U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 77-32-459

CONALCO
HANNIBAL, OHIO

FEBRUARY 1978

I. TOXICITY DETERMINATION

A Health Hazard Evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) in the Conalco Aluminum Rolling Mill in Hannibal, Ohio. On March 9, May 10 and 11, 1977, environmental samples were taken for airborne particulate, aluminum, freon, chlorine, oil mist, trichloroethylene, tridecyl alcohol, kerosene, welding fumes, formaldehyde, and carbon monoxide.

Findings on the days of this evaluation indicate that environmental levels of most contaminants were below the evaluation criteria used here. However, potentially toxic concentrations of nickel were found in welding operations and potentially toxic concentrations of carbon monoxide were found to be coming from the exo gas area. The NIOSH recommended criteria for nickel exposure is 0.015 mg/M3. Four of the five personal breathing zone samples taken on welders in the maintenance department were above that value. The NIOSH recommended criteria for carbon monoxide exposure is 35 ppm. Two areas were found which exceeded this value. Also, an estimate of the amount of air required for proper performance of general exhaust ventilation indicated that, unless provisions are made for make-up air when doors and windows are closed, contaminants will build up in the main mill building.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. 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:

a) Conalco
b) United Steelworkers of America, Local 5760
c) United Steelworkers of America International
d) U.S. Department of Labor, Region V
e) NIOSH, Region V

For the purpose of informing the approximately 450 "affected employees", the employer shall promptly "post" for a period of 30 calendar days the determination report in a prominent place near where exposed employees work.

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 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 received such a request from the United Steelworkers of America, Local 5760, regarding materials used in the cast house, rolling mills and other areas of the main mill building.

IV. HEALTH HAZARD EVALUATION

A. Process Description

This plant produces aluminum rolls and plates from impure aluminum blocks. There are basically three steps involved: 1) production of aluminum alloys from raw material, 2) hot and cold rolling, and 3) finishing.

Raw aluminum "pigs" are brought into the cast house where they are melted in eight furnaces with small amounts of alloying material and fluxed with gases usually containing chlorine or freon (dichlorodifluoromethane). Impurities rise to the top and are skimmed off as dross, while the desired metal is poured into ingot molds. The furnaces are generally well ventilated when they are open to the plant atmosphere. The only actions which would create metal fumes from the molten alloys are wand fluxing, which occurs inside the furnace, and pouring. Dross skimming and dumping are potentially dusty operations, with the primary contaminant in the dust being aluminum. Flux gases are piped to the furnaces from outside the plant, and leaks in the pipe and escape of gas during fluxing are possible sources of contamination in the cast house.

In preparation for rolling, the aluminum ingots are sent through a scalping operation to shave off the outer crust of impurities. They are placed in ovens to heat to the proper temperature for the hot rolling process. During the hot rolling and subsequent cold rolling, the metal is sprayed with oil. Contaminants from these operations include dust from the scalping and oil mist (including formaldehyde as a bactericide) from rolling. Some ingots or rolls are annealed in a reducing atmosphere containing carbon monoxide, which is also a possible contaminant.

The finishing process involves various common operations such as metal stamping, cutting, edging and heat treating. Most operations are mechanical, but some involve cutting oils as lubricants which create potential exposures.

In addition to production operations, some maintenance employees are potentially exposed to toxic substances. Various welding and painting operations are performed, and these are sources of metal fume and solvent vapor exposure, the exact compound depending on the composition of the metal being welded or the paint being sprayed.

The final area of interest to this health hazard evaluation was a water treatment facility in the pump house. Periodically an employee would enter this area to take measurements or check the supply of treatment materials, including chlorine dioxide. The potential exposure of concern to the requestor was to airborne chlorine dioxide.

B. Evaluation Design

On March 9, 1977, a preliminary visit was made to the plant. A walk-through survey was conducted with representatives of both the company and the union. During this survey detector tube measurements were made for carbon monoxide, formaldehyde, and chlorine dioxide. Settled dust samples were collected to be analyzed for free silica and aluminum. Some employees were informally interviewed regarding work histories and physical complaints. Information was gathered concerning work practices, materials, controls and ventilation. Data gathered during this visit was used to develop a protocol for a more thorough follow-up evaluation.

The follow-up evaluation was conducted on May 10 and 11, 1977. Personal breathing zone and area environmental samples were taken in the areas and for the substances listed below:

Cast House - total particulate, aluminum, freon, chlorine, oil mist
Rolling Mill - total particulate, aluminum, oil mist
Finishing Department - total particulate, aluminum, oil mist, trichloroethylene, tridecyl alcohol, kerosene
Maintenance Department - total particulate, aluminum, welding fumes (iron oxide and nickel).

No samples were taken in the maintenance department for paint solvent because no spraying was done during the days of the survey. The choice of analysis for metal fumes was based on the composition of the metals being welded.

Detector tube measurements were made in the cast house for chlorine, in the pump house for chlorine dioxide, in the rolling mill for formaldehyde, in the finishing department for total hydrocarbons, and in all areas for carbon monoxide.

Confidential interviews were conducted with employees in all areas regarding working histories and health problems.

Ventilation measurements were made to estimate the amount of air coming into the plant through wall openings. Air velocity readings were taken and approximate opening dimensions were obtained to calculate the volume of air being drawn into the plant to make up for the air being removed by the general exhaust ventilation. There was no local exhaust ventilation in the areas of the evaluation.

C. Evaluation Methods

Environmental samples were collected using battery powered portable sampling pumps calibrated immediately prior to going into the field. Breathing zone samples were obtained by placing the sampling pump on the belt of the worker and connecting this by flexible tubing to the collecting media positioned in his breathing zone. Area samples were obtained by placing the sampling apparatus near where the worker spent a large part of his work shift. In the case of some short duration samples such as chlorine, the sampling apparatus was held near the worker while he was performing a particular task.

Table I shows the various parameters for each type of sample including collection media, flow rate, duration of sample, substance used for extraction of sample from collection media, and type of analysis.

D. Evaluation Criteria

Table II lists various criteria used in the evaluation of the toxicity of the substances under study. Listed in this table are OSHA Standards[3], NIOSH Criteria Document Recommendations[2,4-7], and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists[7], along with health effects of each substance.

The only compound for which none of these organizations proposed a maximum safe concentration is tridecyl alcohol. Decyl alcohol, a chemically similar compound, is described by Patty[8] to have LD_{50}'s in the gram per kilogram range. Although the slopes of the dose response curves were not available, decyl alcohol is assumed to be no more than moderately toxic, and tridecyl alcohol by association is also assumed to have a fairly low toxicity. The NIOSH toxic substance list[9] shows tridecyl alcohol to have an aquatic toxicity rating (TL_m96) of over 1000 ppm, which corresponds to a rating of "insignificant hazard."

The NIOSH recommendation of 0.015 mg/M^3 for a nickel standard is based to a large extent on recent studies indicating that nickel has carcinogenic potential. The Documentation of TLV's[7] does not consider evidence of nickel carcinogenicity conclusive and establishes a TLV of 1 mg/M^3 for nickel dust and fume, although it states that this level is probably not sufficiently low to prevent nickel itch.

In addition to the substances listed in Table II, some detector tube samples were taken to determine the presence of any hydrocarbon. There is no standard for such measurements since the measuring device responds to the entire range of organic compounds. These measurements were taken to determine if additional testing needed to be done.

E. Evaluation Results

1. Environmental

Results of most environmental samples were below recommended levels. No free silica was found in the settled dust samples. Concentrations, duration and other information are given in the appropriate table:

Table III - Results of Total Particulate and Aluminum Samples
Table IV - Results of Oil Mist Samples
Table V - Results of Freon Samples
Table VI - Results of Trichloroethylene Samples
Table VII - Results of Chlorine Samples

Four of the five personal breathing zone samples taken on welders in the maintenance department were above the NIOSH recommended standard for nickel of 0.015 mg/M^3. As shown below and in Table VIII, the samples ranged from 0.01 to 0.08 mg nickel per cubic meter of air.

			Concentrations, mg/M^3			
Location	Day	Time	Particulate	Iron Oxide	Nickel	Aluminum
Welder #1	May 10	8:50-3:00	21	2.6	0.08	0.5
Welder #2	May 10	8:55-2:55	3.2	3.0	0.02	0.05
Welder #3	May 10	8:55-3:00	2.7	1.3	0.01	0.1
Welder #4	May 11	8:05-3:15	7.5	6.5	0.04	0.3
Welder #5	May 11	8:45-3:15	3.9	2.9	0.03	0.03

Two samples were collected for tridecyl alcohol, both near the 48-inch slitter in the finishing department. The first, taken May 10, from 10:05am to 3:25pm, was a personal breathing zone sample on the operator. The second, on May 11, from 9:10am to 3:05pm, was an area sample placed near the operators station. Both were below the limit of detection of tridecyl alcohol, approximately 0.1 ppm.

One sample was taken for a combination of kerosene and trichloroethylene. This sample was on the take-off man for the skin pass machine in the finishing department, from 9:30am to 3:10pm on May 11. The concentrations found were 10 mg/M^3 for kerosene and 6 ppm for trichloroethylene.

Detector tube measurements taken during the March visit indicated occasional traces (less than 5 ppm) of carbon monoxide in 18 samples taken around the furnaces and rolling mills; no formaldehyde was detected in the mill area; no chlorine dioxide was detected in the water treatment area.

Detector tube measurements taken for carbon monoxide, formaldehyde and hydrocarbons during the May visit are shown in Table IX. Three of the carbon monoxide measurements were quite high. While the value of greater than 500 ppm was obtained at a point thought to be a source of contaminant and not an area where anyone would work, two other samples were approximately 50 ppm and were locations where maintenance men and other employees would work. The sample in the exo gas area is not a location normally populated, but the wide tension leveling line console area is in the finishing department and is frequently manned.

An estimate of the amount of general exhaust ventilation was made by measuring the air flow into the plant. Air velocities ranging from 600 to 1200 fpm through open doors and windows resulted in almost three quarters of a million cubic feet of outside air per minute being drawn into the furnace and rolling mill area.

2. Employee Interviews

Results of employee interviews were as follows:

43 employees interviewed
28 had no complaints or symptoms
2 had non-job related complaints

The remaining thirteen employees had the following complaints which are possibly related to their work environment:

Irritating symptoms:

5 complained of sinus problems
3 stated they had eye problems or irritation
1 complained of a sore throat
1 complained of an increased cough since beginning in welding department (cigarette smoker)

Other symptoms:

2 claimed hearing loss
2 claimed of shortness of breath, aggravated at work (smoking histories unknown)
1 stated he sometimes became dizzy when using trichloroethylene
1 had a possible dermatitus (face)
1 claimed side and/or chest pains, aggravated at work
1 complained of headaches

Other than the sinus problems, hearing loss and some shortness of breath, these complaints were intermittent or occasional.

F. Summary and Conclusions

Two potentially toxic situations were judged to exist during the days of this evaluation. The first was the exposure of the welders in the maintenance department to nickel. Four of five persons sampled were above the NIOSH recommended standard of 0.015 mg/M^3, the highest being more than five times that concentration.

The second potentially toxic exposure was to carbon monoxide. No personal exposures were measured, but carbon monoxide measurements in work areas were measured in excess of the 35 ppm NIOSH recommended standard.

Samples taken for aluminum, iron oxide, oil mist, freon, trichloroethylene, kerosene, chlorine, chlorine dioxide and formaldehyde were below all evaluation criteria. Tridecyl alcohol exposure was also judged to be below toxic concentrations, although no numerical criteria was established. The responses to questions asked during employee interviews indicated that, other than occasional over-exposure to irritant vapors, there were relatively few job related complaints.

The large amount of air being drawn into the plant through open doors and windows raises the question of whether sufficient provisions are made for make-up air to supply the general exhaust ventilation. During inclement weather, when doors and windows would not be open, such ventilation would not be effective and airborne contaminants could build up in the work area if make-up air was unavailable. A waste air heating system was installed to take hot waste air from the exhaust stacks of the cast house melting furnaces and the hot mill soak furnaces, dilute it with outside air, and direct it back into the plant. This was to provide heat during cold weather and would have supplied some of the make-up air needed. This system is not in operation since it does not operate as designed, and it is not known if it will be made operational.

V. RECOMMENDATIONS

Local exhaust ventilation should be supplied in the welding section of the maintenance department. Due to the diverse sizes and configurations of various parts being welded, the most appropriate type would probably be a flexible duct which can be moved within a few inches of the weld. (Figures 1 and 2 below show typical systems). This duct should terminate in a bell mouth inlet or a type which would consider entry loss as well as convenience. Minimum face velocity should be 1500 fpm, and minimum duct velocity should be 3000 fpm[10]. The system should be designed and balanced by someone familar with such work and also with the process being ventilated. The system should exhaust outside the plant and provisions for make-up air should be considered.

Figure 1

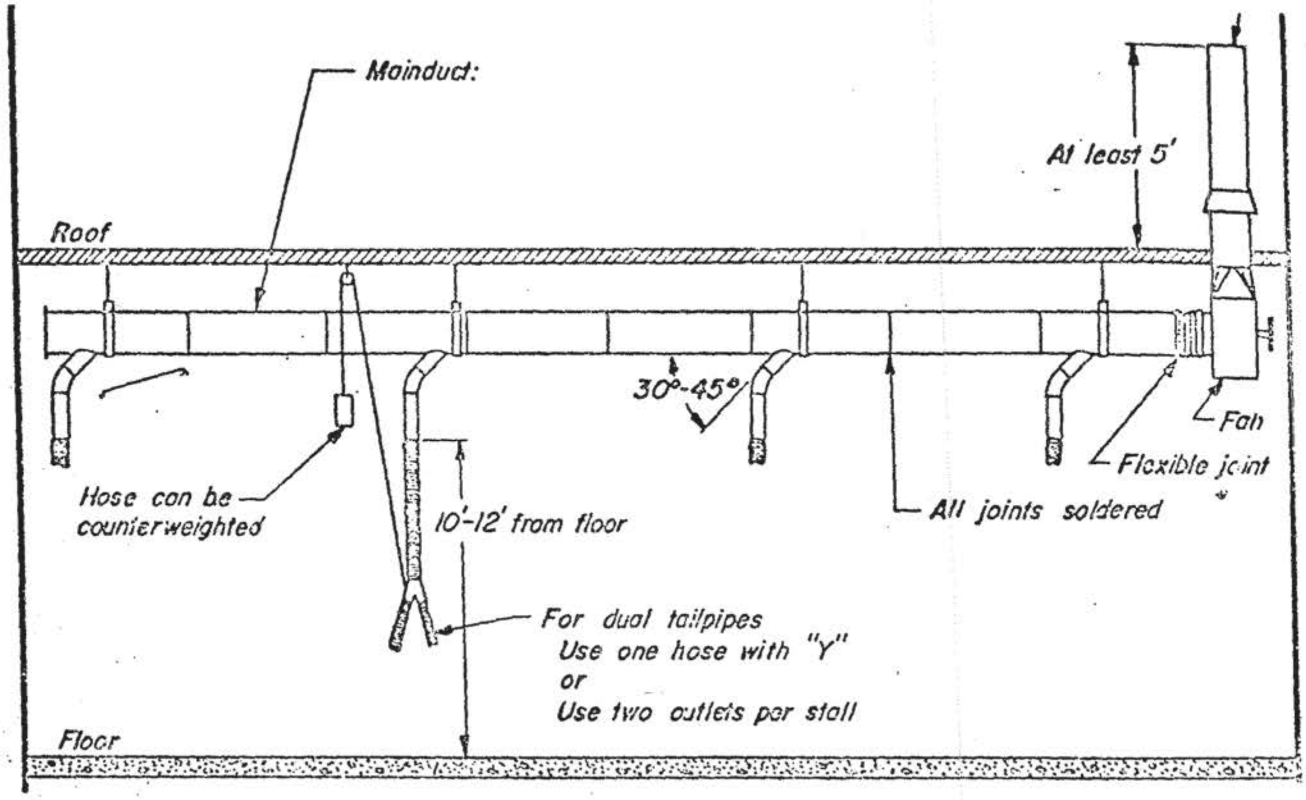
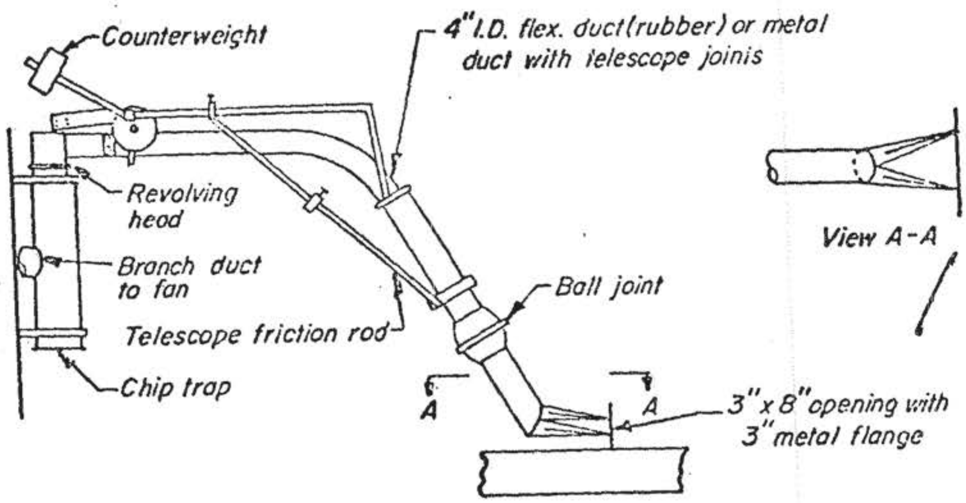


Figure 2



Figures 1 & 2 - Typical flexible duct local exhaust systems which could be adapted to welding operations

Carbon monoxide emissions in the exo gas generating area should be controlled so that employees working near that area are not exposed to toxic concentrations of carbon monoxide and so that maintenance or other workers who might go into that area are not exposed to acute concentrations of carbon monoxide. This is probably best done by controlling leaks from the system, but general exhaust ventilation of that area might also be needed. Before employees begin working on this system, tests should be done to be sure the concentration of carbon monoxide will not overcome them.

A decision needs to be made on make-up air for the general exhaust ventilation for the plant. Either the waste air heating system should be placed in operating order or some other method of providing conditioned make-up air should be devised. Without sufficient air being supplied to the plant, the exhaust system will not eliminate airborne contaminants as it was during the days of this evaluation.

VI. REFERENCES

1. NIOSH Manual of Analytical Methods, 2nd Ed., NIOSH, 1977.

2. Criteria for a Recommended Standard, Occupational Exposure to Chlorine, NIOSH, 1976.

3. OSHA Safety and Health Standards, 25 CFR 1910.

4. Criteria for a Recommended Standard, Occupational Exposure to Nickel, NIOSH, 1977.

5. Criteria for a Recommended Standard, Occupational Exposure to Trichloroethylene, NIOSH, 1973.

6. Criteria for a Recommended Standard, Occupational Exposure to Refined Petroleum Solvents, NIOSH, 1977.

7. Documentation of the Threshold Limit Values, American Conference of Governmental Industrial Hygienists, 1971.

8. Patty, F.A., Industrial Hygiene and Toxicology, Vol. II, Interscience Pub., New York, N.Y., 1963.

9. Registry of Toxic Effects of Chemical Substances, NIOSH, 1976.

10. Industrial Ventilation, a Manual of Recommended Practice, 13th Ed., American Conference of Governmental Industrial Hygienists, 1974.

11. Background Information on Trichloroethylene, NIOSH Office of Occupational Health Surveillance and Biometrics, 1975.

VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:

G. Edward Burroughs,
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Cincinnati, Ohio

Originating Office:

Jerome P. Flesch,
Acting Chief
Hazard Evaluations and Technical
Assistance Branch
Cincinnati, Ohio

Study Participants:

Clifford L. Moseley
Industrial Hygienist
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Cincinnati, Ohio

Clinton Collins
Co-Step
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Cincinnati, Ohio

Jerry Clere
Environmental Health Technician
Appalachian Laboratory for
Occupational Safety and Health
Morgantown, W. Va.

Report Typed By:

Marie Holthaus, Clerk-Typist
Industrial Hygiene Section
Hazard Evaluations and Technical
Assistance Branch
Cincinnati, Ohio

Table I

Sampling Parameters

May 10 & 11, 1977

CONALCO
Hannibal, Ohio

Substance	Collection Media	Flow Rate	Duration	Extraction	Analysis[a]
Total Particulate	Vinyl Metricel[b] Filter	1.5 lpm	Full Shift[c]	-	Reweigh
Metals	Vinyl Metricel Filter	1.5 lpm	Full Shift	Acid	Atomic Absorption (P + CAM 173)
Oil Mist	Vinyl Metricel or Cellulose Ester Filter[d]	1.5 lpm	Full Shift	Carbon Tetrachloride	Nondispersive Infrared Spectrophotometry
Freon	Activated Charcoal[e]	100 or 200 cc/minute[f]	Full Shift	Carbon Disulfide	Gas Chromatography (P + CAM 127)
Trichloro-ethylene	Activated Charcoal	100 or 200 cc/minute	Full Shift	Carbon Disulfide	Gas Chromatography (P + CAM 127)
Tridecyl Alcohol	Activated Charcoal	100 or 200 cc/minute	Full Shift	Carbon Disulfide	Gas Chromatography (P + CAM 127)
Kerosene	Activated Charcoal	100 or 200 cc/minute	Full Shift	Carbon Disulfide	Gas Chromatography (P + CAM 127)
Chlorine	Impinger	1.0 lpm	10-30 minutes	Colorimetric[g]	-

a - when available, number of standard analytical method is given, see Reference 1.
b - preweighed 37 mm VM-1 filter in 3-piece, closed face cassette.
c - samplers were operated for as close to a full 8-hour shift as practical, actual duration usually ranging from six to seven hours.
d - cellulose ester "AA" filters, not preweighed, used for samples not also being analyzed for total particulate.
e - due to possible migration of freon between sections of the sample tube, two tubes were used in series to collect this substance; front and back sections of each tube were analyzed together.
f - flow rate depended on the capabilities of the sampling pump being used.
g - this analysis is described in the NIOSH Criteria Document on Chlorine, Reference 2.

Table II
EVALUATION CRITERIA
CONALCO
Hannibal, Ohio

Substance	OSHA Standard	NIOSH Recommendation	Threshold Limit Value	Health Effects[a]
Total Particulate	15 mg/M^3 [b]	N.A.[c]	10 mg/M^3	Irritation of eyes and upper respiratory tract, reduced visability, skin damage
Aluminum[d]	15 mg/M^3	N.A.	10 mg/M^3	Same as total particulate
Iron Oxide	10 mg/M^3	N.A.	10 mg/M^3	Benign lung changes
Nickel	1 mg/M^3	0.015 mg/M^3, 10 Hr. TWA	1 mg/M^3	Skin effects, lung and nasal cancer
Oil Mist	5 mg/M^3	N.A.	5 mg/M^3	Lung changes
Freon	1000 ppm	N.A.	1000 ppm	Narcosis
Trichloroethylene	100 ppm; 200 ppm ceiling[e]	100 ppm; 150 ppm, 10 minute ceiling	100 ppm	Central nervous system depressant[g]
Tridecyl Alcohol	N.A.	N.A.	N.A.	------------------
Kerosene	N.A.	100 mg/M^3, 10 Hr. TWA	N.A.	Eye, nose and throat irritation; dermatitis; Central nervous system effects
Chlorine	1 ppm	0.5 ppm, 15 minute ceiling	1 ppm	Eye and airway irritation
Carbon Monoxide	50 ppm	35 ppm; 200 ppm ceiling	50 ppm	Heart effects
Formaldehyde	3 ppm[f] 5 ppm ceiling	1 ppm ceiling, 30 minutes	2 ppm ceiling	Irritation, lung effects
Chlorine Dioxide	0.1 ppm	N.A.	0.1 ppm	Eye and respiratory tract irritation, Bronchitis

(a) Primary effects considered in establishing NIOSH recommended standards when available, otherwise effects described by ACGIH>

(b) Criteria are 8-hour time weighted averages except as noted.

(c) Recommended exposure limits not available for these substances.

(d) Aluminum is considered a "nuisance dust" and as such would be considered in the category of total particulate. However, due to the nature of the process, it is listed separately.

(e) Standard includes a provision for acceptable maximum peak of 300 ppm above ceiling value for five minutes in any two hours.

(f) Standard includes a provision for acceptable maximum peak of 10 ppm above ceiling value for 30 minutes.

(g) There are some preliminary indications of carcinogenicity in rodents; additional animal and epidermiologic studies are anticipated.

Table III

TOTAL PARTICULATE AND ALUMINUM CONCENTRATIONS

May 10 & 11, 1977

CONALCO
Hannibal, Ohio

Location	Day	Time	Concentration, mg/M^3 Total Particulate	Aluminum*
Area near 48" Slitter control	May 10	10:20- 3:25	0.4	N.D.
Plate Saw Helper	May 10	9:55- 3:30	17.0+	12.8+
Furnace Operator	May 10	8:05- 3:55	0.4	N.D.
Furnace Operator	May 10	8:15- 3:00	0.4	N.D.
Pourer	May 10	8:20- 3:00	0.7	N.D.
Scalper Operator	May 10	8:30- 2:55	27.5+	1.9
Mill Operator	May 10	8:55- 2:45	0.5	N.D.
Wide Tension Leveling Line Utility Man	May 11	8:25- 3:00	0.1	N.D.
Plate Saw Operator	May 11	8:20- 3:10	0.02	N.D.
Pourer	May 11	8:15- 3:20	0.6	N.D.
Furnace Operator	May 11	8:15- 3:20	1.8	N.D.
Assistant Furnace Operator	May 11	8:25- 3:25	0.8	0.2
Furnace Operator	May 11	9:40- 3:20	0.7	N.D.
Mill Operator	May 11	8:35- 3:30	21.8+	N.D.
Mill Feeder	May 11	8:55- 3:34	0.5	N.D.
Wide Tension Leveling Line Operator	May 11	8:25- 3:00	0.1	N.D.
Ingot Saw Operator	May 11	9:40- 3:20	0.6	N.D.
Mill Helper	May 11	9:00- 3:35	0.3	N.D.
Mill Helper	May 11	9:10- 3:35	0.5	N.D.
Mill Operator	May 11	9:15- 3:35	0.5	N.D.
Mill Expediter	May 11	9:15- 3:35	0.5	N.D.
Mill Feeder	May 11	9:15- 3:40	0.5	N.D.
Mill Relief Man	May 11	9:25- 3:35	0.5	N.D.
Dross Operator	May 11	8:15- 3:20	0.4	-
Dross Operator	May 10	8:10- 3:05	0.6	-
Wide Tension Leveling Line Utility Man	May 10	10:15- 3:20	0.4	-
Shear Operator	May 10	8:45- 3:10	1.1	-
Checker/Welder	May 10	9:00- 2:50	0.5	-
Plate Saw Helper	May 11	8:15- 3:10	7.6**	-
Assistant Furnace Operator	May 11	8:20- 3:20	1.2	-
Speed Operator, Mill	May 11	8:40- 3:30	0.6	-
Laborer, Mill	May 11	8:50- 3:30	0.6	-
Mill Operator	May 11	9:05- 3:40	0.4	-
Mill Helper	May 11	9:10- 3:35	0.5	-
Mill Helper	May 11	9:20- 3:35	0.5	-

* "N.D." indicates concentration below limit of detection of analytical method, approximately 0.02 mg/M^3; where no value or notation is made, sample was not analyzed for aluminum.

** Not thought to be a valid sample due to interference of tobacco smoke with analysis.

\+ Not thought to be a valid sample since large particles of material could be seen in the filter cassette.

Table IV

OIL MIST CONCENTRATIONS

May 10 & 11, 1977

CONALCO
Hannibal, Ohio

Location	Day	Time	Concentration, Mg/M^3
Wide Tension Leveling Line Utility Man	May 10	10:15- 3:20	0.3
Shear Operator	May 10	8:45- 3:10	1.0
Checker/Welder	May 10	9:00- 2:50	0.7
Plate Saw Helper	May 11	8:15- 3:10	2.9*
Assistant Furnace Operator	May 11	8:20- 3:20	0.3
Speed Operator, Mill	May 11	8:40- 3:30	0.6
Laborer, Mill	May 11	8:50- 3:30	0.4
Mill Operator	May 11	9:05- 3:40	0.4
Mill Helper	May 11	9:10- 3:35	0.3
Mill Helper	May 11	9:20- 3:35	0.3
Wide Tension Leveling Line Operator	May 10	9:25- 3:20	0.2
Plate Saw Operator	May 10	10:25- 3:30	0.3
Speed Operator, Mill	May 10	8:50- 2:50	0.6
Shear Operator	May 10	8:45- 3:10	0.6
Mill Operator	May 10	8:55- 2:45	0.7
Checker/Welder	May 10	9:00- 2:50	0.3
Assistant Mill Operator	May 10	9:10- 2:40	0.1
Mill Operator	May 10	9:10- 2:35	0.3
Mill Helper	May 10	9:15- 2:40	0.1
Mill Operator	May 10	9:20- 2:40	0.2
Mill Feeder	May 10	9:25- 2:35	<0.05
Mill Operator	May 10	9:25- 2:35	0.1
Area Near Slitter Operator	May 11	8:40- 3:05	0.1
Mill Operator	May 11	8:35- 3:25	0.4
Checker/Welder	May 11	8:40- 3:30	0.3
Laborer	May 11	8:45- 3:25	0.4
Mill Helper	May 11	9:00- 3:35	0.1
Mill Operator	May 11	9:00- 3:35	0.2
Mill Feeder	May 11	9:25- 3:35	0.1

* Not thought to be valid sample due to interference of tobacco smoke with analysis.

Table V

FREON CONCENTRATIONS

May 10 & 11, 1977

CONALCO
Hannibal, Ohio

Location	Day	Time	Concentration, ppm
Furnace Operator	May 10	8:05- 3:55	0.2
Dross Operator	May 10	8:10- 3:05	0.5
Furnace Operator	May 10	8:15- 3:00	0.3
Pourer	May 10	8:20- 3:00	0.5
Pourer	May 11	8:15- 3:20	0.3
Furnace Operator	May 11	8:15- 3:20	0.3
Assistant Furnace Operator	May 11	8:20- 3:20	0.3
Assistant Furnace Operator	May 11	8:25- 3:25	0.3

Table VI

TRICHLOROETHYLENE CONCENTRATIONS

May 10 & 11, 1977

CONALCO

Hannibal, Ohio

Location	Day	Time	Concentration, ppm
Wide Tension Leveling Line Take-off Man	May 10	9:15- 3:20	0.1
Wide Tension Leveling Line Asst. Operator	May 10	9:25- 3:20	0.1
Plate Saw Helper	May 10	9:55- 3:30	2.2
Plate Saw Operator	May 10	10:25- 3:30	2.6
Wide Tension Leveling Line Asst. Operator	May 11	8:30- 3:05	0.1
Wide Tension Leveling Line Take-Off Man	May 11	8:35- 3:05	0.1
Plate Saw Helper	May 11	8:15- 3:10	6.7
Plate Saw Operator	May 11	8:20- 3:10	5.8
Press Operator	May 11	10:25- 3:10	57.3

Table VII

CHLORINE CONCENTRATIONS

May 11, 1977

CONALCO
Hannibal, Ohio

Location	Time	Concentration, ppm
#3 & 4 Furnace Operators Station	11:02-11:15	0.003
Near #3 Fluxer	11:06-11:14	0.008
#5 & 6 Furnace Operators Station	11:30-12:00	0.005
#7 & 8 Furnace Operators Station	11:51-12:21	0.007
Near #8 Fluxer	1:19- 1:31	0.008
#7 & 8 Furnace Operators Station	1:23- 1:35	0.011

Table VIII

WELDING FUME CONCENTRATIONS

May 10 & 11, 1977

CONALCO
Hannibal, Ohio

Location	Day	Time	Concentrations, mg/M^3			
			Particulate	Iron Oxide	Nickel	Aluminum
Welder #1	May 10	8:50-3:00	21	2.6	0.08	0.5
Welder #2	May 10	8:55-2:55	3.2	3.0	0.02	0.05
Welder #3	May 10	8:55-3:00	2.7	1.3	0.01	0.1
Welder #4	May 11	8:05-3:15	7.5	6.5	0.04	0.3
Welder #5	May 11	8:45-3:15	3.9	2.9	0.03	0.03

Table IX

DETECTOR TUBE MEASUREMENTS

May 11, 1977

CONALCO
Hannibal, Ohio

Substance	Location	Concentration
Carbon Monoxide	Welding Area	<5 ppm
Chlorine	#3 & 4 furnace, fluxing	N.D.*
Chlorine	#5 & 6 furnace, fluxing	N.D.
Chlorine Dioxide	Water treatment (three samples)	N.D.
Chlorine	At #8 furnace opening	0.2 ppm
Chlorine	#7 & 8 furnace, wand fluxing	N.D.
Carbon Monoxide	Exo gas area, directly over where heating gas enters boiler	>500 ppm
Hydrocarbons	Same as above sample for CO	N.D.
Carbon Monoxide	Ambient levels around Exo gas area	50 ppm
Carbon Monoxide	Saw operator, Finishing Dept.	<10 ppm
Carbon Monoxide	Wide tension leveling line console	40-50 ppm
Hydrocarbons	Wide tension leveling line console	N.D.
Carbon Monoxide	Splitter operation, Finishing Dept.	5-10 ppm
Hydrocarbons	Splitter operation, Finishing Dept.	N.D.

* Indicates concentration was below the limit of detection of measuring device.