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

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 73-130 - 94

HANFORD FOUNDRY
SAN BERNARDINO, CALIFORNIA
NOVEMBER 1973

I. TOXICITY DETERMINATION

It was determined by NIOSH investigators that no health hazard exists from exposure to welding exhaust gases. However, a potential health hazard was considered to exist from exposure to welding fumes. Of special concern was exposure to fumes of alloys containing a high percentage of chromium and nickel. The long term health effects of these materials is not fully understood at the present time. The toxicity determination is based upon: (1) A complete lack of local exhaust ventilation in all of the welding areas, (2) the quantity of welding conducted, (3) environmental measurements in the breathing zone of the welders, (4) employee interviews, and (5) available literature regarding the toxicity of various contaminants.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Hanford Foundry, San Bernardino, California
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region IX
d) NIOSH - Region IX

For the purposes of informing the "affected employees" the employer will promptly "post" the Determination Report in a prominent place(s) near where exposed 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 U.S.C. 669(a)(6), authorizes the Secretary of Health Education, and Welfare, following a written request by 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 National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees to evaluate the potential hazards associated with the alleged exposure to welding gases and fumes produced at the Hanford Foundry, San Bernardino, California.

IV. HEALTH HAZARD EVALUATION

A. Conditions of Use

The Hanford Foundry, a General Alloys Company, produces corrosion and heat-resistant high alloy castings. Low alloy and carbon steel castings are also produced. A company brochure indicates that over half the tonnage produced is now in high nickel-chromium alloy steels.

The Health Hazard Evaluation Request concerned conventional arc-welding operations at this plant. Welding is conducted in 4 areas namely: main cast cleaning area, alloy area, impeller area, and the maintenance shop. Eight welders were at these work locations during the survey. The welding areas are relatively large and in most cases the welder has a large air volume in which to weld. However, local exhaust ventilation is not provided at any welding station. Persons in nearby areas are protected from ultraviolet exposure by permanent screens. Most of the 32 heat and corrosion resistant alloy castings specified by the Alloy Casting Institute are produced at the Hanford Foundry. These alloy castings contain from 1 to 2% manganese, 8 to 32% chromium, up to 68% nickel, up to 4% molybdenum, and small amounts of carbon, silicon, phosphorus, and sulfur. The plant also produces some 21 carbon steel castings. A variety of welding rods are used which contain up to 35% chromium. A pure nickel rod is also used. Some of the fluxes contain fluorides.

A small amount of silver soldering is done by the maintenance welder. No galvanized or lead painted materials are welded upon. No solvents are used in the welding area. About 300,000 pounds of casting are produced per month, and about 50% of the casts are welded upon.

B. Worksite Evalution

On Wednesday, October 10, 1973, Mr. Lee Larsen met with union and management representatives of the Hanford Foundry. On October 11-12, 1973, samples were collected inside the welding hoods of the 8 welders during welding and analyzed for nickel, chromium, iron, manganese, and molybdenum. One sample from the maintenance area was also analyzed for cadmium. Indicator tube samples were collected at each of the 8 welding sites in the breathing zone of the welder during welding and evaluated for ozone, nitrogen dioxide, and carbon monoxide exposure. Urine samples were obtained from the welders and analyzed for fluoride.

At the completion of the plant site evaluation an exit interview was held with management and union representatives to discuss potential health hazards. It was recommended that local exhaust ventilation be provided at each welding station.

C. Evaluation Methods

1. Air and Urine Sampling

Employee exposures to the welding fumes discussed in this report were measured via personal air sampling equipment. Indicator tube samples were obtained for determination of ozone, nitrogen dioxide, and carbon monoxide. Urine samples were obtained for the determination of fluoride.

2. Employee Interviews

All of the 8 arc-welders were asked non-directive questions regarding work related and non-work related health problems. Information regarding their employment history was also collected.

D. Evaluation Criteria

The OSHA Standards for the air contaminants of interest are taken from Part 1910 of Title 29 of the Code of Federal Regulations, Section 1910.93, Tables G-1 and G-2.[1]

Material	8-hour time weighted average	Acceptable ceiling concentration
Cadmium Fume	0.1 mg/M^3	3 mg/M^3
Carbon Monoxide	50 ppm	
Chromium	1 mg/M^3	
Iron Oxide Fume	10 mg/M^3	
Manganese		5 mg/M^3
Molybdenum	15 mg/M^3	
Nickel	1 mg/M^3	
Nitrogen Dioxide	5 ppm	
Ozone	0.1 ppm	

Threshold Limit Values adopted by the American Conference of Governmental Industrial Hygienists for these substances are as follows:[2]

Cadmium	0.1 (proposed change to 0.05 mg/M^3)
Carbon Monoxide*	50 ppm
Chromium	0.1 mg/M^3
Iron Oxide Fume	10 mg/M^3 (proposed change to 5 mg/M^3)
Manganese	5 mg/M^3 (ceiling value)
Molybdenum	10 mg/M^3
Nickel	1 mg/M^3
Nitrogen Dioxide	5 ppm (ceiling value)
Ozone	0.1 ppm

*A recent NIOSH Criteria Document recommends a value of 35 ppm for Carbon Monoxide.

No biological threshold limit values for any substance has been adopted by the U.S. Department of Labor. All standards for toxic materials are based on airborne concentrations expressed as parts per million of air or milligrams per cubic meter of air.

Largent states that, "If fluoride exposures are controlled so well that no workman repeatedly excretes fluoride at a level as high as 8 mg. per liter, there is very little likelihood that any ill effects will result from exposure to fluorides, although a slight increase in osseous radiopacity might in rare instances develop after many years of occupational exposure. Under conditions in which urinary fluoride levels rarely or never exceed 4 mg. per liter, there is very little likelihood that even the slightest increases in osseous radiopacity will occur among workmen, and fluoride-induced disability and/or ill effects will certainly never occur."[3]

E. Evaluation Discussion

Generally in welding the air contaminants emitted consist of a mixture of gases and metallic oxides. Ozone, nitrogen dioxide, and carbon monoxide are generally the gases of most concern. The toxic effects of these gases will not be discussed since only trace quantities were determined during welding. Metallic oxides can come from material being welded upon, the coating on the material welded, coatings on the electrode and from the electrode itself.

"It is generally agreed that any welding in a confined or semi-confined space can give rise to harmful concentrations of fume. In this regard the use of adequate ventilation to effectively remove the fume produced and supply sufficient air to the welder is of the utmost importance."[4]

Metal oxide fumes of iron, chromium, nickel, molybdenum, and manganese, would be expected to be found in the welding fumes produced at the Hanford Foundry. The concentrations existing at a given time would depend on the materials being welded upon and the type of rods and coatings being used. Since a variety of metals, rods, and coatings are used it would be unlikely that air samples could be obtained at the most hazardous concentrations during the routine welding operations. Therefore, recommendations are based upon work practices rather than air concentrations data.

The metallic oxides of iron, chromium, and nickel are the metals most likely to be present in high concentrations due to the high percentage of these materials in the substances being used. Exposure to the oxides of nickel and chromium is the exposure of greatest concern. Experimental evidence has been reported indicating that trivalent chromium possesses carcinogenic properties.[6] An increase in nasal, sinus, and lung cancer has been noted in workers employed in nickel refineries.[7-11] The specific carcinogenic agent is still not defined and is a subject of continuing research.[5] It should be pointed out there is some difficulty in relating exposures to mixed nickel dust in refining with those in welding and other operations.[5] Manganese poisoning has also been reported in two welders who worked frequently in confined spaces for 25 years.[12] However, exposure levels in the study referred to were well above existing standards for manganese.

Only 2 reports bearing on the industrial toxicology of molybdenum have appeared in the literature.[13-14] The 2 reports agree in their general conclusions that molybdenum compounds exhibit a low order of toxicity.[5]

Fluoride coated welding rods are used at the Hanford Foundry. Use of fluoride coated welding rods may cause irritation of the upper respiratory tract. Local exhaust ventilation is recommended where fluoride fluxes are used. Nickel oxides may also cause upper respiratory tract irritation.

Only the maintenance welder uses silver solder. Silver solder may contain varying amounts of cadmium. Toxic levels of cadmium oxide fumes may be generated in a short period of time during welding. For this reason silver soldering (brazing) should be conducted using local exhaust ventilation or approved respiratory protective equipment.

F. Evaluation Results

1. Air and Urine Values

Thirty-one breathing zone air samples were collected during welding inside the welding hoods of the eight welders and analyzed for chromium, nickel, manganese, iron, and molybdenum. Air concentrations of all of these metallic oxides were below existing Federal Standards. (See Table 1) However, high alloy materials were not being used on the day of the survey.

Breathing zone samples were obtained with direct reading indicator tubes for ozone, nitrogen dioxide, and carbon monoxide. Only trace amounts of these materials were detected.

Urinary fluoride values for the 8 welders were within normal range for fluoride. (See Table 2) However, irritation of the upper respiratory tract during welding is possible without fluoride accumulating in the body in excessive amounts.

2. Employee Interviews

Of the eight welders interviewed, one mentioned infrequent headaches and another dizziness. The other six employees did not relate any health problems.

G. Recommendations

1. It is recommended that local exhaust ventilation be provided for each welding booth to prevent irritation of the upper respiratory tract during welding with fluoride fluxes, and to control cadmium, chromium and nickel oxide fumes.

V. REFERENCES

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VI. AUTHORSHIP AND ACKNOWLEDGMENTS

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TABLE 1

AIR CONCENTRATION OF WELDING CONTAMINANTS

HANFORD FOUNDRY

October 11-12, 1973

	Total Volume M^3	Fe_2O_3 mg/M^3	Ni mg/M^3	Cr mg/M^3	Mn mg/M^3	Mo mg/M^3
Welder Alloy Section 10/11/73	1.034	6.1	<0.1	<0.1	0.1	<0.1
Welder Alloy Section 10/11/73	.716	2.8	<0.1	<0.1	0.1	<0.1
Welder Alloy Section 10/11/73	1.026	3.4	<0.1	<0.1	0.3	<0.1
Welder Alloy Section 10/11/73	.998	2.5	<0.1	<0.1	0.2	<0.1
Welder Alloy Section 10/11/73	.970	2.1	<0.1	<0.1	0.2	<0.1
Welder Main Cleaning 10/11/73	.970	1.8	<0.1	<0.1	0.1	<0.1
Welder Main Cleaning 10/11/73	.960	2.4	<0.1	<0.1	0.2	<0.1
Maintenance Welder 10/11/73	1.004	1.4	<0.1	<0.1	<0.1	<0.1
Welder Cleaning & Alloy 10/12/73	.270	4.0	<0.1	<0.1	0.4	<0.1
Welder Main Cleaning 10/12/73	.240	2.7	<0.1	<0.1	0.1	<0.1

TABLE 1 (cont'd)

	Total Volume M^3	Fe_2O_3 mg/M^3	Ni mg/M^3	Cr mg/M^3	Mn mg/M^3	Mo mg/M^3
Impeller Section 10/12/73	.230	2.5	<0.1	<0.1	0.3	<0.1
Welder Alloy Section 10/12/73	.290	1.3	<0.1	<0.1	<0.1	<0.1
Welder Alloy Section 10/12/73	.256	1.7	<0.1	<0.1	0.3	<0.1
Welder Alloy Section 10/12/73	.204	1.4	<0.1	<0.1	0.1	<0.1
Maintenance Welder 10/12/73	.176	4.6	<0.1	<0.1	0.3	<0.1
Welder Main Cleaning 10/12/73	.200	3.4	<0.1	<0.1	0.1	<0.1

TABLE 2

Fluoride In Urine Concentrations

Welder	Milligrams Fluoride/liter of Urine (corrected for specific gravity)
1	2.9
2	1.1
3	1.8
4	3.9
5	1.5
6	1.4
7	2.0
8	2.3
Drinking Water	0.5*

*Not corrected for specific gravity.