

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

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HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 74-60-255

TRANSPORTATION PRODUCTS DIVISION
NATIONAL STEEL CORPORATION
PORTAGE, INDIANA

JANUARY 1976

I. TOXICITY DETERMINATION

It has been determined that production welders were exposed to iron oxide fume in excess of the Threshold Limit Value established for this effluent, at the time of this evaluation (May 1, 1975). This conclusion is based on breathing zone measurements made within the welders' helmet and evaluated on the basis of an 8-hour Time Weighted Average (TWA) and the medical questionnaires completed for affected employees which provided evidence of the development of acute irritation over the work shift.

II. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U. S. Post Office Building, Room 508, Fifth and Walnut Streets, Cincinnati, Ohio 45202.

Copies have been sent to:

- a) Transportation Products Division, Portage, Indiana
- b) Authorized Representative of Employees
- c) U. S. Department of Labor - Region V
- d) NIOSH - Region V

For the purposes of informing the 21 "affected employees", the employer will promptly "post" the Determination Report in a prominent place(s) near where affected employees work for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 CFR, U.S. Code 669(a)(6) authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees of the Transportation Products Division, regarding employee exposure to welding fumes in the production welding and adjacent areas.

The request was prompted by employee concern over the lack of ventilation in the production welding area which allegedly cause high exposure of welding fumes to production welders and to employees working in adjacent areas.

During the time between the filing of the Request (April 25, 1974), and the ensuing NIOSH initial evaluation (August 29, 1974), eight canopy hood mechanical ventilation systems were installed in the production welding area. The addition of these systems modified the conditions prompting the request.

IV. HEALTH HAZARD EVALUATION

A. Plant Process - Conditions of Use

Transportation Products Division, Portage, Indiana fabricates nailable steel floorings for railroad cars. Approximately 104 people are employed in this manufacturing operation which includes production welders, progressive welders, painters, material handlers and general laborers. Fabrication takes place during 3 eight-hour shifts.

The area specified in the request is the production welding area, where angles are welded to the steel panels. Metal joining is done with wire welding utilizing a flux-cored wire. Production welding takes place at eight welding benches, with each bench having a team of two welders.

At the time of the NIOSH evaluations a canopy ventilation hood was located over each bench. The face of the hood was approximately 66 inches from the top of the table. Each hood was equipped with two louvers with which to alter air flow direction and rate. Around the back and sides of each welding bench, and attached to the canopy hoods were drapery type amber shaded plastic curtains which extended below the level of the table.

B. Work-Site Evaluation

(1) Initial Survey - Part I

On August 29, 1974 two NIOSH representatives conducted an observational survey of the production welding and adjacent area. Pertinent information regarding plant process was obtained from the employer, work procedures and welding techniques observed, and affected employees interviewed.

Detector tube measurements for Carbon Monoxide (CO), Nitrogen Dioxide (NO₂) and Ozone (O₃) were made near the employees' breathing zone, outside the welders' helmets.

Smoke tube tests were taken of several canopy hoods to ascertain ventilation hood efficiency. Tests were made with the emission of smoke midway between the welding bench and the canopy hood face. (at face level).

Interviews were conducted in a non-directed manner with six affected employees regarding health effects due to employment.

a. Initial Survey - Evaluation Criteria

Criteria considered in the initial survey are the Threshold Limit Values (TLV) as issued by the American Conference of Governmental Industrial Hygienists (ACGIH) in the document "Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment - 1974." Threshold limit values refer to time-weighted averages (TWA) for a 7 or 8-hour workday and 40-hour workweek.

<u>Substance</u>	<u>TLV ppm^a</u>
Carbon Monoxide	50.0
Ozone	0.1
Nitrogen Dioxide	5.0

^a Parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm Hg. pressure.

Of all gases that have poisonous effects upon man and animals, Carbon Monoxide (CO) is the most frequently encountered. It is a product of incomplete combustion of carbon containing material and exerts its effect by combining with the hemoglobin of the blood and interrupting the normal oxygen supply to the body tissue. Acute effects of exposure to CO include headache, nausea, general disability, weakness, vertigo, and ataxia.

Ozone, a constituent of the atmosphere we breathe, is very irritant to all mucous membranes. Significant exposures can cause pulmonary edema. Its prolonged inhalation in concentrations above .05 ppm is inadvisable because of danger of pulmonary irritation.² In low concentrations, ozone may cause dryness of the mouth, irritation of the throat, headaches, coughing and pressure or pain in the chest, followed by difficulty in breathing.

Nitrogen Dioxide (NO_2) which can react with water to form a mixture of nitrous acid (HNO_2) and nitric acid (HNO_3) has a distinct odor in concentrations as low as 5 ppm. In concentrations of 10 to 20 ppm the gas is mildly irritating to the eyes, nose, and upper respiratory mucosa.³ Nitrogen dioxide may cause pulmonary irritation with severe breathing difficulties.

b. Initial Survey - Part I - Discussion

Detector tube measurements were made near the welders' breathing zones, outside the helmet at bench No. 3, between benches No. 3 and No. 4, and between benches No. 4 and No. 5. No detectable levels of ozone or nitrogen dioxide were found. Carbon monoxide measurements indicated a concentration of 10 ppm at the above three locations. It should be emphasized that these concentrations are "grab" sample values and are not to be construed as 8-hour Time Weighted Average (TWA). The detector tubes used are designed to measure levels of ozone between .05-1.4 ppm; nitrogen dioxide from .5-10 ppm; and of carbon monoxide 10-300 ppm.

Smoke tube tests made indicated canopy hood ventilation to be functioning adequately (at the point of the test), although some smoke was seen to drift into adjacent welding areas where tests were made at the end of the canopy hood farthest from the wall.

Interviews were conducted with six affected employees. In view of the fact that the conditions prompting the request had been modified non-directed questions concerning health effects were, probably, of an historical nature. A summary of these interviews conducted in this evaluation are shown in Table I.

Observation of employee work practice revealed that good welding technique was lacking in several welders. These welders positioned themselves directly in line with the fume stream in such a way that needless exposure to fumes (and gases) occurred. Coupled with poor welding technique was the canopy hood mechanical ventilation system which "pulled" the fume stream through the breathing zone of the welder unnecessarily. Other factors which served to increase exposure were incorrect louver settings in the canopy hood, improper positioning of the welding bench under the canopy hood, and several openings in the tinted plastic curtain along the back of the welding bench.

c. Initial Survey - Part I - Conclusions

Based upon environmental measurements taken, employee interviews, and observations of work practice and welding technique, it was concluded that additional investigation was deemed necessary to determine the extent of adverse health effects occurring in these welding operations.

(2) Initial Survey - Part II

On October 7, 1974, interviews were conducted with nine additional employees regarding health effects due to employment.

A summary of these interviews conducted is shown in Table I.

a. Initial Survey - Part II - Conclusions

Based upon interviews conducted with these employees, a follow-up environmental survey was deemed necessary to clarify the exposure vs. symptom relationship.

(3) Environmental Survey

On May 1, 1975, environmental samples were collected for iron oxide fume, a major constituent of the welding fume stream.

a. Evaluation Method

Personal samples were collected from eight production welders. Two samples were collected from each welder; a morning sample and an afternoon sample. Samples were collected on the day shift only. Discussion with plant management indicated that production welding on the shift was representative in frequency with the evening and night shifts.

The sampling train for the collection of iron oxide fume consisted of a modified welders' helmet which was fitted with a filter cassette holder just below the glass to sample breathing zone air "inside" the helmet. The filter cassette was connected via plastic tubing to a personal sampling pump operating at 1.5 liters per minute. Type AA 0.8 μ filters were used to collect the fume.

b. Employee Interview

Pre- and post shift interviews were conducted with the eight production welders to ascertain the development of any health effects over the work shift.

c. Evaluation Criteria

Criteria used in determining the basis for toxicity for the substance identified in the environmental evaluation are the Threshold Limit Values (TLV) as issued by the ACGIH as documented in Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment - 1975.

<u>Substance</u>	<u>TLV mg/M³^b</u>
Iron Oxide Fume	5.0

^b Milligrams of substance per cubic meter of air.

Prolonged excessive exposure to iron oxide fume gives rise to iron pigmentation of the lungs known as siderosis which is generally considered to be a benign pneumoconiosis. Physical exams and tests of work capacity of welder with iron pigmentation show that it causes little or no disability.⁴

d. Environmental Results and Discussion

A summary of results of environmental measurements made for iron oxide fume are shown in Table II. The 8-hour TWA was computed by extrapolation of concentrations measured during the sampling periods.

A review of the data indicates that two of the eight welders sampled (B and D) exceeded the TLV for iron oxide fume.

Additionally, welders B and D exceeded the Permissible Excursion Value of the TLV. This value gives the maximum exposure to a substance which should not be exceeded for any length of time.⁵ For iron oxide fume the Permissible Excursion Value is 10 mg/M³.

A significant finding in this evaluation was welder exposure as a function of welding technique. It was seen that in both cases where concentrations exceeded the TLV (B and D), poor welding technique was used. This was in contrast to welders G and H, whose samples indicated low concentrations and who had good welding technique. "Good" welding technique was defined as that technique in which the welder does not have his helmet directly in line with the fume stream emanating from the welding operation.

Ventilation design was an important factor in exposure of welders to fume. From an industrial hygiene viewpoint, canopy hood mechanical ventilation is not the recommended control of choice for welding operations in that it tends to "pull" the fume stream through the breathing zone of the welder (particularly in bench welding). A slot mechanical ventilation system designed to exhaust from the point of generation is a more acceptable control measure.

e. Interview Results and Discussion

A summary of pre- and post shift questionnaire results appears in Table I. The symptoms reported on the post shift interview are evidence of an irritating exposure developing over the shift due to fume and/or gas inhalation.

Reviewing the total numbers of reported symptoms, the most often reported effects are "Dry Throat - Sore Throat(5); Burning or Itching Eyes (4); Stuffy Nose (7); and Chest Problems (5). Those symptoms are evidence of irritating exposure from welding fumes.

V. CONCLUSIONS

Environmental measurements, observation of work practices, and employee questionnaire results indicate that excessive welding fume exposure to several welders was occurring at the time of this evaluation due to poor welding technique and improper and inadequate ventilation.

The following recommendations are suggested:

1. Proper and adequate ventilation should be provided to collect welding fumes at the source of generation, as previously discussed and seen in ACGIH Ventilation Manual Illustration US-416.6
2. All production welders should receive instructions on proper welding technique.
3. Until adequate ventilation is provided, the following recommendation is suggested:

Production welders should be instructed on proper louver setting on any installed canopy hoods, and the importance of table positioning with respect to the canopy hood.

VI. REFERENCES

1. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II, 2nd Revised Ed., 1967, P. 924-936.
2. Ibid, P. 915.
3. Ibid, P. 920.
4. Ibid, P. 1056.

5. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes - 1974, American Conference of Governmental Industrial Hygienists, P. 52-53.
6. Industrial Ventilation - A Manual of Recommended Practice - American Conference of Governmental Industrial Practice, P. 5-52.

VII. AUTHORSHIP AND ACKNOWLEDGMENTS

Report Prepared By: Thomas F. Bloom
Assistant Regional Industrial Hygienist
NIOSH, Region V
Chicago, Illinois

Originating Office: Jerome P. Flesch, Chief
Hazard Evaluation Services Branch
Cincinnati, Ohio

Field Evaluation: Charles H. Borcharding, Jr.
Regional Industrial Hygienist
NIOSH, Region V
Chicago, Illinois

Table I
 SUMMARY - EMPLOYEE INTERVIEWS
 Symptoms Present During Interview

Symptom	Number-Employees Reporting Symptoms			
	Interview Date (During Shift) August 29, 1974	(During Shift) October 7, 1975	(Pre-shift) May 1, 1975	(Post-shift) May 1, 1975
Number Interviewed	6	9	8	8
Dry Throat-Sore Throat	1		1	3
Burning or Itching Eyes	1			2
Tearing of Eyes				1
Stuffy Nose	1		2	4
Runny Nose	1			
Headache	1		1	2
Coughing			1	
Chest Problem		3		2
Stomach Pains				2
Sinus Problem	2	1		

Table II

SUMMARY - IRON OXIDE (Fe_2O_3) FUME EXPOSURE - PRODUCTION WELDERS

May 1, 1975

Welder	Sample 1 mg/M ³	Sample 2 mg/M ³	TWA 8-hr	Weld Technique by Observation
A	4.88	1.50	1.99	Poor
B	11.74	9.14	6.10	Poor
C	1.24	--	.78	Fair
D	8.14	13.07	5.85	Poor
E	8.16	4.38	3.78	Poor
F	1.76	2.12	1.10	Poor
G	.61	.32	.47	Good
H	.81	.52	.38	Good