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

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 76-33,34-431

KAISER ALUMINUM AND CHEMICAL CORPORATION
RAVENSWOOD, WEST VIRGINIA
September, 1977

I. TOXICITY DETERMINATION

It has been determined that the anode setters in the Pot Area may be exposed to excessive concentrations of total/nuisance particulate, (aluminum oxide). This determination is based on the evaluation of the work place atmosphere on July 27-29, 1976. The work atmosphere in this area was also evaluated for soluble and insoluble flourides. Exposure to these contaminants was not excessive.

The work atmosphere in the casting area was evaluated for carbon monoxide, sulfur dioxide, and ammonia gases; and for beryllium, copper, chromium and manganese fumes. Exposure to these contaminants was minimal during this evaluation.

The findings related to determining whether a high rate of coronary heart disease existed were inconclusive. Medical data available to date does not conclusively prove that workers in the pot or casting rooms do or do not have an excess number of heart attacks.

Recommendations are presented in the body of this report for the control of environmental exposures and for medical surveillance of employees.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this determination report are 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 have been sent to:

a) Kaiser Aluminum and Chemical Corporation

b) Authorized Representatives of Employees - United Steel Workers of America, Local 5668
c) U.S. Department of Labor - Region III
d) NIOSH Regional Consultant - Region III

For the purpose of informing the approximately 550 "affected employees" the employer should promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) where affected employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 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 the employees regarding the physical impairments, primarily a high incidence of coronary heart disease (CHD), caused by their work environment in the pot and casting departments of Kaiser Aluminum, Ravenswood, WV.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

The area covered by this evaluation is involved with the production of virgin aluminum metal by the electrolytic reduction of alumina using pre-baked carbon electrodes and cryolite flux. This is accomplished in the following areas:

1) Pot Area

There are four pot rooms in this area each being approximately 750' x 30' x 40' with an "A" type roof. There are approximately 48 (6' x 4') openings in the roof and the sides of the building can be opened.

There are approximately 92 pots to a room, each pot measuring 20' x 8' x 6' and contains 20 electrodes. The power to the pots is 45,000 amperes, 4 1/2 volts. When in operation each pot is equipped with local exhaust ventilation.

On top of each pot there is a storage bin where the raw material, a mixture of alumina, reclaimed material from the air pollution collectors, and cryolite flux are stored. This material is periodically and automatically added into the pots, in addition to about 20 pounds of manganese and limestone daily.

The temperature of molten aluminum metal is brought to approximately 1,000°C, and is aspirated once every 24 hours by suction into a holding pot utilizing a U tube. These pots are taken to a holding area in the Casting Department.

Spent anodes must be removed every 24 hours which entails opening the lids, breaking the crust and removing and replacing the spent anodes.

2) Casting Department

This area is about 40 feet high with 30 inch ceiling fans over each furnace. In this area there are eight casting and four barrel furnaces. In this area, there is also a scrap melting furnace. This furnace is used to melt purchased scrap, defective ingots, and ends of ingots.

The charge for the casting furnace may be either aluminum reclaimed from dust collectors or virgin aluminum from the Pot Area. This furnace is lanced approximately 3 times a day with chlorine gas and the dross is removed. Every 8 hours the furnace is taped and direct chill ingots are poured. Prior to pouring, other alloys are added to impart certain characteristics, such as hardness. The ingots can weigh up to 15 tons and be fifteen feet long.

The barrel furnaces are used to reclaim the aluminum from the dross. Stones to break up the dross are added. The furnace is heated and the aluminum is recovered. All furnaces are either oil or gas heated depending on supply available.

B. Evaluation Design

On April 20-22, 1976, Walter Chrostek, NIOSH Industrial Hygienist, Dr. Channing Meyer, NIOSH Industrial Physician and Drs. Kenneth Powell and William Watson, Epidemiological Investigation Service, (EIS) Officers, conducted an initial walk-through survey and non-directed medical questionnaires were completed to gather data regarding the incidence of coronary heart disease.

Following the initial walk-thru, a return visit was made on July 27-29, to conduct atmospheric sampling for total particulate, soluble and insoluble fluorides and fluorine gas in the Pot Department. In the Casting Department, samples were collected for beryllium, copper, chromium and manganese dust and fume, and atmospheric determinations were made for carbon monoxide and ammonia gas.

C. Evaluation Methods

Environmental

1) Pot Department

Employee exposure to airborne total/nuisance dust were evaluated using personal air sampling equipment. Breathing zone samples were collected on pre-weighted PVC filters. The dust concentrations were calculated from the results of the gravimetric analysis.

Employee exposure to airborne fluorides was evaluated using personal air sampling equipment. The total fluorides were collected on AA cellulose acetate filters and the soluble fluorides were collected in impingers containing a 0.15 percent sodium acetate collecting media. These samples

were subsequently analyzed for fluorides by an ion specific electrode. An attempt was made to evaluate the exposure of automatic floor sweeper operators to carbon monoxide, carbon dioxide,and airborne dust; however, the vehicle became disabled and the operation was discontinued.

2) Casting Department

Employee exposure to airborne beryllium, copper, chromium and manganese fume and dust were evaluated utilizing personal air sampling equipment and AA cellulose acetate membrane filters. These samples were subsequently analyzed by atomic absorption spectroscopy for these individual contaminants. The lower limit of detection for beryllium was 1 microgram and for all others it was 2 micrograms per cubic meter of air. Nine samples were collected for these contaminants.

Length of stain detector tubes were utilized to measure atmospheric concentrations of chlorine, during the fluxing operation, and carbon monoxide in the casting area, fluxing and skimming operations are of 5 to 10 minute duration.

Medical

Data pertinent to the question of a possible excess number of heart attacks among certain workers at the plant was utilized.

1) Data Sources

a) Plant medical records. Every employee receives a routine physical examination at least every 2 to 3 years. Almost all exams include: height, weight, vital signs, eye and ear exams, urinalysis, SMA-20, EKG, Chest x-ray, pulmonary function tests, smoking history, marital history and family history (pre-employment exam only).

b) Union medical records. Members of United Steel Workers of America, Local 5668 maintain records of persons with medical illnesses requiring time off from work or a change in work status. Union officials reviewed the records and identified all persons thought to have heart disease.

c) Life insurance records. A company Life Insurance Program covers all persons currently working at the plant, receiving workman's compensation for a work related injury or retired after 10 years service. Company officials provided to NIOSH a list showing the number of hourly workers who had died from 1966 to 1975. The list included year of death, age, cause of death, total length of employment, and length of employment in the pot room and casting room.

d) Present number of employees. Company officials supplied the total number of salaried and hourly workers, the number of salaried and hourly pot room workers and the number of salaried and hourly casting room workers as of March 31, 1976. (Table I)

2) Work Experience Estimates

Many employees worked in the pot and casting rooms for only short or periodic lengths of time. Therefore the number of workers currently in those areas is an underestimate of the number of plant workers who had ever worked in those areas. We estimated the number of employees who had ever worked in the pot and casting rooms from data on the death list and from the number of employees currently working in those areas: Workers who had died and who had worked in either the pot room or the casting room had spent only 39% of their working time in those areas. Therefore, the total number of workers at the plant who have worked in the pot or casting room at any time is estimated by dividing the number of those presently working there by 0.38 (Table 2). Similarily the pot room workers spent only 22% of their time in the pot room, so the estimated total who have worked in the pot room is the number presently working there divided by 0.22 (Table 2).

D. Evaluation Criteria

The primary sources of environmental evaluation criteria considered in this report are: 1) NIOSH Criteria Documents recommending occupational health standards, 2) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values with Supporting documentation and 3) OSHA Standards as found in the Federal Register, Vol. 39, 23540-23543, June 27, 1974.

Ammonia Gas	NIOSH(a)	50 ppm(b)	5 minute ceiling
Beryllium Fume	OSHA(c)	1.0 ug/M3(d)	8-hour TWA(e)
Carbon Dioxide	OSHA(f)	5,000 ppm	8-hour TWA
Carbon Monoxide	NIOSH(g)	35 ppm	
Chlorine Gas	NIOSH(h)	0.5 ppm	15 minute ceiling
Chromium	NIOSH(i)	25 ug/M3	8-hour TWA
Copper Dust	OSHA(f)	1.0 mg/M3	8-hour TWA
Copper Fume	OSHA(f)	0.1 mg/M3	8-hour TWA
Fluorides	NIOSH(j)	2.5 mg/M3	8-hour TWA
Manganese	OSHA(f)	5.0 mg/M3	ceiling valve
Nuisance Particulate (Aluminum Oxide)	ACGIH	10.0 mg/M3	8-hour TWA
Ozone	ACGIH(k)	0.3 ppm 0.1 ppm	15 minute STEL(l) 8-hour TWA

a) NIOSH in its Criteria for a Recommended Standard - Occupational Exposure to Ammonia Gas, Aug. 1972

b) ppm denotes parts of contaminant per million parts of air

c) OSHA U.S. Department of Labor, Federal Register, in its Proposed Standard for Beryllium Fume, October 17, 1975

d) ug/M3 denotes micrograms of contaminant per cubic meter of air.

e) 8-hour TWA denotes 8-hour Time-Weighted-Average exposure standard.

f) OHSA, U.S. Department of Labor Federal Register, June 27, 1974, revised January, 1976, Vol. 39, No. 125, Title 29, Chapter XVII, Part 1910.1000, Subpart Z, Table 2-1

g) NIOSH in its Criteria for a Recommended Standard - Occupational Exposure to Carbon Monoxide, Aug. 3, 1972.

h) NIOSH in its Criteria for a Recommended Standard - Occupational Exposure to Chlorine, May 25, 1976.

i) NIOSH in its Criteria for a Recommended Standard - Occupational Exposure to Chromium VI, December 1, 1975.

j) NIOSH in its Criteria for a Recommended Standard - Occupational Exposure to Inorganic Fluorides, June 20, 1975.

k) ACGIH - in its Threshold Limit Values for Chemical Substances in Workroom Air for 1976.

l) STEL denotes short term Exposure Limit as proposed by ACGIH in their 1976 TLV List.

E. Evaluation Results

Environmental

1) Pot Department

Nine samples were collected for total/nuisance dust (Table 3). Only the anode setter sample showed levels in excess of the 10 mg/M^3 criteria.

Four samples were collected for soluble and insoluble flourides (Table 4). All samples were below the acceptable limit for fluorides.

During the visit of April 20-22, 1976, excessive amounts of dust were noted on the covers of the pots and adjacent structures. Prior to the evaluation, the third shift was assinged to blowing off the accumulated dust. This may have accounted for the low concentrations found during the evaluation.

During the evaluation period on July 27-28, excessive dust and smoke was generated by the floor sweeping machine. An attempt was made to evaluate this operation, however, shortly after personal air sampling pumps were placed on the employee, the sweeping machine malfunctioned and became inoperable.

Four samples were taken for ozone gas and the samples were non-detectable for this contaminant.

During the evaluation, it was noted that charging virgin alumina generated less dust than the 50/50 mixture of virgin alumina/collector reclaim material.

2) Casting Department

Seven determinations were made to determine the operator's exposure to chlorine during lancing and drossing and all determinations were negative. To evaluate exposures when aluminum is alloyed with various other metals, nine samples were collected and analyzed for beryllium, copper, chromium and manganese. Only one sample showed approximately 11 micrograms of copper fume and dust. All others were less than the lower limit of sensitivity for the analysis.

Four determinations were made for ammonia gas at the dross storage area. At a distance of eight feet, the concentrations of this gas were measured from 5 to 10 parts per million parts of air.

Eight determinations were made for carbon monoxide gas at the furnaces. The concentrations found ranged from a trace to 5 parts per million parts of air. There may be some problems in this area during the conversion from oil to gas and vice versa, as adjustments have to be made.

Medical

1) Morbidity Estimates

a) Prevalance of coronary heart disease (CHD). The plant medical records of 144 casting room workers were reviewed and seven were found with evidence suggesting CHD (Premature Ventricular Contractions (PVC) - 2, "ischemic" ST-T changes - 3, probable old Myocardial Infartions (MI-2). Table 5 shows that these numbers do not differ significantly from estimates based on the national health survey.

b) The union medical records included 66 persons for whom the physician diagnosis was myocardial infartion, or, in our judgement, a diagnosis indicative of certain or possible CHD. Thirty-two of the persons at one time had worked in the pot room, 34 had not worked in the pot room. Table 6 shows that the morbidity ratio due to CHD was not significantly different for persons who had worked in the pot room and for persons who had never worked in the pot room.

2) Mortality Estimates

a) Life insurance records included 33 persons whose death was judged by NIOSH to be due to CHD, 15 of the persons had worked in the pot or casting room and 18 had never worked in the pot or casting room. Table 7 shows that the estimated mortality ratio for those working in the pot room or casting rooms did not differ from the mortality ratio for those who had not.

b) Life insurance records revealed a total of 93 persons who died some time between 1966-75. Using the cause of death and work history for the 93 persons, proportionate mortality ratios were calculated (Table 8). In all comparisons cause of death was categorized as "heart disease related" or "not heart disease related", and workers were categorized into "no exposure" to the suspect area or "any exposure" to the suspect areas. Twelve comparisons were

made using various combinations of age and duration of employment. Only one comparison yielded a statistically significant difference. A disproportionate number of workers less than 50 years of age and with more than 10 years service died because of heart disease.

F. Discussion and Conclusions

Environmental

1) Pot Department

During the initial survey of April 20-22, 1976, excessive accumulations of dust were noted on the pot covers and adjoining structures. This dust was blown off on the shift prior to the atmospheric evaluation on July 27, 1976. This would account for much lower exposures to dust. It was also noted that the charges were mostly virgin alumina which did not produce the excessive dust noted when a blend of virgin and reclaim was being charged.

There was also excessive dust produced when mechanical sweeping was being performed. This operation could not be evaluated because of a malfunction in the machine.

2) Casting Department

Exposure to all contaminants was less than their respective permissible limits, however, the outside area where the dross is stored is adjacent to a large open bay. With the lower odor Threshold Limit Value for ammonia and a wind direction tending to blow gas back into the department, some complaints can be expected expecially when employees are working adjacent to the bay.

During the evaluation, it was noted that employees entered the furnaces without a prior check of the furnace for air contaminants and also without the proper approved respiratory protection. These areas are considered confined spaces and the proper precautions should be taken. It was also noted that employees eat in areas where beryllium is used. This practice should also be discouraged.

Medical

The data collected thus far does not conclusively prove that workers in the pot or casting rooms do or do not have an excess number of heart attacks. Using easily available data, a variety of methods were used to evaluate the potential problem. All methods, save one, suggest that heart disease among workers in the pot and casting rooms is not a greater problem than expected. (Heart disease is, admittedly, a major problem among United States males of all occupations). However, a four-fold table evaluating deaths among plant workers less than 50 years of age and greater than 10 years of service does suggest an increased number of heart disease related deaths among workers in the pot room. This was only one of a series of similar analyses and, admittedly, may be merely a statistical aberration. It is NIOSH opinion that further study of this problem is indicated. Even

though the risk of excess CHD among workers in the pot and casting rooms is, at most, only slightly greater than the already high risk for the general population it may still account for many extra deaths on an industry wide basis.

Two general methods to study the problem further were considered; a retrospective case control study and a cohort mortality study. Estimates based on the predicted number of heart attacks among workers at the plant in the past 5-10 years and the prevalance of CHD in the United States suggest that the retrospective case control will be unable to give a definitive answer to the problem. The prevalance of CHD is so great and the potential number of cases at this point so small (estimated at 75-100 in the past 5-6 years) that the rate among pot and casting room workers would need to be about 3 times that of other workers to detect a significant difference.

G. Recommendations

Medical

Since findings to date re cardiovascular disease are not conclusive, a cohort mortality study should be conducted. In order to facilitate study of this potential problem, we recommend the following:

1) that management keep accurate records about the following:

a) the exact dates the worker spends in each work area and work position

b) the diagnosis of all major illnesses and causes of death among all workers. Insurance and death certificate diagnosis may be used for the latter.

2) the discharge and death certificate diagnosis should be coded according to standard techniques and the code number included with the records. Standard Coding Procedures can be obtained by consulting, if necessary, any hospital record room or the state health department.

Industrial Hygiene

1) Pot Department

a) Discontinue the blowing off of dust accumulation. Cleaning should be done by wet or vacuum methods.

b) Investigate measures to control the dust during pot charging. The following should be considered:

1) change in design of the charging
2) change in the mixing blend with less reclaim
3) better blending of the reclaim and virgin material
4) better enclosures on the pots

The above were discussed at the closing conference.

c) Set up a maintenance program for the mechanical sweeper to ascertain that it is working at maximum efficiency.

2) Casting Department

a) Relocate the dross bins to an area where there is the least possibility for air contaminants to reenter the work area.

b) Establish procedure for entry into confined spaces.

c) Supply only NIOSH approved personal respiratory protective equipment.

d) Discontinue eating and drinking in areas where beryllium is used.

e) Set up procedure that change over from gas to oil is done during periods when the minimum number of employees are present.

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KAISER CHEMICAL AND ALUMINUM CORPORATION
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Table 1
Number of Employees as of March 31, 1976

243	Pot room workers (salaried and hourly)
298	Casting room workers (salaried and hourly)
541	Total pot and casting room workers
675	Salaried workers
2571	Hourly workers
3246	Total workers

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Table 2
Estimated Number of Workers at the Plant Who Have
Ever Worked in the Pot or Casting Rooms or the Pot Room Alone

$$\frac{541 \text{ current pot and casting room workers}}{.39} = 1387 \text{ currently employed workers who have ever worked in pot or casting room.}$$

$$\frac{243 \text{ current pot room workers}}{.22} = 1105 \text{ currently employed workers who have ever worked in pot room.}$$

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Table 3
Total Particulate Air Concentration Data
July 27-28, 1976

Job Description	Time	Air Concentration mg/M^3*	Remarks
Line 2			
Cell Operator	8:23-15:05	2.5	Operator's Exposure
Butt Bath Cell Operator	8:26-15:05	3.5	Operator's Exposure
Anode Setter	8:29-15:07	54.6	Operator's Exposure
Crane Operator	15:50-21:35	1.3	Operator's Exposure
Cell Operator	15:45-21:37	0.9	Operator's Exposure
Line 4			
Anode Setter	8:03-15:12	2.3	Operator's Exposure
Tapper	8:07-15:12	5.4	Operator's Exposure
Butt Cell Operator	8:10-15:10	2.5	Operator's Exposure
Boiler Operator	8:50-14:58	2.6	Operator's Exposure

* mg/M^3 - denotes milligrams of contaminant per cubic meter of air sampled.

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Table 4
Soluble and Insoluble Fluoride Air Concentration Data
July 27-28, 1976

Job Description	Time	Flouride ug/M3* Soluble	Insoluble	Remarks
Line 2				
Tapper	8:20-14:30	7	178	Operator's Exposure
Anode Butt Cleaner	16:02-21:23	5	175	Operator's Breathing Zone**
Sweeper	8:20-15:20	4	110	Operator's Breathing Zone**
Line 4				
Cell Operator	8:02-15:11	1	79	Operator's Exposure

* ug/M^3 - denotes micrograms of contaminant per cubic meter of air sampled.

** - denotes respirator was worn

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Table 5
Prevalence of EKG Evidence of CHD Among Casting Room Workers Compared with Prevalence of CHD in the General Population

Casting Room Workers				National Health Survey	
Age	Number of charts Reviewed	Number with Abnormality	Percent with Abnormality	Age	Percent of males with definite and suspect CHD**
20-29	1	0	0		
30-39	39	0	0		
40-49	82	3	3.7 (0-7.7)*	40-44	2.0
				45-49	6.8
50-59	20	4	20.0 (7-42.2)*	50-54	7.1
				55-59	13.2
60-69	2	0	0		
	144	7			

* 95% Confidence Interval

** National Center for Health Statistics, Publication No. 1000, Series 11, Number 10, "Coronary Heart Disease in Adults, United States - 1960-1962." September, 1965.

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Table 6
Morbidity Ratio Due to CHD Among Workers Who Had Worked
In the Pot Room and Workers Who Had Not Worked in the Pot Room

Work History	Estimated Denominator**	Number with CHD	Percent with CHD
Ever Pot Room Workers	1105	32	2.9*
Never Pot Room Workers	1466	34	2.3*

* P > .05
** See Table 2

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Table 7
Mortality Ratio Due to CHD Among Workers Who Had and Had Not Ever Worked in the Pot or Casting Rooms

Work History	Estimated Denominator**	Number Who Died Due to CHD	Percent Who Have Died Due to CHD
Ever Pot or Casting Room	1387	15	1.1*
Never Pot or Casting Room	1183	18	1.5*

* P > .05
** See Table 2

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Table 8
The Cause of Death Among Workers With and Without Exposure to the Suspect Areas

	Exposure to Pot or Casting Room	Cause of Death		
		Heart Related	Not Heart Related	Total
All Ages, ≥ 10 yrs. of Service P > .05	None	21	29	50
	Some	10	15	25
	Total	31	44	75
All Ages. any length of service P > .05	None	23	37	60
	Some	15	18	33
	Total	38	55	93
< 60 yrs, ≥ 10 yrs of service P > .05	None	12	20	32
	Some	8	12	20
	Total	20	32	52
< 60 yrs, any length of service P > .05	None	14	28	42
	Some	13	15	28
	Total	27	43	70
< 50 yrs, ≥ 10 yrs of service P > .05	None	2	9	11
	Some	4	10	14
	Total	6	19	25
< 50 yrs, any length of service P > .05	None	2	14	16
	Some	7	13	20
	Total	9	27	36

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Table 9
The Cause of Death Among Workers With and Without Exposure to the Suspect Areas

	Exposure to Pot Room Only	Cause of Death		
		Heart Related	Not Heart Related	Total
All ages. ≥ 10 yrs of service P > .05	None	23	35	58
	Some	8	9	17
	Total	31	44	75
All Ages, any length of service P > .05	None	27	43	70
	Some	11	12	23
	Total	38	55	93
< 60 yrs, ≥ 10 yrs of service P > .05	None	13	24	37
	Some	7	8	15
	Total	20	32	52
< 60 yrs, any length of service P > .05	None	17	32	49
	Some	10	11	21
	Total	27	43	70
< 50 yrs, ≥ 10 yrs of service P > .05	None	2	12	14
	Some	4	7	11
	Total	6	19	25
< 50 yrs, any length of service P > .05	None	3	17	20
	Some	6	10	16
	Total	9	27	36