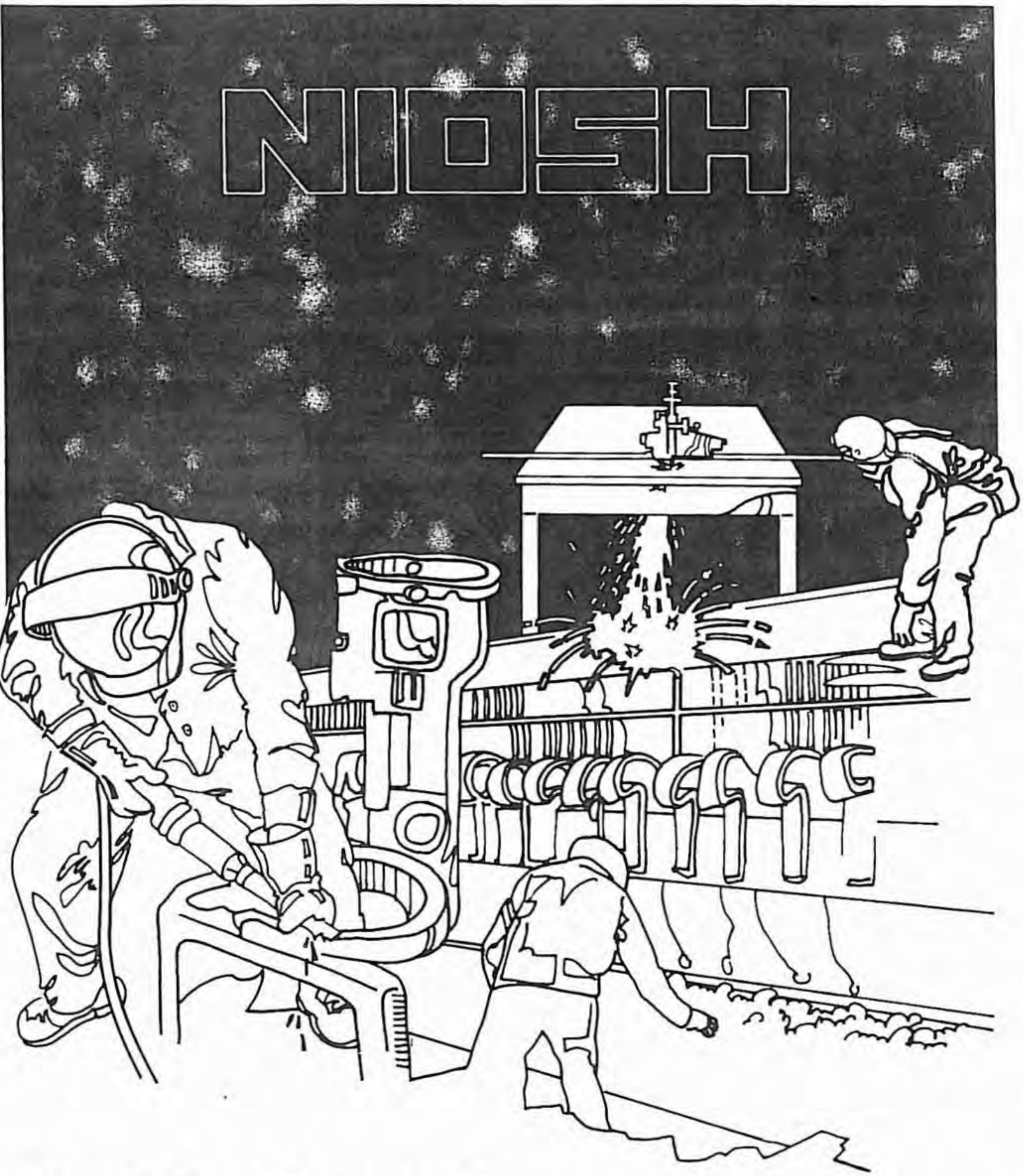
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 81-439-1256
ROBINSON-NUGENT, INC.
NEW ALBANY, INDIANA

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 81-439-1256
JANUARY 1983
ROBINSON-NUGENT, INC.
NEW ALBANY, INDIANA

NIOSH INVESTIGATORS:
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I. SUMMARY

In August 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate environmental conditions in the Electroplating Department of their factory. The requestors were concerned about reports of extended menstrual periods and excessive menstrual bleeding from employees in this department.

On August 31, and September 1, 1981, NIOSH collected 15 personal breathing zone and seven area environmental air samples analysis for lead, nickel, hydrogen cyanide, hydrogen fluoride, phosphoric and sulfuric acid, and total alkalinity. A questionnaire survey of all workers in the Electroplating Department and, for comparison, a sample of workers from the Pin socket and general assembly department (P & GA) was made.

With two exceptions, all personal area and breathing zone concentrations of substances measured were found to be within recommended limits (nickel, 0.008 to 0.05 mg/m^3; lead, non-detectable; cyanide, non-detectable; fluoride, non-detectable to 0.072 mg/m^3; total alkalinity, non-detectable; phosphoric acid mist non-detectable).

The overall rate of menstrual disorders was found to be significantly higher in the workers in the Electroplating Department when compared to the P & GA group (83% vs. 52%). A higher but not significant prevalence of increased menstrual flow (42 vs. 33%) was also found. Other workplace-related health problems were identified including dermatitis, eye irritation, and headache, but only eye irritation was significantly higher in the electroplaters ($P = 0.05$).

Based on the results of the environmental evaluation, NIOSH found no evidence of lead, nickel, hydrogen cyanide, hydrogen fluoride, phosphoric acid, sulfuric acid or total alkalinity concentrations in excess of recommended levels. In light of present knowledge, we cannot attribute the reported menstrual effects to chemicals to which these workers are exposed, but it is possible that a work requirement that electroplating workers stand all day may be a contributing etiologic factor.

Recommendations for changing the latter practice, modification of the existing ventilation system, establishment of a environmental surveillance system, and the use of personal protective devices are made in Section VIII.

KEYWORDS: SIC 3470, Electroplating, Menstrual Disorders, Eye Irritation, Metal Mist, Lead, Nickel, Hydrogen Cyanide, Hydrogen Fluoride, Phosphoric Acid, Sulfuric Acid, Total Alkalinity

II. INTRODUCTION/BACKGROUND

On August 19, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a joint request from the the United Auto Workers Local Union 1708, and the Manager of Human Resources, Robinson-Nugent Corporation, to investigate exposures of employees working in the Electroplating Department (E.P.). They were concerned about vapors and mists such as lead, nickel, alkaline mists, hydrogen cyanide, and sulfuric and phosphoric acids emanating from the various tanks. There was also concern about the potential toxic effects of the plating cast on electrical component parts which were made of tin-lead, gold, silver, and/or nickel. The health effects of particular concern included extended menstrual periods and excessive menstrual bleeding reports by employees in the Electro Plating Department

In January, 1982, a five-page interim report which included preliminary environmental and medical findings and initial recommendations was submitted to the company and union by NIOSH.

III. PROCESS DESCRIPTION

The E.P. department employs about 18 people on two shifts to electroplate tin, nickel, silver and gold onto brass and copper intergrated circuits. There are two barrel plating lines, and six strip plating lines in the department, each of which is approximately 30 feet long with about eight plating cells and corresponding holding tanks (30 to 70 gallon each). The plating cells where the acutal plating process occurs carry relatively low plating currents (100-500 amps) and temperatures (75°F to 140°F). The nickel tanks are maintained at the highest temperature, and the tin cell operates on the highest current. On the strip plating lines, plating solutions are continually circulated through the plating cells by small pumps, from holding tanks located directly below each cell. The strip lines are so named because the circuits being plated are connected together forming a long strip which is pulled through the plating cells in one continuous motion and rolled up on large reels. On the barrel plating lines the plating occurs in open surface tanks. Circuits are placed in eight inch long, 5" diameter perforated barrels which are manually dipped in each to tank on the plating line.

The work force includes plating line operators, lead persons, maintenance workers, and laboratory technicians. Maintenance workers may spend various amounts of time in the plating department depending on frequency of malfunction. Personnel from the laboratory in a room adjacent to the electroplating lines are responsible for taking quality control samples daily and chemically recharging the plating tanks once or twice weekly. Approximately two months prior to the survey, line operators had performed recharging duties on their own lines. The operators and lead persons continually walk their plating line monitoring the tanks, and are responsible for repositioning strips of intergrated circuits that break during the plating process. There is one operator and one lead person at the end of each line who operates the controls, loads and unloads the spools, and corrects minor line malfunctions. A typical plating line consists of a series of tanks containing in succession, an alkaline cleaner, an acid dip, nickel sulfamate, potassium gold cycanide, a 95% tin fluoroborate, 5% lead fluoroborate mixture and a mild alkaline cleaner. Plating lines differ slightly but personal exposures are similar.

The degreasing department is in a separate room of the plant. Circuits are manually dipped in a 50-gallon trichlorethylene degreasing tank before going to the plating department. The one degreasing department operator bends over the tank to dip the circuits and subsequently sets them aside on an adjacent table to air dry.

The most recent process change occurred two years age. The tin-low lead line was introduced to the system. The most recent procedural change occured about two months prior to the NIOSH survey, when the duty of adding chemicals to the plating tanks was given to a laboratory technician. Prior to that, it had been done by the operator of each line.

IV. DESIGNS AND METHODS

A. Environmental Evaluation

An industrial hygiene survey was conducted on all eight lines (6 strip, 2 barrel plating) of the Electroplating Department by NIOSH industrial hygienists.

Potential contaminants measured during the survey include area and personal breathing zone samples for sulfuric and phosphoric acid, total alkalinity, hydrogen cyanide, hydrogen fluoride, nickel and lead.

Eight personal samples and one area sample for sulfuric and phosphoric acid were collected on impregnated silica gel tubes with personal sampling pumps operating at 0.20 liters of air per minute (Lpm). These samples were analyzed by ion chromatography (NIOSH method P & CAM No. 339).[1]

Two personal and two area total alkalinity samples were collected on teflon filters with personal sampling pumps operating at 2.0 Lpm. These samples were analysed using titration (NIOSH Method No. S-381).[1]

Three personal and four area hydrogen cyanide and hydrogen fluoride samples were collected on impregnated AA filters using personal sampling pumps operating at 2.0 Lpm. Analysis was conducted using a specific ion electrode (NIOSH Method No. P & CAM 212)(1) with the following modification for particulates: Both filters and standards were placed in nickel crucibles containing 5 ml of 20% NaOH. The samples were dissolved with distilled water and quantitatively transferred to a plastic breaker to a volume of 20 ml. The potentials of the electrode system were then measured giving a value corresponding to cyanide concentration. Upon completion of the cyanide analysis, each sample was then neutralized to a pH of 5 $\pm$ 0.5 with 2:1 HCl and diluted to a volume of 25 ml with distilled water. An equal volume of TISAB solution (P & CAM 117-2, sec. 7.7)(1) was added to each breaker. The potentials of the electrode system were measured and data used to calculate the amount of particulate and gaseous fluoride per sample filter from the appropriate standards.

Two personal breathing zone samples for lead and nickel were collected on AA filters using personal sampling pumps operating at the rate of 2.0 Lpm. These samples were analyzed according to NIOSH Method No. P & CAM 173.(1) Perchloric acid was used to complete the ashing of the filters.

Ventilation measurements were made on all hoods, slots, and other local exhausts in the plating department using a Kurtz air meter. A smoke tube technique was used to verify air flow directions.

Ventilation measurements and visual examination of work practices were conducted in the degreasing department where parts are manually dipped in trichloroethylene (TCE). No sampling was conducted since NIOSH was not aware of this process prior to the survey and, therefore had not prepared to sample TCE.

B. <u>Medical</u>

NIOSH distributed a questionnaire seeking information on demographic characteristics, menstrual and reproductive history, and past and present occupational exposures to the 12 women currently working in E.P. (both shifts) or the Quality Control Laboratory, and to an unexposed comparison group of 29 women from the plant Pinsocket and General Assembly Department (P & GA). Both groups were similar in age, sex, and race.

The interviewer met with each group to explain the purpose of the survey and to answer any questions. A total of 42 questionnaires was then distributed for self-administration. Upon return of the completed questionnaire each respondent was privately interviewed to provide an opportunity to discuss any other health work-related problems or concerns.

V. EVALUATION CRITERIA AND TOXICOLOGY

The exposure criteria to toxic chemicals are derived from existing human animal data, as well as the effects of industrial exposure. The recommended levels are those to which nearly all workers may be exposed for a 8-10 hour day, 40-hour work week, over a working lifetime with no adverse effects. However, due to variations in individual susceptibility, a small percentage of workers may experience effects at levels at or below the recommended exposure limit; a smaller percentage may be more seriously affected by aggravation of a pre-existing condition or by development of an occupational illness.

Two sources of criteria are use in this report to assess workroom concentrations of air contaminant: (1) NIOSH criteria for recommended standards; (2) Occupational Safety and Health Administration (OSHA) Standards (29 CFR 1910.100), 1980.(2) The most recent criteria are given prominence in this evaluation.

Substance	NIOSH Recommended Standard (mg/m^3)	Current OSHA Standard (mg/m^3)
Nickel	0.015 *(ref. 3)	1 **
Lead	0.05 **	0.05 **
Hydrogen cyanide	5 *** (ref. 6)	11 **
Hydrogen fluoride	5 **** (ref. 7)	-
	2.5 * (ref. 7)	2 **
Sodium hydroxide	2 **** (ref. 8)	2 **
Phosphoric acid	1 (ref. 9)	1 *
Sulfuric acid	1 * (ref. 10)	1 **

mg/m^3 = milligrams of substance per cubic meter of air
* 10 hour time weighted average
** 8 hour time weighted average
*** 10 minute ceiling level
**** 15 minute ceiling level

Nickel

Nickel can enter the body by inhalation, ingestion, and skin and eye contact. The most toxic route of entry is inhalation. Nickel is a skin and respiratory irritant, sensitizer and carcinogen. Acute effects of nickel overexposure include inflammation of the mouth and gums, metallic taste, metal fume fever, and nickel itch (skin rash). Chronic exposures may result in carcinoma of the nasal sinuses and lungs.(3)

NIOSH recommends that occupational exposure to nickel be controlled so that workers are not exposed to concentration greater than 0.015 mg/m^3(3) and that nickel be regulated as an occupational carcinogen. The NIOSH recommended standard for nickel is much lower than the OSHA standard, which was established prior to recent research implicating nickel as a potential carcinogen.

Lead

Lead enters the body primarily through inhalation and ingestion, and exhibits toxic effect on the kidneys, peripheral and central nervous systems, and the hematopoietic system. Effects of overexposure include weakness, tiredness, irritability, digestive disturbances, nephritis, and mental deficiencies. There is some suggestive evidence of adverse effects of lead exposure on the menstrual cycle.(4)

NIOSH recommends that occupational exposure to lead be controlled so that no workers are exposed to concentrations greater than 0.05 mg/m^3, similar to the OSHA standard.

Hydrogen Cyanide

Cyanides can enter the body through inhalation, ingestion, and skin contact. Acute high overexposure results in loss of consciousness and death. At lower concentrations acute symptoms include: weakness, headache, confusion, nausea, and vomiting, which may be followed by death. There may be damage to the central nervous system from prolonged anoxia. Effects from long term chronic exposure to cyanides are non-specific and rare.(6)

HYDROGEN FLUORIDE

Hydrogen fluoride can enter the body by inhalation, ingestion and skin absorption. Acute overexposure to hydrogen fluoride causes inflammation and congestion of the lungs, sometimes hours after exposure, which may result in death. Hydrogen fluoride is extremely irritating to the skin, eyes, nose, and throat. Chronic exposures to fluoride salts can cause changes in the bones, and irritation to the nose, throat, and bronchial tubes.(7)

SODIUM HYDROXIDE

Sodium hydroxide (Na OH) can enter the body by inhalation and ingestion. It is a strong alkaline and is corrosive to any tissue with which it comes in contact. Overexposure to sodium hydroxide dusts and mists can cause mild irritation or severe burns to the skin, eyes, and respiratory tract resulting in a severe chemical pneumonitis depending on the level of exposure.(8)

Phosphoric acid

Phosphoric acid can enter the body by inhalation and ingestion. Acute and chronic exposure will cause skin, eye, and respiratory tract irritation and can cause burns depending on concentration levels.[9]

Sulfuric Acid

Sulfuric acid can enter the body by inhalation and ingestion. Acute exposure can cause irritation to the skin, eyes, nose and respiratory tract. Long term chronic exposure to lower concentrations may cause teeth erosion, chronic eye irritation, and chronic inflammation of the nose, throat, and bronchial tubes.[10]

VI. RESULTS

A. Environmental

Results of environmental air sampling which included 15 breathing zone and 7 area samples with 7 different chemical analyses (See Tables 1-4) indicated that lead, hydrogen cyanide, hydrogen fluoride, total alkalinity, phosphoric acid, and sulfuric acid existed in concentrations which were below NIOSH laboratory analytical limits of detection. Two personal air samples for nickel showed exposure levels of 0.005 and 0.008 mg/m^3 (Table 1). These levels are below the NIOSH recommended standard of 0.015 mg/m^3 (8 hr. TWA) and the OSHA standard 1.00 mg/m^3 (8 hr. TWA) for nickel. In conclusion, environmental air measurements indicate that employees working in the plating department were not overexposed to lead, nickel, hydrogen cyanide, hydrogen fluoride total alkalinity, phosphoric add, or sulfuric acid during the survey. However, since nickel is considered by NIOSH to be a potential carcinogen, the company should strive to keep these exposures as low as possible through good work practices and maintenance of a porper ventilation system. One personal breathing zone 1-1/4 hour sample for fluoride showed a level of 0.072 mg/m^3. This is significantly below the NIOSH recommended criteria of 5.0 mg/m^3 for 15 minute period and 2.5 mg/m^3 for a 8-hour time-weighted average.

Results of ventilation measurements (Tables 5-6) taken on the slots and ports of the plating line system indicate a lack of pressure balance in the exhaust ducts is causing low slot velocities at the extremities of the system. Smoke released inside the acid storage area showed that airflow through the canopy hood was not sufficient to prevent gas escape. Ventilation measurement, along with a visual inspection of the degreasing area, indicate that a potential overexposure to trichloroethylene (TCE) exists due to a lack of proper local exhaust ventilation and poor work practices.

Information collected concerning personal protective equipment indicated that boots, gloves, aprons, etc. were not being used, because they did not fit properly, and therefore were cumbersome to wear and interfere with work practices.

B. Medical

Of the questionnaires distributed, 41 (98%) were completed and returned (one worker chose not to participate). Two questionnaires were returned but were incomplete. The exposed and non-exposed groups were similar in both racial distribution, (i.e., >75% caucasian), and age, (i.e., the majority being between 21 and 40 years of age). (Tables 7-8).

a. Reproductive System Complaints

Sixty-one percent (61%) of all women interviewed reported ever experiencing some change in their menstrual pattern with the prevalence rate significantly different among women in electroplating at 83% as compared to 52% among women in P & GA. Irregular periods, and increased flow accompanied by increased pains or cramps were the most frequently reported problems in both groups. (Table 9).

When asked whether they could relate the reported change to something in particular, only ten women attempted to do so, and 3 of them related it to the workplace. Seventeen percent (17%) of the exposed group and 24% of the controls reported using birth control pills or intrauterine devices (IUDs) at the time the change occurred, so this factor may have contributed to, or been associated with, the change in menstrual pattern.

The mean number of pregnancies for each group was similar, less than two per woman. There was no apparent gross excess of adverse outcomes but there were too few pregnancies to draw any epidemiologically meaningful conclusions. It was noted that the rate of premature births was five times higher in the women employed in EP when compared to women in P & GA; however, once again the number of premature babies is too small to make any comparison. (Table 10).

Finally, the reported prevalence rate of hysterectomies among the women interviewed which initially appeared to differ significantly between the electroplating department (1 of 12, or 8.3%) and the control group (8 of 29, or 28%) was in fact, similar, when statistical tests (chi-square, and Fischer's Exact test) were applied.

b. Non-Reproductive Health Complaints

Analysis of the questionnaires revealed several work-related health problems other than menstrual disorders. Although information was sought on 12 different health effects reported to be associated with the specific chemicals found at Robinson-Nugent, not all of these are a problem to the workforce. While skin problems and headaches were common, only eye irritation was significantly more frequent in EP employees ($x^2 = 4.413$; $P = 0.05$) (Table 11).

VII. SUMMARY AND DISCUSSION

a. Reproductive

The literature supports several possible theories which could explain the reported menstrual irregularities among women working in the E.P. department. A review paper by Zielhuis and Wibowo which looked at the reported effects of lead on reproductive function in females and

males. Reports from the late 19th and early 20th century state that disturbances of menstruation, including irregularity of menses, amenorrhea, dysmenorrhea and menorrhagia, occur commonly in women with lead poisoning. The authors conclude "there is suggestive evidence that in moderate exposure there is an increased incidence of menstruation disturbances".[11]

A study done in 1975 on Scandinavian women at the workplace to determine changes in their work capacity before, during, and after menses, revealed that at 70% of their usual work load, pulmonary ventilation (l/min) was highest during menstruation. It is conceivable that a greater amount of chemical vapors are being inhaled at this time and therefore produce more noticeable physiological effects. Second, the authors found perceived physical exertion among the women to be greater at the time of menstruation.[12]

Michon's study of women working with aromatic hydrocarbon exposures demonstrated that body position affects the menstrual flow, i.e., abundant flow was most numerous among women who stand during work.[13] Approximately six months ago there was a change in policy at the plant which caused the employees of the electroplating department to stand for the entire shift whereas P & GA workers sit for all or part of their shift. Prior to this, chairs were provided for the women to sit on; and, therefore, they alternated between the two positions. A short time after this policy change was affected, there was a complaint of extended menstrual periods and increased flow from the female workers in this area. Prevalence of "increased flow" and "increased pain/cramps" was found to be similar in both groups (42 vs. 35%, and 42 vs. 31%). However, between 20% and 40% of the women in electroplating reported these symptoms within the past 6 months compared to none in the control. Therefore, it is possible that some event occurred within the past 6 months in E.P. which contributed to this change in menstrual patterns.

There are several limitations to consider when reviewing these studies however. In the paper on lead, quantitative data on levels of exposure are lacking. Since we therefore do not know how the authors define "moderate exposure" it is uncertain whether our study group (whose measured lead exposure was < 3.0 mg/m^3) falls into this category.

Second, although menstruating women may be exposed to greater amounts of chemical due to increased pulmonary ventilation, we conducted no such measurements on our sample.

Finally, factors other than body position which could potentially contribute to increased menstrual flow, such as age, stress, and family history, were not investigated in this study.

Although upon initial examination, the rate of hysterectomy found among the control group was noticeably higher than in the exposed group, several factors might help explain this finding. Since the majority of women in the control group were between 31 and 40 years old, while those in the exposed group were between 21 and 30 years old, this could account for some of the difference in frequency of operations performed. Second, the hysterectomy rate among the control group - while differing noticably but not significantly ($P = 0.20$) from the exposed group - is similar to the rate reported by Walker and Jick for the United States as a whole.(14)

b. Non-Reproductive

The most frequently reported complaints--dermatitis, headache, and eye irritation--can all be potentially related to the specific chemical exposures in the plant(15), although only the last symptom was found to differ significantly between the two groups ($P=0.05$).

Skin irritation/rash was found to be of similar frequency in both groups and this is understandable since each group has an exposure to a different recognized skin irritant: P & GA workers are in direct contact with fibrous glass on a daily basis while E.P. workers are exposed to several potential skin irritants.

Irritation of the eye and upper respiratory tract (nose, throat) may also be caused by exposure to hydrogen cyanide, nickel, phosphoric acid or tin either separately or more likely in combination. Irritation of skin can be produced by exposure to tin, phosphoric acid, hydrogen cyanide and nickel ("nickel itch"). Although all measured levels for individual compounds were found to be low, there is a possibility of a combined effect at low levels. Additionally, both lead and tin fumes can cause headaches which have also been a frequently reported complaint (61%). However, other potential causes of headache, such as stress and noise level, have not been evaluated in this study.

VIII. RECOMMENDATIONS

The following recommendations were initially made by NIOSH in the Interim Report dated January, 1982:

1. Efforts should be made to eliminate exposure of employees in the Pinsocket and General Assembly area to fibrous glass, perhaps through the use of protective gloves or barrier creams. Automation of one part of this process, i.e., insertion of electrial component into the plastic casing in order to prevent direct hand contact with the fibrous glass might also be a feasible approach.

2. Eating, drinking, and smoking in the immediate work area should be prohibited. This appeared to be common practice among employees especially in the Electroplating Department.

3. The ventilation system in the heat treatment process should be redesigned, since the employee performing this job function may be excessively exposed to trichloroethylene. If redesign of the process is infeasible, then substitution of trichloroethylene with a less toxic substance, or rotation of the employee to other work areas may offer alternate solutions.

4. The local exhaust ventilation system in the Plating Department should be balanced, and all deteriorated slots should be replaced. Also, employees need to be instructed to keep the lids on the plating cells during operation.

5. The acid storage canopy hood's capture velocity should be increased either by increased airflow or by redesign.

6. The operator in the degreasing area should be instructed on proper work practices. Dipped pieces of metal should be placed under a ventilation hood while drying so that vapors are not released into the general room air. Also, the tank itself should have an upgraded ventilation system. Personal environmental sampling should then be conducted in order to characterize exposure levels. Based on the results of this sampling appropriate measures should be taken to reduce exposure if necessary in the form of upgrading the ventilation.

7. Employees in the Plating Department should be instructed on the proper use and handling of the chemicals used in the department.

8. Management provide protective equipment for employees that fits properly and does not prevent employees from performing their jobs. Also, employees should be educated on the proper use of their protective equipment.

9. Work practices should allow employees in the Electroplating Department to alternate between sitting and standing during the work shift.

10. Periodic environmental monitoring should be carried out by a qualified person to assure that all airborne chemicals in the area be maintained within acceptable limits. Included should be personal monitoring of the worker in the heat treatment area for TCE exposure.

11. OSHA has determined that "to protect against the adverse effects of lead exposure to persons planning pregnancies (or pregnant) the blood lead level should be maintained below 30 ug/100g (Reference 11) with the Air level = Permissible Exposure Limit [PEL] of 50 ug/M^3 averaged over an 8 hour period.[4] Continuing to maintain lead levels below this will also minimize the risk of other adverse reproductive effects including menstrual irregularities.

XI. REFERENCES

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. United Auto Workers, Local 1708
2. Manager of Human Resources, Robinson-Nugent Corporation
3. NIOSH, Region V
4. OSHA, Region V

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

PERSONAL AIR SAMPLES FOR NICKEL AND LEAD
Plating Department, Robinson Nugent

New Albany, Indiana
HETA 81-439
October 1, 1981

Job/Location	Sample Time	Nickel (mg/m^3)	Lead (ug/m^3)
Operator line 1	8:00 a.m. - 3:50 p.m.	0.05	< 3.0
Operator barrel line	8:00 a.m. - 3:45 p.m.	0.008	< 3.0
NIOSH Recommended Criteria		0.015*	0.050*
OSHA Standard		1.00**	.050**

* 10 hour Time Weighted Average (TWA)

** 8 hour Time Weighted Average (TWA)
ug/m^3 - micrograms of contaminant per cubic meter of air.

TABLE 2

PERSONAL AND AREA SAMPLES FOR CYANIDE AND FLUORIDE
Plating Department, Robinson Nugent
New Albany, Indiana
HETA 81-439
10/1/81

Job/Location	Sample Time Personal Samples	Cyanide Particulate (mg/m^3 HCN)	Fluoride Particulate and Gaseous (mg/m^3 HF)
Maintenance	9:45 a.m. - 11:00 a.m.	< 0.024	0.072
Maintenance	11:00 a.m. - 3:50 a.m.	< 0.006	< 0.021
Chemical Analysist	1:15 p.m. - 3:50 p.m.	< 0.016	< 0.046
	Area Samples		
Quality Control	8:50 a.m. - 3:50 p.m.	< 0.006	< 0.014
Barrel Line Gold strike tank line #5	8:45 a.m. - 3:50 p.m.	< 0.006	-
Gold strike tank line #1	8:22 a.m. - 3:50 p.m.	< 0.005	-
Hard Gold tank	8:25 a.m. - 3:50 p.m.	< 0.005	-
NIOSH Recommended Criteria		5 ***	5.0 * 2.5 **
OSHA Standard		5**	2 **

* 15 minute ceiling
** 8 hour Time Weighted Average (TWA)
*** 10 minute ceiling
mg/m^3 - milligrams of contaminant per cubic meter of air

TABLE 3

PERSONAL AND AREA AIR SAMPLES FOR TOTAL ALKALINITY
Plating Department, Robinson Nugent

New Albany, Indiana
HETA 81-439
10/1/81

Job/Location	Sample Time Personal Samples	Total Alkalinity (mg/m^3 NaOH)
Operator line #5	8:10 am. - 3:45 pm.	< 0.033
Maintenance line #3	9:45 am. - 3:50 pm.	< 0.035
	Area Samples	
Alkaline tank line #6	8:30 am. - 3:50 pm.	< 0.030
Alkaline tank	8:30 am. - 3:50 pm.	< 0.030
NIOSH Recommended Criteria		2 *
OSHA Standard		2 **

* 15 minute ceiling

** 8 hour Time Weighted Average (TWA)
mg/m^3 - milligrams of contaminant per cubic meter of air

TABLE 4

PERSONAL AND AREA AIR SAMPLES FOR SULFURIC AND PHOSPHORIC ACID
Plating Department, Robinson Nugent

New Albany, Indiana
HETA 81-439
10/1/81

Job/Location	Sample Time Personal Samples	Sulfuric Acid (mg/m^3)	Phosphoric Acid (mg/m^3)
Chemical Analysist†	1:15 p.m. - 3:50 p.m.	< 0.13	< 0.13
Operator barrel line	8:00 a.m. - 3:50 p.m.	< 0.05	< 0.05
Operator line #2	8:05 a.m. - 3:50 p.m.	< 0.06	< 0.06
Maintenance	9:45 a.m. - 3:50 p.m.	< 0.10	< 0.10
Operator line #6	8:15 a.m. - 3:00 p.m.	< 0.05	< 0.05
Lead person	8:00 a.m. - 3:50 p.m.	< 0.06	< 0.06
Operator line #5	8:10 a.m. - 3:50 p.m.	< 0.05	< 0.05
Operator line #1	8:00 a.m. - 3:50 p.m.	< 0.05	< 0.05
	<u>Area Sample</u>		
Quality control lab	8:45 a.m - 3:50 pm.	< 0.06	< 0.06
NIOSH Recommended Criteria		1*	-
OSHA Standard		1**	1**

* 10 hour Time Weighted Average (TWA)

** 8 hour Time Weighted Average (TWA)

mg/m^3 - milligrams of contaminant per cubic meter of air

TABLE 5

VENTILATION MEASUREMENTS
Plating Department, Robinson Nugent

New Albany, Indiana
HETA 81-439
10/1/81

	Location	Slot Velocity Center (FMP)
Plating line #4		
	Alkaline cleaner and acid cleaner	800
	Nickel tank	800
	Gold strike	1500
	#1 hard gold	1400
	#2 hard gold	1400
	Tin tank	800
Plating line #3		
	Alkaline cleaner	600
	Acid cleaner	1300
	Copper strik and nickel	1800
	Gold strike	2500
	Empty tank	1600
	Empty tank	800

TABLE 5 (Cont'd)

Location		Slot Velocity Center (FPM)
Barrel line (line #4 side)		
	Gold strip	4000
	Electro-clean	4000
	Empty-tank	3500
	Acid cleaner	1800
	Nickel strike	2000
	Gold strike	2800
	Gold plate	500*
	Post dip tank	3800
Barrel line (line #5 side)		
	Empty tank	4400
	Acid cleaner	3500
	Acid dip	3200
	Silver strike	3200
	Silver hard	500
	Watts nickel	800
	Tin Sulfate	1000

* Ventilation Slots need repair

TABLE 6

VENTILATION MEASUREMENTS
Plating Department, Robinson Nugent
New Albany, Indiana

HETA 81-439

	Location	Air Velocity (FPM)	
Plating line #2		Left end	Right end
	Alkaline cleaner	1100	1100
	Acid cleaner	1100	800
	Nickel tank	< 50	< 50
	Tin low lead #1	1200	900
Plating line #1			
	Alkaline cleaner	180	500*
	Acid cleaner	600	500
	Nickel tank	400	90
	Tin low lead #2	200	150*

See figure 1 for an illustration of the ventilation Lids used on plating lines #1 and #2.

* Electroplating cell top needs repair

Table 7

Distribution of Respondents by Race

Electroplating (N=12)		P & GA (N=29)
White	9 (75%)	23 (79%)
Black	1 (8%)	4 (14%)
Hispanic	0 (0%)	0 (0%)
Other	2 (2%)	2 (7%)

Table 8

Distribution of Respondents by Age

Age (years)*	Electroplating	P & GA
< 20	0 (0%)	0 (0%)
21-30	7 (58%)	12 (41%)
31-40	2 (17%)	15 (52%)
41-50	2 (16%)	2 (7%)
> 50	1 (8%)	0 (0%)

*The majority of both groups are within the major reproductive years, i.e., between 21 and 40.

Table 9
Reported Menstrual Complaints among Both Groups

SYMPTOMS	EP (%) (n = 12)	P & GA (%) (n = 29)
irregular periods	5 (42%)	6 (21%)
increased flow	5 (42%)	10 (35%)
increased pain/cramp	5 (42%)	9 (31%)
no change	2 (16.5%)	12 (41%)

TABLE 10
Pregnancy Outcome of Both Groups

Robinson Nugent
New Albany, Indiana
HETA 81-439

	Electroplating	P & GA
Total No. of Pregnancies	21	49
Mean No. Pregnancies	1.75	1.68
Total No. Miscarriages	1 (4.8%)*	4 (8.2%)'
Total No. Premature Births	2 (9.5%)*	1 (2.0%)'
Never Pregnant	2 (16.6%)**	5 (17.0%)''

* denominator = 21
** denominator = 12

' denominator = 49
'' denominator = 29

TABLE 11
Statistical Significance of Reported Complaints Between Groups

Robinson Nugent
New Albany, Indiana
HETA 81-439

Health Effect	Chi-square (X^2)	P - value	Percent Reporting Problem E. P.	Percent Reporting Problem P & GA
headaches	0.462	0.50	67	59
eye irritation	4.413 *	0.05*	58	24
skin irritation/rash	2.658	0.10	44	34
prevalence of hysterectomy	1.836	0.20		
prevalence premature births	2.006	0.10		
menstrual changes	4.340*	< 0.05*		
menstrual changes in past 6 months	3.791*	0.05*		
increased flow	0.188	0.60		

* statistically significant at P = 0.05