-Black Ball	84°	85°	87°
D.B. - Psychrometer	82° (75°)	83° (80°)	85° (83°)
W.B. - Psychrometer	68° (69°)	70° (66°)	72° (65°)
N.W.B. - Thermometer	70°	73°	73°
Air Velocity - Anemometer	30 fpm	40 fpm	40 fpm

August 30, 1972

Time	10:00	2:00
Globe-Black Ball	80°	84°
D.B. - Psychrometer	80° (76°)	85° (84°)
W.B. - Psychrometer	70° (65°)	72° (69°)
N.W.B. - Thermometer	69°	72°
Air Velocity - Anemometer	50 fpm	40 fpm

Above measurements result in the following Wet Bulb-Globe Temperature Indices (WBGT):

August 29, 1972

Time	WBGT
11:00	74.2°
12:30	76.6°
2:15	77.2°

August 30, 1972

Time	WBGT
10:00	72.3°
2:00	75.6°

Note: All readings in degrees Fahrenheit; fpm--velocity in feet per minute; and (-) readings taken outside of building.

EXHIBIT J (page 2 of 2)

Heat Measurements and Results, 4th Station Motch

August 29, 1972

Time	11:00	12:30	2:10
Globe-Black Ball	82°	84°	87°
D.B. - Psyschrometer	80° (75°)	85° (80°)	88° (83°)
W.B. - Psyschrometer	67° (64°)	71° (66°)	69° (65°
N.W.B. - Thermometer	68	70°	70°
Air Velocity - Anemometer	40 fpm	40 fpm	30 fpm

August 30, 1972

Time	10:00	2:00
Globe-Black Ball	80°	88°
D.B. - Psyschrometer	80° (76°)	86° (84°)
W.B. - Psyschrometer	69° (65°)	71° (69°)
N.W.B. - Thermometer	69°	72°
Air Velocity - Anemometer	30 fpm	40 fpm

Above measurements result in following Wet Bulb-Globe Temperature Indicies (WBGT):

August 29, 1972

Time	WBGT
11:00	72.2°
12:30	74.2°
2:10	75.1°

August 30, 1972

Time	WBGT
10:00	72.3°
2:00	76.8°

Note: All measurements in degrees Fahrenheit; fpm--velocity in feet per minute; and (-) readings taken outside of building.

EXHIBIT K

Summary of Ventilation Measurements on Systems Servicing Machining Operations at Point of Exhaust to System or Maximum Flow

Location	Face Velocity or Comments (feet per minute (fpm))
Line 288-Station 2	300
Line 288-Station 1	300
Line 278-Station 2	Vent System Out of Service
Line 287-Station 1	Vent System Out of Service
Line 284-Stations 1, 2, 3	No Ventilation
Line 283-Station 1	200; One Trunk Out of Service
Line 291-Motch Station	400
Line 293-Motch 1	150
Line 293-Motch 2	200
Truck Assembly Motch	100 (visible dust after filtration--collectors not doing job)
Truck Assembly-Paint Booth	Average 230
Operator-Paint Booth	140