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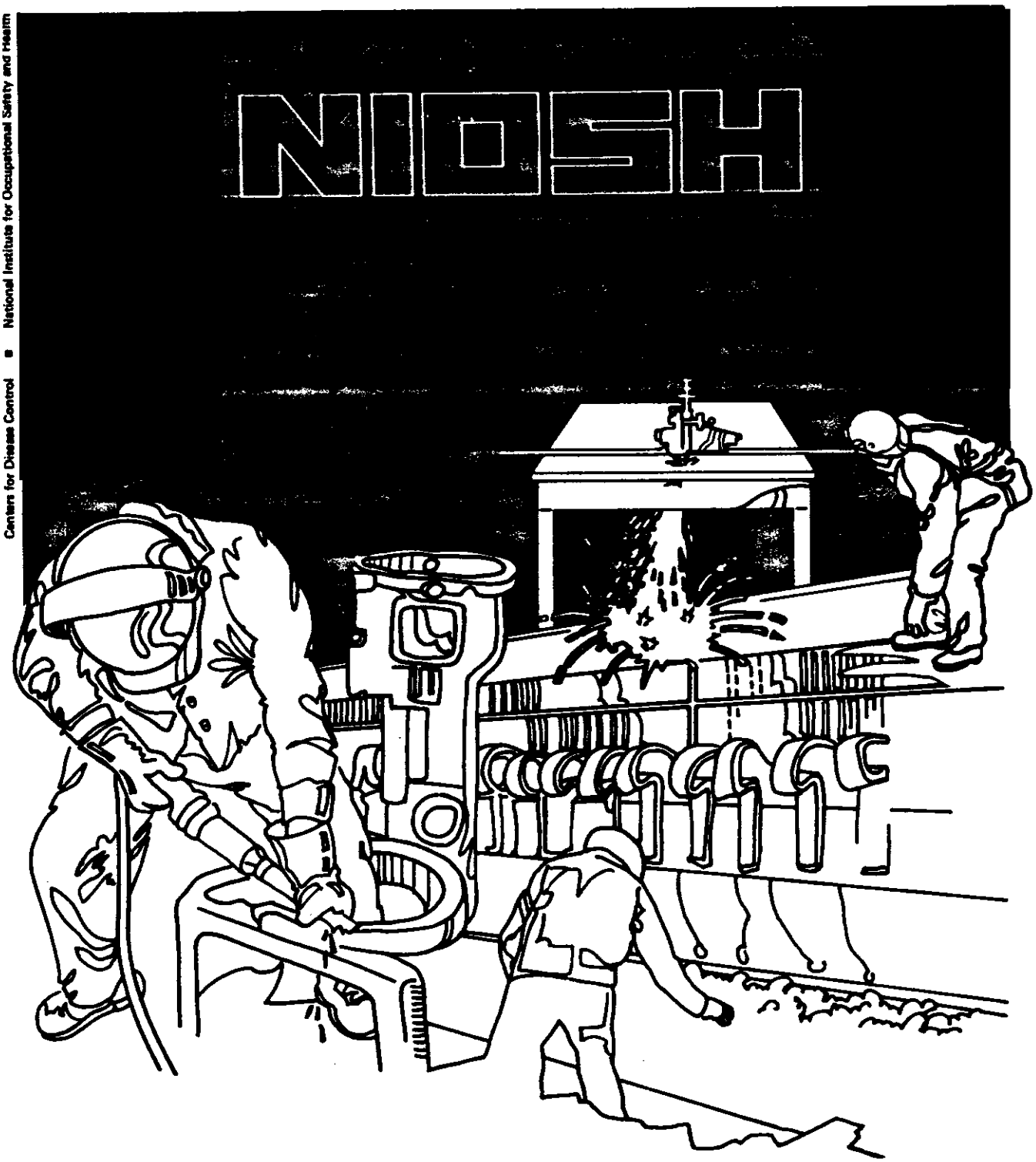

Health Hazard Evaluation Report

HETA 88-266-1970
GLENNWOOD RANGE

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.

HETA 88-266-1970
JUNE 1989
GLENNWOOD RANGE
DELAWARE, OHIO

NIOSH INVESTIGATORS:
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I. SUMMARY

On May 23, 1988, the National Institute for Occupational Safety and Health (NIOSH) received a request from Glennwood Range, Delaware, Ohio, to evaluate employee complaints of skin problems in the Enamel Department. Glennwood Range is a division of the Raytheon Company, which manufactures consumer gas and electric ranges.

An initial environmental and medical evaluation was conducted on June 29, 1988. Confidential interviews and a brief physical examination were conducted with the seven workers reporting skin problems. The observed symptoms and signs included yellowish discoloration of hands, plus burning and soreness with ulcerations over the hands and forearms. Only those employees who handle the hooks appeared to be affected. Bulk samples collected by NIOSH from the curing oven and scrapings from two small hooks that are used to hang the range parts showed chromium VI concentrations of 0.09 to 2.41 micrograms per milligram (ug/mg) of sample. Trace metal analysis detected the presence of 19 additional metals.

A follow-up investigation, including environmental monitoring and the administration of a medical questionnaire, was conducted on September 26-27, 1988, following the repair on the curing oven coils. The medical questionnaire, administered to 74 employees in the Enamel Department, identified 10 ulceration cases occurring between January 1 to June 30, 1988. Among the 10 cases, 8 were "hangers" or "hookers." The questionnaire data indicated that the "hangers" or "hookers" were 7 times more likely to develop skin ulceration than workers in other job classifications. Bulk samples showed chromium VI concentrations ranging from 0.3 to 4.4 ug/mg of sample. Trace metal analysis detected the presence of 24 additional metals. Personal breathing zone samples for chromium VI were all found to be below the analytical limit of quantification.

Although chromium VI concentrations in the bulk samples were practically identical between the initial and follow-up evaluations, we determined that the open flames were causing an improper curing of the paint, thus making the chromium VI more readily available on the hooks. In addition, the sharp edges that developed on the hooks in combination with the normal mechanical friction that existed when the employees placed a great number of hooks in their hands, resulted in skin abrasions that allowed the chromium VI a direct route of entry beneath the skin surface to cause the ulcerations.

NIOSH data from this investigation determined that a health hazard existed among the hook handling workers in the enamel department due to the potential for skin contact with sharp surfaces contaminated with chromium VI. The skin abrasions facilitated the penetration of chromium VI compounds beneath the skin. Repair of the curing oven resolved the skin problems. Recommendations for oven maintenance and worker protection are discussed.

Keywords: SIC 3469 (Metal stampings) Appliance parts, enamel paints, porcelain enameled, dermatitis, Chromium VI

II. INTRODUCTION

On May 23, 1988, NIOSH received a request for a health hazard evaluation from Glennwood Range, Delaware, Ohio. Glennwood Range is a division of the Raytheon Company which manufacturers consumer gas and electric ranges. NIOSH was asked to evaluate the source of skin problems in the Enamel Department.

An initial survey of the Enamel Department was conducted on June 29, 1988. The initial survey consisted of environmental and medical components. During the initial survey, bulk samples were collected in the Enamel Department for chromium VI and trace metals analysis and selected workers were interviewed and examined. A follow-up investigation was conducted on September 26-27, 1988, following repair of the curing oven coils. The follow-up investigation included the collection of bulk and air samples for chromium VI and trace metal analysis, the distribution of a medical symptom questionnaire, and examination of workers' skin.

III. BACKGROUND

Glennwood Range is a single story facility located in Delaware, Ohio. It employs approximately 750 employees, of whom 87 work in the Enamel Department. Glennwood Range produces consumer gas and electric ranges. The production rate is approximately 2200 ranges per day.

The facility is divided into many different departments, all of which are responsible for some aspect of the range production process. The Enamel Department is primarily responsible for painting the individual range parts prior to their final construction. Porcelain enamel paints are applied to the range parts by either a dipping or flow coat process. The porcelain enamels are trivalent chromium based. Oxidizers are added to the enamels, causing the potential for the trivalent chromium to change to a hexavalent state. Following the application of the paint, the parts enter a drying oven (approximately 400 degrees Fahrenheit) and a reinforcing ground coat is applied. The parts are then hung on small hooks and enter the curing oven (approximately 1500 degrees Fahrenheit).

The ground coat line workers, responsible for hanging the parts on small hooks prior to entering the curing oven, originally reported the skin problems. The first reported case occurred around January, 1988. Most of the ground coat line workers do not wear protective gloves when handling the hooks; the gloves reportedly reduce dexterity. The workers are paid on an incentive basis, causing them to handle a large quantity of hooks during the shift.

Management reported that prior to January 1988 there were no reported skin problems in the Enamel Department. They also stated that there were no changes made in the process when the skin problems began to occur. However, in March 1988, open flames were detected in the curing oven, causing a greater number of product defects. When the flames contacted the enameled surface, they burned off small patches of enamel from the parts. In addition, it was reported that the flames caused sharp edges to form on the hooks, cutting the employees hands.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

Based on the information obtained during the preliminary telephone conversations and the initial walk-through evaluation, it appeared that the problem was a direct skin contact phenomenon. The reported symptoms were apparently limited to the ground coat line workers in the Enamel Department. During the initial survey on June 29, 1988, bulk samples from the curing oven and two hooks were collected for water soluble chromium VI and trace metal analysis.

The bulk samples were split into replicate aliquots using the entire sample. Scrapings from the two hooks were combined and ground with a mortar and pestle. The sample aliquots were weighed and extracted with 90 degree Celcius deionized water to collect the soluble hexavalent chromium. The sample extracts were analyzed for hexavalent chromium following NIOSH Method 7600.[1] The remaining solids were wet-ashed with concentrated nitric and perchloric acids. The residues were dissolved in a dilute solution of the same acids and analyzed for trace metal analysis by inductively coupled plasma-atomic emission spectrometry (ICP-AES). The results were reported as average percent by weight for each element. The limits of quantitation (LOQ) were 0.01 micrograms per milligram (ug/mg) of sample for soluble hexavalent chromium and 0.01 percent (0.01% is equivalent to 0.1 ug/mg) for trace metals.

A return visit was conducted on September 26-27, 1988, following repair of the curing oven. The purpose of the return visit was to again collect bulk samples from the curing oven and hooks for hexavalent chromium and trace metals analysis. In addition, personal breathing zone (PBZ) samples and area air samples were collected for hexavalent chromium and trace metals.

Personal breathing zone and area air samples for hexavalent chromium were collected on the ground coat line. The samples were collected with 5.0-micron (um) pore size, tared, polyvinyl chloride filters connected via tygon tubing to battery powered pumps operating at a flow rate of 1.0 liters per minute (lpm). The sample filters were extracted in 5 milliliters (mL)of a 2% sodium hydroxide/3% sodium carbonate solution and transferred into 25 mL volumetric flasks. Color was then developed by adding 1.90 mL of 6 N sulfuric acid and 0.5 mL diphenylcarbazide solution to the flasks. The samples were diluted to a final volume of 25 mL with distilled water and analyzed for chromium VI by visible spectroscopy according to NIOSH Method 7600.[1] The limit of detection (LOD) was 0.3 microgram (ug) per sample. The LOQ was 0.76 ug per sample.

PBZ and area air samples for trace metals were also collected on the ground coat line. The samples were collected on 0.8-um pore size cellulose ester membrane filters connected via tygon tubing to a battery-powered pump at a flow rate of 1.0 lpm. The sample filters were prepared with nitric and perchloric acid and diluted to 25 mL after digestion. The samples were analyzed via NIOSH Method 7300 using a scanning inductively coupled plasma emission spectrometer.[2] The LOD varied according to the 30 individual analytes.

Bulk dust samples for chromium VI were prepared by weighing a portion of the sample onto a tared PVC filter. In the case of the hooks, the samples were scraped with a steel spatula. The bulk samples were extracted in 5 ml 2% sodium hydroxide/3% sodium carbonate solution, transferred into 25 mL volumetric flasks, and the filter was discarded. Color was then developed by adding 1.90 mL of 6 N sulfuric acid and 0.5 mL diphenylcarbazide solution to the flasks. The samples were diluted to a final volume of 25 mL with distilled water and analyzed for chromium VI by visible spectroscopy according to NIOSH Method 7600.[1]

Bulk dust samples for trace metals were weighed and digested using NIOSH Method 7300.[2] The samples were diluted to 25 mL after digestion and analyzed for trace metals by ICP-AES. The results were reported by micrograms per gram of sample. The LOD varied according to the 30 different analytes.

B. <u>Medical</u>

On June 29, 1988, the NIOSH medical officer reviewed the OSHA 200 logs. In addition, private interviews and brief physical examinations were conducted on the seven workers who were reported to have skin problems. During the September 26-27, 1988, follow-up survey, a questionnaire was

administered to 74 of the 78 workers in the enamel department. Participation in the survey was voluntary. The questionnaire asked for information regarding skin ulcerations, job history, demographics, hand washing, glove use, and barrier cream application. Workers reporting a skin ulceration after January 1, 1988 were given a brief physical examination. The physician examined the skin for active skin ulcerations and for hyperpigmentation or scar formations resulting from previous ulcers. The data collected by the questionnaire were analyzed by Chi-square analyses. Continuous variables (age, frequency of handwashing, seniority) were first analyzed using the Student's t test. Further evaluation was done after dichotomizing each variable into two categories of equal numbers of workers and using Chi-square analyses. Stratified analyses were used to control for confounding variables.

V. CHROMIUM TOXICOLOGY

Chromium is a major industrial chemical widely used in anodizing, plating, pigment production, and alloy, battery and match manufacturing.[3] The most extensive use of chromium is in electroplating. Many household appliances are chrome plated. In addition, many enamels applied to metal products contain chrome pigments. The chrome enamel prevents corrosion caused by acids, corrosive waters, high temperatures, and atmospheric conditions.

In 1974, NIOSH estimated that approximately 175,000 workers were potentially exposed to chromium.[4] The chief exposure to hazardous chromium substances in industry is believed to be to an acid-soluble, water-insoluble, chromate-chromite mixture, produced in the preparation of chromate.[5]

The principal toxicological reaction sites from industrial exposures to chromium are the skin, larynx, lung, and upper respiratory tract. The harmful effects of chromium include carcinogenicity, skin sensitization, and skin and mucosal ulcerations. The harmful effects are heavily dependent on the valence state of the chromium. Divalent chromium is of minor importance in industrial exposures because it readily oxidizes to the trivalent state. The tetravalent and pentavalent forms are essentially unstable and are used as intermediates in chemical production. Trivalent and hexavalent chromium are the only compounds known to be significantly associated with human disease. With specific regard for skin ulcerations, trivalent chromium is poorly absorbed through the skin. Normally, trivalent chromium does not cause skin ulcers unless it is oxidized to a hexavalent state, which can easily penetrate the skin.[6] Hexavalent chromium can have a corrosive, necrotizing effect on living tissue, forming ulcerations known as chromium holes.

Chromium-induced skin ulcerations and perforations of the nasal septum have been well documented since the 1930.[3, 7, 8] Ulcerations generally occur on exposed areas of the body, chiefly the hands, forearms, and feet. They may develop more readily if there is a break in the skin, such as at the site of an insect bite or other injury. The ulcerations are round and deeply penetrating, with a clean-cut central crater, 2 to 5 mm in diameter, whose base is covered with exudate or a tenacious crust. Once developed the ulcer is slow to heal, and if exposure continues it may persist for many months. The healing process usually leads to scar formation.

VI. RESULTS

A. Environmental

Table 1 presents bulk sample results for water soluble chromium VI and trace metals collected on June 29, 1988. Quantifiable levels (LOQ of 0.01 ug/mg of sample) of water soluble chromium VI were detected in each of the three samples collected. Chromium VI levels ranged from 0.1 to 2.4 ug/mg of sample. The highest chromium VI level was collected in number 1 coupler in the curing oven. Trace metals were detected in 19 of the 31 tested analytes.

Table 2 presents bulk sample results for chromium VI and trace metals collected on September 27, 1988. Quantifiable levels (LOQ of 0.3 ug/mg of sample) of chromium VI were detected in two of the four samples collected. The highest chromium VI level was in a bulk sample of scrapings from the two hooks collected on the floor of the ground coat line. Trace metals were detected in 24 of the 30 tested analytes.

Five air samples collected on the ground coat line, September 27, 1988, were all reported below the analytical LOQ for chromium VI. One personal breathing zone sample detected a trace amount of chromium VI (0.4 ug/sample) which is between the analytical LOD and LOQ and therefore cannot be reported as an accurate exposure concentration.

Five air samples collected on the ground coat line for trace metal analysis, on September 27, 1988, were nondetected for 29 of the 30 tested analytes. Small quantities of iron were detected in each of the five samples, ranging in concentration from 2.5 ug/cubic meter of air (m^3) to 5.0 ug/m^3. The documented concentrations are well below the ACGIH recommended TLV for iron oxide of 5.0 mg/m^3. NIOSH has not established a Recommended Exposure Limit for iron oxide, therefore the ACGIH TLV is recommended.

B. Medical

Employee interviews and physical examinations on June 29, 1988, revealed seven workers with a yellowish discoloration of the hands, accompanied by a burning sensation and punched-out ulcerations, and chafing on the hands and forearms. One of the seven workers also had multiple ulcerations and scarring with increased pigmentation over the left subaxillary region. The ulcerations were compatible with those seen in workers exposed to hexavalent chromium.

On September 26-27, 1988, 78 workers were employed in the Enamel Department. Job classifications in the Enamel Department include loader, mill room, inspector, auto pickler, silk screener, sprayer, stock keeper, tally, utility wash-off, repair/spare, hanger, and hooker. Seventy-four of the workers completed the questionnaire, giving a participation rate of 95%. The four workers who did not participate in the study were either on vacation or medical leave. Those on medical leave were off for reasons that were not related to skin problems.

Analysis of the questionnaire revealed the following information:

1. The majority of the workers were male (82%) and white (97%).

2. The mean age of the workers was 40 years old, ranging in age from 22 to 63.

3. The average number of employment years at Glenwood Range is 14 years, ranging from 2 to 35 years.

4. 18 of the 74 workers were either hookers or hangers.

5. Only 43 of the 74 workers in the Enamel Department reported wearing protective gloves. Among the 18 hookers and hangers, only 7 reported wearing gloves.

6. The mean frequency of hand washing during the work shift was 6 times, ranging from 1 to 50 times.

7. Only four workers reported using barrier creams to protect their skin.

Workers who reported a chromium ulcer on the upper extremities, armpits, or abdomen, after January 1, 1988, were considered cases. By this definition, ten cases were identified during the period of January 1 to September 27, 1988. The overall attack rate was 14% (10/74). Among the ten cases, eight were hangers or hookers (hook handler). Hangers and hookers (combined) were at a greater risk for developing ulcerations (Rate Ratio (RR) = 12.44, 95% confidence interval (CI) = 2.90-53.35) than workers with other job classifications. The association between chromium ulceration and gender, glove use, age, frequency of handwashing, and job classification can be found in Table 3. The association between gender, glove use, age, frequency of handwashing and chromium ulceration only among hook handlers is given in Table 4.

Workers who developed an ulcer were on the average seven years younger than those who did not. The mean age for the cases was 34.4 (standard deviation (s.d.) = 4.8) while the mean age for controls was 41.2 (s.d. = 9.5). This difference was statistically significant (p less than 0.05). Age was then categorized into those less than 38 years and those 38 years and older. The relative risk of being a case for the younger workers was 3.79 (95% CI = 0.86-16.66). However, when categorized in this manner, the association was no longer statistically significant. Younger workers were at excess risk if they worked as hooker handlers as shown in Table 4 (RR = 4.45, 95% C.I., 0.69-28.87).

Workers who developed an ulcer washed their hands on the average of four times (s.d. = 1.1) each day. The mean frequency of handwashing for workers without ulcers was 6.5 times (s.d. = 8.8) each day. This difference was statistically significant (p less than 0.05). Frequency of handwashing was then categorized into less than four times per day and those four times or more. The relative risk of being a case for workers who washed four or more times a day was 0.77 (95% CI = 0.24-2.47), and this association was not statistically significant. Among hooker handlers, those with ulceration washed their hands less frequently than those who did not (RR = 1.33, 95% C.I. 0.45-3.96).

Among the ten workers with an ulcer, four were female and six male. In general, women were three times more likely to develop an ulcer than man. Proportionately, women were more likely to work as hooker handlers than men. Among hooker handlers, men and women were equally likely to develop ulceration (RR = 0.94, 95% C.I. 0.32-2.76).

Among the 43 workers who reported wearing gloves, only one developed an ulcer. Nine of the 31 workers who did not wear gloves developed ulcers. Overall, those who wore gloves were protected from developing an ulcer (RR = 0.08, 95%CI = 0.01-0.60). The protective effect of glove wearing was also seen among hook handlers (Table 4).

On the average, workers who developed an ulcer had worked at this facility for about 11 years (s.d. = 5). Workers without ulcers had been in this facility for about 14 years (s.d. = 9). This difference was not statistically significant.

Among the ten cases, only one reported using barrier creams. In fact, only four of the 74 enamel department employees used these creams.

After controlling for age, sex, and frequency of handwashing, the hangers or hookers remained seven times more likely of developing ulcers than the other workers in the enamel department.

VII. DISCUSSION/CONCLUSION

Based on the observations made during the initial site visit, June 29, 1988, NIOSH investigators determined that the ground coat line workers developed chromium ulcers as a result of their employment. The observed symptoms were the result of a direct skin contact phenomenon and were diagnosed to be chromium VI induced. No new cases were reported after the initial visit.

These findings left the following two questions unanswered:

1. Why were no new cases found after June 29, 1989?

2. What originally caused the ulcerations to develop in March, 1988?

To address the question as to why no new cases occurred after June 29, 1989, a comparison was made between the concentration of chromium VI in the bulk samples. The analytical results from the initial (0.09 to 2.4 ug/mg) and follow-up (0.3 to 4.4 ug/mg) evaluations, revealed that the chromium VI levels were slightly higher during the follow-up investigation. Prior to the follow-up investigation, it was assumed that that the chromium VI levels would be higher during the initial site visit when the skin problems existed, but this was not the case.

The discrepancy between the analytical results and the lack of active skin disorders during the follow-up evaluation was thought to be attributed to the different extraction techniques used for the two sample sets. Deionized water was used in the initial analysis to

extract the chromium VI whereas sodium hydroxide and sodium carbonate were used in the follow-up investigation. The chemist did not feel however, that this difference would effect the sample results. The following rationale was used in deciding that the two separate extraction methods did not effect the chromium VI sample results:

1. A comparison of the sample results collected from the two evaluations in the curing oven, number one coupler, reveals that they are practically identical (2.4 ug/mg and 2.6 ug/mg).

2. A comparison of the total chromium results collected from the two evaluations in the curing oven, number one coupler, (where both analysis were conducted under similar conditions according to NIOSH Method 7300), reveals that they are consistent (44 ug/mg and 63 ug/mg).

3. When referencing Table 1 and 2, it is noted that the trace metals detected from the number one coupler in the curing oven are consistent throughout.

Next, process changes that may have caused the symptoms to develop were investigated. Discussions with both management and employees revealed that nothing different was added to the paint mixtures when the problems began to occur. A review of the paints and additives for the previous two year period did show that they have remained consistent throughout. Nothing was noted that would have dramatically changed the consistency of the paints. Also the employees stated that their work practices had not changed during the period. Most of the employees had worked on the line for several years prior to having any work-related skin problems.

At this point in the evaluation, efforts were focused on the time frame of when the symptoms began to occur. It was determined that the skin problems began to occur in March 1988, when the hook handling employees noticed a yellowish discoloration on the hooks, which rubbed off onto their hands. About this time, the company noticed a greater number of part defects exiting the curing oven. As a result of the increased number of defects, an inspection of the curing oven was conducted. This inspection detected open flames present in the oven, resulting from tiny holes in the heating coils. As a result, the flames were causing "burn-off" on the parts which came into contact with the flames. Several employees also mentioned that the hooks used to hang the parts were developing very sharp edges and were cutting their hands. Further investigation revealed that the hooks were being used to hang smaller parts on the conveyor prior to receiving the ground coat application. Therefore, the hooks were also receiving a direct application of the ground coat and developed an excess layer of enamel.

To reduce the increased number of part defects, the company repaired the tiny holes in the oven coils during the last weekend in June. Following the repair of the oven, the employees noticed that the hooks were no longer discolored. Also, the part defect ratio was reduced drastically. Finally, the employees reported that the hooks no longer had sharp edges and that their skin problems began to clear.

Based on the prior information, it is evident that repair of the oven coils not only reduced the part defect ratio, but also resolved the skin problems on the ground coat line. We conclude that the open flames were causing an improper curing of the paint, thus making the chromium VI more readily available on the hooks. In addition, the sharp edges that developed on the hooks in combination with the normal mechanical friction that existed when the employees placed a great number of hooks in their hands, resulted in skin abrasions that allowed the chromium VI a direct source of entry beneath the skin surface to cause the ulcerations.

VIII. RECOMMENDATIONS

Based upon these findings, the following recommendations are made:

1. Quarterly maintenance should be conducted to inspect the curing oven coils for leaks.

2. A mechanism should be developed to clean the hooks after they exit the curing oven.

3. The workers should wear protective gloves to minimize the potential for skin exposures.

4. Should the problems occur again (i.e. discoloration of the hooks) we recommend a ten percent ascorbic solution or ointment which has been shown effective in preventing as well as treating the chromium ulcers until the oven can be repaired.[9-16]

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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

1. Glennwood Range
2. NIOSH, Cincinnati Region
4. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Trace Metal and Chromium VI Bulk Sample Analysis

Glennwood Range
Delaware, Ohio
HETA 88-266
June 29, 1988

Sample:	Number One Coupler Curing Oven (ug/mg of sample)	Number Two Coupler Curing Oven (ug/mg of sample)	Hook (ug/mg of sample)
ANALYTE			
Gold	ND	ND	ND
Aluminum	28.4	67.1	19.1
Arsenic	ND	ND	ND
Barium	0.2	0.3	1.0
Beryllium	ND	ND	ND
Calcium	12.2	12.1	43.0
Cadmium	ND	ND	ND
Cobalt	0.4	0.3	1.6
Chromium	44.3	37.0	6.7
Copper	1.1	1.2	4.6
Iron	37.2	33.2	5.7
Lanthanum	ND	ND	ND
Lithium	2.7	1.9	ND
Magnesium	9.4	23.2	1.0
Manganese	1.4	1.5	2.1
Molybdenum	0.7	0.4	ND
Sodium	47.5	43.0	ND
Nickel	23.3	16.0	8.8
Phosphorus	0.1	0.3	0.8
Lead	0.8	0.7	0.1
Platinum	ND	ND	ND
Antimony	ND	ND	ND
Selenium	0.5	0.5	ND
Strontium	ND	ND	ND
Tellurium	ND	ND	ND
Titanium	2.4	3.5	0.6
Thallium	ND	ND	ND
Vanadium	ND	ND	ND
Yttrium	ND	ND	ND
Zinc	ND	0.2	0.1
Zirconium	1.0	1.1	ND
Chromium VI	2.4	1.3	0.1

ND = Nondetected

Table 2
Trace Metal and Chromium VI Bulk Sample Analysis

Glennwood Range
Delaware, Ohio
HETA 88-266
September 27, 1988

Sample:	Number One Coupler Curing Oven (ug/mg of sample)	Number Two Coupler Curing Oven (ug/mg of sample)	Hook 1 (ug/mg of sample)	Hook 2
ANALYTE				
Aluminum	42.0	33.0	35.0	7.5
Arsenic	0.8	0.3	0.4	0.8
Barium	0.4	1.1	0.9	0.1
Beryllium	ND	ND	ND	ND
Calcium	17.0	27.0	31.0	4.0
Cadmium	0.03	ND	ND	0.01
Cobalt	0.3	0.9	1.7	0.1
Chromium	63.0	34.0	79.0	49.0
Copper	1.8	3.9	4.5	0.6
Iron	26.0	50.0	64.0	10.0
Lithium	3.0	3.5	1.8	2.9
Magnesium	15.0	1.2	0.8	2.4
Manganese	2.0	6.2	5.3	0.5
Molybdenum	0.4	0.06	0.1	0.5
Sodium	68.0	88.0	110.0	45.0
Nickel	14.0	130.0	140.0	7.2
Phosphorous	0.4	0.2	0.2	0.2
Lead	0.9	0.08	0.08	0.7
Platinum	ND	ND	ND	ND
Selenium	1.5	ND	ND	0.1
Silver	0.02	ND	ND	0.01
Tin	ND	ND	ND	ND
Tellurium	ND	ND	ND	ND
Titanium	4.7	7.2	6.1	0.9
Thallium	ND	ND	ND	ND
Tungsten	ND	ND	ND	ND
Vanadium	0.07	0.03	ND	0.01
Yttrium	0.02	0.08	0.1	ND
Zinc	1.0	3.3	2.5	0.2
Zirconium	1.0	12.0	2.7	0.5
Chromium VI	2.6	NA	0.3	4.4

ND = Nondetected
NA = Not analyzed

Table 3

The Association Between Chromium Ulceration and Gender, Glove Use, Age, Frequency of Handwashing, and Job Classification.

Glenwood Range
Delaware, Ohio
HETA 88-266
September 26, 1988

	Case	Noncase	RR*	95% CI+
Gender				
Female	4	9		
Male	6	55	3.1	1.0-9.5
Glove				
Use	1	42		
Nonuse	9	22	0.1	0.0-0.6
Age				
LT 38 yr	8	30		
GE 38 yr	2	34	3.8	0.9-16.7
Handwashing Frequency				
GE 4/day	6	43		
LT 4/day	4	21	0.8	0.2-2.5
Job Classification				
Hook handler	8	10		
Other jobs	2	54	12.4	2.9-53.4

RR* = Relative risk.
CI+ = Confidence interval.

Table 4

The Association Between Chromium Ulceration and Gender, Glove Use, Age, Frequency of Handwashing, among the Hook Handlers

Glenwood Range
Delaware, Ohio
HETA 88-266
September 26, 1988

	Case	Noncase	RR*	95% CI+
Gender				
Female	3	4		
Male	5	6	0.94	0.32-2.76
Glove				
Use	1	6		
Nonuse	7	4	0.22	0.03-1.45
Age				
LT 38 yr	7	4		
GE 38 yr	1	6	4.45	0.69-28.87
Handwashing Frequency				
GE 4/day	5	5		
LT 4/day	3	5	1.33	0.45-3.96

RR* = Relative risk.
CI+ = Confidence interval.