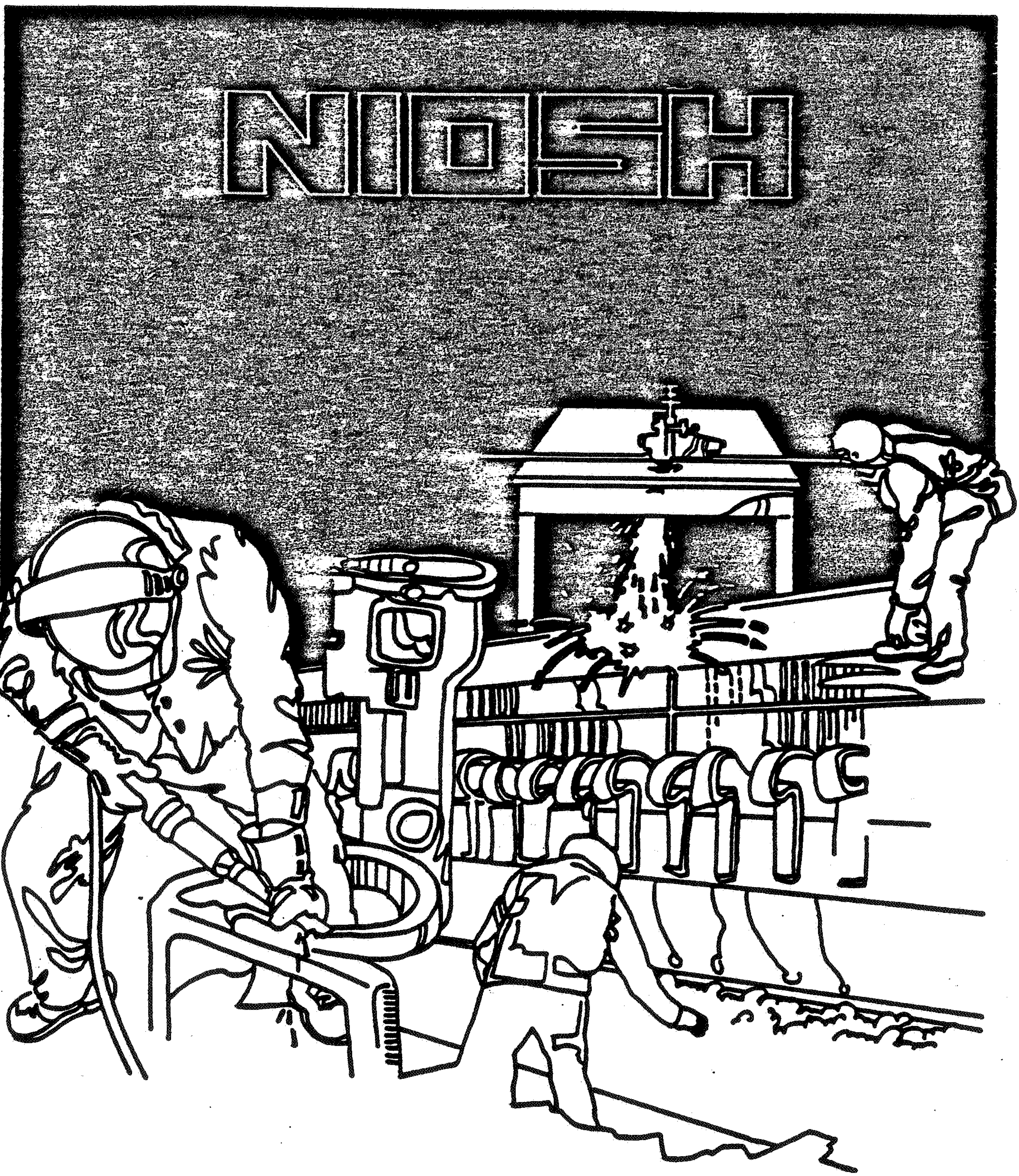
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES • Public Health Service
Centers for Disease Control • National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 83-296-1491
JOHNSON CONTROLS, INC.
WATERTOWN, WISCONSIN

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 83-296-1491
JULY 1984
JOHNSON CONTROLS, INC.
WATERTOWN, WISCONSIN

NIOSH INVESTIGATORS:
Daniel Almaguer, I.H.
Richard S. Kramkowski, P.E.
Peter Orris, M.D., M.P.H.

I. SUMMARY

On May 26, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate reported symptoms of upper respiratory tract irritations associated with occupational exposures at Johnson Controls, Watertown, Wisconsin. In June 1983, NIOSH investigators conducted an initial survey during which confidential employee interviews were conducted. In August 1983, an environmental survey was conducted and personal breathing zone and general area air samples were collected.

General area air samples for hydrogen chloride (HCl) and chromic acid showed small quantities in the assembly area. HCl ranged from non-detectable to 0.5 parts of HCl per million parts of air (ppm). Chromic acid ranged from non-detectable to 0.7 micrograms per cubic meter of air (ug/M^3). Both less than 10% of the applicable environmental criteria. Sampling for trichloroethylene (TCE) in the metal treating room showed personal breathing zone levels of 6.1 ppm (TWA - 4.1 ppm) and 24.9 ppm (TWA - 9.5 ppm) for two employees working at the degreasing unit. Traces of TCE were detected on the roof at the air make-up unit suppling "fresh" air to the assembly department. NIOSH recommends that TCE be treated as a suspect human carcinogen and that exposures be reduced to the lowest feasible level. The OSHA-PEL is 100 ppm as an eight-hour TWA with a 15-minute ceiling of 200 ppm.

Sampling for solvents used in the assembly department showed ethyl acetate levels ranging from 0.4 to 6.9 ppm (OSHA-PEL - 400 ppm) and no detectables levels of xylene or methyl ethyl ketone. Samples collected in the assembly area over a three week period, by management and union representatives, were analyzed by NIOSH. These samples showed TWA concentrations of 1,1,1-trichloroethane and TCE ranging from 1.4 to 4.9 ppm and 0.1 to 0.6 ppm, respectively.

HCl, TCE, 1,1,1-trichloroethane, and chromic acid were not used in the assembly department and would not be expected to be found in that area. The low levels detected are probably the result of re-entry of exhaust vapors from the metal treating room via the air make-up units.

Confidential employee questionnaires revealed a variety of symptoms suggestive of low-dose exposure to these substances. A few employees were exhibiting typical symptoms of mucous membrane irritation of the eyes, nose, throat, and sinuses. A review of pertinent medical records and questionnaires by a NIOSH medical officer showed no evidence of any chronic health effects in any of these employees.

On the basis of the data obtained in this investigation, it has been determined that a health hazard did not exist in the final assembly area of the Johnson Controls, Inc. facility, at the time of this evaluation. Employee symptoms were related to the re-entry of exhaust emissions; however, the levels of exposure detected will not produce significant health effects. Recommendations for correction of the exhaust re-entry situation are included in this report.

KEYWORDS: SIC 3822, hydrochloric acid, trichloroethylene, metal plating, cleaning, and degreasing.

II. INTRODUCTION

On May 26, 1983, the National Institute for Occupational Safety and Health received a request from the Allied Industrial Workers Union to conduct a Health Hazard Evaluation at Johnson Controls, Incorporated, Control Products Division, Watertown, Wisconsin. The requestor was concerned with the effects of possible exposure to various solvents and other chemicals used throughout the plant.

III. BACKGROUND

A. Plant Production and Workforce

Johnson Controls Incorporated, Control Products Division manufactures energy conservation products. The Watertown, Wisconsin facility has been in existence since 1957. Since that time several large additions have been made to the facility, including the assembly department (the area of the request) which was built in 1977. At the time of the survey the plant was running two shifts and provided employment for approximately 372 persons which included 298 production workers, 13 maintenance workers, and 61 administrative personnel. The assembly department had about 40 female employees and the plating department had about 9 male employees.

B. Process Description and Employee Duties

1. Assembly Department

The assembly department covered an area of approximately 20,000 square feet and was located in the middle of the plant. Adjacent to the assembly department on the north was the metal treating department (physically separated by walls but directly connected by two doors); on the west the lunch room and sub-assembly department; on the south, storage and supplies, customer returns, and plastic molding (physically separated by walls); and on the east the stock room.

Both conveyorized and bench assembly lines are utilized in the assembly of products. Employee duties include assembly of valve components, adjusting valves to regulate proper BTU gas flow, and testing of valves for leaks and proper functioning. The area of the assembly department where employees expressed concern was, the northeast corner of the department, the area nearest the plating department doors. In this area the employees were using inks to stamp and label parts and completed products, and the employees were also using a solvent to remove ink from mislabeled parts. These tasks were performed infrequently, approximately one time per week for a few hours. Other tasks performed in this area included assembly, testing, and packaging of damper operators, processing of pilot lots of new and proposed valves, and assembly of electro-magnetic switches.

2. Metal Treating Department

The metal treating room was approximately 5200 square feet and had four doors leading into the department, two from the assembly department. Seven major degreasing, metal cleaning, and metal plating processes were conducted in the metal treating department. Trichloroethylene was the main degreasing agent used, various acids (including hydrochloric) and caustics were used for metal cleaning, and zinc and copper were the main metals used for plating.

Employee duties involved placing component parts onto racks or into baskets for dipping into the various acids and caustics for metal cleaning, solvents for degreasing, and plating solutions for metal plating.

C. Engineering, Administrative, and Personal Protective Controls

Plating department employees were required to wear goggles, rubber boots, rubber aprons, gloves, and metal treating processes were locally exhausted. Assembly department employees were not required to use any type of personal protective equipment.

IV. EVALUATION DESIGN AND METHOD

A. Environmental

An initial survey was conducted by NIOSH investigators on June 21, 1983. Prior to the initial survey, the NIOSH project officer contacted the union and the company to obtain information regarding the process and the materials used in the area of interest. Background information related to the process and material safety data sheets of products used in the assembly department and metal treating departments were obtained and evaluated.

An environmental survey was conducted on August 18 and 19, 1983. Processes were selected for environmental sampling based on their potential hazards and occurrence during the survey dates. Substances used in both the metal treating and assembly areas were evaluated and sampling was conducted to determine the potential for employee exposure to these substances or components of these compounds. The selection of substances for the environmental sampling was based primarily on the substances' irritant potential, the amount of and conditions of use, the presence of engineering controls, and the results of previous environmental studies conducted at the facility.

The environmental evaluation consisted of personal breathing-zone and general area air sampling for methyl ethyl ketone, ethyl acetate, xylene, chromic acid, hydrochloric acid, trichloroethylene, and 1,1,1-trichloroethane. Personal exposures were obtained by placing the appropriate sampling media in the workers' breathing zone while general area air samples were obtained by locating the sampling pump and media at the desired location.

1. Sampling for chromic acid mist was conducted using polyvinyl chloride filters connected via Tygon® tubing to personal sampling pumps calibrated at a flow of 1.5 liters per minute (LPM).

2. Sampling for total chromium and zinc was conducted using mixed cellulose ester membrane filters, AA type, connected via Tygon® tubing to personal sampling pumps calibrated at a flow rate fo 1.5 LPM.

3. Sampling for sodium hydroxide was conducted using Teflon® filters connected via Tygon® tubing to personal sampling pumps calibrated at a flow rate of 1.5 LPM.

4. Sampling for sulfuric acid, nitric acid, and hydrochloric acid was conducted using silica gel tubes connected via Tygon® tubing to personal sampling pumps calibrated at a flow rate of 20 cubic centimeters per minute (cc/minute).

5. Sampling for trichloroethylene, ethyl acetate, and xylene was conducted using charcoal tubes connected via Tygon® tubing to personal sampling pumps calibrated at a flow rate of 20 cc/minute.

6. Sampling for methyl ethyl ketone was conducted using Ambersorb® sampling tubes connected via Tygon® tubing to personal sampling pumps calibrated at a flow rate of 20 cc/minute.

7. Local exhaust ventilation measurements and general ventilation measurements were obtained using an air velocity meter.

B. Medical

To assess the presence of work related health problems, confidential, non-directed medical questionnaires were administered to 13 of 40 employees working in the assembly department. These included questions on the employees work and medical histories. All employees wishing to participate were interviewed. Medical records were collected on all those indicating that they had visited a physician for their health problems.

Additionally, during the follow-up environmental monitoring performed by representatives of the management and the union, concurrent symptomatology among employees was noted. This simultaneous symptom and environmental monitoring was conducted to ensure that the episodic nature of these complaints would not prevent accurate analysis and correlation with environmental levels.

The questionnaire and follow-up symptom surveys were reviewed for prevalence of symptoms and their correlation with environmetal levels. Additionally, the medical records supplied were analyzed to determine whether acute or chronic effects of the potential toxins had been documented.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

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

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor/Occupational Safety and Health Administration (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 required by the Occupational Safety and Health Act of 1970 (29 USC 651, et seq.) 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.

A. Hydrochloric acid

The current OSHA standard and ACGIH recommendation for occupational exposure to hydrochloric acid is a ceiling of 5 ppm.[1] Hydrogen chloride (HCl) is a colorless, nonflammable gas, soluble in water. The aqueous solution is known as hydrochloric or muriatic acid and may contain as much as 38% HCl.[2]

Hydrochoric acid and high concentrations of hydrogen chloride gas are highly corrosive to eyes, skin, and mucous membranes. The acid may produce burns, ulceration, and scarring on skin and mucous membranes, and it may produce dermatitis on repeated exposure. Eye contact may result in reduced vision or blindness. Dental discoloration and erosion of exposed incisors occur on prolonged exposure to low concentrations. Ingestion may produce fatal effects from esophageal or gastric necrosis. The irritant effect of vapors on the respiratory tract may produce laryngitis, glottal edema, bronchitis, pulmonary edema, and death.[2]

Short-term exposures: When hydrogen chloride gas is inhaled, it may cause irritation of the respiratory tract with burning, choking, and coughing. Severe breathing difficulties may occur which may be delayed in onset. At times ulceration of the nose and throat may occur. Hydrogen chloride gas and solutions of hydrogen chloride (hydrochloric acid) may cause eye irritation and severe burns of the skin unless the acid is washed off immediately. Exposure of the skin to hydrogen chloride gas may cause skin inflammation or burns. Swallowing hydrogen chloride solution may cause burns of the mouth, throat, and stomach.[1]

B. Chromic acid

The current OSHA standard for chromic acid is a ceiling limit of 100 micrograms of chromic acid per cubic meter of air (ug/M^3) determined by a 15-minute sample period. NIOSH recommends that the permissible exposure limit for chromic acid be reduced to 25 ug/M^3 averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 50 ug/M^3 averaged over a 15-minute period. Chromic acid mist may cause severe irritation of the nose, throat, bronchial tubes, and lungs. Repeated or prolonged exposure may cause ulceration and perforation of the nasal septum. Respiratory irritation may occur with symptoms resembling asthma. Persons with a history of asthma, allergies, or known sensitization to chromic acid would be expected to be at increased risk from exposure.[1,3,4]

C. Trichloroethylene (TCE)

The current OSHA permissible exposure limit (PEL) for trichloroethylene (TCE) is 100 ppm as an eight-hour TWA with an acceptable ceiling concentration of 200 ppm; acceptable maximum peaks above the ceiling, to 300 ppm are allowed for 5 minutes duration in a two-hour period.[2]

Trichloroethylene is absorbed rapidly by the lungs and affects the central nervous system, the cardiovascular system, the liver, and the kidneys. It produces narcosis as well as eye and skin irritation. Trichloroethylene causes liver cancer in some rodents. The NIOSH recommended maximum TWA environmental level is 25 ppm. NIOSH considers that a level of 25 ppm, as a TWA, can be uniformly achieved by use of existing engineering control technology. However, as TCE is considered to be a potential human carcinogen this should not serve as a final goal: rather, industry should exert a concerted effort to develop methodology which would enable an even further reduction in worker exposure.[5]

D. 1,1,1-trichloroethane[6]

The current OSHA standard and ACGIH recommendation for occupation exposure to methyl chloroform (1,1,1-trichloroethane; 1,1,1-trichloroethane stabilized) is 350 parts of methyl chloroform per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 1910 milligrams per cubic meter of air (mg/M^3). NIOSH has recommended that the permissible exposure limit be changed to a ceiling limit of 350 ppm (1910 mg/M^3) averaged over a 15-minute period. NIOSH defines occupational exposure to 1,1,1-trichloroethane as exposure above 200 ppm measured as a time-weighted average (TWA) for up to a 10-hour workday, 40-hour workweek.

E. Ethyl Acetate

The current OSHA standard for ethyl acetate is 400 ppm as an 8-hour TWA.[7] The ACGIH also recommends that exposure to ethyl acetate be limited to 400 ppm as an eight-hour TWA.[8] Ethyl acetate can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. It is an irritant to the mucous membranes and can irritate the eyes and nasal passages in varying degrees. Prolonged exposure can cause irritation of the intact skin. These local effects are the primary risk in industry. All acetates may cause headache, drowsiness, and unconsciousness if the concentrations are high enough. These effects are relatively slow and gradual in onset and slow in recovery after exposure.[2]

F. Methyl Ethyl Ketone (MEK)

The current OSHA standard for exposure to MEK is 200 ppm as an eight-hour TWA.[2] NIOSH recommends that exposure to MEK be limited to 200 ppm for up to 10 hours per day, 40 hours per week.[9] The ACGIH recommends a TLV of 200 ppm as an eight-hour TWA and a short term exposure limit (STEL) of 300 ppm. Methyl ethyl ketone is a colorless, flammable liquid with an acetone-like odor. It is soluble in water and all common industrial organic solvents. MEK is used in the manufacture of colorless synthetic resins, as a solvent and in the surface coating industry. MEK has found wide use as an industrial solvent, and while workers frequently complain about the odor, there have been relatively few reports of serious ill effects.[10]

MEK is irritating to the eyes, mucous membranes, and skin. At high concentrations, it causes narcosis in animals, and it is expected that severe exposure in humans will produce the same effect. In humans, short-term exposure to 300 ppm was "objectionable", causing headache and throat irritation; 200 ppm caused mild irritation of the eyes; and

100 ppm caused slight nose and throat irritation. MEK can be recognized at 25 ppm by its odor, which is similar to acetone but more irritating. The TLV recommended by the ACGIH (200 ppm) was established to prevent injurious effects and minimize complaints about odor and irritation.[11]

G. Xylene

The current OSHA standard for xylene is 100 ppm averaged over an eight-hour work shift. This may also be expressed as 435 mg/M^3. NIOSH has recommended that the permissible exposure limit be changed to 100 ppm averaged over a work shift of up to ten hours per day, forty hours per week, with an acceptable ceiling level of 200 ppm averaged over a 10-minute period.[1] Xylene can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. Xylene vapor may cause irritation of the eyes, nose, and throat.[2]

VI. RESULTS

Sampling for HCl revealed detectable levels in the assembly area and the metal treating room. One general area air sample collected in the assembly department (10 feet from the metal treating room door) showed a level of 0.5 ppm. Two general area air samples collected on the roof at the assembly area air intake, showed non-detectable levels of HCl (HCl was probably not detected on the roof because of the small sample size collected). A qualitative general area air sample collected in the metal treating room at the foreman's desk (NW corner of room) showed a detectable level. See Table I for complete sample results.

Sampling for chromic acid revealed the following. A general area air sample collected for chromic acid in the assembly department (10 feet from the metal treating room door) showed a level of 0.2 ug/M^3. Two general area air samples collected during the morning at the roof air make-up unit each showed levels of 0.6 ug/M^3 and two area samples collected at the air make-up unit during the afternoon showed a level of 0.7 ug/M^3 chromic acid and one non-detectable level (eight-hour calculated TWA's = 0.5 ug/M^3). A level of 0.5 ug/M^3 was detected the following day within the metal treating room (sample collected in the NW corner of room at the foreman's desk). See Table II for complete sample results.

Personal breathing zone air sampling for two employees working in the metal treating room at the degreaser units revealed TCE levels of 6.1 ppm for a sample period of approximately five and one-half hours (8-hour TWA = 4.1 ppm) and 24.9 ppm for a sample period of approximately 3 hours (8-hour TWA = 9.5 ppm). Samples collected on the roof next to the air intake units the day of August 18, 1983, showed no detected levels of TCE while qualitative samples collected on the roof the following day showed detectable levels. See Table III for complete sample results.

Sampling for substances used in the assembly department included a solvent containing ethyl acetate, another containing xylene, and an adhesive containing methyl ethyl ketone. Ethyl acetate sampling showed levels ranging from 0.4 to 6.9 ppm. This substance was used to remove small ink stamps from mislabeled parts and was used approximately one hour per day. Sampling for methyl ethyl ketone and xylene showed non-detectable levels. See Table IV for complete ethyl acetate sample results.

Samples were collected over a three week period by representatives of management and the union according to the instructions of the NIOSH investigators. These results showed low levels of TCE ranging from 0.1 to 0.6 ppm and levels of 1,1,1-trichloroethane ranging from 1.4 to 4.9 ppm as time weighted average concentrations. These samples were intended to be qualitative samples (indicating wether or not the substance was present) and therefore, these levels should not be considered extremely accurate. See Tables V and VI for complete sample results.

Confidential employee questionnaires administered to thirteen employees working in the assembly area or nearby areas at the time of the survey revealed a variety of symptoms suggestive of low-dose exposure to irritant substances. A few of these employees were exhibiting typical symptoms of mucous membrane irritation of the eyes, nose, throat, and sinuses.

VII. CONCLUSIONS

Sample results and ventilation measurements indicate that exhaust emissions from the metal treating department were re-entering the facility via the air make-up units on the roof. All metal treating processes are local exhaust ventilated and contaminant vapors are exhausted to the roof of the facility. Exhaust stacks are located approximately 40 to 50 feet from the air make-up units which supply unconditioned outdoor (fresh) air to the assembly area during the summer months. During the winter months conditioned (heated) air is supplied through air make-up units located approximately 20 to 30 feet from the metal treating room exhaust stacks.

Air samples collected revealed traces of HCl, TCE, and chromic acid in the assembly department and at the air make-up units. These three substances were not used in the assembly department but were used in the adjacent metal treating department. Since, these substances were not used in the assembly department they would not normally be expected to be detected in that area.

Visual observations of air flow patterns using smoke tubes showed that the metal treating room was under negative pressure (air flow was into the metal treating room). Spot checks of the local exhaust ventilation in the metal treating room using smoke tubes indicated that all exhaust units were working satisfactorily.

Additionally, it was noted that a fan was being used in the metal treating room at the degreaser unit for comfort purposes. Visual observation of the air flow patterns using smoke tubes showed turbulent eddies of air at the face of the degreaser unit. This probably resulted in reduced efficiency of the local exhaust ventilation system at the degreaser unit and may have accounted for the high TCE levels recorded for the employee working in that area.

Based on a review of the symptoms and medical records obtained during this evaluation, it appears that a few employees in the assembly department may be reacting to low levels of irritant substances. These employees are exhibiting typical symptoms of mucous membrane irritation of the eyes, nose, throat, and sinuses. There is no evidence that chronic health effects have occurred in any of these employees due to this exposure.

Many additional substances were used throughout the plant that were not evaluated during this survey. This was due largely to the variability in quantities, frequencies, and manner in which they were used, and does not imply that these materials are not capable of presenting a health hazard.

VIII. RECOMMENDATIONS

1. Use of trichloroethylene should be discontinued, if possible, due to its toxic effects and evidence of carcinogenicity. Use of a less toxic chemical solvent should be investigated and implemented as soon as feasible.

2. Workers should be trained and informed of the potential dangers from overexposure to tricholoethylene. If a suitable substitute is found workers should be informed of any hazards associated with that substance and proper precautions to take when using.

3. The feasiblity of raising exhaust stacks from the metal treating room should be investigated, to eliminate the possibility of re-entry of exhaust emissions.

4. All local exhaust ventilation systems should be periodically inspected to assure the proper removal of the contaminants for which they were designed.

5. Company policy should dictate that material safety data sheets (MSDS) be obtained for all materials brought into the plant. The individual components of these materials should then be evaluated to ensure that proper engineering controls, work practices, and personal protection are implemented when necessary.

6. Management should coordinate with engineering to locate areas and uses of each and every product brought into the plant.

7. Employees should be given proper training in the handling and usage of all chemical substances with which they come in contact.

8. Solvents should be used in a manner so as to avoid unnecessary inhalation or skin contact. Protective gloves should be used to prevent the possibility of dermatitis. Solvent rags should be properly disposed of in covered containers to reduce the escape of solvent vapors into the work area.

9. Eating, drinking, and smoking should be prohibited at employee work stations and should be allowed only in designated areas, such as, lunch and break areas.

10. Good personal hygiene and work practices should be observed by all employees. Washing of hands before smoking, eating, and drinking will help reduce possible contamination.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:	Daniel Almaguer Industrial Hygienist NIOSH - Region V Chicago, Illinois
	Peter Orris, M.D., M.P.H. Medical Officer NIOSH, Region V Chicago, Illinois
Environmental Evaluation Assistance:	Richard S. Kramkowski Regional Consultant NIOSH - Region V Chicago, Illinois
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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

1. Allied Industrial Workers Union
2. Johnson Controls, Incorporated
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 I

General Area Air Concentrations of Hydrochloric Acid

Johnson Controls, Inc.
Watertown, Wisconsin

Sample location (Date)	Sample Time	ug/sample	L/sample	mg/M^3	ppm
Final assembly, 10 feet from metal treating room door (8/18)	340	5	6.1	0.8	0.5
Roof air-intake (8/18) A.m.	210	<LOD	3.2	<LOD	---
Roof air-intake (8/18) P.M.	183	<LOD	2.7	<LOD	---
Plating Dept. (8/19)	406	8	Qualitative	0.013	detected
Blank	-0-	<LOD	-0-	----	---

NOTE: Environmental Standards/Criteria
OSHA - 5 ppm as a ceiling limit, 15-minute sample period
ACGIH - 5 ppm as a ceiling limit

Abbreviations:
ug/sample - micrograms per sample
<LOD - below limit of detection (4 ug/sample)
L/sample - liters/sample
mg/M^3 - milligrams of hydrogen chloride per cubic meter of air
ppm - parts of hydrogen chloride per million parts of air

Table II

General Area Air Concentrations of Chromic Acid

Johnson Controls, Inc.
Watertown, Wisconsin

Sample location (Date)		Minutes	mg/sample	L/sample	ug/M³
Final assembly area 10 feet from metal treating room door (8/18)		437	0.1	656	0.2
Final assembly area 10 feet from metal treating room door (8/18)		437	0.2	656	0.3
Roof air-intake (8/18) Morning		210	0.2	315	0.6
Roof air-intake (8/18) Afternoon		183	<0.1	274	---
	TOTAL	393			8-hr TWA = 0.5
Roof air-intake (8/18) Morning		210	0.2	315	0.6
Roof air-intake (8/18) Afternoon		183	0.2	274	0.7
	TOTAL	393			8-hr TWA = 0.5
Plating Dept. NW corner at foreman's desk (8/19)		406	0.2	406	0.3
Blank		-0-	0.3	-0-	---
Blank		-0-	<0.1	-0-	---

NOTE: Environmental Standards/Criteria
NIOSH - 25 ug/M³ as a time weighted average, up to 10 hours per day
50 ug/M³ as a 15-minute ceiling limit
OSHA - 100 ug/M³ as a 15-minute ceiling limit
ACGIH - 50 ug/M³ as an eight-hour time weighted average

Abbreviations:
mg/sample - milligrams per sample
L/sample - liters per sample
ug/M³ - micrograms per cubic meter
ppm - parts per million

Table III

General Area and Personal Breathing Zone Air
Concentrations of Trichloroethylene

Johnson Controls, Inc.
Watertown, Wisconsin

Sample location (Date)	Sample Time	mg/sample	L/sample	mg/M^3	ppm
Blank	-0-	<0.02	-0-	---	---
Blank	-0-	<0.02	-0-	---	---
Employee #1 - Metal Treating Room (8/19)	322	0.16	4.9	32.7 8-hour TWA =	6.1 4.1
Employee #2 - Metal Treating Room (8/19)	183	0.56	4.2	133.3 8-hour TWA =	24.9 9.5
Roof plating exhaust (8/18/83) A.M.	210	<0.02	4.1	---	---
Roof plating exhaust (8/18/83) P.M.	183	<0.02	1.3	---	---
Roof air intake NE side of unit (8/19/83)	243	0.04	qualitative	detected	
Roof air intake SW side of unit (8/19/83)	243	0.03	qualitative	detected	
Roof east of plating dept. exhaust stacks (8/19/83)	243	0.28	qualitative	detected	

NOTE: Environmental Standards/Criteria
NIOSH - lowest feasible limit, 25 ppm attainable utilizing current engineering control technology
OSHA - 100 ppm as an eight-hour time weighted average
200 ppm as a 15-minute ceiling value
ACGIH - 50 ppm as an eight-hour time weighted average
150 ppm as a 15-minute ceiling value

Abbreviations:
mg/sample - milligrams per sample
L/sample - liters per sample
mg/M^3 - milligrams per cubic meter
ppm - parts per million

Table IV

General Area and Personal Breathing Zone Air Concentrations of Ethyl Acetate

Johnson Controls, Inc.
Watertown, Wisconsin

Sample location	Sample Time	mg/sample	L/sample	mg/M^3	ppm
Blank	-0-	<0.01	-0-	---	---
Blank	-0-	<0.01	-0-	---	---
Employee #1 - assembly dept. (8/18)	58 min.	0.03	1.2	25	6.9
Employee #2 - assembly dept. (8/19)	305 min.	0.01	6.8	1.5	0.4
Assembly dept. ten feet from metal treating room door (8/18)	437 min.	0.02	9.1	2.2	0.6
Sample taken at plant about one foot above rag soaked with solvent (8/19)	58 min.	0.03	1.3	23	6.4

NOTE: Environmental Standards/Criteria
OSHA - 400 ppm as an eight-hour time weighted average
ACGIH - 400 ppm as an eight-hour time weighted average

Abbreviations:
mg/sample - milligrams per sample
L/sample - liters per sample
mg/M^3 - milligrams per cubic meter
ppm - parts per million

Table V

General Area Air Concentrations of Trichloroethylene

Three-week Sample Period
Aug. 22 - Sept. 12, 1983

Johnson Controls, Inc.
Watertown, Wisconsin

Sample Date	mg/sample*	L/sample	mg/M^3	ppm
8/22	0.11	173	0.6	0.1
8/23	0.22	181	1.2	0.2
8/25	0.44	183	2.4	0.4
8/26	0.14	184	0.8	0.1
8/30	0.21	186	1.1	0.2
8/31	0.16	185	0.9	0.2
9/01	0.13	184	0.7	0.1
9/06	0.10	186	0.5	0.1
9/07	0.13	184	0.7	0.1
9/12	0.61	192	3.2	0.6
BLANK	LT 0.01	-0-	---	---

NOTE: Environmental Standards/Criteria
NIOSH - lowest feasible limit, 25 ppm attainable utilizing current engineering control technology
OSHA - 100 ppm as an eight-hour time weighted average
200 ppm as a 15-minute ceiling value
ACGIH - 50 ppm as an eight-hour time weighted average
150 ppm as a 15-minute ceiling value

Abbreviations:
mg/sample - milligrams per sample
L/sample - liters per sample
mg/M^3 - milligrams per cubic meter
ppm - parts per million

Table VI

General Area Air Concentrations of 1,1,1-Trichloroethane

Three-week Sample Period
Aug. 22 - Sept. 12, 1983

Johnson Controls, Inc.
Watertown, Wisconsin

Sample Date	mg/sample*	L/sample	mg/M³	ppm
8/22	2.0	173	11.5	2.1
8/23	3.5	181	19.3	3.6
8/25	2.2	183	12.0	2.2
8/26	2.2	184	12	2.2
8/30	4.1	186	22	4.0
8/31	4.9	185	26.5	4.9
9/01	3.1	184	16.8	3.1
9/06	1.4	186	7.5	1.4
9/07	1.5	184	8.2	1.5
9/12	2.6	192	13.5	2.5
BLANK	LT 0.01	-0-	---	---

NOTE: Environmental Standards/Criteria
NIOSH - 350 ppm averaged over a 15-minute period
OSHA - 350 ppm as an eight-hour time weighted average
ACGIH - 350 ppm as an eight-hour time weighted average
450 ppm as a 15-minute ceiling value

Abbreviations:
mg/sample - milligrams per sample
L/sample - liters per sample
mg/M^3 - milligrams per cubic meter
ppm - parts per million