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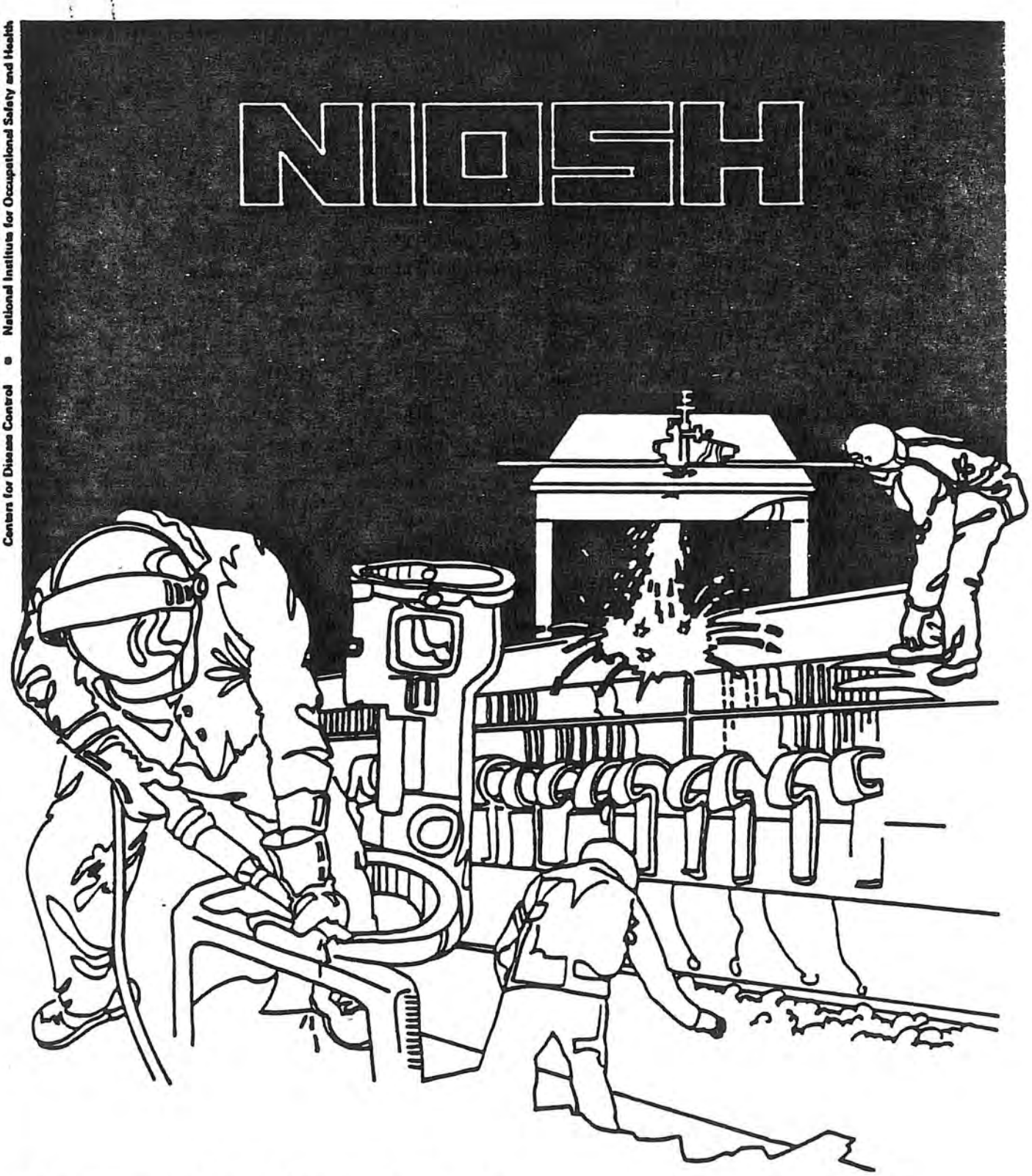
NIOSH



# Health Hazard Evaluation Report

HETA 83-095-1484
WESTERN STATES MACHINE COMPANY
HAMILTON, OHIO

## 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 83-095-1484
JULY 1984
WESTERN STATES MACHINE COMPANY
HAMILTON, OHIO

NIOSH INVESTIGATORS:
MICHAEL S. CRANDALL, C.I.H.

## I. SUMMARY

On January 4, 1983, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate reports of respiratory irritation among workers in electric arc gouging operations at Western States Machine Company, Hamilton, Ohio.

To determine if health complaints were related to exposures, NIOSH investigators conducted site visits at the plant on January 26 and August 31, 1983. The investigators obtained personal and area air samples for arc welding fumes during both surveys. During the follow-up survey, ozone and noise levels were also measured.

During the first visit, NIOSH investigators found that short-term exposures to iron, manganese, total fume, nickel and chromium were excessive, especially during plasma arc operation. The exposures measured are likely worst case due to no exhaust or dilution ventilation being used. Welder plasma arc iron exposure was 44.6 $mg/m^3$ for 17 minutes of sampling (carbon arc exposure, 4.5 $mg/m^3$ for 13 minutes). The ACGIH TLV-STEL is 10 $mg/m^3$. Welder plasma arc exposure to manganese for the same sampling period was 6.5 $mg/m^3$ (carbon arc exposure, 0.5 $mg/m^3$ for 13 minutes). The OSHA 15-minute PEL is 5 $mg/m^3$. Total plasma arc fume levels resulted in an 8-hour TWA exposure of 6.2 $mg/m^3$, exceeding the OSHA PEL of 5 $mg/m^3$ for respirable nuisance particulates. The welder's exposure to nickel and chromium for the 30-minute demonstration were 4.8 $mg/m^3$ (8-hour TWA = 0.30 $mg/m^3$) and 5.1 $mg/m^3$ (8-hour TWA = 0.32 $mg/m^3$), respectively. These exposures were below the OSHA 8-hour PEL of 1 $mg/m^3$. Nickel and forms of chromium found in fumes from arc welding stainless steel are associateed with increased incidences of respiratory cancer. NIOSH recommends that exposures to these compounds be kept to the lowest feasible limit. Area sample concentrations during the demonstration averaged 33.8 $mg/m^3$ for iron, 5.3 $mg/m^3$ for manganese, 6.0 $mg/m^3$ for nickel, and 12.9 $mg/m^3$ for chromium. During the follow-up survey, exposures were measured for a one-hour routine gouging job. There was very good natural and dilution ventilation on this day. The welder's exposures to nickel and chromium averaged 0.28 $mg/m^3$ and 0.19 $mg/m^3$, respectively for the sampling period. Area samples ranged from not detectable to 0.23 $mg/m^3$ for nickel and from not detectable to 0.11 $mg/m^3$ for chromium. All other fume exposures were below applicable criteria. Average breathing zone ozone concentrations were 0.02 ppm (OSHA PEL, 0.18 8-hour TWA). The welder's noise exposure was 94 dBA (slow-response) for the hour (84 dBA, 8-hour TWA). NIOSH recommends that average noise exposure not exceed 85 dBA (slow-response) for an 8-hour time period.

It is likely that typical exposures during routine electric arc gouging tasks would fall between those measured during the two NIOSH surveys. Based on these results, we concluded that a health hazard existed from overexposure to nickel and chromium at Western States Machine Company. Recommendations are made to reduce exposure for the welders and nearby workers.

KEYWORDS: SIC 3559 (Special Industry Machinery), stainless steel carbon arc, plasma arc, gouging operations, iron, manganese, nickel, chromium, ozone, noise, welding fumes.

## II. INTRODUCTION

In January 1983, NIOSH received a request for a health hazard evaluation at Western States Machine Company, Hamilton, Ohio. The request was submitted by an officer of United Auto Workers Local 176. The requestor asked NIOSH to evaluate exposure to the fume created from carbon arc gouging of stainless steel centrifuge parts.

NIOSH initially surveyed a demonstration gouging operation on January 26, 1983. The particular operation of interest is an infrequent, short-duration task which affected follow-up scheduling. The follow-up survey was not conducted until August 31, 1983.

## III. BACKGROUND

The Western States Machine Company is a manufacturer of industrial centrifugal equipment. The plant in Hamilton, Ohio employs approximately 80 workers, 8 of whom are welders. One step in the production process required the edges of a stainless steel part to be removed (gouging) using arc welding equipment. This is a one person, infrequent, short duration, non-stationary task. Any of the 8 welders may perform this job.

## IV. EVALUATION DESIGN AND METHODS

### A. Initial Environmental

On January 26, 1983 two arc welding methods were evaluated, plasma arc and carbon arc, although the request only indicated carbon arc welding. Both methods are used for gouging. The carbon arc method is preferred by the welders. This demonstration evaluation was conducted to determine the welding fume composition and to become familiar with the welding methods.

Three personal exposure and five area air samples for welding fume were collected on preweighed Glasrock PVC filters. The battery operated sampling pumps were calibrated at a flowrate of 3.0 liters per minute (lpm). For personal sampling, the pump was clipped to the worker's belt and the filter was attached in his breathing zone. Area samples were located so that the collecting media was at breathing zone height.

The previously tared filters were reweighed for total particulate exposure. The analytical method for trace metals was NIOSH method number P&CAM 351. The collected samples were ashed with concentrated nitric acid and then dissolved in a dilute solution of

nitric and perchloric acids. The resulting sample solutions were analyzed by nebulization into an inductively coupled argon plasma and monitoring the emission spectra of the various elements (Table I). The detection limit for this procedure is 1 ug per element per sample.

Table I

Elements Included in Trace Metals Analysis

Western States Machine Company
Hamilton, Ohio
HETA 83-095

| | |
|---|---|
| aluminum | manganese |
| antimony | nickel |
| arsenic | phosphorous |
| barium | platinum |
| beryllium | selenium |
| calcium | sodium |
| cadmium | strontium |
| chromium | tellurium |
| cobalt | thallium |
| copper | titanium |
| iron | vanadium |
| lanthium | yttrium |
| lead | zinc |
| lithium | zirconium |
| magnesium | |

B. Follow-up Environmental

On August 31, 1983, a welder performed a typical gouging operation on 316L stainless which lasted approximately an hour. Exposures to welding fume constituents, ozone and noise were measured. Plasma arc equipment (Thermal Arc Pak-10-/$N_2$-$CO_2$) was used for the first half hour. The job was finished with carbon arc equipment (HOBART M-300). Separate environmental air samples were obtained for each type of welding.

Two personal and eighteen general area samples were collected to measure welding fume exposure. Air was drawn through Millipore 0.8 um pore size mixed cellulose ester filters in closed face cassettes at a flow rate of 2.0 liters per minute. The same analysis was used as in the initial survey for these filter samples (P&CAM 357). The analytes were as in Table I.

Ozone was measured using a Columbia Scientific Instruments CSI-2000 portable ozone meter. This instrument allows the operator to directly read the ozone concentration. The instrument is sensitive enough to reliably detect ozone concentrations below 0.01 ppm. Metrosonics, Inc. dB-301 Datalogger noise dosimeters were used to monitor sound levels.

## V. EVALUATION CRITERIA

### A. Environmental Criteria

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

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

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department

of Labor (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 legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

1. Exposure to Nickel

The following effects have been reported in humans exposed to nickel: dermatitis, cancer of the lungs, of the nasal sinus cavities, and of the larynx; irritation and perforation of the nasal septum and loss of the sense of smell; and asthma-like lung disease, pulmonary irritation, pneumoconiosis, and a decrease in lung function.[1]

Because it is not possible at present to establish a safe exposure level for a carcinogen, the NIOSH recommendation is to restrict exposure to very low levels that can still be reliably measured in the workplace (lowest feasible level, LFL). This recommendation can be expected to materially reduce the risk of nickel-induced respiratory cancer.

The current OSHA permissible exposure limit (PEL) to nickel is 1 $mg/m^3$ as a 8-hour TWA.

2. Exposure to Chromium

Chromium(VI) materials have been implicated as responsible for such effects as: skin ulceration, ulcerated nasal mucosae, perforated nasal septa, rhinitis, nosebleed, performated eardrums, kidney damage, pulmonary congestion and edema, epigastric pain, erosion and discoloration of the teeth, and dermatitis. In addition they have been associated with an increased incidence of lung cancer.[2]

To some extent the toxicities of chromium(VI) materials vary with their solubilities, but denotation of compounds on the basis of solubility alone has not been sufficiently precise to suggest a dichotomy of toxic effects.

NIOSH recommends that exposure to chromium(VI) materials be kept at the LFL in order to materially reduce the risk of chromium(VI)-induced lung cancer. The current OSHA PEL for exposure to chromium metal and insoluble salts is 1 $mg/m^3$ as an 8-hour TWA.

3. Other Exposures

Effects of exposure and environmental exposure criteria for other constituents in the welding fume zone and noise are in Table II.

Table II

Exposure Criteria and Effects of Exposure to Agents at

Western States Machine Company
Hamilton, Ohio
HETA 83-095

| | Exposure Criteria ($mg/m^3$) | | | |
|---|---|---|---|---|
| | NIOSH | ACGIH | OSHA | Effects of Exposure[3,4] |
| Iron Oxide Fume | -- | 5 TWA*<br>10 Ceil.** | 10 TWA* | Benign Pneumoconiosis |
| Molybdenum | -- | 10 TWA<br>20 Ceil. | 15 TWA | Irritation of eyes, nose, throat; weight loss |
| Manganese | -- | 1 TWA<br>3 Ceil. | 5 Ceil.*** | Irritation of eyes and respiratory tract; Parkinson's disease, Asthenia; metal fume fever, insomnia, tight chest, vomiting, malaise, fatigue. |
| Ozone | -- | 0.1 ppm,TWA<br>0.3ppm Ceil. | 0.1ppm,TWA | Irritation of eyes and mucous membranes; pulmonary edema, chronic respiratory disease. |
| Noise | 85dBA, TWA | | 90dBA,TWA | Temporary hearing threshold shift, permanent hearing loss; rise in blood pressure, increase in heart rate. |

*TWA - 8-hour time weighted average
**ACGIH Ceiling - 15-minute sampling period
***OSHA Ceiling - shall at no time be exceeded

## VI. RESULTS

### A. Environmental

#### 1. Initial Survey

Environmental sampling during the demonstration in January 1983 revealed high short-term exposure to the welder to iron, manganese and total fume during the plasma arc gouging (Table III). The exposures to iron were 11.7 and 62.6 $mg/m^3$ (samples P-5 and P-6), averaging 44.6 $mg/m^3$ for a 17 minute exposure. The ACGIH-STEL for iron is 10 $mg/m^3$. Exposure to manganese was 0.2 and 10.0 $mg/m^3$ (P-5 and P-6) averaging 6.5 $mg/m^3$ for 17 minutes. The OSHA ceiling PEL for manganese is 5 $mg/m^3$, and the ACGIH-STEL is 3 $mg/m^3$. Total fume exposure for these two personal samples (P-5 and P-6) results in an 8-hour TWA exposure of 6.2 $mg/m^3$, exceeding the OSHA 5 $mg/m^3$ PEL for respirable nuisance particulates.

Exposures during the carbon arc demonstration were much lower overall than the plasma arc results.(Table III) Most were below applicable criteria.

Nickel and chromium exposures were significant during both operations, especially plasma are use. Nickel exposures were 2.3, 10.6 and 1.1 $mg/m^3$ respectively for the personal samples P-5, P-6 and C-3 (8-hour TWA = 0.30 $mg/m^3$). Chromium results for the same samples were 2.0, 12.2 and 0.6 $mg.m^3$ (8-hour TWA = 0.32 $mg/m^3$). These exposures are well below the OSHA standard of 1 $mg/m^3$ for each for an 8-hour TWA. However, nickel, and forms of chromium which are known to be found in the fumes from arc welding stainless steel are associated with increased incidences of cancer of the respiratory organs.[5,6] Therefore, NIOSH recommends that exposure to each of these compounds be kept to the lowest feasible level (LFL) since there is no known safe level of exposure to a carcinogen.

Area sampling results show surrounding workers can experience significant exposures to the welding fume contaminants. The area samples were placed within fifteen feet of the welding. None of the welders or nearby workers wore respiratory protective equipment.

#### 2. Follow-up Survey

The welding fume exposure data collected during August 1983 for carbon arc and plasma arc gouging on 316L stainless steel are presented in Table IV and V. Relative locations of the sampling equipment are shown in Figure 1.

The exposures of concern were to nickel and chromium. Nickel exposures for the welder were 0.23 mg/$m^3$ during the plasma arc gouging and 0.35 mg/$m^3$ during the use of the carbon arc (1-hour TWA = 0.28 mg/$m^3$). Chromium exposures for plasma and carbon arc use were 0.23 and 0.14 mg/$m^3$ respectively (1-hour TWA = 0.19 mg/$m^3$). NIOSH recommends LFL exposures for these contaminants. The other exposures from the welding fume were below all exposure criteria. Neither the welders, nor any nearby workers wore respiratory protective equipment.

The peak exposure to ozone in the welders breathing zone was 0.03 parts per million (ppm). The average exposure while welding was nearer 0.02 ppm. Ozone is produced by the ultraviolet radiation in the air near arc welding operations. It is very irritating to all mucous membranes at low levels (< 1.0 ppm) and can cause headache and dryness of the respiratory tract. The ACGIH STEL for ozone is 0.30 ppm (OSHA 0.10, 8-hour TWA).

The noise exposure of the welder averaged 94.1 dBA (slow response) during the sampling period (64 minutes). Assuming an 80 dBA exposure for the remaining 7 hours of work, the welders 8-hour TWA noise exposure is 84 dBA. The carbon arc gouging (over 100 dBA) was louder than the plasma arc gouging (90-100 dBA). NIOSH recommends 85 DBA (slow response) for an 8-hour TWA exposure. The current OSHA standard is 90 dBA for 8-hour TWA. A worker can be exposed to noise at 94 dBA for a period of 4.6 hours. The welder was not wearing hearing protection.

## VII. DISCUSSION

The primary purpose of the initial survey was to characterize the fume created while arc welding stainless steel. The fume contained agents known to cause the respiratory irritation symptoms reported as well as cancer of the respiratory organs. Since this was a demonstration the exposure results might not represent routine operations. However, they might be considered worst case exposures since no local exhaust or dilution ventilation was used.

The NIOSH investigators observed that the plasma arc process produced a more concentrated fume than the carbon arc. The carbon arc uses a high velocity air jet to clear molten metal from the weld and this disperses the fume. The sampling results showed this as higher exposure to the welder during plasma arc use. Both processes were very noisy.

On the day of the follow-up survey the weather was mild and allowed good natural ventilation. The gouging was performed very close to an overhead fan which supplied fresh air. These conditions led to low level exposure to ozone and the fume constituents.

The initial survey provided information concerning the arc welding fume composition. It also indicated that under confined conditions and/or in severe weather when adequate ventilation may not be provided there are excessive exposures to irritant and potentially carcinogenic constituents in the arc welding fume while gouging stainless steel. The personal and nearby area environmental samples collected during the follow-up revealed exposures to low levels of irritant and carcinogenic constitutents in the welding fumes and excessive noise levels during the operation of electric arc welding equipment. The fumes and ozone in sufficient concentrations could cause the irritation symptoms reported in nearby workers. Respiratory and hearing protective equipment were not being used by the welders or nearby workers.

## VIII. CONCLUSIONS

Based on the results of the environmental evaluations conducted on January 26 and August 31, 1983, it was determined that a health hazard existed from exposures during electric arc gouging operations at the Western States Machine Company. The following points are the basis for this conclusion:

A. Electric arc gouging resulted in exposure to nickel and chromium, both potential respiratory organ carcinogens. The intensity of these exposures directly depended upon the degree of control through ventilation.

B. It is likely that the respiratory irritation symptoms reported by the requestor are caused by the arc welding fume constituents and ozone if adequate ventilation is not provided or if proper respiratory protection is not worn.

C. The welder and nearby workers are also exposed to high noise levels.

## IX. RECOMMENDATIONS

In light of these findings, the following recommendations are made:

1. A portable local exhaust system with high efficiency particulate absolute (HEPA) filtration should be used during carbon arc and plasma arc gouging. The system should have a hood on flexible ducting which can be positioned for maximum fume capture. In addition, the piece to be gouged should be moved to an open area with good dilution ventilation, if possible.

2. Until a local exhaust system is available, the welder and nearby workers should wear respiratory protection against welding fumes created while gouging stainless steel.

3. The welder should wear hearing protection while using either the plasma arc or carbon arc equipment.

## X. REFERENCES

1. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to inorganic nickel. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW publication no. (NIOSH) 77-164).

2. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to chromium VI. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1976. (DHEW publication no. (NIOSH) 76-129).

3. National Institute for Occupational Safety and Health. Occupational diseases: a guide to their recognition. Revised ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) publication no. 77-181).

4. National Institute for Occupational Safety and Health. NIOSH/OSHA occupational health guidelines for chemical hazards. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) publication no. 81-123).

5. Sjogren, Bengt. A retrospective cohort study of mortality among stainless steel welders. Scandinavian Journal of Work, Environment and Health 1980; 6:197-200.

6. U.S. Army Environmental Hygiene Agency. Assessment of worker exposure to hexavalent chromium and inorganic nickel during stainless steel welding processes. Aberdeen Proving Ground, Maryland: U.S. Army Environmental Hygiene Agency, (No Date, Unpublished).

## XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted and
Report Prepared by:

Michael S. Crandall, C.I.H.
Industrial Hygiene Engineer
Industrial Hygiene Section

Richard W. Hartle, C.I.H.
Industrial Hygienist
Industrial Hygiene Section

Laurence D. Reed
Industrial Hygiene Engineer
Industrial Hygiene Section

| | |
|---|---|
| Analytical Support: | Measurements Development Section<br>Measurements Research and Support Branch<br>Division of Physical Sciences and Engineering |
| Originating Office: | Hazard Evaluations and Technical Assistance Branch<br>Division of Surveillance, Hazard Evaluations, and Field Studies |
| Report Typed By: | Connie L. Kidd<br>Clerk-Typist<br>Industrial Hygiene Section |

## XII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 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. Western States Machine Company, Hamilton, Ohio
2. Employee Representative, Local 176, United Auto Workers Union
3. United Auto Workers Health and Safety, Detroit, Michigan
4. NIOSH, Region V
5. 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 III

Demonstration Sampling Results

Western States Machine Company
Hamilton, Ohio
HETA 83-095

January 26, 1983

| Job | Sample* # | Duration | Concentration ($mg/m^3$) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Iron | Nickel | Chromium | Molybdenum | Manganese | Copper | Total Welding Fume |
| Welder | P-6 | 1022-1033 | 62.61 | 10.55 | 12.15 | 0.24 | 10.00 | 0.92 | 251.5 |
| Area | P-8 | 1022-1031 | 98.70 | 16.07 | 20.40 | 0.38 | 16.56 | 1.55 | 387.8 |
| Area | P-10 | 1022-1031 | 78.11 | 13.30 | 10.67 | 0.32 | 12.70 | 1.17 | 341.1 |
| Welder | P-5 | 1036-1042 | 11.72 | 2.31 | 2.01 | 0.44 | 0.21 | 0.34 | 32.8 |
| Area | P-2 | 1035-1042 | 16.60 | 3.33 | 2.94 | 0.63 | 2.27 | 0.45 | 39.0 |
| Welder | C-3 | 1050-1103 | 4.51 | 1.08 | 0.58 | 0.12 | 0.47 | 0.20 | 13.9 |
| Area | C-1 | 1050-1103 | 5.95 | 1.50 | 0.67 | 0.16 | 0.53 | 0.24 | 16.7 |
| Area | C-4 | 1050-1103 | 4.87 | 1.26 | 0.55 | 0.13 | 0.45 | 0.21 | 12.8 |
| Criteria (TWA/ceiling): | | | | | | | | | |
| | NIOSH | | - | LFL** | LFL** | - | - | | |
| | ACGIH | | 5/10 | 1/- | 0.05/- | 10/20 | 1/3 | | |
| | OSHA | | 10/- | 1/- | 1/- | 15/- | -/5 | | |

* P - Plasma Arc Gouging
C - Carbon Arc Gouging
** Lowest Feasible Level (no known safe level for exposure to a carcinogen)

Table IV

Follow-up Plasma Arc Sampling Results

Western States Machine Company
Hamilton, Ohio
HETA 83-095

August 31, 1983

| Job | Sample # | Duration | Concentration ($mg/m^3$) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Iron | Nickel | Chromium | Molybdenum | Manganese |
| Welder | 1 | 0929-1004 | 0.94 | 0.23 | 0.23 | 0.07 | 0.04 |
| Area | 2 | 0935-1007 | 0.15 | 0.04 | 0.04 | ND | ND |
| Area | 3 | 0935-1008 | 0.10 | 0.03 | 0.03 | ND | ND |
| Area | 4 | 0935-1008 | 0.11 | 0.02 | 0.03 | ND | ND |
| Area | 5 | 0935-1009 | 0.11 | 0.03 | 0.03 | ND | ND |
| Area | 6 | 0935-1009 | 0.12 | 0.03 | 0.03 | ND | ND |
| Area | 7 | 0935-1009 | 0.03 | ND | ND | ND | ND |
| Area | 8 | 0935-1009 | 0.05 | ND | ND | ND | ND |
| Area | 9 | 0935-1007 | 0.13 | 0.03 | 0.03 | ND | ND |
| Area | 10 | 0940-1010 | 0.15 | 0.02 | 0.02 | ND | ND |
| Criteria (TWA/ceiling): | | | | | | | |
| | NIOSH | | - | LFL* | LFL* | - | - |
| | ACGIH | | 5/10 | 1/- | 0.05/- | 10/20 | 1/3 |
| | OSHA | | 10/- | 1/- | 1/- | 15/- | -/5 |

* Lowest Feasible Level (no known safe level for exposure to a carcinogen)
ND not detectable (<1 ug/sample)

Table V

Follow-up Carbon Arc Sampling Results

Western States Machine Company
Hamilton, Ohio
HETA 83-095

August 31, 1983

| Job | Sample # | Duration | Concentration ($mg/m^3$) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Iron | Nickel | Chromium | Molybdenum | Manganese |
| Welder | 20 | 1011-1034 | 1.15 | 0.35 | 0.14 | 0.09 | ND |
| Area | 21 | 1007-1036 | 0.68 | 0.20 | 0.10 | 0.05 | ND |
| Area | 22 | 1007-1036 | 0.69 | 0.20 | 0.11 | 0.05 | ND |
| Area | 23 | 1008-1039 | 0.36 | 0.10 | 0.06 | 0.03 | ND |
| Area | 24 | 1008-1039 | 0.40 | 0.11 | 0.05 | 0.03 | ND |
| Area | 25 | 1009-1037 | 0.72 | 0.23 | 0.10 | 0.05 | ND |
| Area | 26 | 1009-1037 | 0.59 | 0.18 | 0.09 | 0.04 | ND |
| Area | 27 | 1009-1042 | 0.06 | ND | ND | ND | ND |
| Area | 28 | 1009-1042 | 0.06 | ND | ND | ND | ND |
| Area | 30 | 1010-1041 | 0.36 | 0.11 | 0.05 | 0.03 | ND |
| Criteria (TWA/ceiling): | | | | | | | |
| | NIOSH | | - | LFL* | LFL* | - | - |
| | ACGIH | | 5/10 | 1/- | 0.05/- | 10/20 | 1/3 |
| | OSHA | | 10/- | 1/- | 1/- | 15/- | -/5 |

* Lowest Feasible Level (no known safe level for exposure to a carcinogen)
ND not detectable (<1 ug/sample)

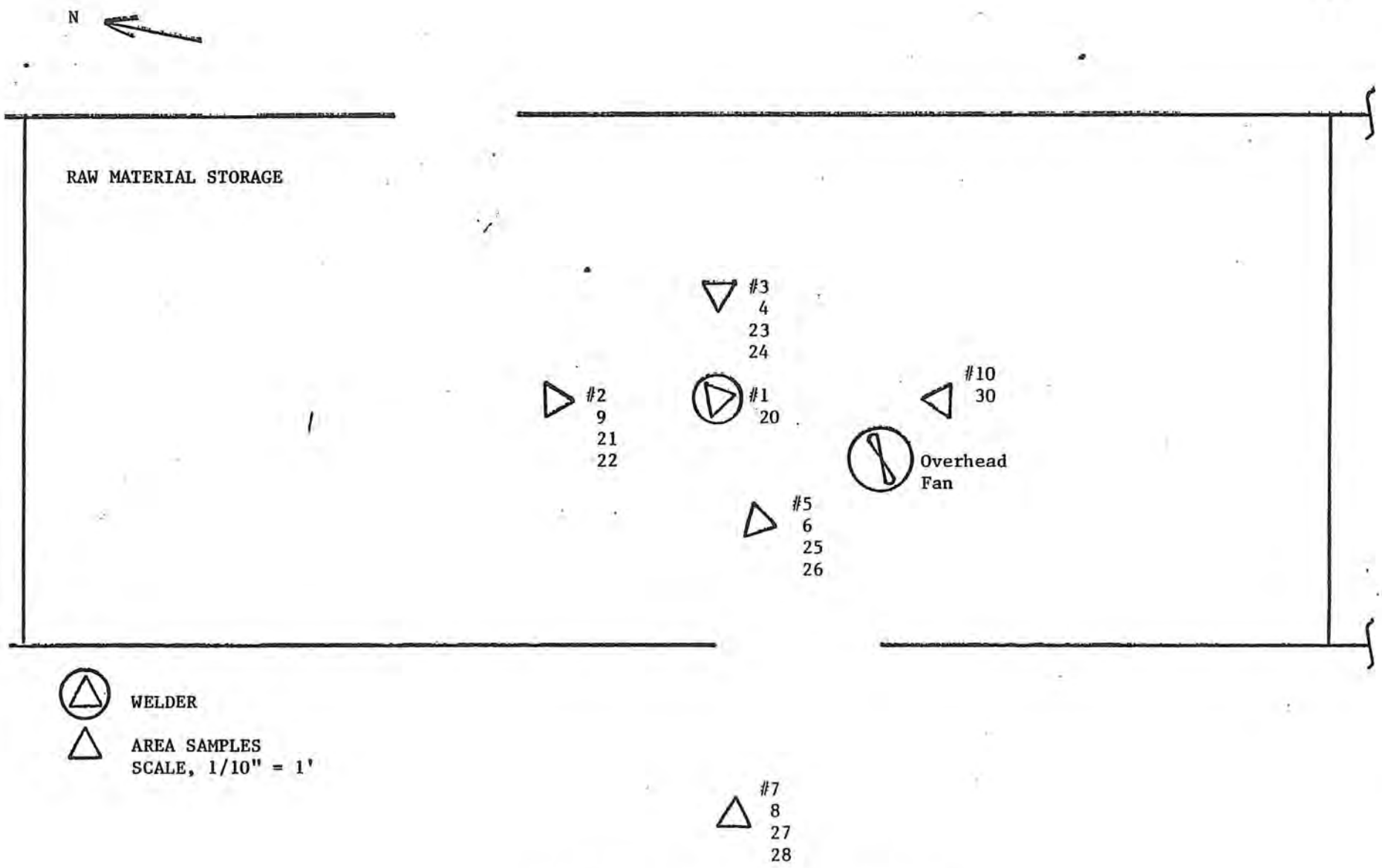



Figure 1 Welding Fume Sample Locations
HETA 83-095
Western States Machine Company
August 31, 1984