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

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 74-25-267

KAISER ALUMINUM AND CHEMICAL CORPORATION
RAVENSWOOD, WEST VIRGINIA

MARCH 1976

I. TOXICITY DETERMINATION

It has been determined that employees performing various operations in the bridging departments (Bldgs. 51, 52, and 53) are exposed to potentially toxic concentrations of dust, particulate polycyclic organic matter (PPOM), and benzo(a) pyrene (BaP). This determination is based on evaluation of the work place atmosphere on July 9-12, 1974 and March 11-14, 1975. Although authorities differ on the particular contaminant which is the most detrimental to health, evaluations were performed on various constituents which may be in the atmosphere.

Medical evaluations were conducted on July 2-12, 1974 and August 26, 1974, encompassing employee interviews, medical examinations and testing.

Although physical agents are outside the scope of section 20(a)(6), it is NIOSH policy that where potential health hazards are observed in workplaces under investigation, specific mention of such be incorporated and reported. Although the noise levels were high, the present permissible standards were not exceeded if the time spent at the work station is considered.

Tables of our findings and recommendations have been offered in the body of the report for control of environmental exposure of the employees to the potentially toxic substances and for medical surveillance of exposed employees.

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, Fifth and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Kaiser Aluminum and Chemical Corporation
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region III
d) NIOSH Regional Consultant - Region III

For purposes of informing the approximately 150 "affected employees" the employer shall 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 U.S. Code 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) has received such a request from an authorized representative of employees regarding several employees in Carbon Operations and Rodding Department who felt they had respiratory impairment caused by their work environment.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

a) Rodding Department

This department is engaged in reconditioning spent rods used in the electrolytic furnace for making aluminum. Rods are brought into the department and manually hung on an overhead conveyor belt. From here they pass through the rod straightener, spent butt remover, butt crusher, cast iron thimble remover, shot cleaner, a graphite release agent is applied, the rods are matched with an anode, and a cast iron thimble is poured. The anodes are then removed to the furnace area and used as needed.

The butt crusher, chipper and combination press operators may be exposed to dust and fluorides from the spent butts. The fluorides are residues on the butts from the electrolytic refining process. The welding operators may be exposed to iron oxide and manganese fumes.

b) Green Carbon Area

This area consists of the anode batch mixing and the anode press. Predetermined amounts of pitch (coal tar), calcined coke (coarse and fine), and remake (crushed spent butts) are dropped into a mixer. This material is heated to approximately 170°C for approximately 30 minutes. The material is then dropped to a conveyor which removes it to a storage area. Approximately 90 mixes (350 tons total) per day are processed. Preweighed amounts of the mix are dropped into a mold and the anodes are pressed. This is an automatic process whereby the mold is sprayed with a parting oil, the batch dropped into the mold, and the pressure is applied. The operator is located approximately ten feet from the machine in a glassed enclosure.

c) Finished Carbon Area

This area is also called the bridging area. It consists of three buildings (Nos. 51, 52, and 53). The first two are full buildings and the third has half the capacity. These buildings have pits (60 rows, 6 pits per row) where the anodes are placed. Approximately 215-225 anodes are put in one row of pits and covered with a coke blanket. The baking cycle consists of preheating, heating to approximately 1050°C, and cooling. The whole cycle takes approximately 40 hours. The anodes are inserted and removed by a bridge crane utilizing compressed air to uncover the anodes.

The crane operators are supplied with air supplied hoods, however, at times these are not utilized. Following the removal of the anodes, the coke blanket mix is removed from the pits with crane buckets and put into bins for reuse. Natural gas is used for heating.

B. Evaluation Design

On March 6-7, 1974, Walter Chrostek, NIOSH regional industrial hygienist, conducted an initial walk-through survey, and non-directed medical questionnaires were completed. The results of that survey indicated that a comprehensive environmental and medical evaluation was necessary. The final evaluation was carried out on July 8-11, 1974 and August 26, 1974. Because of technical difficulties with the sampling media, it was necessary to resample the environmental conditions on March 11-14, 1975.

The final medical evaluation encompassed the following areas:

1) Investigation concerning possible respiratory disability with included interviews utilizing the

   a) Appalachian Laboratory for Occupational Respiratory Diseases (ALFORD) modified Medical Research Council (MRC) respiratory questionnaire.
   b) Spirometry - at least five forced vital capacity maneuvers.
   c) Posterior-anterior and laterial chest x-ray examination.

2) Investigation concerning possible dermatologic problems which included:

   a) Questions regarding dermatologic history.
   b) Cutaneous (skin) examination.

Initially, the scope of the Health Hazard Evaluation (HHE) included an assessment of causes of mortality among the workers who have worked in the areas covered by the HHE. Both union and management representatives provided the medical investigators with information in this regard. However, discussion with the NIOSH Division of Field Studies and Clinical Investigations (DFSCI) indicated that much more information would have to be obtained for an indepth mortality study. Because DFSCI was not able to carry out the mortality study at this time, the investigators decided to exclude the mortality study from the final HHE determination.

The initial selection of the population for the study in the areas of the Health Hazard Evaluation (HHE) was made by random selection. Statistical analysis of the population indicated that it would be necessary to include about 100 of the 171 production and maintenance employees. The specific breakdown of sample and population sizes by department is shown in Table VII. Additionally, it was decided to evaluate the 11 individuals who were working or had worked in the areas of the HHE request and who had filed workmen compensation claims for respiratory disability.

To compare with the exposed groups of employees, 40 individuals were chosen from the Inspection and Loading area in the Fabrication plant. These individuals gave no previous history of working in the Reduction plant and were matched as closely as possible with the exposed group for height, weight, age, race, and smoking history.

Following the initial walk-thru, it was determined that atmospheric sampling would be conducted for total particulate and (PPOM). In the rodding area, samples were collected for soluble and insoluble fluorides, iron oxide and manganese fumes at the welding station and airborne respirable particulate in the buildings. In the finished carbon area samples were collected for total particulate and (PPOM). Subsequently, the latter was analyzed for its components, such as (BaP), beta-naphthylamine, etc. Noise levels were measured in various locations, where they were deemed excessive.

C. Evaluation Methods

a) Environmental

Employee exposures to airborne respirable dust was evaluated using personal air sampling equipment. Breathing zone samples were collected on pre-weighed PVC filters following a cyclone pre-sampler which removed non-respirable particles. Respirable dust concentrations were calculated from results of filter gravimetric analysis.

Samples of respirable dust were analyzed for quartz content using NIOSH "Free Silica (Quartz, Cristobalite, Tridymite)" method No. P&CAM 109.[1]

Exposure to (PPOM) were evaluated according to NIOSH sampling method No. 8.01.[2] The samples were subsequently analyzed for the benzene soluble fraction using the "Parma Standard Test Method," PSM-1013.[3] Samples were also analyzed for (BaP) utilizing thin layer chromatography-fluorescent spectrophotometric methods.

In the rodding area, air samples were collected on mixed cellulose ester filters utilizing personal air sampling pumps and analyzed for iron oxide, manganese, and fluorides.

The analytical method used to analyze for iron oxide fume and manganese was atomic absorption spectroscopy. Fluorides were determined gravimetrically and by fluoride specific ion electrode.

Occupational noise exposure levels (dBA re2($10^{-5}N/M^2$) were determined using a General Radio Model 1565B sound level meter.

b) Medical

Respiratory Disability

(1) ALFORD modified MRC respiratory questionnaire.

Chi square tests were used for testing the differences in the percentages between the exposed and non-exposed workers for smoking status, bronchitis, breathlessness, and wheezing. A Fisher's exact test was used for race because of the small percentages. A "t" test was used for variables which could be assumed normally distributed. These variables were: age, height, and weight. Also, there were 17 exposed and 7 non-exposed workers who had worked in other dusty jobs. The years in dusty jobs were tested using the "t" test, and since no difference was found, both the exposed and non-exposed workers were judged to have a similar distribution of years in other dusty jobs.

(2) Spirometry

A "t" test was used for variables which could be assumed normally distributed. These variables were: forced vital capacity (FVC), forced expiratory flow at 50% of the VC(FEF_{50}). The Mann-Whitney test was used for the remaining variables, namely, peak flow (PF), FEF_{25}, FEF_{75}, and FEF_{90}.

(3) Chest X-ray Examination

X-rays of the exposed and non-exposed individuals were interpreted using the UICC classification[4] for pneumoconiosis.

c) Dermatologic Problems

Chi square tests were used for testing the differences in the percentages between the exposed and non-exposed workers for: presence or absence of skin cancer by history, presence or absence of other skin conditions by history, presence or absence of ease of sunburn by history.

D. Evaluation Criteria

a) Environmental Standards

Occupational health standards for individual substances are established at levels designed to protect workers occupationally exposed on an 8-hour per day, 40-hour per week basis over a working lifetime.

In a Field Information Memorandum No. 74-64[5] from the U.S. Department of Labor, a ruling was made that "in electrode manufacturing where the coal tar pitch is heat-baked, auto-claved, or heat applied over the melting point temperature, the coal tar pitch volatiles standard does apply."

The Occupational Health Standards relevant to this evaluation as promulgated by the U.S. Department of Labor, Federal Register, June 27, 1974, Vol. 39, No. 122, Part II, Tables G-1[6] are as follows:

Substance	mg/m^3*
Coal dust (respirable fraction less than 5% SiO_2)	2.4
Fluorides (as F)	2.5
C** Manganese	5
Particulate polycyclic organic matter (PPOM) (benzene soluble fraction)	0.2

*Approximate milligrams of substance per cubic meter of air.
**Ceiling value - employee's exposure shall at no time exceed this value.

Noise

The Occupational Health Standard relevant to this evaluation as promulgated by the U.S. Department of Labor (Federal Register, June 27, 1974, page 23597) is:

Table G-16, "Permissible Noise Exposures"

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

"When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: C1/T1+C2/T2+Cn/Tn exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure permitted at that level."

"Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level."

The American Conference of Governmental Industrial Hygienists in their "Threshold Limit for Chemical Substances, 1975"(7) have adopted the following standards for the substances applicable to this evaluation:

Substance	mg/m^3
Nuisance Particulates	10
Iron oxide fume	5

Furthermore, the American Conference of Governmental Industrial Hygienists has listed (BaP) as an occupational substance suspect of oncogenic potential for workers. The method of entry can be through skin absorption, with no permissible exposure listed.

At the NIOSH presentation to OSHA, on Proposed Coke Oven Emissions (November 5, 1975), a "working limit" of 2 micrograms per cubic meter of air of (BaP) was proposed.

b) Medical Criteria

Respiratory Disability

(1) ALFORD modified MRC respiratory questionnaire

A person was considered to have chronic bronchitis if he reported the following:

(a) usually bringing up phlegm from his chest the first thing in the morning or during the day in the winter for as much as three months each year, or if he brought up phlegm like this for less than three months, but coughed in the morning or during the day in the winter for at least three months each year.

(b) breathlessness was defined as reporting to being troubled by shortness of breath when walking with people of his own age on level ground.

(c) wheezing was defined as reporting that his chest ever sounded wheezing or whistling.

Differences between the exposed groups and non-exposed group were considered significant as the $p \leq 0.05$ level.

(2) Spirometry and Dermatologic Problems

Differences between the exposed groups and non-exposed groups were considered significant at the $p \leq 0.05$ level.

E. Results

a) Environmental

The results of atmospheric sampling showed that employees' exposures can exceed the threshold limit value (TLV) for (PPOM), (BaP) and dust containing (PPOM) (See Table 1.). The dust contains less than 1% quartz as determined from the samples collected in the rodding and finishing departments. Toxic materials such as (BaP) and (PPOM) are present in this dust, which would take this material out of the nuisance dust category. The threshold limit value (TLV) for coal dust would be more applicable to this evaluation.

Twenty-nine atmospheric samples were collected in the batch mixing and finished carbon areas during the July 9, 1974 and March 11, 1975 evaluation periods. Due to a laboratory error, the samples collected during the July 9, 1974 period could not be analyzed for total respirable matter, however, exposure to (PPOM) and (BaP) were evaluated. Samples collected on March 11, 1975 were analyzed gravimetrically and also for (PPOM) (Table 1).

Some of the benzene extractable (PPOM) samples were analyzed for acridine, beta-naphthylamine and (BaP) by the gas liquid chromatograph method. All results were below the minimum detectable level.

Atmospheric sampling was done in the rodding department for iron oxide fume, manganese, and fluorides. All samples were below acceptable levels (See Tables 2 and 3.).

Exposure to noise was below the present permissible levels, however, should the standards be changed or it was necessary to spend more time in the area, exposures may exceed the permissible levels (See Table 4.).

b) Medical

For purposes of comparison, exposed employees were divided into four exposure groups - namely, green carbon, finish carbon, rodding, and mixing. This last group included mostly maintenance employees who had exposures in more than one area.

Age, height, weight, race, and smoking status for each of the groups were compared and are shown in Table IX. The exposed groups were significantly older than the non-exposed groups but no other significant differences were found.

Respiratory Disability

(1) ALFORD modified MRC respiratory questionnaire.

The results from this questionnaire are shown in Table X. No significant difference was found in the prevalence of bronchitis. However, the finish carbon workers reported a history of wheezing and breathlessness more often than the control group or other exposed groups. These differences were significant at the $p < 0.5$ level.

(2) Spirometry

Of the original groups of exposed and non-exposed workers, a number were eliminated from spirometric comparisons because of technically unsatisfactory (TU) PFT or because of prior work exposure in a dusty trade (i.e., prior to Kaiser) for ten years or more. The final group sizes are shown below:

	Original	T.U. PFT	10+ Years	Final
Green Carbon	19	2	3	14
Finish Carbon	25	2	7	16
Rodding	28	0	2	26
Mixing	28	0	5	23
Control	40	1	7	32

The spirometric results are shown in Table XI. No significant differences in any measurements of ventilatory capacity were noted between the control and exposed nor among any of the exposed groups. However, the finish carbon values tended to be lower on all measurements.

(3) Chest X-ray Examination

Of the 100 chest x-rays of the exposed workers, two were unreadable. One x-ray in the exposed group (finish carbon) was read as Category 3 pneumoconiosis (i.e., indicative of a marked degree of pneumoconiosis). NIOSH consultants felt this x-ray was compatible with asbestosis and review of this individual's pre-employment chest x-ray showed no evidence of pneumoconiosis.

Within the control group, one chest x-ray was technically poor and could not be interpreted. All of the remaining 39 films showed no evidence of pneumoconiosis.

c) Dermatologic Problems

Table XII shows the prevalence of individuals with (1) a history of skin cancer or tumor, (2) a history of other skin conditions, and (3) a greater ease of sunburn. While only the green carbon, finish carbon, and mixing exposure groups had any skin cancers and tumors, the numbers were too small to be significant. The skin tumor noted by the men were identified as basal cell epithelioma (1) and lipomata (3). No statistically significant differences were noted between any of the exposed groups and the control group for "other skin conditions," although a considerable percentage (50%) of men in the green carbon department reported a history of such. However, with regard to "ease of sunburn," the green carbon, finish carbon, and mixing exposure workers exhibited a significantly larger prevalence ($p < 0.05$) of complaints in the sunburn category.

Cutaneous examination of the 100 production and maintenance employees revealed several workers with residual phototoxic effects - i.e., skin peeling and hyperpigmentation of sun-exposed areas. Other dermatoses such as folliculitis, keratoses, epitheliomata, acne, and atrophy, associated with the handling of crude coal tar and pitch, were not found.

F. Discussion and Conclusions

a) Environmental

There is a potential for excessive exposure to airborne respirable particulate (PPOM) and (BaP) in the mixing and finish carbon areas (Table I). This condition is further aggravated when the respirators are non-approved or the employee refused to wear the air-supplied respirator as was noted during this evaluation.

During the initial visit it was noted that non-approved respirators were being used. Although these were subsequently mostly replaced, certain employees were wearing these respirators during the two environmental studies that were made.

(1) Mixing Department

The installation of new hoods on the mixers greatly improved conditions as can be seen in Table I. It was noted that there were ventilation ducts which were not used. Capping these ducts will increase ventilation capacities at sources where the ventilation is desirable.

During both environmental studies, it was noted that there were leaks around the shafts showing dust and smoke to escape. Establishing a maintenance program will help in improving environmental conditions and also improve housekeeping.

As was discussed during the closing conference, the point where the batch is dumped on the conveyor is too near to the source of the exhaust ventilation. This causes the particulate matter to be drawn into the exhaust ventilation system and reduce its efficiency. Extension of the hood will alleviate this problem.

(2) Rodding Department

All samples collected showed no problems in this area, however, during the visit it was noted that the dust collector located outdoors periodically spewed massive amounts of dust into the building. The necessary engineering repairs will prevent unnecessary exposures. A periodic housekeeping program such as was practiced during the evaluation should be instituted.

(3) Finished Carbon Areas

During our visit to the plant, we were informed that change in material handling is being planned, however, other temporary control measures should be considered. The air blown to locate the anodes is excessively used. A better method would be by vacuum, with the cover material going to a bin. Vacuum methods should also be considered for all cleaning operations. Consideration should also be given to enclosure of the crane cab and supplying positive pressure tempered air. This would greatly reduce the operator's exposure to air contaminants.

Until such a time as exposure to air contaminants are reduced to acceptable levels by engineering means, a respirator program should be enforced.

b) Medical

Respiratory Disability

None of the workers in this study showed evidence of carbon pneumoconiosis. Although not all of the employees in the areas of the Health Hazard Evaluation were evaluated, a substantial sample chosen randomly were seen. Additionally, 5 of the 11 individuals who had filed for workmen compensation benefits for pneumoconiosis and were tested showed no evidence of carbon pneumoconiosis. The remaining 6 individuals could not be contacted.

As noted earlier, one individual (finish carbon) showed pronounced x-ray changes compatible with asbestosis. The absence of significant chest x-ray abnormality prior to his work at Kaiser Aluminum, coupled with a history of exposure to asbestos in earlier years at the company, indicate probably occupationally-acquired pneumoconiosis. Of particular concern are other individuals who may have had significant exposure to asbestos in the past - i.e., other furnace firemen and possibly pipefitters who have handled asbestos. This concern is based upon the fact that (1) asbestos is a known carcinogen predisposing affected individuals to lung carcinoma as well as mesothelioma and (2) excessive exposure to asbestos may cause respiratory disability ("asbestosis"). Respiratory impairment due to asbestos may take an unpredictable course. Thus, despite termination of exposure to asbestos, the disease may worsen producing marked respiratory disability. Specific recommendations for medical surveillance have been outlined under "Recommendations."

Workers in the green carbon and rodding areas and workers with mixed exposures from several areas showed no apparent difference in the respiratory symptomatology or ventilatory capacity when compared to the control group. Within the finish carbon area, employees had demonstrably more breathlessness and wheezing than did the other groups. Yet no significant deficit in these employees could be demonstrated by spirometry. It may be that a different test of respiratory function would correlate with these complaints. However, the percentage of smokers in the finish carbon area was considerably higher than all other departments. Because wheezing and breathlessness are associated with cigarette smoking, this factor alone may account for the increased symptomatology in the finish carbon employees.

It should be emphasized that the most important cause of respiratory disability in all groups of individuals (whether working in industry or not) is smoking. In this study, nearly all of those individuals with respiratory symptoms or deficits in pulmonary function were smokers or ex-smokers who had smoked for a considerable period of time.

c) Dermatologic Problems

In this study the questionnaire results from employees in the green carbon and finish carbon departments, as well as those with mixed exposure, indicate a significant prevalence of occupationally induced contact photodermatitis. As noted in the environmental findings, considerable exposure to coal tar and (PPOM) was present in the green carbon and finish carbon departments. (PPOM) derivatives such as anthracene, acridine, phenathrene, and pyridine are notable phototoxic agents, producing a sunburn-like reaction or "smarts" limited to light-exposed skin areas.

Phototoxic reactions affect principally light-skinned individuals. The increased pigmentation of the Negro and Indian has proven to be of definite protective value and these workers are essentially immune to this reaction. Photosensitivity is a seasonal disease, since sufficient ultraviolet light to trigger the reaction is only present during the summer months. Although complete recovery from episodes of phototoxic reactions is the usual case, it must be emphasized that repeated and prolonged phototoxic injury to the skin may increase the danger of developing more serious skin disease. Every effort should be made to minimize phototoxic reactions. Procedures for reducing or eliminating exposure are found under "Recommendations."

G. Recommendations

a) Environmental

(1) Until such a time as engineering controls are established, supply and require employees to wear personal respiratory protective devices approved by NIOSH.

(2) Where supplied air respirators are used, periodically check air quality.

(3) Establish a respirator maintenance program.

(4) As previously discussed, make engineering changes necessary to control the contaminants at the source.

(5) All cleaning should be performed by vacuum or wet methods.

(6) Establish a maintenance program on all machinery to minimize contaminant escape.

(7) Establish a maintenance program on all exhaust ventilation systems to assure that they are operating at maximum efficiency.

(8) The yard area where pitch is unloaded and stored should be routinely wetted down to control reintroduction of settled particulate into the air by truck traffic, wind, etc.

(9) Before large spills or accumulations of pitch in the yard area are cleaned up, the accumulation should be dampened to minimize dust generation.

(10) Employees should wear fresh clothing for work each day. Long sleeves and gloves are recommended. Cuffs or collars should be loosefitting to prevent entrapment of particulate matter. Hard hats should be fitted with capes (neck and shoulder protectors) to prevent pitch from falling into and down the back of the neck. These capes would also offer some kind of protection from sunlight for those with outdoor work exposure.

(11) Safety glasses with slide shields or goggles should be worn to prevent pitch particulate from getting in the eyes.

(12) The areas of the Health Hazard Evaluation should be assessed for possible worker exposure to asbestos. If such exposure is found to occur, then environmental and medical monitoring in accordance with the NIOSH document, Occupational Exposure to Asbestos,(8) should be carried out.

(13) Areas where there is a potential for exposure to (PPOM) should be monitored to measure the exposure. Where initial measurement reveals levels of (PPOM) to be over the permissible exposure limit, monthly monitoring is required.(9)

b) Medical

(1) Individuals with past exposure to asbestos should be evaluated by chest x-ray examination and pulmonary function testing. Chest x-ray examination, pulmonary function testing (FVC - forced vital capacity and $FEV_{1.0}$ - forced expiratory volume at one second) and a physical examination with special attention to pulmonary roles, clubbing of fingers, and other signs related to cardiopulmonary systems. These tests should be given annually to individuals (1) who have a history of 10 or more years of employment involving exposure to asbestos, or (2) who show x-ray findings which suggest or indicate pneumoconiosis or other reactions to asbestos, or (3) who have changes in pulmonary function which indicate restrictive or obstructive lung disease. In the event that individuals are found whose chest x-rays or pulmonary function tests show abnormalities consistent with asbestosis, it is strongly recommended that these individuals be removed from further exposure to asbestos. Furthermore, it is recommended that they not work in areas where other forms of significant dust exposure occur. Needless to say, individuals who are smokers may be at additional risk to respiratory impairment.

(2) Individuals with exposure to coal tar and (PPOM) in the green and finish carbon areas should use a sun screen when seasonal exposure to ultraviolet is conducive to phototoxicity.

REFERENCES

1) NIOSH Manual of Analytical Methods.

2) NIOSH Manual of Sampling Data Sheets.

3) Union Carbide Corporation, Parma Technical Center.

4. UICC/Cincinnati, Classification of the Radiographic Appearances of Pneumoconiosis, Chest Journal, Vol. 58, page 57, 1970.

5) Field Information Memorandum, No. 74-64, U.S. Department of Labor, Subject: Coal Tar Pitch Interpretation, from Barry J. White, Associate Assistant Secretary for Regional Programs.

6) Federal Register, Vol. 39, No. 125, Part II, June 24, 1974.

7) American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1975.

8) Criteria for a Recommended Standard, "Occupational Exposure to Asbestos," U.S. Department of Health, Education, and Welfare, NIOSH.

9) Proposed Standards for Exposure to Coke Oven Emissions, Vol. 40, No. 148, Part III, July, 1975.

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Table I

Total Particulate(TP)[1], Particulate Polycyclic Organic Matter(benzene soluble fraction)(PPOM)[2], Benzo(a)Pyrene(BaP)[3] Air Concentrations

Job Description	Time (Min)	Air Concentrations(mg/m^3)* (TP)	(PPOM)	ug/m^3** (BaP)	Remarks
July 9-12, 1974 Batch Mixing					
#1 Batch Mixer	500		0.4	6.9	O. E. Respirable Fraction
#2 Batch Mixer	445		0.2	0.8	O. E. Respirable Fraction
Cathode Batch Mixer	320		0.6	1.0	O. E. Respirable Fraction
Anode Pressman	347		0.5	0.4	O. E. Respirable Fraction
Anode Pressman	347		0.2	7.7	O. E. Total Fraction
March 11, 1975 Batch Mixing					
#1 Batch Mixer	141	4.2	N.D.***		Operator's Exposure
#2 Batch Mixer	120	3.4	N.D.		Operator's Exposure
March 12, 1975					
#1 Batch Mixer	149	2.3	N.D.		Operator's Exposure
#2 Batch Mixer	160	3.0	N.D.		Operator's Exposure
Anode Pressman	360	1.1	N.D.		General Air
July 9-12, 1974 Finishing Department					
Operator	80	6.8	Sample Lost		Operator's Breathing Zone
Bldg. 51	1173	2.6	N.D.****		Operator's Breathing Zone
Operator, Bldg. 51	405	1.6	0.7		Operator's Breathing Zone
Operator, Bldg. 52	570	0.1	Sample Lost		Total Fraction
Laborer, Bldg. 52	401	N.D.			Total Fraction
Operator, Bldg. 52	570		0.3		Respirable Fraction, Oper. B.Z.
March 12, 1975 Finishing Department					
Operator, Bldg. 52	269	20.5	1.1		Total Fraction, Operator's B. Z.
Operator, Bldg. 52	267	8.7	0.6		Total Fraction, Operator's B. Z.
Bldg. 52		0.3	N.D.		General Air
Operator	358	5.8	0.4		Operator's Breathing Zone
Operator	211	13.9	0.7		Operator's Breathing Zone
Operator	213	4.7	N.D.		Operator's Breathing Zone
Operator	359	1.2	N.D.		General Air
Laborer	275	3.5	1.6		Operator's Exposure
Operator, Bldg. 51	252	1.2	N.D.		Operator's Breathing Zone
Cleaner	369	1.1	N.D.		Operator's Exposure
Crane Operator	247	2.4	0.4		Operator's Exposure
Operator, Bldg. 51	223	2.2	N.D.		Operator's Exposure
General Air, Bldg. 51, Section 14	302	1.0			

* Denotes milligram of contaminant per cubic meter of air sampled
** Denotes microgram of BaP per cubic meter of air sampled
*** Denotes detection limit is 0.1 milligram for both total particles and benzene soluble fraction.
**** Denotes dection limit is less than 0.4 microgram per sample
1)(TP)-total respirable particulate-permissible concentration as coal dust-2.5 milligram of air sampled.
2)(PPOM)(benzene solubles)-permissible concentration-0.2 milligram per cubic air sampled.
3)(BaP)-proposed permissible concentration 2 micrograms per cubic meter of air sampled.

Kaiser Chemical and Aluminum Corporation
Ravenswood, West Virginia
Report No. 74-25
Table II

Iron Oxide Air Concentration Data
July 9-12, 1974

Sample No.	Department	Job Description	Time (Minutes)	Air Volume Meter^3	Air Concentration M^3	Remarks
16521	Rodding	MIG Welding	422	.75	5.63	Operator's Exposure
16526	Rodding	Welding	412	.85	0.64	Operator's Exposure

TABLE III

Manganese Air Concentrations

Sample No.	Department	Job Description	Time (Minutes)	Air Volume Meter^3	Air Concentration M^3	Remarks
16526	Rodding	Welding	412	.85	0.05	Operator's Exposure

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Table IV
Fluoride Air Concentrations
July 9-12, 1975

Sample No.	Department	Job Description	Time (Min)	Air Concentration mg/M^2	Remarks
16505	Rodding	Crane operator	365	N.D.**	General Air
16506		Rodding ramp	440	N.D.	
16507		Rod straightening	373	N.D.	
16508		Thimble press	380	0.17	

Table V
Fluorine Air Concentrations
July 9-12, 1975

16509	Rodding	Crane operator	365	N.D.	General Air
16510		Rodding ramp	440	N.D.	
16511		Rod straightening	373	N.D.	
16512		Thimble press	380	N.D.	

Table VI
Respirable Dust Concentrations
March 12, 1975

1155	Rodding	Butt crusher	298	0.51	Operator's Exposure
1156		Combination press	285	0.50	Operator's Exposure
1158		Chipper	122	6.48	Operator's Breathing Zone
1159		Block crusher	110	0.43	Operator's Exposure

*Denotes "none detected."

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Table VII
Noise Exposure Levels
July 9-12, 1974

Operation	Noise Levels - Decibels - dBA*	Duration-hours	Remarks
Anode mixing area	85-86	4	Area noise
	95-96	1/2	Area noise when vibrator is on
Cathode mixing area	95	1/2	Area noise
Scale car area	91-97	1/2	Area noise
Primary crusher	104-105	1/4	Area noise

*A - weighted sound pressure level, in decibels, having a reference level of 0.0002 N/M^2

Table VIII

Proposed Sample Size

DEPARTMENT	POPULATION	SAMPLE
Production		
Green Carbon	19	13
Finish Carbon	47	22
Rodding	30	18
Maintenance		
Green Carbon	17	12
Finish Carbon	16	12
Rodding	29	16
Utility	13	10
TOTAL	171	103

Table IX
Comparison of Variables Among Groups

Variable	Non-exposed			Green Carbon			Finish Carbon			Rodding			Mixed		
	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s
Age*	33	41.21	26.00	16	47.44	7.91	18	46.94	7.55	26	44.92	6.39	23	45.52	6.73
Height	33	69.85	2.11	16	69.62	2.68	18	69.06	1.80	26	69.00	6.39	23	69.17	2.23
Weight	33	186.24	26.00	16	188.81	15.49	18	179.17	21.40	26	169.31	31.12	23	184.61	22.89
Race															
White	33 (100%)			15 (93.8%)			17 (94.1%)			26 (100%)			23 (100%)		
Non-white	0 (0%)			1 (6.2%)			1 (5.9%)			0 (0%)			0 (0%)		
Smoking															
Smoker	12 (36.4%)			5 (31.2%)			11 (61.1%)			13 (50.0%)			8 (34.8%)		
Ex-smoker	15 (45.5%)			1 (6.2%)			4 (22.2%)			8 (30.8%)			9 (39.1%)		
Non-smoker	6 (18.2%)			50 (31.2%)			3 (16.7%)			5 (19.2%)			6 (26.1%)		

Table X
Comparison of Symptoms Among Groups

	Non-exposed	Green Carbon	Finish Carbon	Rodding	Mixed
Bronchitis					
Without	29 (87.9%)	14 (87.5%)	13 (72.2%)	19 (73.1%)	18 (78.3%)
With	4 (12.1%)	2 (12.5%)	5 (27.8%)	7 (26.9%)	5 (21.7%)
Breathlessness*					
Without	32 (97.0%)	15 (93.8%)	12 (66.7%)	23 (88.5%)	21 (91.3%)
With	1 (3.0%)	1 (6.2%)	6 (33.3%)	3 (11.5%)	2 (8.7%)
Wheezing*					
Without	29 (87.9%)	13 (81.2%)	8 (44.4%)	21 (80.8%)	15 (65.2%)
With	4 (12.1%)	3 (18.8%)	10 (55.6%)	5 (19.2%)	8 (34.8%)

Table XI
Comparison of Spirometric Findings Among Groups

	Non-exposed			Green Carbon			Finish Carbon			Rodding			Mixed		
	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s
FVC (L)	32	5.14	.68	14	5.30	1.16	16	4.71	.67	26	5.21	.96	23	5.07	.76
FEV (L/sec)	32	3.79	.53	14	3.96	.86	16	3.48	.55	26	3.81	.72	23	3.92	.68
PF (L/sec)	32	8.66	1.30	14	8.50	1.84	16	7.47	2.18	26	8.36	1.77	23	8.51	2.01
FEF_{25} (L/sec)	32	7.03	1.47	14	7.24	1.80	16	6.50	1.73	26	6.71	1.62	23	7.43	1.59
FEF_{50} (L/sec)	32	4.08	1.39	14	4.53	1.63	16	3.82	1.24	26	3.68	1.15	23	4.40	1.41
FEF_{75} (L/sec)	32	1.31	.68	14	1.24	.57	16	1.01	.37	26	1.11	.39	23	1.35	.40
FEF_{90} (L/sec)	32	.27	.25	14	.25	.16	16	.19	.05	26	.23	.15	23	0.26	.16

Table XII

Comparison of Skin Symptoms Among Groups*

Variable	Non-exposed %	Green Carbon %	Finish Carbon %	Rodding %	Mixed %
Skin Cancer or Tumor					
Without	100	87.5	88.9	100	87.0
With	0	12.5	11.1	0	13.0
Other Skin Conditions					
Without	87.9	50.0	61.1	65.4	74
With	12.1	50.0	38.9	34.6	26
Sunburn					
Without	97.0	62.5	72.2	88.5	78.0
With	3.0	37.5	27.8	11.5	21.1

*The questions regarding the three above items which were asked were:

1. Have you ever had skin cancer or any other type of tumor?
2. Have you ever been troubled with any skin conditions or problems since working for Kaiser Aluminum?
3. Do you feel you sunburn more easily since working for Kaiser Aluminum?