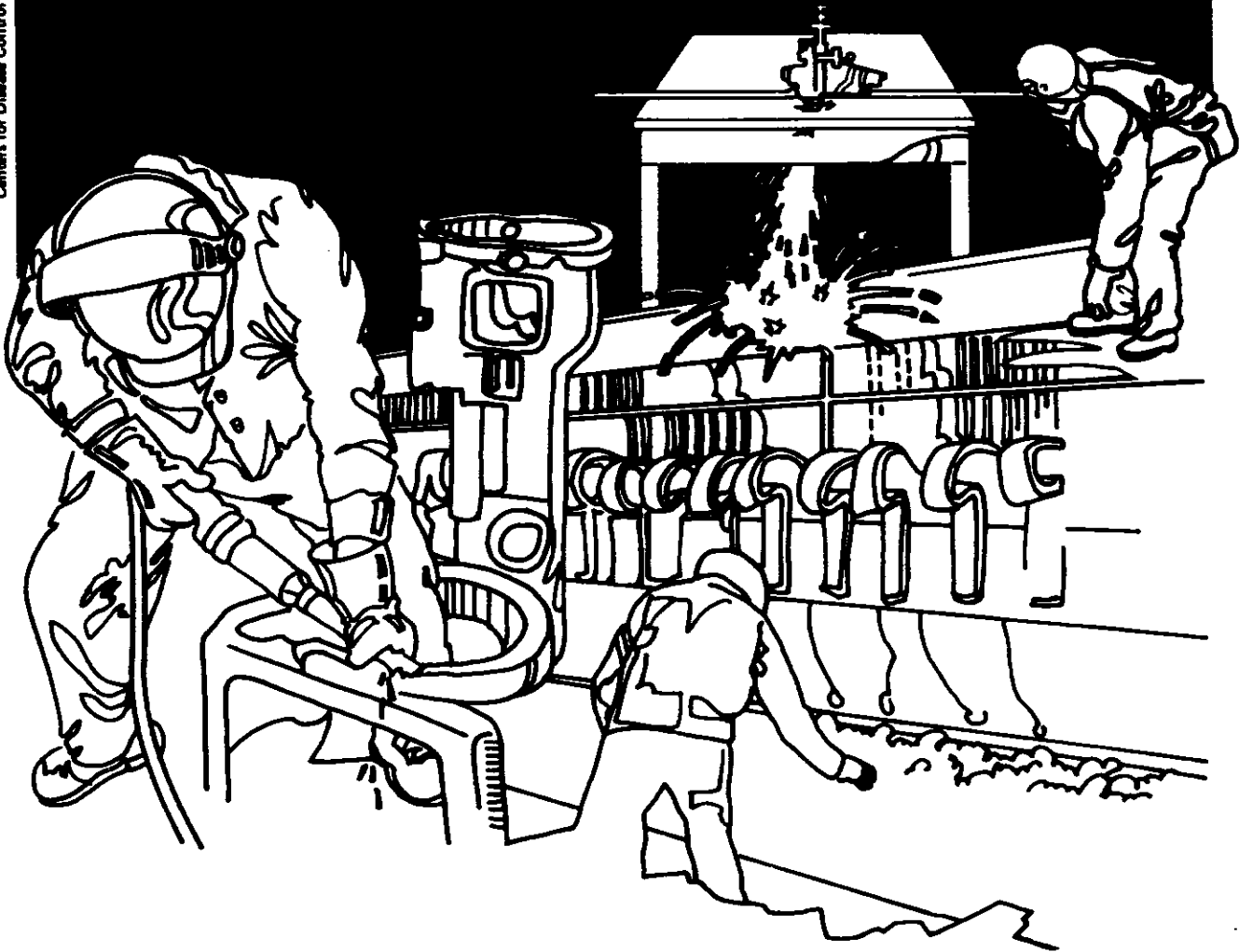


This Health Hazard Evaluation (HHE) report and any recommendations made herein are for the specific facility evaluated and may not be universally applicable. Any recommendations made are not to be considered as final statements of NIOSH policy or of any agency or individual involved. Additional HHE reports are available at <http://www.cdc.gov/niosh/hhe/reports>

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

NIOSH



Health Hazard Evaluation Report

HETA 86-063-1843
OLSON INDUSTRIES
DENVER, COLORADO

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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

I. SUMMARY

On November 20, 1985, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate employee exposures to chemicals used in electroplating, machining, spot welding, and soldering operations at Olson Industries, Denver, Colorado.

In August 1986, NIOSH investigators conducted initial and environmental surveys at the facility. Personal and area air samples were collected for chromium, nickel, and 1,1,1-trichloroethane. In December 1986, a follow-up environmental survey was conducted to monitor processes which were not operating during the previous survey. During this survey, personal and area air samples were collected for oil mist, trace metals, and sulfuric and hydrochloric acids.

Analysis of the samples collected in the electroplating area revealed the presence of hydrochloric acid in only one of four air samples at a time-weighted average (TWA) concentration of 0.59 milligrams per cubic meter of air (mg/M^3). This value is below the Occupational Safety and Health Administration's (OSHA) Permissible Exposure Limit (PEL) of 7 mg/M^3 as a ceiling limit. Sulfuric acid was found to be below the limit of detection of 5 micrograms (μg)/sample in four air samples collected. Nickel was detected in four of seven air samples at TWA concentrations ranging from 0.0025 to 0.0045 mg/M^3 , with a mean of 0.0034 mg/M^3 . These nickel concentrations are below the OSHA PEL of 1 mg/M^3 , the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) of 0.1 mg/M^3 , and the NIOSH Recommended Exposure Limit (REL) of 0.015 mg/M^3 . Chromium was detected in three of seven samples at TWA concentrations of 0.0013, 0.0017, and 0.0027 mg/M^3 . TWA concentrations of hexavalent chromium [Cr(VI)] found in two samples collected were 0.0014 and 0.0018 mg/M^3 . These concentrations are below the OSHA PEL of 0.1 mg/M^3 , the ACGIH TLV of 0.05 mg/M^3 , and the NIOSH REL of 0.025 mg/M^3 for chromic acid and other noncarcinogenic forms of hexavalent chromium. A TWA concentration of 1.7 parts of 1,1,1-trichloroethane per million parts of air (ppm) was detected in a personal sample for an employee conducting degreasing operations. This TWA concentration is below the OSHA PEL and ACGIH TLV of 350 ppm as an 8-hour TWA, and the NIOSH REL of 350 ppm as a 15 minute ceiling limit for 1,1,1-trichloroethane.

During machining operations, oil mist was detected in one of two personal samples at a TWA concentration of 0.22 mg/M^3 , which is below the OSHA PEL and the ACGIH TLV of 5 mg/M^3 oil mist, as an 8-hour TWA. A personal air sample collected during spot welding operations revealed TWA concentrations of 0.0056 mg/M^3 iron, 0.0043 mg/M^3 lead, and 0.0068 mg/M^3 zinc. A personal air sample collected during soldering operations revealed a TWA concentration of 0.0042 mg/M^3 iron. These values are below their corresponding evaluation criteria [iron oxide fume: OSHA 10 mg/M^3 , ACGIH 5 mg/M^3 ; lead: OSHA 0.050 $\mu\text{g}/\text{M}^3$, ACGIH 0.15 mg/M^3 ; zinc oxide fume: OSHA, NIOSH, and ACGIH 5 mg/M^3).

No exposures above the evaluation criteria were found for any of the substances evaluated in this survey. Recommendations to further reduce employee exposures by engineering controls, personal protective equipment, and work practices are contained in Section VIII of this report.

KEY WORDS: SIC 3471, Electroplating, Metal Cleaning, Chromium, Nickel, Metals, Hydrochloric Acid, Sulfuric Acid, Oil Mist, Degreasing.

II. INTRODUCTION

On November 20, 1985, NIOSH received a request from Olson Industries, Denver, Colorado, for a health hazard evaluation. The requestor was concerned with employee exposures to the various acids, metals, and solvents used in electroplating, machining, spot welding, and soldering operations within the plant.

On August 6, 1986, NIOSH investigators conducted an initial survey at the facility. An opening conference was held during which background information was obtained related to the basis for the request and the nature of plant operations. Following this meeting, a walk-through survey was conducted in the production area of the plant. On August 11, 1986, an environmental survey was conducted during which personal and area air samples were collected for chromium, nickel, trace metals, and 1,1,1-trichloroethane. On December 5, 1986, a follow-up environmental survey was conducted in order to monitor processes which were not operating during the previous survey visit. During this survey, personal and area air samples were collected for oil mist, trace metals, and sulfuric and hydrochloric acids.

III. BACKGROUND

A. Plant Information

Olson Industries, located in Denver, Colorado, manufactures guides and tips for fishing rods. Some of the various activities carried out in the plant include assembly, spot welding, soldering, electroplating, and machining. Although employee exposures in other areas of the plant were examined during the survey, the major area of concern in this request was the plating shop. The plating shop contained two decorative chromium electroplating lines, one hard chromium electroplating line, and one miscellaneous cleaning and plating line.

B. General Discussion of Electroplating

1. Metal Pretreatment

Prior to electroplating, a thorough cleaning of the surface of the workpiece or metal stock is required in order to ensure the proper adherence of the plating metal to the base metal. Commonly used pretreatment processes include solvent, acid, and alkaline cleaning. The process of solvent cleaning or vapor degreasing utilizes an organic solvent to remove grease, lubricants, and soluble soils. Acid solutions are used to remove layers of metal oxides, with the process of removing thick layers of oxide being referred to as pickling, and the process of removing thin oxide layers referred to as bright dipping. Alkaline solutions are also used to remove oils and solid soils from workpiece surfaces by way of their detergent action. Certain alkaline cleaners (electrolytic types) can also be agitated by gas bubbles to enhance their effectiveness. Tanks or baths containing the pretreatment solutions are located at the beginning of each plating line, with the particular arrangement and types of substances used based on the

particular needs of the metal to be plated. A water rinse tank is usually located between each of these tanks.¹

2. Electroplating

Electroplating is an electrochemical process by which a metallic layer is deposited on a base metal through the action of an electrical current. Although different methods of electroplating exist, the process usually involves the use of an anode (composed of the metal to be plated), a cathode (composed of the part to be plated), and an electrolytic solution (usually containing metallic salts of the metal to be plated and acids, alkaline materials and other additives to impart stability or functional properties to the solution, e.g. brighteners). The application of an electrical current, usually from a low voltage DC power supply, causes a migration of the metal ions from the electrolyte solution to the cathode where they are deposited on the base metal. Metal from the anode then dissolves into the solution to replace the metal ions as they are depleted from the electrolyte.^{1,2}

C. Description of Plant Operations

The major type of plating carried out at Olson Industries is chromium electroplating, both the decorative and hard chrome types. In decorative chrome plating, a thin layer of chromium is applied over a nickel coating in order to provide a protective, durable, and nontarnishing finish. The two decorative chrome plating lines present in the plating shop are referred to as the "Wally" and "Daw" lines. Both lines are constructed in a circular fashion with the tanks arranged in the following order; alkaline cleaner, sulfuric acid with fluorides, nickel strike, nickel plate, chrome plate, and sulfuric acid. Water rinse baths are located between each of these tanks. Racks suspended from conveyors automatically move the parts through the various solutions. The employees are located at a work station in the center of the line. Their major function is to remove the plated parts from the racks that have passed through the line, and to place unplated parts back on the racks. Local exhaust ventilation was present at the acid, alkaline, and chrome plating tanks.

A hard chrome line was located adjacent to the decorative chrome lines. In hard chrome plating, a heavier chromium plate is applied, usually directly to the base metal to be plated. The hard chrome line at Olson Industries consisted of tanks containing alkaline cleaner, sulfuric acid, chromic acid, and water rinses. The two chromic acid tanks were equipped with local exhaust ventilation. One employee was responsible for the operation of this line.

A fourth plating line (referred to as the "black oxide" or "cleaning" line) was also present in the plating shop. This line consisted of tanks containing hydrochloric acid, sulfuric acid, chromic acid, nickel plate, and sodium hydroxide. The various baths on this line were reportedly used on an infrequent basis. A vapor degreaser, which utilized 1,1,1-trichloroethane, was also present in the plating shop. This degreaser was used by one employee for approximately 30 minutes per day for degreasing batches of parts.

In addition to the plating operations, other areas of the plant were also examined in this survey. This included a separate area of the plant where spot welding and soldering operations were carried out. In addition, a screw machine shop, located in a building adjacent to the main plant structure, was also evaluated.

IV. MATERIALS AND METHODS

During the initial survey of August 8, 1986, information was collected regarding general plant operations, the specific types of processes being conducted, the substances used, and the types of exposure controls which were in place. On August 11, 1986, an environmental survey was conducted during which personal samples and general area air samples were collected to assess the airborne concentrations of the various contaminants. A follow-up environmental survey was conducted on December 5, 1986, in order to monitor processes which were not operational during the earlier survey visit.

A. Rationale for Sample Collection

The selection of substances to be included in the sampling protocol was based on a consideration of the types of contaminants which could be released from the various processes, their toxicity, and the potential for employee exposure. A brief discussion of the specific rationale for the inclusion substances in the sampling protocol is provided below.

1. Electroplating Operations

During electroplating, the electric current passes through the plating solution resulting in the deposition of the plated metal on the cathode. However, in most plating operations, inefficiencies in the electrochemical process cause a portion of the current to cause the disassociation of water at the electrodes. This results in the release of hydrogen and oxygen gas bubbles, which as they rise to the surface of the tank, entrain plating solution droplets which are carried into the atmosphere forming a mist. The degree of misting from a particular operation can often be predicted by the current efficiency of the plating solution. In hard chromium plating, the current efficiency may be as low as 12% to 15%, resulting in severe misting; while in nickel plating, current efficiencies may run as high as 95% to 98%, resulting in much less misting.¹

Since a significant portion of the mist generated above electroplating baths consists of metal salts of the plating solution,² it is usually necessary to evaluate the airborne concentrations of these substances. Chromium, which was present in the chromic acid baths used at the hard and decorative chrome plating lines, was evaluated due to its relatively high toxicity and the low current efficiencies (and high degree of misting) usually associated with its' plating baths. Since chromium can exist in various oxidation states, additional samples were collected to determine the amount of hexavalent chromium [Cr(VI)], which is of the greatest toxicological concern. In addition, samples were also collected for nickel, a component of the plating baths on the decorative chrome line, which is also of significant toxicological interest.

Inorganic acids are also widely used in electroplating operations. Airborne concentrations of these substances can result from their use in either the metal cleaning or electroplating baths. In the plating operations evaluated in this survey, sulfuric and hydrochloric acids were the most commonly used acids. Therefore, airborne exposures to these substances were evaluated at the various work locations. Since 1,1,1-trichloroethane was also used to degrease parts prior to electroplating, employee exposures to this substance were also evaluated during the survey.

2. Spot Welding and Soldering Operations

Although emissions from spot welding and soldering operations appeared minimal, air samples were collected at each of these operations to assess employee exposures to trace metals which might be present in the emissions as a result of their presence in either the base metal, its' coating, or in the solder.

3. Machining Operations

Samples for airborne oil mist were collected for those employees working at machining operations in the screw machine shop. In addition, air samples were collected for 1,1,1-trichloroethane and trichloroethane, which were reported to have been used during the spin recycling of the oil.

B. Sample Collection

All air samples collected were either personal samples (collected near the breathing zone of the employees) or general area samples (collected in the vicinity of the employees work area). Samples were obtained using battery-powered pumps attached via tygon tubing to the sampling media. A complete listing of the pump flow rates, sampling media, analytical procedures and limits of detection is provided in Table 6. Specific information regarding the locations and durations of sample collection is provided in Tables 1 through 5.

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 preexisting 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 becomes 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 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 summary of the evaluation criteria and the major health effects of the substances evaluated in this survey is presented in Table 7.

VI. RESULTS

The results of the air samples collected for sulfuric and hydrochloric acid are presented in Table 1. Sulfuric acid was not detected above the limit of detection (LOD) of 5 micrograms (ug) per sample in any of the four samples collected. Hydrochloric acid was found to be above the limit of quantitation of 3 ug/sample in only one of the four samples collected. A TWA of 0.59 milligrams per cubic meter of air (mg/m^3) was detected in a personal sample collected during a stripping operation at the cleaning line. This concentration is well below the OSHA PEL and ACGIH TLV of $7.0 \text{ mg}/\text{M}^3$ hydrochloric acid as a ceiling limit.

The results of the air samples collected for chromium and nickel are presented in Table 2. Nickel was detected in four of seven samples at TWA concentrations ranging from 0.0025 to $0.0045 \text{ mg}/\text{M}^3$, with a mean of

0.0034 mg/M³. These exposures are below the OSHA PEL of 1 mg/M³, the ACGIH TLV of 0.1 mg/M³, and the NIOSH REL of 0.015 mg/M³ for nickel. Chromium was detected in three of seven samples at TWA concentrations of 0.0013, 0.0017, and 0.0027 mg/M³. TWA concentrations of 0.0018 and 0.0014 mg/M³ Cr(VI) were found in two samples. These exposures are below the OSHA PEL of 0.1 mg/M³, the ACGIH TLV of 0.05 mg/M³, and the NIOSH REL of 0.025 mg/M³ for chromic acid and other noncarcinogenic forms of hexavalent chromium.

Table 3 presents the results of the air samples collected for 1,1,1-trichloroethane. A TWA concentration of 1.7 parts of contaminant per million parts of air (ppm) was detected in a personal sample for an employee conducting degreasing operations, and a TWA concentration of 15 ppm was detected in an area sample collected next to the degreaser. Both values are below the OSHA PEL and ACGIH TLV of 350 ppm as an 8-hour TWA, and the NIOSH REL of 350 ppm as a 15 minute ceiling limit for 1,1,1-trichloroethane .

Table 4 shows the results of the personal samples collected for oil mist at machining operations. Oil mist was detected in one personal sample at a TWA concentration of 0.22 mg/M³, but was below the limit of quantitation of 41 ug/sample in the other personal sample. These results are well below the OSHA PEL and the ACGIH TLV of 5 mg/M³ oil mist as an 8-hour TWA. In addition, 1,1,1-trichloroethane and trichloroethane were not detected (LOD 0.06 mg/M³ and 0.07 mg/M³, respectively) in a personal sample collected on an employee working in this area.

Table 5 shows the results of the samples collected at the spot welding and soldering operations. Each of these samples were analyzed for 27 trace metals. The personal air sample collected for the spot welder revealed TWA concentrations of 0.0056 mg/M³ iron, 0.0043 mg/M³ lead, and 0.0068 mg/M³ zinc. The personal air sample collected for the solderer revealed a TWA concentration of 0.0042 mg/M³ iron. These values are well below the corresponding evaluation criteria found in Table 7. The remaining metals were either less than the limit of detection or present in such low quantities that they were insignificant when compared to their evaluation criteria.

VII. DISCUSSION AND CONCLUSIONS

The results of the environmental samples collected for inorganic acids, metals, solvents, and oil mist were all found to be below their respective evaluation criteria at the time of the survey. However, despite the finding of no excessive employee exposures, it would be prudent to provide ongoing attention to maintaining the local exhaust ventilation systems at the plating tanks to ensure they continue to function effectively. This is particularly important for the chromic acid tanks where a potential for substantial mist generation exists. Furthermore, although NIOSH stated in the 1976 recommended standard that chromic acid is considered noncarcinogenic, several studies have been published in the interim that suggest chrome platers have excess cancer mortality rates. While none of these studies are conclusive, it would be prudent to reduce chromium (VI) exposure levels as low as possible.¹

The use of personal protective equipment is another area which should receive ongoing attention. Job tasks such as chemical mixing and chemical addition present a great potential for inadvertent contact, i.e. splashes and spills. The corrosive effects of many of the substances used in the plating operations can cause severe damage to the skin and eyes. Particular emphasis should be given to selecting the appropriate personal protective equipment for each task. In instances where the employee may come into direct or indirect contact with the plating solutions, the proper type protective equipment should be chosen so as to provide adequate coverage of the potentially exposed body areas. Gloves and other protective garments should be selected to provide a suitable degree of impermeability to the particular solutions being worked with. Proper training and supervision is also necessary to ensure that the proper personal protective equipment is selected and worn by the employees during these tasks.

Good personal hygiene and work practices are also areas which should be emphasized to the employees, particularly those who work with chromic acid. Literature reports available on chrome plating operations have consistently found problems among workers which includes skin lesions, nasal ulcerations and perforations, and other nasal mucosa problems.¹ Even when airborne levels are low, poor hygiene and work practices can be responsible for these problems. Therefore, it is important that employees working with these solutions frequently wash their hands. Smoking, eating, and drinking in the plating shop should be discouraged in order to minimize the possibility of ingestion of these materials. In order to prevent contamination of other areas, employees working with these materials should refrain from wearing contaminated work clothing into other "clean" areas, such as the lunchroom.

VIII. RECOMMENDATIONS

Although no exposures above the evaluation criteria were noted during this survey, the following recommendations are provided in order to help ensure that the hazards presented by the chemicals used in the electroplating processes are minimized.

- 1) Local exhaust ventilation systems should periodically be evaluated for their effectiveness. This should include the use of smoke tubes or other suitable methods in order to qualitatively evaluate the airflow characteristics at the individual tanks, including the effects of room air currents and other external sources of air disturbance on the the ventilation system's performance. In addition, a quantitative evaluation of system performance should be made following any major changes or revisions in the systems to ensure that minimum recommended exhaust rates are achieved.³
- 2) Face shields, chemical goggles, splash aprons, arm coverings, gloves, and boots should be made readily available to the employees for jobs such as chemical mixing and addition. Individual job tasks should be carefully evaluated, with the selection of the appropriate type of protective equipment based on the potential for skin or eye contact with the various solutions. The employees should also receive periodic training as well as adequate supervision to ensure the proper use of this equipment.

- 3) Employees should be encouraged to utilize work practices which minimize the risk of exposure at all times. This includes practices such as closing plating tank covers whenever possible. All tanks and storage containers should be clearly and accurately labeled to allow for easy identification of their contents, and should be immediately relabeled to reflect any changes in the solutions.
- 4) Proper personal hygiene procedures should be stressed for all personnel working on the electroplating lines. Hands should be washed regularly, and contact with the nose avoided, particularly after contact with any of the chromium solutions. Any skin problems (i.e., dermatitis) should be promptly reported to management so that proper corrective actions can be taken. Regular housekeeping should be emphasized in the plating tank area, as well as the employee lunch room. Eating, drinking, or smoking should not be allowed in the vicinity of the plating lines.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. Control Technology Assessment: Metal Plating and Cleaning Operations. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1984. [DHHS (NIOSH) Publication No. 85-102].
2. Crawley, L.J., Crawley, L.V. Industrial Hygiene Aspects of Plant Operations, Volume 2, Unit Operations and Product Fabrication. New York: Macmillan Publishing Company, 1984.
3. National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods, Volumes 1 & 2, Third Edition. Cincinnati, Ohio: National Institute for Occupational Safety and Health 1984. [DHHS(NIOSH) Publication No. 84-100].
4. National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods, Volume 1, Second Edition. Cincinnati, Ohio: National Institute for Occupational Safety and Health 1977. [DHEW(NIOSH) Publication No. 77-157A].
5. National Institute for Occupational Safety and Health/Occupational Safety and Health Administration. Occupational Health Guidelines for Chemical Hazards. Cincinnati, Ohio. [DHEW (NIOSH) Publication No. 81-123]
6. American Conference of Governmental Industrial Hygienists, Threshold Limit Values and Biological Exposure Indices for 1985-86. Cincinnati, Ohio: American Conference of Governmental Industrial Hygienists, 1980.
7. National Institute for Occupational Safety and Health. Occupational Diseases: A Guide to Their Recognition. Cincinnati, Ohio. [DHEW (NIOSH) Publication No. 77-181].
8. National Institute for Occupational Safety and Health. Criteria for a recommended standard: Occupational Exposure to Inorganic Nickel. Cincinnati, Ohio, 1977. [DHEW(NIOSH) Publication No. 77-164].

9. National Institute for Occupational Safety and Health. Criteria for a recommended standard: Occupational Exposure to Chromium (VI). Cincinnati, Ohio, 1975. [DHEW(NIOSH) Publication No. 76-129].

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By: William J. Daniels, CIH
Industrial Hygienist
NIOSH - Region VIII
Denver, Colorado

Bobby J. Gunter, PhD., CIH
Regional Consultant
NIOSH - Region V
Chicago, Illinois

Originating Office: Division of Surveillance, Hazard
Evaluations & Field Studies
Hazard Evaluation and
Technical Assistance Branch
Cincinnati, Ohio

Laboratory Support Measurement Support Branch
NIOSH/DPSE
Cincinnati, Ohio

Utah Biomedical Test Laboratory
Salt Lake City, Utah

XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Services (NTIS), Springfield, Virginia. 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 the following:

- A. Olson Industries
- B. U. S. Department of Labor, OSHA - Region VIII
- C. NIOSH Regional Offices/Divisions

For the purposes of informing the affected employees, copies of the report should be posted in a prominent place accessible to the employees, for a period of 30 calendar days.

TABLE 1
Results of Air Samples Collected for Hydrochloric and Sulfuric Acids

Olson Industries Denver, Colorado December 5, 1986				
<u>Sample Type/ Location</u>	<u>Sample Duration (minutes)</u>	<u>Sample Volume (Liters)</u>	<u>TWA Concentration Hydrochloric Acid (mg/M³)</u>	<u>TWA Concentration Sulfuric Acid (mg/M³)</u>
Area/Wally South Workstation	422	87.7	< LOQ	< LOD
Area/Wally North Workstation	424	81.5	< LOQ	< LOD
Area/Daw South Workstation	378	80.4	< LOQ	< LOD
Personal/ Pickle Line	208	27.0	0.59	< LOD
NIOSH Recommended Exposure Limit**			---	1.0 TWA
OSHA Permissible Exposure Limit**			7.0 Ceiling	1.0 TWA
ACGIH Threshold Limit Value**			7.0 Ceiling	1.0 TWA

Abbreviations and Key

TWA - Time-weighted average concentration (all sample results are expressed as a TWA for the duration of sample collection).

mg/M³ - milligrams of contaminant per cubic meters of air

< LOD - Less than the limit of detection: 5 micrograms/sample for sulfuric acid and 1 microgram/sample for hydrochloric acid.

< LOQ - Less than the limit of quantitation: 18 micrograms/sample for sulfuric acid and 3 microgram/sample for hydrochloric acid. (Substances with this notation were detected, but not in high enough concentrations to reliably quantitate.)

**Refer to Table 7 for a complete discussion of the evaluation criteria

TABLE 2
Results of Air Samples Collected for Chromium and Nickel

Olson Industries Denver, Colorado				
<u>Sample Type/ Location</u>	<u>Sample Duration (minutes)</u>	<u>Sample Volume (Liters)</u>	<u>TWA Concentration Chromium (mg/M3)</u>	<u>TWA Concentration Nickel (mg/M3)</u>
(Samples Collected August 11, 1986)				
Personal/ Hard Chrome Plater	330	660	< LOD 0.0018*	< LOD
Area/by Chromic Acid Plating Tank	422	844	< LOQ 0.0014*	< LOD
Area/Work Table Center of Room	403	806	< LOD	< LOD
(Samples Collected December 5, 1986)				
Area/Wally South Workstation	420	840	0.0017	0.0025
Area/Wally North Workstation	422	844	0.0013	0.0039
Area/Daw South Workstation	404	808	< LOD	0.0045
Personal/ Hard Chrome Plater	401	802	0.0027	0.0030
NIOSH Recommended Exposure Limit**			0.025	0.015
OSHA Permissible Exposure Limit**			0.1	1.0
ACGIH Threshold Limit Value**			0.05	0.1

Abbreviations and Key

- TWA - Time-weighted average concentration (all sample results are expressed as a TWA for the duration of sample collection).
- mg/M³ - milligrams of contaminant per cubic meters of air
- < LOD - Less than the limit of detection: 1 microgram (ug)/sample
- < LOQ - Less than the limit of quantitation: 3 ug/sample. (Substance was above LOD, but not present in an amount sufficient to reliably quantitate.)
- * Samples with this notation represent side-by-side samples which were analyzed specifically for hexavalent chromium [Cr(VI)].
- **Refer to Table 7 for a complete discussion of the evaluation criteria

TABLE 3
Results of Air Samples Collected 1,1,1-Trichloroethane
 Olson Industries, Denver, Colorado
 August 11, 1986

<u>Sample Type/ Location</u>	<u>Sample Duration (minutes)</u>	<u>Sample Volume (Liters)</u>	<u>TWA Concentration 1,1,1-Trichloroethane (ppm)</u>
Personal/ Plating Supervisor	325	33.0	1.7
Area/Behind Degreaser Tank	317	38.1	15.0
NIOSH Recommended Exposure Limit**			350 (15-min)
OSHA Permissible Exposure Limit**			350 TWA
ACGIH Threshold Limit Value**			350 TWA 450 (15-min)

TABLE 4
Results of Air Samples Collected Oil Mist
 Olson Industries, Denver, Colorado
 December 5, 1986

<u>Sample Type/ Location</u>	<u>Sample Duration (minutes)</u>	<u>Sample Volume (Liters)</u>	<u>TWA Concentration Oil Mist (mg/M³)</u>
Personal/ Machinist	359	718	0.22
Personal/ Machinist's Helper	366	732	< LOQ
NIOSH Recommended Exposure Limit**			---
OSHA Permissible Exposure Limit**			5 TWA
ACGIH Threshold Limit Value**			5 TWA 10 (15-min)

Abbreviations and Key

TWA - Time-weighted average concentration (all sample results are expressed as a TWA for the duration of sample collection).

ppm - parts of contaminant per million parts of air

mg/M³ - milligrams of contaminant per cubic meters of air

< LOQ - Less than the limit of quantitation: 41 micrograms oil mist/sample.
 (Substance was above LOD, but not present in an amount sufficient to reliably quantitate.)

**Refer to Table 7 for a complete discussion of the evaluation criteria

TABLE 5

Results of Air Samples Collected for Trace Metals

Olson Industries
 Denver, Colorado
 August 11, 1986

<u>Sample Type/ Location</u>	<u>Sample Duration (minutes)</u>	<u>Sample Volume (Liters)</u>	<u>TWA Concentration/ Contaminant* (mg/M³)</u>
Personal/ Spot Welder	418	836	0.0056/iron 0.0043/lead 0.0068/zinc
Personal/ Solderer	409	613	0.0042/iron
NIOSH Recommended Exposure Limit**		iron oxide fume lead zinc oxide fume	-- 0.05 5
OSHA Permissible Exposure Limit**		iron oxide fume lead zinc oxide fume	10 0.05 5
ACGIH Threshold Limit Value**		iron oxide fume lead zinc oxide fume	5 0.15 5

Abbreviations and Key

TWA - Time-weighted average concentration (all sample results are expressed as a TWA for the duration of sample collection).

mg/M³ - milligrams of contaminant per cubic meters of air

* Each sample was analyzed for 31 trace metals. Unless otherwise indicated, the results were less than the limit of detection of 1 microgram/filter for each element.

**Refer to Table 7 for a complete discussion of the evaluation criteria

TABLE 6
Sampling and Analysis Methodology

Olson Industries, Denver, Colorado
 August 11 & December 5, 1986

Substance	Collection Media	Flow-rate (LPM)	Analysis Method	NIOSH Reference Method ^{3,4}
INORGANIC ACIDS (Sulfuric, Hydrochloric)	Silica Gel Tubes	0.2	Ion Chromatography	7903
TRACE METALS	0.8-um AA Filter	1.5	Inductively Coupled Plasma, Atomic Emission Spectroscopy	7300
CHROMIUM, NICKEL	0.8-um AA Filter	1.5	Atomic Absorption Spectroscopy	P&CAM 173
HEXAVALENT CHROMIUM	0.5-um PVC Filter	1.5	Visible Spectroscopy	7600
OIL MIST	0.8-um AA Filter	1.5	Infrared Spectrophotometry	P&CAM 283
1,1,1-TRICHLOROETHANE	Charcoal Tube	0.2	Gas Chromatography	1003

Table 7
Evaluation Criteria and Health Effects Summary

SUBSTANCE	EVALUATION CRITERIA ^{5,6}			PRIMARY HEALTH EFFECTS
	NIOSH REL	OSHA PEL	ACGIH TLV	
<u>Hydrogen Chloride</u> (Hydrochloric acid or HCL)	NA	7 mg/M ³ (C)	7 mg/M ³ (C)	High concentrations are very corrosive to eyes, skin, and mucous membranes. HCL can cause burn ulcers and scarring of skin mucous membranes can cause dermatitis with repeated exposure. Inhalation can result in burning, choking, coughing, laryngitis, bronchitis, pulmonary edema, and death. Long-term exposure may cause erosion of the teeth. ⁵
<u>Sulfuric acid</u>	1 mg/M ³	1 mg/M ³	1 mg/M ³	Concentrated sulfuric acid can cause rapid damage to mucous membranes, is exceedingly dangerous to the eyes, and can burn and char the skin and mouth. Diluted sulfuric acid is irritating to the eyes, nose, throat, and skin and may cause scarring of the skin and blindness. Inhaled sulfuric acid can cause irritation of the eyes, nose, and throat, etching of dental enamel and edema of the lungs and throat. ^{5,7}
<u>Nickel</u>	0.015	1 mg/M ³	0.1 mg/M ³ (soluble)	Skin sensitization is the most commonly seen toxic reaction to nickel and its compounds. Nickel is also an irritant to the eyes and mucous membranes of the respiratory tract. Due to concern about the potential carcinogenicity of nickel compounds, NIOSH recommends that occupational exposure to nickel be reduced to the lowest feasible level. ^{7,8}
<u>Chromic Acid and Chromates</u> [for noncarcinogenic forms of Cr(VI)]	.025 mg/M ³	0.1 mg/M ³	0.05mg/M ³	In some workers, chromium compounds act as allergens, causing dermatitis and pulmonary sensitization. In the hexavalent state Cr(VI), these compounds are irritating and corrosive to the skin and mucous membranes. Certain forms of hexavalent chromium have been found to cause respiratory cancer. ^{7,9}

Table 7 (continued)
Evaluation Criteria and Health Effects Summary

SUBSTANCE	EVALUATION CRITERIA ^{5,6}			PRIMARY HEALTH EFFECTS
	NIOSH REL	OSHA PEL	ACGIH TLV	
<u>1,1,1-Trichloroethane</u> (methyl chloroform)	350 ppm (15 min)	350 ppm	350 ppm 450 ppm (15-min)	Prolonged or repeated exposure can cause irritation of the skin. Short-term exposure may cause headache, dizziness, and at high concentrations it may cause drowsiness, irregular heart beat, and death. ⁵
<u>Inorganic Lead</u>	<0.1 mg/M ³	0.05 mg/M ³	0.15 mg/M ³	Can cause fatigue, loss of sleep, headache, abdominal pain and decreased appetite. Inhalation or ingestion may damage the kidneys, nervous system, and bone marrow. Long-term exposure is associated with infertility and fetal damage in pregnant women.
Iron Oxide (fume)	NA	10 mg/M ³	5 mg/M ³	Inhalation of the fume can cause an apparently benign pneumoconiosis termed siderosis. ⁵
Zinc Oxide (fume)	5 mg/M ³	5 mg/M ³	5 mg/M ³	Inhalation of fumes may cause a metallic or sweet taste in the mouth, dryness and irritation of the throat, coughing at the time of exposure, and an influenza-like illness termed metal fume fever. ⁵
Oil Mist (Mineral)	NA	5 mg/M ³	5 mg/M ³ 10 mg/M ³ (15 min)	Inhalation of the mist in high concentrations may cause pulmonary effects, although this has rarely reported. Skin contact may cause dermatitis. ⁵

All evaluation criteria are expressed as 8-hour (OSHA, ACGIH) or 10-hour (NIOSH) time-weighted averages (TWA's) unless a shorter duration of exposure is specified below the criteria.

"C" or "P" - Ceiling or Peak exposure limit; criteria should not be exceeded at any time during the workshift.

mg/M³ - milligrams of contaminant per million parts of air

ppm - parts of contaminant per million parts of air

NA - No applicable standard or criteria