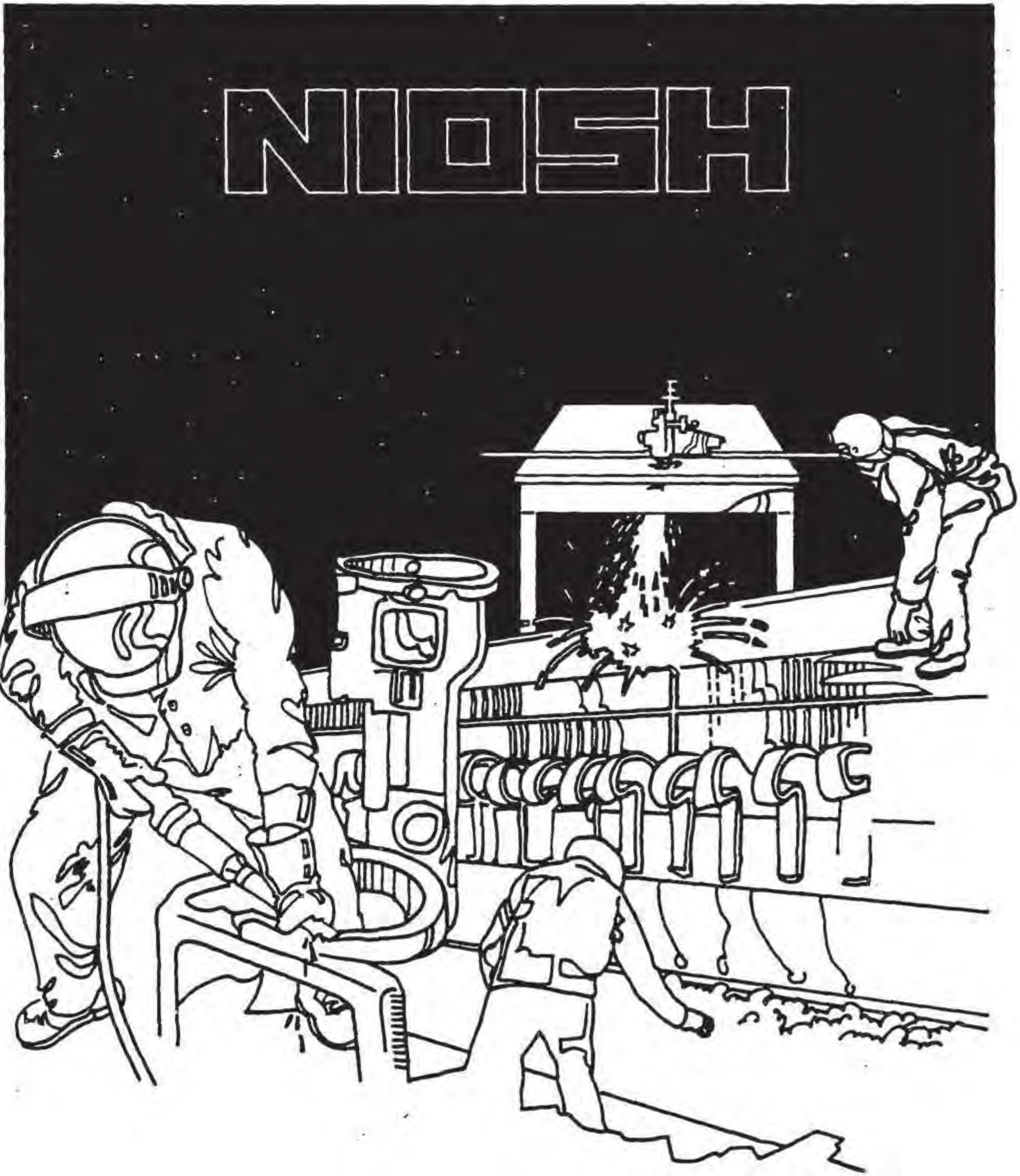
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 83-003-1539
HAMILTON TECHNOLOGY, INCORPORATED
LANCASTER, PENNSYLVANIA

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 83-003-1539
DECEMBER 1984
HAMILTON TECHNOLOGY, INCORPORATED
LANCASTER, PENNSYLVANIA

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I. SUMMARY

On October 5, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate complaints of respiratory infections, dry mucous membranes, sore throats, and earaches among employees at Hamilton Technology, Incorporated, Lancaster, Pennsylvania. These symptoms reportedly began soon after the company moved into a windowless, energy efficient building. The company employs approximately 760 production and 250 office workers in the manufacture of time fuses. Operations primarily involve those typically found in machine shops, with the primary environmental contaminant being oil mist.

On November 17-18, 1982, NIOSH investigators conducted an initial walkthrough survey. Follow-up medical and environmental evaluations were conducted on December 8 and December 15-16, 1982, respectively. During the environmental evaluation air samples for oil mist, paint solvents, and acetic acid vapors were collected, and psychrometric measurements were taken. Analytical problems encountered in the analysis of the air samples necessitated a second follow-up visit on November 29-30, 1983, at which time additional air samples for the aforementioned substances were obtained.

Oil mist exposures of 34 machine operators in the Automatics, Gear cutting, Secondary, and AMS departments ranged from 0.06 to 1.56 mg/m^3, the highest level being 31% of the OSHA standard (and ACGIH TLV) of 5.0 mg/m^3. Two personal air samples obtained from a paint sprayer showed combined exposures to solvents at 54 and 56% of the evaluation criteria. Three samples for acetic acid from M577 line assemblers using silicone sealer ranged up to 20% of the OSHA standard (and ACGIH TLV) of 25 mg/m^3. Since improvements in ventilation and in manufacturing operations were made by the company prior to our final visit in November 1983, the air sampling results are not indicative of environmental conditions present in the building in November/December 1982. Psychrometric measurements indicated that the temperature and relative humidity were within the ASHRAE recommended comfort zone.

In the medical evaluation, the NIOSH physician administered medical questionnaires to 220 production workers in 6 departments throughout the building and to 31 office workers. The four most common symptoms reported by production workers were nose/throat irritation (62%), headache (52%), drowsiness/tiredness (45%), and eye irritation (34%). The prevalence of these symptoms among office workers, who were presumably unexposed to chemicals, was very similar to that among the production workers, suggesting that the factor responsible for such symptoms is found plantwide, possibly inadequate air circulation. This appears to be a reasonable explanation since complaints decreased after ventilation changes were made. Ten cases of dermatitis were reported by workers exposed to cutting oils.

Based on the results of this evaluation, it is determined that inadequate air circulation probably was the cause of the various symptoms reported by employees and that dermatitis existed among workers exposed to cutting oils. Improvements in the ventilation system appeared to have corrected the problem relating to indoor air quality. Recommendations concerning personal hygiene and work practices associated with handling cutting oils are presented in Section VIII of this report.

KEYWORDS: SIC 3489 (Ordinance and Accessories)
indoor air quality, ventilation, oil mist, throat irritation, dermatitis.

II. INTRODUCTION

In October 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from a management representative of Hamilton Technology, Incorporated, Lancaster, Pennsylvania. The request stated that workers complained of dry mucous membranes, sore throats, ear aches, and general malaise, and attributed these problems to the work environment. In May 1982, the company moved into a smaller, energy efficient building and it was not until after the move that employees began to report these symptoms.

NIOSH investigators conducted an initial site visit on November 17-18, 1982 which included a walk-around tour, informal interviews with company representatives and employees, and collection of a limited number of air samples, primarily for screening purposes. Because air temperature fluctuations were reported, psychrometric measurements also were obtained at this time. On December 8, 15, and 16, 1982, NIOSH conducted a follow-up environmental and medical survey. Air samples for oil mist, acetic acid vapor, and paint solvents were collected, and psychrometric measurements were made. Medical questionnaires were administered to employees in various departments throughout the plant. Because of analytical difficulties encountered with the analysis of the environmental samples, additional air samples were collected on November 29-30, 1983.

A summary of survey activities, findings, and preliminary recommendations were presented to both company and union representatives in an interim report dated January 1983, and in two letter reports, dated December 15, 1983 and February 14, 1984.

III. BACKGROUND

Hamilton Technology, Incorporated (HTI), Lancaster, Pennsylvania, employs approximately 260 salaried and 750 hourly workers in the manufacture of time fuses for the Department of Defense. In May 1982, the company changed locations, moving from a large, open manufacturing facility with windows into an energy-efficient, windowless, four-story building that was formerly a department store. The present building, occupying approximately 200,000 sq. ft., is about one-third smaller than the previous building, yet houses the same machinery. Renovations including, but not limited to, modifications of the existing ventilation system and installation of dedicated local exhaust ventilation systems were needed to make this building suitable for industrial use.

Manufacturing operations at HTI involve those typically found in machine shops, i.e., cutting, drilling, tapping, and boring of various metal components using lathes, drill presses, screw and milling machines, with the principal environmental contaminant being oil mist. Purchased metal parts are machined to specifications, degreased and deburred, painted or plated if necessary, then assembled into fuses. The first, third and fourth floors are used for manufacturing; the second floor houses the offices. All of the machining, degreasing, and painting, operations are performed either on the first or third floors. Final assembly of fuses is done exclusively on the fourth floor.

Following the move, the company continued to make changes in the ventilation system and in specific manufacturing operations in an attempt to improve environmental conditions in the building. Changes in the ventilation included: (1) A 15% increase in the amount of supply air in the building (of which 20% is outdoor air) to provide a minimum of 4 air changes per hour, (2) Installation of electrostatic precipitators in the Automatics and Secondary Departments to control oil mist, (3) Installation of dust collectors in the grinding and maintenance areas, and (4) Installation of additional ducting to provide conditioned air to problem areas which were difficult to control with regard to temperature and humidity. Process changes made after the move included replacement of trichloroethane degreasers with enclosed and/or ventilated freon degreasers, substitution of all but two petroleum-based cutting oils with water-based formulations, and discontinuation of use of Chucker machines. Most of the ventilation and process changes were made between December 1982, and our last site visit in November 1983. These changes, according to the company, considerably improved environmental conditions in the building and lessened many of the complaints concerning the air quality.

IV. METHODS AND MATERIALS

A. Environmental

Air samples for oil mist, solvent vapors, and acetic acid vapors, and psychrometer meausurements were obtained on November 17-18 and December 15 and 16, 1983. However, due to analytical problems, the only environmental data that will be present in this report from these two site visits will be the psychrometric data. Air sampling data included in this report will be from the second follow-up survey conducted on November 29-30, 1983. During this visit, NIOSH collected a total of 39 full-shift breathing zone air samples. These included 34 air samples for oil mist from operators and/or set up persons in the Automatics, Gear Cutting, Secondary, and Automatic Machine Screw (AMS) departments, two air samples for solvent vapors from the paint sprayer in the Finishing Department, and three air samples for acetic acid from assemblers using silicone sealant. A brief description of the sampling and analytical methods used to collect these air samples is provided below.

Oil Mist

Air samples were collected on pre-weighed polyvinyl chloride filters (0.5 um pore size) using sampling pumps calibrated at 1.5 liters per minute (Lpm). Although analyses by fluorescence and/or infrared spectrophotometry is common for oil mist, all 34 samples were analyzed gravimetrically[1] since, on the basis of recent company industrial hygiene data, relatively low environmental levels were expected. Because this method is not specific for oil mist the actual oil mist levels should be considered a maximum. The analytical precision of the weighings was reported as 0.01 milligrams (mg) per sample.

Paint Solvent Vapors

Prior to the November 1983 survey, the manufacturers of the paint systems used in the Finishing Department were contacted to obtain information on the specific chemical substances contained in their products. Based on this information we decided to evaluate the paint sprayers' exposure to five solvents, including dioxane, cellosolve acetate, n-butyl alcohol, diacetone alcohol, and toluene. Because of the number of solvents of interest in the paint formulation, two charcoal tubes were used to collect the vapor mixture. The tubes were connected to sampling pumps operating at 0.05 Lpm. The two alcohols were analyzed from one tube, and the remaining three compounds were analyzed from the other tube. The compounds were desorbed from the charcoal with carbon disulfide and analyzed by gas chromatography according to NIOSH Method P&CAM 127[2]. The limit of detection for all five analytes was 0.01 mg per sample.

Acetic Acid

Air samples were collected on charcoal tubes connected to sampling pumps calibrated at 0.25 Lpm. The charcoal samples were desorbed in formic acid and analyzed by gas chromatography according to NIOSH Method S169[3]. The limit of detection for the analysis was 0.01 mg per sample.

Ventilation

In order to assess the general ventilation system NIOSH obtained information from the company regarding any changes made to the system since HTI first occupied the building, in addition to specifications for the system as it was operating during our follow-up survey in November 1983. Parameters including total capacity of system, make-up air component, and air exchange rate, were obtained for comparison to pertinent guidelines recommended by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)[4]. In addition, psychrometric measurements were taken with a battery-powered psychrometer throughout the building and were compared to ASHRAE guidelines.

B. Medical

During the initial site visit, November 17-18, 1982, the NIOSH medical officer conducted unstructured interviews with approximately 80 employees in a number of production areas of the plant. These areas were selected on the basis of the walk-through survey of the plant, and according to information obtained from both management and union representatives regarding areas where large numbers of employees had complained of health problems.

On the follow-up visit, December 8, 1982, a questionnaire was administered to 228 production workers in the following areas: chucker (multiple spindle), automatics, gear cutting, and finishing areas on the first floor; secondary area on the third floor; and M577 line on the fourth floor. Although we did not intend to survey the AMS department, seven employees from AMS, which is contiguous with the secondary area, nevertheless filled out questionnaires. The office workers on the second floor, representing a presumably unexposed comparison group, filled out an identical questionnaire.

The questionnaire contained questions pertaining to demographic information, medical history, job parameters and adverse health effects from overexposure to solvents or irritant chemicals, or from working in an environment with excessively low relative humidity. Included were questions pertaining to headache, nausea, vomiting, dizziness, soreness of nose/throat, cough, shortness of breath, chest pain, wheezing, and nosebleeds. A question on skin problems, a common health hazard of working with cutting oils, was inadvertently omitted from the questionnaire. However, a number of workers did mention skin problems in the question regarding "other symptoms".

V. EVALUATION CRITERIA

A. Environmental 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 standards, 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 only 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.

Table I summarizes the environmental criteria for sampled substances with a brief description of their primary health effects.

In assessing health hazards where workers are exposed to a mixture of organic solvents which produce similar health effects upon exposure, overall effects are considered additive. The following formula, published by ACGIH[7], was used in this study to calculate exposure to contaminant mixtures:

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \frac{C_3}{T_3} \quad \ldots$$

Where C_1 is the airborne concentration of contaminant 1 and T_1 is the evaluation criteria of contaminant 1, etc. If the sum of the fraction exceeds unity, then the recommended environmental exposure limit for the mixture is exceeded.

B. Ventilation

Neither NIOSH nor OSHA has developed ventilation criteria for general offices. The criteria used by design engineers are the guidelines and consensus standards published by ASHRAE.

The earlier guidelines for ventilation rates in commercial and residential buildings are based on a number of research projects carried out in the 1920's and 1930's. The research investigated the ventilation rates required to control body odors in test chambers with comfortable levels of temperature and humidity. It was found that the required ventilation rates varied considerably.

The early ASHRAE standards were based on studies performed before the more modern airtight office buildings became so common. These older buildings probably permitted more natural air infiltration, that is, leakage through cracks and interstices, around windows and doors, and through floors and walls, into the buildings. The modern buildings are probably much more airtight and probably permit much less air infiltraton. Due to the reduced infiltration, it was questioned whether the 1973 ASHRAE minimum ventilation values assured adequate outdoor air supply in modern, airtight buildings.

Subsequently, ASHRAE has revised its standard and has published a new standard in 1981. (ASHRAE 62-1981 "Ventilation for Acceptable Indoor Air Quality").[4] The new standard is based on an occupant density of seven persons per 1000 square feet of floor area and recommends higher ventilation rates for areas where smoking is permitted. The new ASHRAE standard states that indoor air quality for general offices shall be considered acceptable if the supply of outdoor air is sufficient to reduce carbon dioxide to less than 2,500 ppm and to control contaminants, such as various gases, vapors, microorganisms, smoke and other particulate matter, so that concentrations known to impair health or cause discomfort to occupants are not exceeded. However, the threshold levels for health effects from these exposures are poorly documented. For general offices where smoking is not permitted, the rate recommended under the new standard is 5 cfm of outdoor air per person. Higher ventilation rates are recommended for spaces where smoking is permitted because tobacco smoke is one of the most difficult contaminants to control at the source. When smoking is allowed, the amount of outdoor air provided should be 20 cfm per person. Areas which are non-smoking may be supplied at the lower rate (5 cfm/person) provided that the air is not recirculated from, or otherwise enters from, the smoking areas.

C. Humidity and Temperature

The majority of references addressing temperature and humidity levels as they pertain to human health appear in the context of assessing conditions in hot environments. Development of a "comfort" chart by the American Society of Heating, Refrigeration, and Air-Conditioning Engineers presents a comfort zone considered to be both comfortable and healthy. This zone lies between 73 and 77°F (23 and 25°C) and 20 to 60 per cent relative humidity. Relative humidity levels below 30% are associated with increased discomfort and drying of the mucous membranes.[14]

VI. RESULTS

A. Environmental

Environmental data from our earlier surveys (November/December 1982) were suspect and thus will not be reported here.

Oil mist exposure levels of set up personnel and operators of machines using cutting oils (November 1983) are presented in Table 2. Environmental concentrations ranged form 0.06 to 1.56 mg/M^3, with an average of 0.40 mg/M^3. The highest levels were measured for workers operating indexing machines in the AMS department and the drill press in the secondary department. None of the samples exceeded the evaluation criteria of 5.0 mg/M^3 (OSHA and ACGIH).

The airborne mixed solvent exposures for the paint sprayer are presented are presented in Table 3. Airborne concentrations of the solvent mixture, equivalent to an 8 hour TWA, were calculated to be 54 and 56% of the TLV for mixtures, when the most stringent health criteria are applied. Dioxane, with its relatively low recommended exposure limit (NIOSH) of 3.6 mg/M^3, accounted for about 80 to 90% of the calculated exposure index. When applying the less stringent OSHA standards, however, the calculated 8 hour TWA exposure index for the solvent mixture was considerably less, about 1% of the TLV for mixtures.

The three breathing zone air samples obtained from assemblers using silicone sealer on the M577 fuse line indicated that workers were exposed to acetic acid at concentrations ranging from 2.8 to 5.2 mg/M^3 (Table 4). The highest concentration was about 20% of the OSHA standard (and ACGIH TLV) of 25 mg/M^3.

Ventilation

Information obtained from the company indicated that they increased the volumetric flowrate of the HVAC system from 172,000 to 198,000 CFM between our 1982 and 1983 surveys. This, in effect, provided a complete change of air in the building every 16 minutes, equivalent to 4 air changes per hour. Since at least 20% (40,000 CFM) of the supply air is from outdoors this means that during peak occupancy (750 employees) each person in the building is provided with approximately 53 CFM of fresh air, assuming that the air is equally distributed throughout the building. This level of fresh air, by comparison, is about 10 times higher than the minimum recommended by ASHRAE. It is interesting to note that even before the increase, the amount of fresh air provided to each person was also well above the ASHRAE guidelines (46 CFM).

Psychrometric measurements (Table 5) revealed that the temperature and relative humidity were generally uniform throughout the building on the three days measurements were taken. The air temperature ranged from 72 to 77°F while the relative humidity ranged from 19 to 41%. Temperature and humidity were within the ASHRAE recommended comfort zone.

B. Medical

During the initial visit, no attempt was made to interview all employees, since the objective was primarily to identify the types of health problems experienced by employees. The most frequent complaint was of dryness of the nose and throat; headaches were also common. Other complaints were of tiredness, nausea, eye irritation, and dermatitis.

In order to better document the types and frequency of health problems among employees, a questionnaire was administered during the return visit. Questionnaires of eight production workers contained insufficient information for use in the analysis. Accordingly, data obtained from 220 production and 31 office workers were analyzed. Results are summarized in Table 6. Symptoms which could be attributed to medical conditions listed on the questionnaire were excluded from the totals. The four most common symptoms reported by workers in each department are nose/throat irritation, headache, drowsiness/tiredness, and eye irritation (Table 7).

Prevalence of each symptom, by department, was compared to that among the office workers, a group presumably unexposed to chemicals. By Fisher's exact test (one-tailed) only dizziness in the secondary ($P=0.013$) and M577 ($P=0.021$) departments were found to be significantly higher at the 5% level. For all production areas combined vs. office area, only dizziness was found to be more frequent ($P=0.024$).

Ten cases of dermatitis were reported: three in automatics, five in secondary, and one each in chuckers and M577. Frequent complaints in all production departments surveyed included "stale, dry air", "poor quality air", "lack of fresh air", "poor ventilation", and "temperature variability".

VII. DISCUSSION

A. Environmental

The environmental findings presented in this report represent environmental conditions existing in the plant after ventilation and process changes were made, and at a time where complaints concerning poor air quality were no longer reported by workers. Our air sampling results show that the levels of oil mist, solvents, and acetic acid vapors were low and at levels where workers would not normally have any associated health problems. While we were unable to document the air levels of these contaminants during our site visits in late 1982, when workers reported symptoms, contaminant levels existing at the plant at that time were probably higher since most of the changes in the ventilation and process were made after that time. Whether they were high enough to produce symptoms in exposed workers is unknown.

Information provided by the company indicated that the HVAC system was providing ample amount of air to the building, well above that recommended by ASHRAE. This is typical in most manufacturing facilities. However, the problem appeared to be in the distribution of the air. Apparently in some areas of the building the air was not properly distributed, and consequently workers became uncomfortable. Installation of additional ducting in these problem areas, according to the company and union, remedied the situation.

B. Medical

Analysis of questionnaire data essentially confirmed our impression that at the time of our initial site visit a large number of employees were experiencing symptoms of upper respiratory irritation, headaches, eye irritation and tiredness. What was surprising, however, was the large percentage of office workers experiencing similar problems. Indeed, the four most common symptoms among office workers were the same as those in most of the other departments surveyed (Table 6). While the explanation for this phenomenon is unclear, these data suggest that the factor responsible for at least some of these symptoms is found throughout the plant, possibly inadequate air circulation. The relative humidity readings alone, while on the lower end of the acceptable range, would not account for such widespread health problems.

Prevalence of symptoms was not significantly higher in production departments compared to the office area, except for dizziness in the secondary and M577 areas. These generally negative results should be interpreted cautiously, since the comparison group (office workers), while not working with chemicals, is exposed to similar conditions of temperature, humidity, and probably air circulation, as production workers. This fact, combined with the small number of workers in some departments, may mask true differences in rates of frequency of symptoms which could be ascribed to chemical exposure. It seems reasonable to postulate that oil mists and/or chemical vapors in production areas, worse on some days than others, could, in combination with rather low humidity and localized inadequate air circulation, contribute to the health problems of employees. Temperature variability in the plant could also add to employee discomfort. While a small number of workers on the M577 line might, on occasion, be exposed to vapors from the freon degreaser, which could cause dizziness, the high overall frequency of dizziness reported on the M577 line and secondary areas is not readily explained by any occupational chemical exposure.

Another health problem among employees at the plant is dermatitis among workers exposed to petroleum-based cutting oils. Since a question pertaining to skin rashes was inadvertently omitted from the questionnaire (workers therefore had to write in skin rash under the "other" category), the ten cases of dermatitis picked up by the questionnaire probably represent a minimum estimate of the extent of the problem. Recent substitution of most of water-based cutting oils for the petroleum-based cutting oils should help to minimize this problem.

Although certain health problems resulting from chemical exposure do affect a small number of workers in the plant, the major problem appears to be one of poor air distribution which may have caused certain areas in the plant to become uncomfortable. While the health complaints are relatively minor, and there is little reason to believe that they will develop into more serious difficulties, many of these problems are likely the result of environmental factors at the plant which appear to have been corrected prior to our (last) site visit in November 29-30, 1983.

VIII. RECOMMENDATIONS

All of the recommendations listed below were already provided to the company in interim reports.

1. All workers exposed to cutting oils should be provided with proper uniforms to minimize skin contact with the oil. This includes oil-resistant gloves and, as an interim measure, oil-resistant aprons for protection against splashes if proper enclosures or splash guards have not yet been installed. Workers exposed to cutting oils should be encouraged to cleanse soiled skin at work breaks, followed by thorough drying and application of emollient cream. Work clothing should be changed daily.

2. The company should consider substituting dioxane and cellosolve acetate in the paint formulation with solvents which are less toxic. It appears that the higher molecular weight glycol ethers are less toxic and may be good substitutes for cellosolve acetate (a low molecular weight glycol ether). If this is not feasible, the existing ventilation in the paint booth should be increased to further reduce airborne levels. In the interim, continued use of approved respirators, impervious gloves, and coveralls is recommended.

3. Eating and drinking at the work stations should be discontinued since inadvertent ingestion of chemicals is a possibility. These activities should be confined to the break areas.

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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, Publications Dissemination Section, 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. Hamilton Technology, Lancaster, Pennsylvania
2. American Federation of Grain Millers Union, Local 687
3. NIOSH, Region III
4. OSHA, Region III

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

Evaluation Criteria

Hamilton Technology, Incorporated
Lancaster, Pennsylvania
HETA 83-003

Substance	Evaluation Criteria[1] (mg/m^3) NIOSH	ACGIH	OSHA	Primary Health Effects	Reference
Acetic Acid	-	25	25	eye and upper respiratory tract irritation, primary skin irritant	9
n-Butyl Alcohol	-	150(c,s)	300	eye and upper respiratory tract irritation, central nervous system (CNS) depressant at high concentrations, potential audiometric impairment	10
Cellosolve Acetate (2-Ethoxyethylacetate)	-	27(s)	540	eye and upper respiratory tract irritation, CNS depressant, may produce dermatitis with repeated contact, may cause adverse reproductive effects in experimental animals	11
Diacetone Alcohol	-	240	240	eye and upper respiratory tract irritation, CNS depressant at high concentrations, dermatitis	10
Dioxane	3.6(c)	90(s)	360	eye and upper respiratory tract irritant, CNS depressant, adverse kidney and liver changes, suspect human carcinogen	5
Oil Mist, Mineral	-	5	5	pulmonary effects rare, possible irritation; lipoid pneumonia possible following aspiration, dermatitis from direct contact with liquid oil	12,13
Toluene	375	375(s)	752	eye and upper respiratory tract irritation, CNS depressant, dermatitis	6

[1] NIOSH: National Institute for Occupational Safety and Health. See references 5 and 6.
ACGIH: American Conference of Governmental Industrial Hygienists - Threshold Limit Values, 1983-1984, Reference 7.
OSHA: Occupational Safety and Health Administration, Reference 8.
c - ceiling limit, value should never be exceeded
s - indicates substances can be readily absorbed through skin.

Table 2

Oil Mist Exposure of Machine Operators and Setup Personnel in the Automatics, Gear Cutting, Secondary, and AMS Departments

Hamilton Technology, Incorporated
Lancaster, Pennsylvania
HETA 83-003

November 29-30, 1983

Date	Department	Job Classification	Sample Time (min)	Sample Volume (liters)	Oil Mist* Concentration (mg/m^3)
11-29	Automatics	Screw Machine Op.	429	643	1.17
11-30	Automatics	Screw Machine Op.	461	691	0.46
11-30	Automatics	Screw Machine Op.	456	684	0.25
11-30	Automatics	Screw Machine Op.	457	685	0.19
11-29	Automatics	Setup Person	477	715	0.15
11-29	Gear Cutting	Gear Cutting Machine Op.	441	661	0.17
11-29	Gear Cutting	Gear Cutting Machine Op.	477	715	0.10
11-30	Gear Cutting	Gear Cutting Machine Op.	411	616	0.06
11-30	Gear Cutting	Gear Cutting Machine Op.	451	676	0.18
11-29	Gear Cutting	Setup Person	472	708	0.08
11-29	Gear Cutting	Setup Person	468	702	0.15
11-30	Gear Cutting	Setup Person	451	676	0.10
11-30	Gear Cutting	Setup Person	446	669	0.12
11-29	Secondary	Drill Press Op.	472	708	1.41
11-30	Secondary	Drill Press Op.	460	690	0.54
11-29	Secondary	Lathe Op.	460	690	0.06
11-30	Secondary	Lathe Op.	474	711	0.10
11-29	Secondary	Lathe Op.	467	700	0.16
11-30	Secondary	Lathe Op.	474	711	0.07
11-29	Secondary	Kummer Lathe Op.	428	642	0.73
11-30	Secondary	Kummer Lathe Op.	436	654	0.41
11-29	Secondary	AHC Lathe Op.	477	715	0.17
11-30	Secondary	AHC Lathe Op.	476	714	0.24
11-29	Secondary	Milling Machine Op.	461	691	0.26
11-30	Secondary	Milling Machine Op.	264	396	0.15
11-29	Secondary	Milling Machine Op.	461	691	0.26
11-30	Secondary	Milling Machine Op.	406	609	0.21
11-29	Secondary	Milling Machine Op.	451	676	0.15
11-29	AMS	H & K Machine Op.	440	660	0.20
11-30	AMS	H & K Machine Op.	475	712	0.22
11-29	AMS	Indexing Machine Op.	447	670	1.33
11-30	AMS	Indexing Machine Op.	471	706	1.56
11-29	AMS	Indexing Machine Op.	427	640	0.89
11-30	AMS	Setup Person	473	709	1.25
Evaluation Criteria:					5.0

* Since these samples were analyzed gravimetrically, actual oil mist levels maybe somewhat lower.

Table 3

Solvent Concentrations in Air Samples Obtained from the Paint Sprayer

Hamilton Technology, Incorporated
Lancaster, Pennsylvania
HETA 83-003

November 29-30, 1983

Date	Sample Time (min)	Sample Volume (liters)	Environmental Concentration[1] (mg/m³) Dioxane	Cellosolve Actetate	n-butyl Alcohol	Diacetone Alcohol	Toluene	Percent of TLV For Mixture[2]
11-29	376	18.3	1.7	1.2			ND	0.54
	376	18.7			4.6	ND		
11-30	376	18.6	1.6	2.5			ND	0.56
	376	18.0			5.2	ND		
Evaluation Criteria:			3.6	27	150	240	375	1.00
OSHA Standards:			360	540	300	240	752	

ND - not detected
1. airborne concentrations are equivalent to an 8 hour time-weighted average
2. ACGIH TLV's (1983-84) Threshold Limit Values for Mixtures

The following formula was used to calculate exposure index for solvent mixtures:

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n}$$

where C_1 is the airborne concentration of solvent 1 and T_1 is the exposure limit of solvent 1, and so on. If the sum of the fractions exceed unity (1), then the TLV of the mixture is exceeded.

Table 4

Acetic Acid Exposures of Assemblers Using Silastic on the M577 Line

Hamilton Technology, Incorporated
Lancaster, Pennsylvania
HETA 83-003

November 29-30, 1983

Date	Sample Time (min)	Sample Volume (liters)	Airborne Acetic Acid Concentration (mg/m^3)
11-29	436	109	5.2
11-29	433	108	2.8
11-30	464	126	4.5
Evaluation Criteria:			25.0

Table 5

Psychrometer Measurements

Hamilton Technology, Incorporated
Lancaster, Pennsylvania
HETA 83-003

November 18, December 15, 1982
November 30, 1983

Date	Location	Time	Dry Bulb (°F)	Wet Bulb (°F)	Relative Humidity (percent)
	1st Floor				
11/18/82	Gear Cutting	12:00n	76	58	31
	2nd Floor				
	Office	11:45a	73	57	35
	3rd Floor				
	AMS	11:40a	74	57	33
	4th Floor				
	Assembly	12:10p	75	60	41
	1st Floor				
12/15/82	Gear Cutting	2:31p	73	55	30
	2nd Floor				
	Office	2:18p	74	55	27
	3rd Floor				
	AMS	2:11p	73	53	24
	4th Floor				
	Assembly	2:03p	72	54	29
	1st Floor				
11/30/83	Gear Cutting	8:50a	77	57	27
	Gear Cutting	1:45p	77	54	19
	2nd Floor				
	Office	8:35a	77	54	19
	Office	1:45p	76	55	23
	3rd Floor				
	AMS	8:30a	76	57	29
	AMS	1:40p	77	54	19
	4th Floor				
	Assembly	8:40a	77	55	22
	Assembly	1:35p	76	55	23

Table 6

Symptoms Reported by Workers on Questionnaire

Hamilton Technology, Incorporated
Lancaster, Pennsylvania
HETA 83-003

December 8, 1982

Department	No. Interviewed	Male/Female Ratio	Age (yrs) Range	Age (yrs) Mean	No. (%) Reporting Symptoms: Headache	Nausea	Vomiting	Dizziness
Gear Cutting	18	8/10	20-54	38	11 (61)	3 (17)	0 (0)	2 (11)
Automatics	18	17/1	23-58	44	6 (33)	0 (0)	0 (0)	0 (0)
Chuckers (Multiple Spindle)	8	5/3	27-53	33	6 (75)	1 (13)	0 (0)	2 (25)
Finishing	16	14/2	25-43	31	11 (69)	4 (25)	0 (0)	2 (13)
Secondary and AMS	62	32/30	19-65	33	23 (37)	5 (8)	2 (3)	14 (23)
M577	98	6/92	18-63	43	58 (59)	8 (8)	1 (1)	19 (19)
All Production Workers	220	82/138	18-63	39	115 (52)	21 (9)	3 (1)	39 (17)
Office Workers (2nd Floor)	31	11/20	24-62	40	15 (48)	2 (7)	0 (0)	1 (3)

(continued)

Table 6 (continued)

Symptoms Reported by Workers on Questionnaire

Department	Nose/Throat Dry or Sore	Eye Irritation	Drowsiness Tiredness	Cough	Short of Breath	Chest Pain	Wheezing	Nosebleed
Gear Cutting	15 (83)	7 (39)	9 (50)	4 (22)	1 (5)	0 (0)	0 (0)	1 (5)
Automatics	7 (39)	2 (11)	3 (17)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Chuckers (Multiple Spindle)	5 (63)	4 (50)	0 (0)	3 (37)	0 (0)	1 (13)	0 (0)	1 (13)
Finishing	7 (44)	4 (25)	10 (63)	3 (19)	0 (0)	3 (19)	0 (0)	2 (13)
Secondary AMS	33 (53)	19 (31)	21 (34)	7 (11)	9 (15)	6 (10)	2 (3)	1 (2)
M577	70 (71)	38 (39)	56 (57)	11 (11)	7 (7)	5 (5)	2 (2)	11 (11)
All Production Workers	137 (62)	74 (34)	99 (45)	28 (13)	17 (8)	15 (7)	4 (2)	16 (7)
Office Workers (2nd Floor)	21 (68)	14 (45)	14 (45)	4 (13)	2 (7)	0 (0)	1 (3)	0 (0)

Table 7

Four Most Common Symptoms, Ranked in Descending Order of Frequency, by Department

Hamilton Technology, Incorporated
Lancaster, Pennsylvania
HETA 83-003

December 8, 1983

Gearcutting, Automatics, Secondary, M577 Line, Office Workers	Finishing	Chuckers
1. Nose/throat dry or sore	1. Headache	1. Headache
2. Headache	2. Drowsiness/Tiredness	2. Nose/throat dry or sore
3. Drowsiness/tiredness	3. Nose/throat dry or sore	3. Eye irritation
4. Eye irritation	4. Eye irritation	4. Coughing

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