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Ingersoll-Rand Company, Von Duprin Division
Indianapolis, Indiana

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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, technical and consultative assistance 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.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Nancy Clark Burton and Ana Navarrete-Contreras, of the Hazard Evaluations and Technical Assistance Branch, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Field assistance was provided by Calvin Cook and Veronica Herrera-Moreno. Desktop publishing was provided by Juanita Nelson. Analytical support was provided by the Data Chem Laboratories, Inc., Salt Lake City, Utah.

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SUMMARY

In February 1997, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at the Ingersoll-Rand Company, Von Duprin Division, in Indianapolis, Indiana. The company produces door hardware. The requesters asked NIOSH to evaluate worker exposures to the Kolene® salt bath (used to remove paint from conveyor racks) and plating processes in the plating/painting department. In the request, employees expressed concern over symptoms including sore throats, skin irritation, and sinus, upper respiratory, and eye irritation. On April 23–24, 1997, NIOSH investigators conducted a walk-through survey of the facility, collected environmental samples for sodium hydroxide, inorganic acids, and metals, conducted voluntary confidential medical interviews with 10 of the 36 employees who work in the plating/painting department, and reviewed the Occupational Safety and Health Administration (OSHA) Log and Summary of Injuries and Illnesses (OSHA Form 200) for 1995, 1996, and 1997 (January to March).

Sodium hydroxide concentrations were all lower than the minimum quantifiable concentration (MQCs) of 0.080 milligrams per cubic meter (mg/m^3), which is well below existing occupational exposure limits. The air concentrations of hydrochloric acid (none detected to trace), nitric acid (none detected to trace), and sulfuric acid (trace levels) were all below the MQCs. Hydrofluoric acid, phosphoric acid, and hydrobromic acid were not detected in any of the samples. The air concentrations of copper, iron, manganese, molybdenum, and zinc were well below their respective occupational exposure limits. Smoking was permitted in the general plant area, and several workers were observed smoking in different areas of the plant, including the plating/painting area. The humidity in the plating/painting department was very low (17%).

Of the ten workers interviewed, six reported a history of health problems they thought were related to their job. In the last year, two workers reported having had skin irritation, three reported eye irritation, and five reported upper respiratory tract irritation. Of the five workers that had respiratory concerns, three smoked cigarettes (average: 13 per day). Employees expressed concern over skin contact with Kolene®. Review of the OSHA 200 logs for the plating/painting department (January 1995-March 1997) showed one case of skin abrasion without lost work days, one case of a burned face due to a chemical splash, two cases of eye irritation with no lost work days, but 38 restricted work days, and two cases of chemical inhalation during a fire in the plating/painting department, with one lost work day. The other entries were for musculoskeletal disorders.

At the time of the site visit, exposures to sodium hydroxide, inorganic acids, and metals were low. Employees reported symptoms of eye, skin, and respiratory irritation which could be related to several factors including low levels of the air contaminants measured, tobacco smoke, or low relative humidity. NIOSH considers environmental tobacco smoke (ETS) to be a potential occupational carcinogen and believes that workers should not be involuntarily exposed to tobacco smoke. Recommendations to address employee exposure concerns are provided in the recommendation section of this report.

Keywords: SIC Code 3471 (Electroplating, plating, polishing, anodizing, and coloring), Kolene® salt bath, sodium hydroxide, hydrochloric acid, nitric acid, sulfuric acid, metals, environmental tobacco smoke (ETS), eye irritation, skin irritation, respiratory irritation.

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INTRODUCTION

In February 1997, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at the Ingersoll-Rand Company, Von Duprin Division in Indianapolis, Indiana. The requesters asked NIOSH to evaluate worker exposures to the Kolene® salt bath and plating processes in the plating/painting department. The employees expressed concern over symptoms including sore throats, skin irritation, and sinus, upper respiratory, and eye irritation. A site visit was conducted on April 23 and 24, 1997, to examine these issues.

BACKGROUND

The Von Duprin Division of the Ingersoll-Rand Company produces hardware for fire doors (such as push bars). The survey focused on the plating/painting area of the facility. Thirty-six employees work in this area on three different shifts: 17 on the first shift (7:30 a.m.- 4 p.m.), 14 on the second shift (4 p.m. - 11:30 p.m.), and five on the third shift (11:30 p.m.- 7:30 a.m.). The general layout of the area is presented in Figure 1 (not to scale). The plating/painting department is not air-conditioned; make-up air, to replace air removed by local exhaust ventilation, is drawn from the rest of the plant.

There are three automated plating lines (single, dual, and zinc barrel). Employees are responsible for loading/unloading parts on racks, monitoring the conveyor system, and adding materials to the plating tanks as needed. The plating tanks contain a variety of substances, including nickel, chromium, copper, cyanide compounds, sulfuric acid, and sodium hydroxide. The plating lines have local exhaust ventilation for each tank.

On the automated paint conveyor line, employees load parts on racks which go through a cleaning/rinsing process. The parts then go to the painting area, where they are either spray-painted or electrostatically coated with powdered paint. The painted parts are unloaded and sent to the assembly area.

The racks covered with paint continue to the Kolene® salt bath system, which contains alkali nitrates and alkali hydroxides. The system is a fully enclosed molten salt bath with a local exhaust ventilation system. The automated salt bath also includes a rinse, spray, and drying system to remove residual Kolene®. The Kolene® system started operating in January 1996.

The company provides gloves, goggles, and NIOSH-approved disposable dust/mist/fume respirators for the employees as optional personal protective equipment. The employees in the plating/painting department have annual audiometric tests performed by the company.

A contractor conducted an environmental exposure assessment in the painting/plating department in October 1996. The contractor monitored for sodium hydroxide, hexavalent chromium, sulfuric acid, nitric acid, and nickel. Detected concentrations were well below their respective occupational exposure criteria.

METHODS

Industrial Hygiene

NIOSH investigators conducted a walk-through survey of the areas of concern and reviewed past sampling data and material safety data sheets. Personal breathing zone (PBZ) and area air samples were collected for sodium hydroxide, inorganic acids, and metals in the plating/painting area of the plant.

Sodium Hydroxide

Four PBZ and two area air samples were collected and analyzed for sodium hydroxide by titration according to NIOSH Method 7401[1] with the

following modification: 0.01 N sulfuric acid was used in place of 0.01 N hydrochloric acid. The limit of detection (LOD) was 20 micrograms (µg), which is equivalent to a minimum detectable concentration (MDC) of 0.024 milligrams per cubic meter (mg/m^3), assuming a sample volume of 838 liters. The limit of quantitation (LOQ) was 67 µg, which is equivalent to a minimum quantifiable concentration (MQC) of 0.080 mg/m^3, assuming a sample volume of 838 liters.

Inorganic Acids

Two PBZ and one area air samples were collected on silica gel tubes (400 mg/200 mg) using a flow rate of 0.2 l/min. The samples were analyzed for inorganic acids (hydrofluoric acid, hydrochloric acid, nitric acid, phosphoric acid, sulfuric acid, and hydrobromic acid) by ion chromatography according to NIOSH Method 7903.[2] The LODs were 1 µg per sample for hydrofluoric acid, hydrochloric acid, nitric acid, sulfuric acid, and hydrobromic acid and 10 µg for phosphoric acid, which are equivalent to MDCs of 0.024 mg/m^3 and 0.24 mg/m^3, respectively, assuming a sample volume of 42.3 liters. The LOQs were 3.4 µg for hydrochloric acid, nitric acid, sulfuric acid, and hydrobromic acid, 3.5 µg for hydrofluoric acid, and 30 µg for phosphoric acid which are equivalent to MQCs of 0.08 mg/m^3, 0.083 mg/m^3, and 0.71 mg/m^3, respectively, assuming a sample volume of 42.3 liters.

Metals

Three PBZ and one area air samples were collected on mixed–cellulose ester filters (37 mm diameter, 0.8 micrometer [µm] pore size) using a flow rate of 2.0 l/min. The samples were analyzed for 28 elements, mostly metals, according to NIOSH Method 7300[3], modified for microwave digestion. In the laboratory, the filters were digested in a microwave oven using nitric acid. The samples were cooled and diluted to volume with distilled water. The resulting sample solutions were analyzed by inductively coupled plasma atomic emission spectrometry. The MDCs and MQCs, using a sample volume of 818 liters, for selected elements (metals) are listed in Table 4.

Medical

The medical evaluation conducted in the plating/painting department included: (1) voluntary confidential medical interviews with workers, (2) a telephone conversation with the Director of Occupational Health and Medicine, Community Hospitals Indianapolis, regarding the medical occupational history of two workers, and (3) review of the Occupational Safety and Health Administration (OSHA) Log and Summary of Injuries and Illnesses (OSHA Form 200) for 1995, 1996, and 1997 (January to March).

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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 even though 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).

The primary sources of environmental evaluation criteria for the workplace are — (1) NIOSH Recommended Exposure Limits (RELs),[4] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[5] and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs).[6] In July 1992, the 11th Circuit Court of Appeals

vacated the 1989 OSHA PEL Air Contaminants Standard. OSHA is currently enforcing the 1971 standards which are listed as transitional values in the current Code of Federal Regulations; however, some states operating their own OSHA approved job safety and health programs continue to enforce the 1989 limits. NIOSH encourages employers to follow the 1989 OSHA limits, the NIOSH RELs, or the ACGIH® TLVs®, depending on which is the more protective criterion for the agent of concern. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard and that the OSHA PELs included in this report reflect the 1971 values.

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 (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Sodium Hydroxide

Sodium hydroxide is considered a severe irritant of the eyes, mucous membranes, and skin.[7] Exposure to sodium hydroxide dust or mist can cause serious injury to the entire respiratory tract, from mild irritation of the nose to severe pneumonitis, depending on the severity of exposure. One report of respiratory effects with chronic occupational sodium hydroxide exposure involved a 63-year-old man exposed to sodium hydroxide mist (as boiling lye solution) for 20 years; he developed severe obstructive airway disease.[8]

Exposure to concentrated solutions of sodium hydroxide can cause tissue destruction of eyes and skin. If sodium hydroxide is not removed from the skin, severe burns with deep ulceration can occur. Contact with the eyes can cause disintegration and sloughing of conjunctival and corneal epithelium, corneal opacification, marked edema, and ulceration. After 7 to 13 days, either gradual recovery begins or there is progression of ulceration and corneal opacification. Complications of severe eye burns are symblepharon (adhesion of one or both eyelids to the eyeball, partial or complete) with overgrowth of the cornea by the vascularized membrane, progressive or recurrent corneal ulceration, and permanent corneal opacification. The OSHA PEL for sodium hydroxide is 2 mg/m^3 as an 8–hr TWA.[6] The vacated 1989 OSHA PEL was 2 mg/m^3 as a ceiling level.[9] The ACGIH® TLV® and NIOSH REL for sodium hydroxide are 2 mg/m^3 as a ceiling level.[4,5]

Inorganic Acids

Inorganic acids, including hydrochloric acid, nitric acid, and sulphuric acid, are primary irritants and are corrosive in high concentrations.[7, 8,9] These acids will cause chemical burns when in contact with the skin and mucous membranes and are a particular hazard to the eye. Vapors and mists are respiratory tract irritants, and ingestion of inorganic acids will result in severe throat and stomach destruction. The NIOSH REL, OSHA PEL, and ACGIH® TLV® for hydrochloric acid are 7 mg/m^3, 7 mg/m^3, and 7.5 mg/m^3, respectively, as ceiling values. The NIOSH REL, OSHA PEL, and ACGIH® TLV® for nitric acid are 5 mg/m^3, 5 mg/m^3, and 5.2 mg/m^3, respectively, as TWAs. The NIOSH REL, OSHA PEL, and ACGIH® TLV® for sulfuric acid are all 1 mg/m^3 as a TWA.

Metals

A list of selected metals along with a brief summary of their primary health effects and the evaluation criteria for occupational exposures to these contaminants are presented in Table 1.

Table 1
Health Effects and Occupational Exposure Limit Summary for Selected Metals

Element	Primary Health Effects[7, 8,9,10,11]	OSHA PEL (mg/m^3)[6]	NIOSH REL (mg/m^3)[4]	ACGIH® TLV® (mg/m^3)[5]
Copper (Cu)	Inhalation of copper fume has resulted in irritation of the upper respiratory tract, metallic taste in the mouth, and nausea. Exposure has been associated with the development of metal fume fever.	1	1	1
Chromium (Cr)	Chromium (Cr) exists in a variety of chemical forms and toxicity varies among the different forms. Elemental chromium is relatively non–toxic, but other chromium compounds may cause skin irritation, sensitization, and allergic dermatitis. In the hexavalent form (Cr(VI)), Cr compounds are corrosive and considered carcinogenic.	1.0	0.5	0.5
Iron (Fe)	Inhalation of iron oxide dust may cause a "benign pneumoconiosis" (X-ray findings without symptoms) called siderosis.	10	5	5
Manganese (Mn)	Manganese fume exposure has been associated with chemical pneumonitis and central nervous system effects.	5 (ceiling)	1	0.2
Molybdenum (Mo)	Inhalation of molybdenum can cause respiratory tract irritation. Inhalation of molybdenum and/or molybdenum trioxide may cause pneumoconiosis.	15 (vacated PEL 10)	____	10
Zinc (Zn)	Zinc oxide exposure has been associated with shortness of breath, minor lung function changes, and metal fume fever.	15 (vacated PEL 5)	5	10

Noise

Noise-induced loss of hearing is an irreversible, sensorineural condition that progresses with exposure. Although hearing ability declines with age (presbycusis) in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This noise-induced loss is caused by damage to nerve cells of the inner ear (cochlea) and, unlike some conductive hearing disorders, cannot be treated medically.[12] While loss of hearing may result from a single exposure to a very brief impulse noise or explosion, such traumatic losses are rare. In most cases, noise-induced hearing loss is insidious. Typically, it begins to develop at 4000 or 6000 Hz (the hearing range is 20 Hz to 20000 Hz) and spreads to lower and higher frequencies. Often, material impairment has occurred before the condition is clearly recognized. Such impairment is usually severe enough to permanently affect a person's ability to hear and understand speech under everyday conditions. Although the primary frequencies of human speech range from 200 Hz to 2000 Hz, research has shown that the consonant sounds, which enable people to distinguish words such as "fish" from "fist," have still higher frequency components.[13]

The A-weighted decibel [dB(A)] is the preferred unit for measuring sound levels to assess worker noise exposures. The decibel unit is dimensionless, and represents the logarithmic relationship of the measured sound pressure level to an arbitrary reference sound pressure (20 micropascals, the normal threshold of human hearing at a frequency of 1000 Hz). Decibel units are used because of the very large range of sound pressure levels which are audible to the human ear. The dB(A) scale is weighted to approximate the sensory response of the human ear to sound frequencies.

The OSHA standard for occupational exposure to noise (29 CFR 1910.95)[14] specifies a maximum PEL of 90 dB(A)-slow response for a duration of eight hours per day. The regulation, in calculating the PEL, uses a 5 dB time/intensity trading relationship, or exchange rate. This means that in order for a person to be exposed to noise levels of 95 dB(A), the amount of time allowed at this exposure level must be cut in half in order to be within OSHA's PEL. Conversely, a person exposed to 85 dB(A) is allowed twice as much time at this level (16 hours) and is within his/her daily PEL. NIOSH has established an exposure limit of 85 dB(A) for 8 hours, 5 dB less than the OSHA standard.[15] The NIOSH criteria also use a 3 dB time/intensity trading relationship in calculating exposure limits. The ACGIH® TLV® is 85 dB(A) for an 8-hour exposure, that also uses a 3 dB exchange rate to calculate time-varying noise exposures.[5] Thus, a worker can be exposed to 85 dB(A) for 8 hours, but to only 88 dB(A) for 4 hours or 91 dB(A) for 2 hours.

The OSHA regulation has an additional action level (AL) of 85 dB(A) which stipulates that an employer shall administer a continuing, effective hearing conservation program when the TWA value exceeds the AL. The program must include monitoring, employee notification, observation, an audiometric testing program, hearing protectors, training programs, and recordkeeping requirements. All of these stipulations are included in 29 CFR 1910.95, paragraphs (c) through (o).

The OSHA noise standard also states that when workers are exposed to noise levels in excess of the OSHA PEL of 90 dB(A), feasible engineering or administrative controls shall be implemented to reduce the workers' exposure levels. Also, a continuing, effective hearing conservation program shall be implemented.

RESULTS

Industrial Hygiene

Sodium Hydroxide

The results for the sodium hydroxide sampling are

presented in Table 2. Concentrations in the four PBZ samples and the two area air samples were all lower than the MQC of 0.080 mg/m^3, which is well below current occupational exposure limits.

Inorganic Acids

The results for the inorganic acid sampling are given in Table 3. The air concentrations of hydrochloric acid (none detected to trace), nitric acid (none detected to trace), and sulfuric acid (trace levels) were all below the MQCs. Hydrofluoric acid, phosphoric acid, and hydrobromic acid were not detected in any of the samples.

Metals

The three PBZ and one area air sample results for metals are shown in Table 4. The air concentrations of copper, iron, manganese, molybdenum, and zinc were well below their respective occupational exposure criteria.

Observations

Several employees reported concern over a reaction in the enclosed Kolene® salt bath that occurred when a few painted metal parts, left on the racks, entered the bath. They reported that the sides of the metal tank moved and shook. The Kolene® salt bath compounds can react explosively with magnesium, tin, and zinc which may explain this reaction.

Smoking was permitted in the general plant area, and we observed several workers smoking in different areas of the plant, including the plating/painting area, where it was prohibited. According to information provided by the company, a fire in the plating/painting area this year was possibly caused by a cigarette.

During the walk-through tour, we observed that the majority of the workers were not wearing hearing protection although it was provided. According to management, noise levels in this area are at the OSHA action level (85 dB(A) with a 5 dB exchange rate).

Measurements showed low humidity levels in plating/painting department (approximately 17%).

Medical

There were 10 female and 26 male employees in the plating/painting department. The average seniority of these workers was ten years (range: 1 month to 31 years), and the average age was 40 years (range: 22 to 56 years).

Interviews

Ten of the 36 workers were interviewed (six males and four females); the rest declined to be interviewed. The average seniority of the interviewed workers was six years (range: five months to 12 years). The average age of the interviewed workers was 38 years (range: 29 to 45 years).

Of the ten workers interviewed, six reported a history of health problems they thought were related to their job. In the last year, two workers reported having had skin irritation, three reported eye irritation, and five reported upper respiratory tract irritation. Of the five workers that had respiratory concerns, three smoked cigarettes (average: 13 per day).

Of the ten interviewed workers, two stated they did not wear the personal protection equipment (gloves, goggles, and respirators) provided by the company, and eight stated they wore it occasionally.

Review of OSHA 200 logs

Between January 1, 1995, and March 30, 1997, the OSHA 200 logs revealed the following:

1) **1995**: Of 81 entries, 14 (17%) were from the

plating/painting area. There was one case of skin abrasion without lost work days and the remaining entries were mostly musculoskeletal disorders, with 12 lost work days and 137 restricted work days.

2) **1996**: Of 92 entries, 13 (14%) were from the plating/painting area. There was one case of a burned face due to a chemical splash and two cases of eye irritation with no lost work days, but 38 restricted work days. The rest of the entries were mostly for musculoskeletal disorders, with 59 lost work days and 235 restricted work days.

3) **1997**, until March 30: Of 20 entries, 7 (35%) were from the plating/painting area. Two entries were for chemical inhalation during a fire in the plating/painting department, with one lost work day and without restricted work days. The remaining entries were for musculoskeletal disorders, also without lost or restricted work days.

DISCUSSION/CONCLUSIONS

Environmental concentrations of sodium hydroxide, inorganic acids, and elements (metals) were below their respective occupational exposure limits and were similar to those found in a contractor's evaluation of this area in October 1996. Interviews with employees revealed that skin contact with the Kolene® salt bath solution was a major concern. Limiting dermal exposure is an important measure to prevent skin irritation. This is preferably done by engineering controls, but proper use of personal protective equipment such as protective gloves, aprons, and clothing is also important. In addition, education and training of the workers regarding dermal effects from Kolene® salt solution and the importance of workplace personal hygiene are important. Eye and respiratory irritation were other concerns of the interviewed employees. Sodium hydroxide and acids from the plating tanks were detected at low levels in the plating/painting department and may be contributing to those symptoms. Also the low humidity and presence of environmental tobacco smoke (ETS) in this department could contribute to symptoms of dryness and irritation.

Smoking in the plant is of concern from both safety and health standpoints. ETS consists of exhaled mainstream smoke from the smoker and sidestream smoke emitted from the smoldering tobacco. ETS consists of between 70 and 90% sidestream smoke. More than 4000 compounds have been identified in laboratory studies, including many known human toxins and carcinogens, such as carbon monoxide, ammonia, formaldehyde, nicotine, tobacco-specific nitrosamines, benzo(a)pyrene, benzene, cadmium, nickel, and aromatic amines.[16,17] Many of these toxic constituents are more concentrated in sidestream than in mainstream smoke.[17] In studies conducted in residences and office buildings with tobacco smoking, ETS was a substantial source of many gas and particulate polycyclic aromatic compounds.[16]

ETS has been shown to be causally associated with lung cancer and cardiovascular disease in adults, and respiratory infections, asthma, middle ear effusion, and low birth weight in children.[18,19,20,21] It is also a cause of annoying odor and sensory irritation. The U.S. Environmental Protection Agency (EPA) has classified ETS as a known human (Group A) carcinogen.[22] NIOSH considers ETS to be a potential occupational carcinogen and believes that workers should not be involuntarily exposed to tobacco smoke.[23]

RECOMMENDATIONS

Several workplace exposures and conditions that could be contributing to employees' symptoms were identified. Based on the results and observations of this evaluation, the following recommendations are offered to improve employee comfort and minimize health complaints:

1. Dermal contact with Kolene® salt compounds should be reduced as much as possible by use of personal protective equipment and modification of work practices. Employees who operate machinery requiring direct contact with the compounds should wear a rubber, not cloth, full-front apron and rubber gloves that cover the forearms.[24] Employees in the paint rack loading area should also wear gloves to prevent dermal contact with this product.

2. The use of chemical safety goggles is important for protection of the eyes when working with the Kolene®salt bath and plating tank compounds.

Eyewash fountains and safety showers should be used when eye and/or significant skin contact occurs.

3. To prevent chemical (potentially explosive) reactions between metals and the Kolene® salt bath solution, employees should make sure that no painted parts are left on the racks before the racks enter the salt bath.

4. To prevent ingestion of substances used in the workplace, eating, drinking, and cigarette smoking should not be allowed along the production lines. Workers should be encouraged to wash hands thoroughly before performing these activities.

5. Smoking should either be prohibited or restricted to designated, separately ventilated smoking areas. Worker exposure to ETS is most efficiently and completely controlled by eliminating tobacco use from the workplace. To facilitate elimination of tobacco use, employers should implement smoking cessation programs. Management and labor should work together to develop appropriate nonsmoking policies that include some or all of the following:

- Prohibit smoking at the workplace and provide sufficient disincentives for those who do not comply.
- Distribute information about health promotion and the harmful effects of smoking.
- Offer smoking-cessation classes to all workers.
- Establish incentives to encourage workers to stop smoking.

6. To prevent hearing loss, employees should use hearing protection devices in the plating/painting department as an interim measure until engineering or administrative controls have reduced noise levels below the NIOSH REL of 85 dB(A).

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Table 2
Sodium Hydroxide Sampling Results
Ingersoll-Rand Company, Von Duprin Division
Indianapolis, Indiana
HETA 97-0111
April 24, 1997

Job Description/Area^	Sample Time	Sample Volume (liters)	Concentration (mg/m^3)^^
Personal Samples			
Kolene® Operation - Unloader (A)	7:55 a.m. - 3:24 p.m.	838	Trace#
Painting Line - Loader (B)	8:06 a.m. - 3:31 p.m.	890	Trace#
Dual Plating Tank - Loader ©	8:15 a.m. - 3:38 p.m.	886	Trace#
Tumbler Operator (D)	8:20 a.m. - 3:23 p.m.	846	ND*
Area Samples			
Kolene® Operation - End of Rinse Bath (E)	7:51 a.m. - 3:29 p.m.	916	Trace#
Kolene® Operation - Next to Heated Salt Bath (F)	7:47 a.m. - 3:26 p.m.	918	ND*
OSHA PEL			2**
ACGIH® TLV®			2 (ceiling)
NIOSH REL			2 (ceiling)
Minimum Detectable Concentration (MDC)		838	0.024
Minimum Quantifiable Concentration (MQC)		838	0.080

^ = Letters correspond to sampling locations shown in Figure 1.
^^ = mg/m^3 - milligrams per cubic meter
# = Between MDC and MQC
* = ND — not detected at the minimum detectable concentration
** = Vacated 1989 OSHA PEL — 2 mg/m^3 as ceiling value

Table 3
Inorganic Acid Sampling Results
Ingersoll-Rand Company, Von Duprin Division
Indianapolis, Indiana
HETA 97-0111
April 24, 1997

Job Description/Area^	Sample Time	Sample Volume (liters)	Concentration (mg/m^3)^^		
			Nitric Acid	Sulfuric Acid	Hydrochloric Acid
Personal Samples					
Painting Line - Parts Loader (G)	8:14 a.m. - 11:46 a.m. (Faulted at 212 min.)	42.3	ND*	Trace#	ND*
Single Line - Loader (H)	8:20 a.m. - 3:32 p.m.	86.4	Trace#	Trace#	Trace#
Area Sample					
Kolene® Operation - Next to Heated Salt Bath (F)	7:57 a.m. - 3:25 p.m.	89.6	Trace#	Trace#	Trace#
OSHA PEL			5	1	7 (ceiling)
ACGIH® TLV®			5.2	1	7.5 (ceiling)
NIOSH REL			5	1	7 (ceiling)
Minimum Detectable Concentration (MDC)		42.3	0.024	0.024	0.024
Minimum Quantifiable Concentration (MQC)		42.3	0.080	0.080	0.080

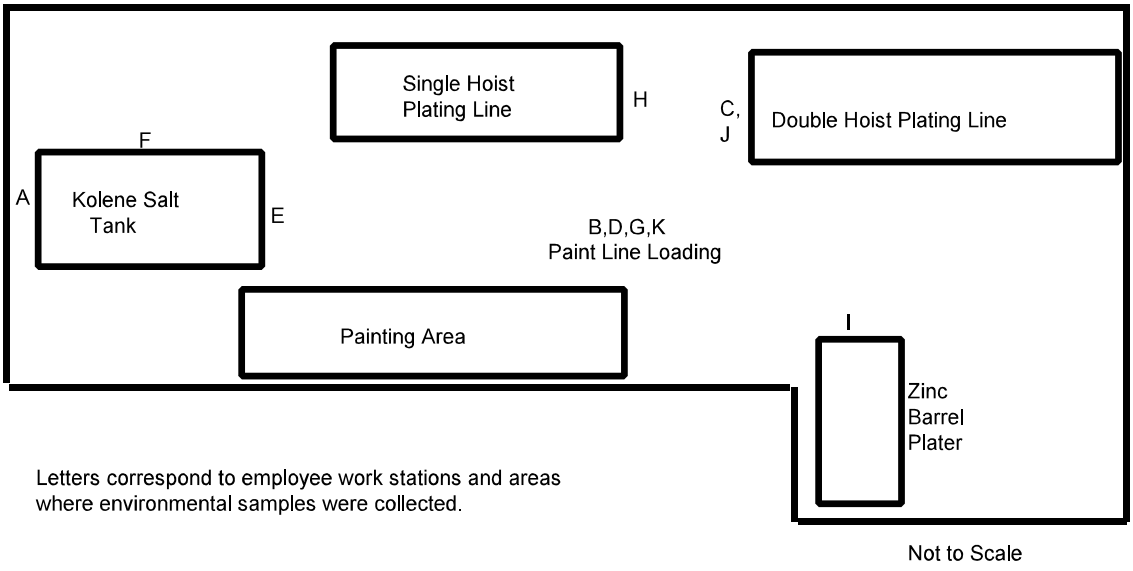
^ = Letters correspond to sampling locations shown in Figure 1.
^^ = mg/m^3 — milligrams per cubic meter
• = ND — not detected at the minimum detectable concentration
= Between MDC and MQC

Table 4
Air Sampling Results For Elements
Ingersoll-Rand Company, Von Duprin Division
Indianapolis, Indiana
HETA 97-0111
April 24, 1997

Job Title/ Location^	Sampling Time	Sample Volume (liters)	Concentration (TWA – mg/m^3)*					
			Cu	Fe	Mn	Mo	Na	Zn
Personal Samples								
Zinc Barrel Line Operator (I)	8:32 a.m. – 3:21 p.m.	818	0.001	Trace#	Trace	0.002	0.014	0.002
Unloader - Dual Tank (J)	8:10 a.m. – 3:36 p.m.	892	0.003	Trace	Trace	Trace	0.012	0.003
Loader-Painting Line (K)	8:08 a.m. – 3:31 p.m.	826	0.001	0.004	Trace	ND	0.012	0.002
Area Samples								
Kolene® Operation - End of Rinse Bath (E)	7:30 a.m. – 2:35 p.m.	902	ND	ND	Trace	Trace	0.011	ND
OSHA PEL			1	10	5	15 (10)**	-----	15
NIOSH REL			1	5	1	----	-----	5
ACGIH® TLV®			1	5	0.2	10	-----	10
MDC		818	0.0001	0.001	0.00001	0.0004	0.0006	0.0006
MQC		818	0.0003	0.003	0.00004	0.001	0.008	0.002

* = TWA mg/m^3 — time weighted average milligrams per cubic meter
** = Vacated 1989 OSHA PEL — 2 mg/m^3 as ceiling value.
# = Between MDC and MQC

Figure 1 - Floor Plan of Plating Department
Ingersoll Rand, Von Duprin Division HETA 97-0111



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