

Region 10

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INDUSTRIAL HYGIENE SURVEY

AT THE

INTALCO ALUMINUM COMPANY

Ferndale, Washington

February, 1973

Report Prepared By: Lee B. Larsen

The National Institute for Occupational Safety and Health
Western Area Occupational Health Laboratory
Salt Lake City, Utah 84108

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Reference Information

Company: INTALCO Aluminum Corporation
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Company
Officials:

Robert Ferrie, President

Phillip Phaure, Vice President and Plant Manager

Mike Kazees, Production Manager

Robert Hollingsworth, Manager, Health, Safety & Security

NIOSH

Participants: Lee B. Larsen

Raymond O. Rivera

William Wagner

Bert Wisner

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GENERAL INFORMATION

The INTALCO Aluminum Plant went into initial production on May 8, 1966. INTALCO has three potlines with an annual capacity of 265,000 tons, making it the largest aluminum reduction plant in the United States. Approximately 1,250 persons are employed at the plant.

The work assignments of employees at the INTALCO plant are different than at other plants we have surveyed. In the potline there are two job classifications, pot operator and pot helper. Workers do not work the same jobs each day but rotate jobs, also each worker spends two hours per day breaking crust. We were able to obtain samples for the different types of jobs but realized that a worker does not spend full time at any job classification. Thus, this is one plant where all of the workers in the potline would be expected to receive similar average type exposures.

The company had initiated a respirator program, they had worked with 3M in developing a disposable type respirator which uses activated alumina bonded over the outer surface of the respirator. Mr. Hollingsworth indicated that they had good acceptance of the respirator by the workers.

The company had recently installed local exhaust ventilation in all of the potlines with the exception of one-half of a potline. We were thus able to obtain samples in the uncontrolled potline, Line A, and in a controlled potline, Line B. The air pollution control equipment in the plant is described in Appendix B.

Introduction

During the time period February 12-16, 1973 a team of National Institute for Occupational Safety and Health (NIOSH) personnel visited the INTALCO Company at Ferndale, Washington to conduct an Industrial Hygiene Survey. NIOSH participants were: Lee Larsen, Raymond Rivera, William Wagner, and Bert Wisner.

The purpose of the survey was to determine exposure levels to coal tar pitch volatiles, fluoride, and other potential health hazards. The information obtained will be used by the Division of Field Studies and Clinical Investigations as part of a broader study of the potential health hazards of various air contaminants in industry. Such studies will provide useful information for development of criteria for recommended standards documents for various toxic materials.

Occupational Safety and Health research is one of the most important functions of the National Institute for Occupational Safety and Health (NIOSH). Under provisions of the Occupational Safety and Health Act of 1970, a wide range of research projects are conducted. The Institute conducts research on effects of exposure to toxic substances and harmful physical agents and to combinations of exposures.

Survey Procedures

Coal Tar Pitch Volatiles and Total Dust:

Personnel samplers were attached to some of the workers and run at 1.7 l/min. for the entire shift if possible, or until the worker left the work area. The total airborne fraction was collected on a 0.8 μ pore size silver membrane filter. The filters were weighed before the survey and then reweighed after sampling to determine the total dust concentration. Next, the samples were analyzed by the Western Area Occupational Health Laboratory for benzene soluble material.

In the benzene soluble determination the particulate material on the preweighed filters is extracted by benzene using the continuous cycling process of a Soxhlet extractor. After extraction, the solution is filtered

through the original filters and the weight loss of the filters is considered to be the amount of benzene soluble material.

The benzene soluble analysis is based on a method requiring weight determinations. Our experience indicates that the practical accuracy of the weight determination is to the nearest 0.1 milligram. To overcome this source of error several samples were combined to give greater accuracy.

Fluorides:

General air samples to determine both particulate fluoride and hydrogen fluoride were taken in the potroom areas. The sampling device consisted of a cassette containing an 0.8 μ pore size Millipore Type AA filter to catch the particulates, this was followed by a backup pad which had been dipped in 6% sodium carbonate solution to collect the gaseous hydrogen fluoride. Urine samples were obtained from workers in the potroom areas and analyzed for fluoride. The amount of fluoride in all samples was determined with a fluoride specific electrode.

Carbon Monoxide

Nineteen carbon monoxide determinations were made using Drager indicator tubes. These samples were taken in A Line and B Line in the potroom.

Sulfur Dioxide

No sulfur dioxide determinations were made. Mr. Hollingsworth, Safety Director, indicated that the measurements taken by the INTALCO Company averaged about 2 ppm in the potrooms. Sulfur dioxide concentrations determined by Dr. Russel H. Hendricks on March 20-21, 1968 are reported in Appendix D.

Heat Stress

No evaluation was made of heat stress at the INTALCO plant. The INTALCO Aluminum Company would like a heat stress study conducted by NIOSH at some future date.

Results and Discussion

Coal Tar Pitch Volatiles:

Table 1 and 1A gives the values obtained for benzene soluble material and total particulate. It will be noted that in Line B (where local exhaust ventilation is provided) that the values obtained for benzene soluble material are 0.1 mg/M³ or less in every instance. Values obtained in Line A (where local exhaust ventilation was not yet provided) were 2 to 3 times higher. It is a moot question whether values obtained in potlines of pre-baked aluminum plants represent exposure to coal tar pitch volatiles. Table II shows a comparison of values obtained for benzene soluble material in Line A and Line B.

Fluorides:

Air concentrations of fluoride, both hydrogen fluoride and particulate fluoride are reported in Table III. The present threshold limit value for particulate fluoride as fluoride (as F) is 2.5 mg/M³. The present threshold limit value for hydrogen fluoride is 3 ppm which is equivalent to 2 mg/M³. Air concentrations of fluoride in the potlines provided local exhaust ventilation do not exceed these values. Values obtained from the analysis of urine for fluoride are reported in Table IV. Values above 8 mg/liter will be re-checked by obtaining and analyzing another urine sample. These re-checked values will be obtained from samples collected by the INTALCO Aluminum Company during their routine scheduled urinary fluoride sampling program. Values obtained from the 1968 survey from the analysis of urine for fluoride are reported in Appendix D.

Carbon Monoxide:

Values obtained from the determination of carbon monoxide in the potroom areas are reported in Table V. Though values as high as 140 ppm were measured in potline A (uncontrolled) values in Line B were all 10 ppm or less which is below present standards for carbon monoxide.

Sulfur Dioxide:

No sulfur dioxide determinations were made during this survey. However, results of a survey conducted during 1968 are reported in Appendix D.

Comments and Conclusions

The improvement made in the potline areas by installation of local exhaust ventilation is readily apparent both from a visual observation and from results obtained during this survey.

This survey was conducted to obtain information to enable NIOSH to evaluate existing guidelines and standards for the air contaminants found in aluminum reduction plants. NIOSH is a research agency not an enforcement organization. Therefore, an evaluation to determine compliance with enforcement type standards for the materials mentioned in this report should be based on samples collected by company or governmental agencies concerned with compliance type activities.

TABLE 1 - Air Concentrations of Total Particulate and Benzene Soluble Material

Job Description	Volume M ³	Total Particulate mg/M ³	Composite Total Particulate mg/M ³	Composite Volume M ³	Composite Benzene Solubles mg/M ³
Pitch Handler	--	--	2.8	2.706	<0.5
Filter B6	.896	2.1			
B86	.928	3.7			
C2	.882	2.4			
Press Operator	--	--	5.7	5.396	0.1
B2	.890	7.2			
B37	.888	7.8			
B84	.936	3.5			
B87	.922	12.8			
B62	.884	1.3			
C7	.876	1.3			
Crusher Operator					
Carbon Plant	--	--	1.9	2.698	0.2
B66	.888	1.9			
B85	.934	--			
B70	.876	1.9			
Baked Anode Handler	--	--	1.0	.918	0.0
B67	.918	1.0			
Baked Anode Handler	--	--	1.0	1.766	0.0
B93	.896	1.2			
B90	.870	0.8			
Crane Operator	--	--	0.7	.902	0.0
Carbon Plant					
B3	.902	0.7			
Crane Operator	--	--			
Carbon Plant			7.1	1.788	<0.1
B92	.888	0.7			
B83	.890	13.5			

TABLE 1 (cont'd)

Job Description	Volume M ³	Total Particulate mg/M ³	Composite Total Particulate mg/M ³	Composite Volume M ³	Composite Benzene Solubles mg/M ³
Oven Tender	--	--	0.8	1.400	0.0
B73	.718	0.9			
B15	.682	0.7			
Oven Tender	--	--	1.1	1.768	0.1
B97	.884	1.6			
B61	.884	0.6			
Cathode Lining Paste Plant Operator	--	--	4.1	1.476	0.5
B12	.772	3.1			
B91	.754	5.1			
Cathode Lining Paste Plant Operator					
B69	Filter Destroyed by worker				
Pot Reliner (Rammer)	--	--	2.4	5.594	0.5
C51	.704	1.9			
B21	.700	2.4			
C53	.720	2.7			
B41	.718	3.4			
B75	.678	2.3			
B52	.708	2.5			
B64	.692	1.9			
B33	.674	2.1			
Pot Reliner (Rammer)	--	--	2.6	7.198	0.2
C32	.888	2.2			
B44	.892	3.7			
B26	.888	2.7			
C5	.888	2.7			
B100	.888	1.5			
B78	.888	2.4			
B88	.888	4.0			

TABLE 1 (cont'd)

Job Description	Volume M ³	Total Particulate mg/M ³	Composite Total Particulate mg/M ³	Composite Volume M ³	Composite Benzene Soluble, mg/M ³
Pot Reliner (rammer)	--	--	2.7	6.200	0.3
Filter C8	.884	3.3			
C76	.902	--			
C6	.898	3.4			
C10	.894	2.3			
C1	.874	1.1			
C18	.874	2.6			
C13	.874	3.6			
General Helper	--	--	2.5	2.528	0.1
Filter B80	.864	3.9			
C11	.826	2.1			
B89	.838	1.5			
Tapper-Operator B Line	--	--	4.1	5.146	<0.1
Filter B34	.826	--			
B45	.886	5.8			
B40	.872	2.1			
B99	.848	4.7			
C45	.900	3.5			
B11	.814	4.5			
Tapper-Operator A Line	--	--	13.1	2.632	0.2
Filter B28	.854	21.0			
C15	.874	7.4			
C16	.904	10.9			
Tapper-Helper B Line	--	--	5.8	4.244	0.1
Filter B25	.830	2.4			
C55	.810	4.1			
B68	.918	2.7			
C28	.850	11.2			
C40	.836	8.8			

TABLE 1 (cont'd)

Job Description	Volume M ³	Total Particulate mg/M ³	Composite Total Particulate mg/M ³	Composite Volume M ³	Composite Benzene Solubles mg/M ³
Tapper-Helper	--	--	17.5	2.646	0.5
A Line					
Filter B35	.870	19.5			
C52	.876	23.3			
C3	.900	10.0			
Samplng-Helper					
A Line	--	--	16.7	2.496	0.2
Filter B8	.748	11.3			
C12	.874	22.6			
C31	.874	15.4			
Tapper-Helper	--	--	5.3	7.112	<0.1
B Line					
Filter B46	.842	14.5			
B55	.852	3.5			
B30	.840	7.3			
B9	.908	6.2			
C22	.272	6.8			
B71	.848	6.8			
C49	.856	3.6			
Samplng-Operator	--	--	3.8	3.290	0.1
B Line					
Filter C54	.734				
B60	.854				
C29	.856				
C44	.846				
Samplng-Operator	--	--	30.4	2.524	0.3
A Line					
Filter B98	.746	17.3			
B79	.906	45.2			
C17	.872	26.2			

TABLE 1 (cont'd)

Job Description	Volume M ³	Total Particulate mg/M ³	Composite Total Particulate mg/M ³	Composite Volume M ³	Composite Benzene Solubles mg/M ³
Anode Changer Operator - B Line	--	--	6.3	10.736	0.1
Filter B58	.894	5.9			
C21	.876	7.0			
B32	.882	1.3			
B19	.858	8.6			
B43	.738	9.3			
B82	.852	3.8			
B7	.846	1.5			
B18	.814	1.9			
C41	.890	4.5			
C33	.556	5.2			
C24	.804	23.5			
B47	.870	5.5			
C30	.856	8.7			
Anode Changer Operator - A Line	--	--	15.6	4.934	0.2
Filter B81	.872	14.2			
C25	.856	16.7			
B29	.746	25.7			
B24	.744	9.7			
C43	.870	19.1			
C39	.846	8.3			
Anode Changer Helper - B Line	--	--	6.3	8.570	<0.1
Filter B77	.948	8.3			
C48	.860	7.2			
B53	.866	4.9			
C4	.850	3.2			
B13	.838	9.5			
B65	.810	3.2			
B39	.848	4.1			
C23	.848	9.6			
B14	.856	6.6			
C38	.846	6.4			

TABLE 1 (cont'd)

Job Description	Volume M ³	Total Particulate mg/M ³	Composite Total Particulate mg/M ³	Composite Volume M ³	Composite Benzene Solubles mg/M ³
Anode Changer Helper - A Line	--	--	18.3	5.240	0.2
Filter B27	.870	9.1			
B10	.868	18.9			
B96	.864	4.3			
B56	.910	20.1			
C14	.852	9.8			
B74	.876	46.8			

TABLE 1A - Air Concentrations of Total Particulate and Benzene Soluble Materials (High Volume Samples)*

Description	Volume M ³	Total Particulate mg/M ³	Benzene Solubles mg/M ³
Potline A - Near Pot 70	167.4	8.96	<0.1
" " " " "	153.9	4.54	lost
" " " " "	117.2	6.83	<0.1
Potline B - Near Pot 70	221.5	0.90	<0.01
" " " " "	225.2	1.78	<0.01
" " " " "	331.6	1.81	<0.01
BLANK			<0.001

*Samples were collected with a Hi Volume sampler operated at 55 cubic feet per minute (initial flow rate). This is a very high sampling rate. Some material may have passed through the filter. Also these were area samples. Personnel samples could be expected to be higher.

TABLE II - Comparison of a Controlled and Non-Controlled Potlines

LINE A UNCONTROLLED		LINE B CONTROLLED	
Job Description	Benzene Solubles mg/M ³	Job Description	Benzene Solubles mg/M ³
Tapper (Operator)	0.2	Tapper (Operator)	<0.1
Tapper (Helper)	0.5	Tapper (Helper)	0.1
Sampler (Operator)	0.3	Sampler (Operator)	0.1
Sampler (Helper)	0.2	Sampler (Helper)	<0.1
Anode Changer (Operator)	0.2	Anode Changer (Operator)	0.1
Anode Changer (Helper)	0.2	Anode Changer (Helper)	<0.1

TABLE III - Fluoride In Air Concentrations

Job Description	Pot Line	Filter Number	Volume M ³	Insoluble Fluoride mg/M ³	Soluble Fluoride mg/M ³	HF mg/M ³	Total Fluoride mg/M ³
Anode Changer (H)	A	A71	.464	0.5	0.2	1.4	2.1
Anode Changer (H)	A	A89	.392	0.6	0.4	1.3	2.3
Raise Beams (O)	A	A83	.452	0.6	0.3	1.2	2.1
" " "	A	A72	.388	0.5	0.4	1.0	1.9
" " (H)	A	A77	.454	0.6	0.4	1.2	2.2
" " "	A	A87	.388	0.9	0.2	1.4	2.5
Pot Operator	A	A88	.486	1.3	0.4	2.7	4.4
" "	A	A73	.338	0.7	0.3	1.9	2.9
Anode Changer (H)	A	A10	.520	0.8	0.3	2.0	3.1
" " "	A	A25	.302	0.8	0.6	1.9	3.3
" " (O)	A	A51	.448	0.7	0.3	2.4	3.4
" " "	A	A8	.390	0.9	0.3	2.0	3.2
Tapper (O)	B	A53	.508	0.2	.1	0.6	0.9
" "	B	A97	.324	0.3	0.2	0.8	1.3
Tapper (H)	B	A91	.500	0.3	0.2	0.5	1.0
" "	B	A58	.328	0.5	0.1	0.6	1.2
General Helper	B	A84	.442	0.1	0.2	0.1	0.4
" "	B	A49	.394	0.3	0.2	0.7	1.2
Sampler (O)	B	A32	.416	0.3	0.1	0.5	0.9
Anode Changer (O)	B	A76	.382	0.3	0.1	0.8	1.2
Pot Line Helper	A	A93	.510	0.8	0.3	2.0	3.1
" " "	A	A33	.304	0.8	1.1	1.4	3.2
BLANK		A82	--	0.009	0.004	0.012	0.03
BLANK		A39	--	0.008	0.002	0.013	0.02
BLANK		A28	--	0.007	0.002	0.009	0.02
Anode Changer (O)	A	A79	.464	0.7	0.3	1.7	2.7
" " "	A	A99	.256	1.2	0.5	1.6	3.3
" " "	A	A66	.546	1.1	0.3	3.5	4.9
" " "	A	A63	.336	1.5	0.7	3.7	5.9

TABLE III (cont'd)

Job Description	Pot Line	Filter Number	Volume M ³	Insoluble Fluoride mg/M ³	Soluble Fluoride mg/M ³	HF mg/M ³	Total Fluoride mg/M ³
Tapper (H)	A	A92	.540	0.9	0.2	3.0	4.1
" "	A	A95	.344	0.9	0.4	2.8	4.1
Beam Raising (O)	A	A67	.452	0.5	0.6	1.0	2.1
" " "	A	A68	.448	0.7	0.2	1.6	2.5
" " (H)	A	A34	.480	0.4	0.2	1.3	1.9
" " "	A	A9	.398	0.7	0.4	1.4	2.5
Anode Changer (H)	A	A29	.442	0.8	0.2	1.5	2.5
" " "	A	A85	.436	0.7	0.4	1.1	2.2
Tapping (O)	A	A47	.448	0.5	0.3	1.7	2.5
" " "	A	A75	.428	0.8	0.4	4.1	5.3
" " "	B	A52	.508	0.2	0.1	0.5	0.8
" " "	B	A43	.374	0.2	0.4	0.4	1.0
Anode Changer (O)	B	A90	.478	0.8	0.3	2.3	3.8
" " "	B	A40	.418	0.4	0.1	0.3	0.8
General Helper	B	A94	.524	0.2	0.2	1.0	1.4
" " "	B	A98	.340	0.4	0.3	0.8	1.5
Changing Anode (H)	B	A56	.460	0.2	0.2	1.1	1.5
" " "	B	A64	.404	0.7	0.1	3.6	4.1
Tapping (H)	B	A86	.486	0.1	0.1	0.2	0.4
" " "	B	A46	.402	0.2	0.1	0.5	0.8
Anode Changer (O)	B	A80	.426	0.3	0.1	1.0	1.4
Pot Line Helper	A	A74	.486	0.5	0.2	1.8	2.5
Average Potline	A	(29 Samples)		0.77	0.38	1.91	3.1
Average Potline	B	(20 Samples)		0.32	0.17	0.83	1.3

CODE: (O) = OPERATOR
(H) = HELPER

NOTE: Potline A Uncontrolled, Potline B Controlled

TABLE IV - Fluoride in Urine Concentrations

Lab. No.	Name	Analysis mg/L F ⁻
11510	D.C. Partlow	9.6
11511	H.H. St. John	3.1
11512	R.B. Heunes	6.3
11513	R.J. Steinbech	8.0
11514	V.J. Arevalo	6.9
11515	R.F. Hunter	6.2
11516	C.D. Joplin	5.5
11517	L.B. Munger	2.4
11518	C.A. Wagner	11.4
11519	Yabsley	1.4
11520	J.H. Reimer	4.7
11521	J.E. Briery	1.4*
11522	S.M. Modenese	4.9
11523	A.M. Hall	12.7
11524	R. Wilson	3.2
11525	S.L. Jaynes	1.6
11526	S. Portrey	1.6
11527	G.W. St. Pierre	8.0
11528	J. Mooney	10.0
11529	E.L. Beech	1.4*
11530	J. Chevalier	7.0
11531	R.H. Anderson	2.8
11532	H.D. Haynie	2.2*
11533	R.W. Wynne	0.4*
11534	D.D. Tenkley	4.2
11535	D.L. Olason	3.0
11536	D.H. Hess	2.0
11537	D.R. McDonald	4.4
11538	C.L. Johnson	2.7
11539	R.A. Cruikshank	4.3
11540	F. Feldman	3.2

*Not Corrected for Specific Gravity.

TABLE IV - (cont'd)

Lab. No.	Name	Analysis mg/L F ⁻
11541	G. Roluig	5.5
11542	J.A. Vooge	5.1
11543	J. Easton	8.3
11544	N.R. Krundiack	4.2
11545	D.L. Duffy III	4.4
11546	H. Kassner	1.3*
11547	D.G. Melton	4.9
11548	J.E. Todahl	4.5
11549	J.D. Haynes	4.2
11550	J.B. McDow	4.0*
11551	D.C. Imhoff	2.9
11552	F.C. Hurt Jr.	17.2
11553	E.R. Truchan	16.1
11554	W.W. Starr	9.2
11555	J.R. Gutierrez	7.4
11556	R.T. Slayton	4.2
11557	K.F. Runnion	2.4
11558	W.J. Polinkus	10.2
11559	R.W. Hall	3.2
11560	T.E. Putnam	22.4
11561	C. Bennett	7.8
11562	C.H. Shine	4.5
11563	M.C. McNulty	5.2
11564	J.R. Tomlinson	7.9
11565	A.R. Lamont	7.6
11566	T.W. Larsen	3.8
11567	J.A. Willis	3.4
11568	J. DeBondt	10.8
11569	D.J. Wolfe	9.2
11570	M.M. Luna	7.0
11571	W.B. Middleton	8.1
11572	D.A. Park	10.5
11573	F.J. Barnes	3.3

*Not Corrected for Specific Gravity.

<u>DEPT.</u>	<u>NUMBER</u>	<u>NAME</u>	<u>HIRE DATE</u>	<u>CLASSIFICATION</u>	<u>Date Started On This Job</u>
43	779	C. H. Shine	10-17-66	helper	3-20-72
43	788	R. W. Hall	12-12-66	operator	10-30-72
43	825	C. Bennett	10-31-66	operator	11-11-68
43	853	W. B. Middleton	9-15-70	helper	1-4-71
43	894	M. M. Luna	11-15-66	operator	1-23-67
43	1331	E. R. Truchon	3-31-67	operator	9-16-68
43	1433	K. F. Runnion	6-9-67	operator	11-8-71
43	1720	R. J. Slayton	2-20-68	operator	10-28-68
43	1745	J. DeBondt	3-18-68	operator	10-7-68
43	1845	M. C. McNulty	5-3-68	operator	10-7-68
43	1883	F. C. Hurt, Jr.	8-29-68	operator	10-7-68
43	1955	W. W. Starr	8-15-68	operator	1-27-69
43	1957	J. R. Gutierrez	8-15-68	operator	11-11-68
43	2009	J. B. McAdow	8-29-68	operator	2-17-69
43	2024	D. G. Imhoff	9-3-68	operator	3-31-69
43	2044	W. J. Polinkus	9-6-68	operator	4-14-69
43	2051	T. E. Putnam	9-6-68	operator	5-19-69
43	2053	D. J. Wolfe	9-6-68	operator	5-19-69
43	2057	J. V. Tomlinson	9-6-68	operator	11-10-69
43	2062	D. A. Maddux	9-6-68	operator	5-19-69
43	458	F. J. Barnes	6-13-66	operator	8-15-66
43	639	D. A. Park	8-17-66	operator	11-27-67
43	2138	T. W. Larsen	9-28-68	operator	5-19-69
43	2173	A. R. Lamont	10-7-68	operator	5-26-69
43	2211	J. A. Willis	10-17-68	operator	6-16-69
43	2223	G. W. StPierre	10-21-68	operator	11-13-72
43	2224	R. F. Hunter	10-21-68	operator	7-7-69
43	2337	J. E. Briery	1-16-69	helper	1-20-69
43	2347	C. D. Joplin	1-17-69	helper	1-20-69
43	2402	L. B. Munger	2-19-69	helper	2-24-69
43	2464	R. B. Hemnes	4-1-69	helper	4-7-69
43	2481	R. J. Steinbach	4-10-69	helper	4-14-69
43	2493	S. M. Modenese	4-21-69	helper	4-28-69
43	2500	H. H. StJohn	4-29-70	helper	5-4-70
43	2534	V. J. Arevald	5-13-69	helper	5-19-69
43	2538	J. H. Reimer	5-14-69	helper	5-15-72
43	2787	E. L. Beech	8-1-69	helper	8-4-69
43	2821	S. L. Jaynes	8-18-69	helper	9-21-70
43	2898	C. A. Wagner	9-17-69	helper	11-24-69
43	2987	D. L. Duffy III	4-21-71	helper	4-19-71
43	3205	N. R. Krumdiack	5-19-70	helper	5-25-70
43	3225	D. R. McDonald	6-3-70	helper	6-8-70
43	3239	D. H. Hess	6-9-70	helper	6-15-70
43	3268	J. D. Haynes	7-8-70	helper	7-13-70
43	3330	J. A. Vooge	10-19-70	helper	7-26-71
43	3348	R. W. Wynne	12-11-70	helper	6-28-71
43	3376	R. A. Cruikshank	3-2-71	helper	3-2-71
43	3415	M. D. Verley	5-13-71	helper	5-13-71
43	3496	C. L. Johnson	3-21-72	helper	3-21-72
43	3518	J. E. Todahl	5-17-72	helper	5-17-72
43	3533	D. D. Tenkley	6-1-72	helper	6-1-72
43	8157	R. H. Anderson	1-24-66	General Foreman	1-24-72
43	8059	G. R. Rorvig	7-22-65	Day Foreman	1-10-72
43	8119	F. Feldmann	9-28-65	Sr. Shift Foreman	9-9-68
43	8018	J. H. Easton	7-26-65	Sr. Shift Foreman	2-20-67
43	8326	J. Chevalier	1-9-67	Shift Foreman	4-22-68
43	8483	H. D. Haynie	10-17-66	Shift Foreman	10-6-69
43	8335	H. P. Kassner	6-27-66	Shift Foreman	4-22-68

<u>DEPT.</u>	<u>NUMBER</u>	<u>NAME</u>	<u>HIRE DATE</u>	<u>CLASSIFICATION</u>	<u>Date Started on This Job</u>
43	8337	D. G. Melton	6-12-67	Shift Foreman	4-22-68
43	8338	J. Mooney	5-13-66	Shift Foreman	4-22-68
43	8527	S. Portrey	6-21-67	Shift Foreman	5-18-70
43	8487	R. Wilson	9-13-67	Shift Foreman	10-6-69
43	3595	D. L. Yabsley	1-16-73	helper	1-24-73

TABLE V - Carbon Monoxide in Air Concentrations

Potline	Cell Number	ppm CO	Potline	Cell Number	ppm CO
A	7	10	B	22	8
A	22	30	B	37	5
A	37	25	B	172	10
A	52	20	B	204	5
A	69	20			
A	84	30			
A	99	35			
A	114	50			
A	127	65			
A	142	75			
A	157	20			
A	204	140			
A	219	60			
A	172	45			
A	189	120			

APPENDIX A

Production of Aluminum at INTALCO

INTALCO OPERATIONS

The production of INTALCO aluminum begins with the mining of high-grade bauxite, the clay-like ore of aluminum. Most of the bauxite that is eventually processed into INTALCO aluminum is mined in Australia, and the ore goes through a series of chemical processing operations to extract alumina (aluminum oxide), the starting material for metallic aluminum. To produce one pound of alumina generally requires two pounds of bauxite.

Arrival of Raw Materials

Like a giant finger reaching out into the deep waters of Puget Sound, a 1,700-foot long pier serves as the docking area for the ships arriving at INTALCO with cargos of alumina. Giant conveyors transport the alumina at a rate of 800 tons an hour to three storage silos of 30,000-ton capacity each.

The other raw materials for the aluminum process--cryolite, aluminum fluoride and carbon materials, which arrive by rail--are stored in special silos.

When the production cycle begins, the alumina is transported by specially-designed trailers to the pot rooms where the aluminum is separated from the alumina in electrolytic cells, or "pots."

The Electrolytic Process

INTALCO aluminum is produced by passing high amperage, low-voltage electric current through carbon anodes immersed in carbon-lined cathode pots containing alumina dissolved in molten cryolite and aluminum fluoride. The oxygen from the alumina combines with the carbon anode to form carbon dioxide and carbon monoxide, and pure molten aluminum is deposited at the bottom of the pot. It is then extracted by a vacuum technique and cast into a variety of ingot shapes.

The three basic ingredients in producing aluminum are alumina, carbon and electricity. To make one pound of aluminum generally requires two pounds of alumina, one-half pound of carbon and between 8.0-8.5 KWH of electricity. Significantly, INTALCO uses only 6.0-6.3 KWH to produce one pound of aluminum.

Anode Fabrication

Since production of every pound of aluminum requires approximately one-half pound of carbon, a significant part of the INTALCO operation is a highly automated plant for the production of carbon anodes. The INTALCO anodes each weigh 540 pounds and are fabricated from petroleum coke and hard pitch.

To make the carbon anodes, the petroleum coke is first crushed and blended in the proper percentages, then mixed with crushed hard pitch. The resulting paste is cooled and transferred by conveyor to a 2,700 ton hydraulic press where it is automatically weighed then formed into "green," or raw, anodes at the rate of one a minute. The anodes are next sent to a baking furnace to transform the pitch into coke to improve electrical conductivity.

After baking, the finished anodes are grouted to aluminum hangers with cast iron and spray-coated with a layer of aluminum to protect the exposed carbon surfaces from combustion during the production cycle. They are now ready to be suspended in the pot. During the electrolytic process, 130,000 ampere DC-current passes through the anode system.

Potlines

The INTALCO potlines each contain 240 electrolytic cells, or pots, which are connected in series. Each potline is housed in three buildings, each building has two pot rooms. The buildings are erected side-by-side and measure 1,450 feet long, 125 feet wide and 50 feet high. Each pot is a fabricated steel shell 15 feet wide by 25 feet long and four feet deep and lined with insulating brick.

The individual pots produce about a ton of aluminum per day. Each of the three potlines has an annual production of 90,000 tons of aluminum.

Ingot Casting

When the liquid aluminum is removed from the pots, it is transferred by ladle to one of the 60,000-pound capacity holding furnaces where the metal is retained in the molten state until it is cast into finished ingot. Of the eleven holding furnaces, ten operate in pairs so that hot metal may be received and alloyed in one, while metal is being cast out of the other.

The molten metal from the holding furnaces is poured into one of seven casting units where it is cast into billet, slab, "T" shapes or 50-pound pigs.

The cast billet, which will later be shipped to extrusion plants, is homogenized in one of four 140,000-pound capacity homogenizing furnaces to improve the metallurgical structure for subsequent fabrication processes at customers' plants.

Master alloys called "hardeners" are produced in a 14,000-pound induction furnace. Master alloys are added to the molten metal in the holding furnaces to produce the desired chemical analyses.

Special Equipment

The INTALCO aluminum production cycle incorporates many refinements to reduce overall costs of ingot production. One of the unique innovations is a specially engineered crane that performs five operations traditionally handled with separate pieces of equipment. This crane breaks the crust that forms above the exposed liquid bath, siphons off the pure molten aluminum, adds alumina and aluminum fluoride to the pot as needed, and replaces and repositions the anode assembly in the pots. One man, with the half-time services of a helper, operates this crane and completely services 20 pots.

APPENDIX B

Air Pollution Control Equipment

Originally, ten million dollars was spent in installing 180 reinforced plastic scrubbers in the top center portion of each potline building to check the escape of industrial gases and alumina dust into the atmosphere. Each of the scrubber units was specifically engineered for the INTALCO facility and weighs nine tons and measures 40 feet long, 12 feet wide, and 25 feet high.

The potline buildings have horizontal louvers running the full length along their outside walls. Air enters the buildings through these specially-designed louvers and flows across the pots and up through the scrubbers, which are located in the roof between the two rows of pots. Potline gases are thus drawn through the scrubber cylinders and cleansed by high pressure water sprays.

One of the scrubber units is installed for every four pots. Each of the scrubber units contain numerous spray nozzles that "wash" some 120,000 cubic feet of air per minute. All air from the potlines passes through the scrubber units.

INTALCO is now in the process of installing some \$15,000,000 worth of additional pollution control equipment. Metal covers are being constructed for each of the 720 pots. Ducts from these pot hoods will carry fumes to a primary treatment system. Then the air will go through the water scrubbing system described earlier for final removal of particles and gases from the air before it is discharged.

A water cleaning station is being built so that water used to scrub the air can be recycled.

APPENDIX C
JOB DESCRIPTIONS

GENERAL INFORMATION

Workers in the potlines rotate jobs, there are only two job classifications, Pot Operator and Pot Helper.

The types of activities which the Pot Operator and Pot Helper engage in in the potrooms are the following:

1. Anode changing and cleaning. Thirteen to fourteen anodes are cleaned daily, this man also makes two line breaks (crust breaking) anode changing and cleaning takes about 1-1/2 to 2 hours per shift.
2. Sampling. The sampler raises beams on three pots which takes about 30 minutes to an hour. Spends about 45 minutes taking samples, he may make fluoride additions about every fourth day which takes about 30 minutes, he makes two line breaks per day which takes about 2 hours maximum. The balance of this workers time is spent at miscellaneous jobs such as sweeping.
3. Tapping. The tapper taps about 30 pots per shift this takes about 2 hours. He makes two line breaks per shift which requires about 2 hours maximum. The balance of his time is spent at miscellaneous jobs.

The operator does most of the crane operating, the helper sweeps while the operator operates the crane and makes the breaks. The helper position is sort of an assistant or training position.

JOB DESCRIPTION

DATE: December 1, 1969 Job Code 21307
21308
21309

JOB TITLE: Pot Operator

DEPARTMENT: Potline

PRIMARY FUNCTION: Maintains assigned pots by charging, tapping, changing anodes and performing those related duties necessary in the reduction process. Operates a customized overhead crane.

MACHINES AND EQUIPMENT USED: E.C.L. Crane with special equipment for tapping, crust breaking, charging anodes, raising beams and adding fluoride products. Forklift. Specialty equipment for pot operation.

SUPERVISION RECEIVED: Shift Foreman

DIRECTION EXERCISED: Works alone or assisted by Potline Helper as directed.

DUTIES:

1. Breaks crust with simple pneumatic device and charges pot with alumina from overhead bridge crane.
2. Operates hydraulic and air jacks from overhead crane to install, adjust, and replace anodes.
3. Siphons aluminum from pots, into a tapping ladle by utilizing controls at floor level then empties crane ladle contents into a transport ladle on the floor.
4. Pick up and position anode support beam to raise beams that have reached low position due to anode depth adjustments.
5. Puts fluoride materials and crust on pots.
6. Takes bath and aluminum samples by use of a hand-held ladle.
7. Maintains constant check for evidence of anode effect or other pot disturbances.
8. In the event of an anode effect, stops effect by using the appropriate means and raise the voltage to target.
9. Reports all equipment damage or malfunctions to supervisor.
10. Helps shift foreman to check quantity of aluminum and bath in pots by cutting hole in crust and determining levels.
11. Sweeps area around pot and sweeps ore on pot.
12. Maintains the work area and equipment in a clean and orderly manner, and observes plant and departmental safety rules.
13. Performs other related duties as directed.

JOB DESCRIPTION

DATE: December 1, 1969 Job Code 21104
21105

JOB TITLE: Potline Helper

DEPARTMENT: Potline

PRIMARY FUNCTION: Performs those duties as assigned necessary to maintain the reduction pots in production of primary aluminum. Functions as a relief man and assists the Pot Operators as directed.

MACHINES AND EQUIPMENT USED: E.C.L. Crane with special equipment for tapping, crust breaking, changing anodes, raising beams and adding fluoride material. Forklift. Specialty equipment for pot operation.

SUPERVISION RECEIVED: Potline Supervisors

DIRECTION EXERCISED: None

DUTIES:

1. As needed and when directed, assists the Pot Operators in performance of their duties.
2. Relieves the Pot Operator during scheduled absence from assigned work area.
3. Observes all plant and departmental safety rules.
4. Helps Shift Foreman to check quantity of aluminum and bath in pots by cutting a hole in the crust.
5. Sweeps area around pot and sweeps ore on pots, and performs general area clean-up.
6. Performs other related duties as directed.

JOB DESCRIPTION

DATE: November 5, 1970 Job Code 31806
31807

JOB TITLE: Crane Operator

DEPARTMENT: Anode Baking Ovens

PRIMARY FUNCTION: Operates overhead bridge crane in order to load and unload anodes into baking furnaces, cover and uncover anodes with granular packing material, and relocate manifolds and burners. Assist Refractorymen as necessary.

MACHINES AND EQUIPMENT USED: Overhead multi-purpose bridge crane and attachments.

SUPERVISION RECEIVED: Carbon Plant supervisors

DIRECTION EXERCISED: None

DUTIES:

1. Picks up green anodes from conveyor with crane clamp attachment and loads anodes into a baking oven chamber.
2. Positions crane over oven chamber and activates a discharge valve control in order to deposit packing material over anodes.
3. Relocates intake and exhaust manifolds by connecting them to crane hook and moving them with the crane.
4. Empties oven chamber of packing material by positioning crane overhead and operating a simple vacuum snorkel device from the crane cab.
5. Unloads baked anodes from oven chamber by picking them up with the crane clamp attachment.
6. Scrapes the flues with a special brush before loading green anodes.
7. Operate crane to assist Refractorymen in demolition and replacement of flue walls.
8. Operate and maintain work area and equipment in a safe, clean, and orderly manner.
9. May be required to assist Furnace Operator at move time.
10. Performs other related duties as directed.

JOB DESCRIPTION

DATE: December 1, 1969 Job Code 31505

JOB TITLE: Pitch Handler

DEPARTMENT: Anode Paste Plant

PRIMARY FUNCTION: Loads hard pitch into a hopper by utilizing a front end loader. Loads anode butts into butt crushing system and operates butt crushers. Provides a supply of scrap paste for paste reclaim system.

MACHINES AND EQUIPMENT USED: Front end loader, butt crushing system, pitch system elevator, bins, hoppers, feeders, and scrap paste reclaim system.

SUPERVISION RECEIVED: Carbon Plant supervisors.

DIRECTION EXERCISED: None

DUTIES:

1. Drives a front end loader in order to scoop-up and deposit hard pitch, anode butts, and scrap paste into a hopper.
2. Operates pitch crusher and related equipment to maintain a continuous supply of hard pitch to weighometer.
3. Operates butt crushing and related equipment to provide sufficient supply of crushed butts to Paste Plant.
4. Operates front end loader and other equipment to supply scrap paste for reclaim.
5. Reports any inconsistencies or breakdowns in hard pitch area to shift foreman.
6. Operate and maintain work area and equipment in a safe, clean, and orderly manner.
7. Performs other related duties as directed.

JOB DESCRIPTION

DATE: December 1, 1969 Job Code 31204

JOB TITLE: Anode Handler

DEPARTMENT: Carbon Plant

PRIMARY FUNCTION: Control the operation of automatic Tilt Table, conveyors, associated equipment and transports anodes as directed.

MACHINES OR EQUIPMENT USED: Tilt Table, conveyors, dust collectors, coring machine, and forklift.

SUPERVISION RECEIVED: Carbon Plant Supervisors

DIRECTION EXERCISED: None

DUTIES:

1. Check performance of equipment and assure that operation is satisfactory. May operate manually in the event equipment is not operating automatically.
2. Transports green or baked anodes from conveyor to anode storage area, stack anodes; reload anodes onto conveyor from storage as needed by Bake Ovens or Rodding Shop.
3. Determine defective anodes by visual observation or as directed and set them aside.
4. Transport defective anodes and scrap to butt crusher as required.
5. Cut anode cores from core sampling machine from preselected anodes.
6. Assure that anode hole formers are free of coke.
7. May make operating adjustments to equipment as necessary or otherwise report inconsistencies or breakdown immediately.
8. Fills out vehicle check out reports or other operating reports as required.
9. Keep area and equipment in a clean and orderly manner, and observe plant and departmental safety rules.
10. Assist others to maintain continuous flow of material through department.
11. Perform other related duties as directed.

JOB DESCRIPTION

DATE: November 5, 1970 Job Code 71206

JOB TITLE: Lining Paste Mixer

DEPARTMENT: Production Services Department - Pot Relining

PRIMARY FUNCTION: Produces pot lining paste by operating a console which actuates a flow process for the mechanical combination of two basic ingredients.

MACHINES OR EQUIPMENT USED: Automated lining paste plant console and machinery, and forklifts.

SUPERVISION RECEIVED: Annex supervisors.

DIRECTION EXERCISED: None

DUTIES:

1. Unloads granular anthracite from railroad car hoppers by opening a simple gate.
2. Activates console switches to start or stop hammer mill, ball mill, conveyors, etc., two or three times hourly as the process requires.
3. Determines by indicator lights on console that three classifications of anthracite are in supply hoppers.
4. Operates from a schedule to determine proper amounts of anthracite and pitch to add to mixers.
5. Checks pitch temperature by reading a thermometer and operates valve to route proper quantity of pitch to mixers.
6. Combines pitch and anthracite in mechanical mixers by operating console controls including buttons and rheostats.
7. Maintains work area and equipment in a clean, orderly, and safe manner, observes Plant and Departmental safety rules.
8. Reports any Paste Plant problems or equipment malfunctions directly to his foreman.
9. Transports paste to the pot.
10. Operates Roto-tap and makes screen analyses.
11. Performs other related duties as directed.

JOB DESCRIPTION

DATE: November 5, 1970 Job Code 71505
71506

JOB TITLE: Pot Relining Rebuilder

DEPARTMENT: Production Services - Pot Relining Department

PRIMARY FUNCTION: Cuts out pots, cuts in pots, pot preparation, major pot relining operations, pot ramming, and miscellaneous relining duties.

MACHINES AND EQUIPMENT USED: E.C.L. crane, forklifts, pneumatic wrenches, pneumatic rammers, hand tools, special relining equipment, metal and bath ladles.

SUPERVISION RECEIVED: Pot Relining foremen and welding foreman.

DIRECTION EXERCISED: None

DUTIES:

1. Cuts pots from circuit and re-starts the pots.
2. Sets and removes the start-up shunts, including changing the steps.
3. Taps and pours liquid bath to re-start the pots including the operation of the pots until turned over to the potlines.
4. Taps out metal and bath, removes anodes and superstructure, moves and sets monorails.
5. Sets anodes and coke in preparation for start-up.
6. Checks and sets cut-out and balance wedges.
7. Prepares the pot for start-up, placing cryolite and related duties as performed by the crews and as outlined in Item No. 1 above.
8. Loosens and tightens and replaces buttress bolts.
9. Rams pots following standard ramming practices, including clean-up, spraying tar and pitch, handling paste boxes, and spreading and compacting the paste.
10. Prepares the tools for the ram, heating the tools with special equipment and heating tar and pitch. Performs all functions necessary to effectively ram a pot.
11. Cuts negative flexes and prepares the buss.
12. Maintains work area and equipment in a clean and orderly manner ensuring that the proper containers are available for debris and recoverable materials and observes Plant and Departmental safety rules.

JOB DESCRIPTION

DATE: December 1, 1969 Job Code 32107

JOB TITLE: Crusher Operator

DEPARTMENT: Anode Paste Plant

PRIMARY FUNCTION: Regulates and controls the operation of the petroleum coke storage silos, anode butt crushing equipment, aerofall mill, conveyors, screens, separators, and allied equipment in order to assure an adequate, classified supply of coke for the paste mixing process.

MACHINES AND EQUIPMENT USED: Anode butt crushing mill, storage silos, aerofall mill, conveyors, screens and separators.

SUPERVISION RECEIVED: Carbon Plant supervisors

DIRECTION EXERCISED: None

DUTIES:

1. Checks and controls the operation of the anode butt crushing equipment and the aerofall mill including checking material levels in silos and hoppers, feed systems, air pressures, flow of drying gas and operation of allied equipment.
2. Takes flow samples and runs granulometric screen analysis on coke samples to check accuracy of aerofall operation and record the results.
3. Inspects and adjusts regularly, material handling equipment such as bucket elevators, screens, magnetic separators, and screw conveyors for proper operation.
4. Checks and assures correct operation of bag filters.
5. Assists other Anode Paste Plant employees in maintaining a continuous flow of material to the anode press and assists maintenance personnel with scheduled and emergency service and repairs to equipment.
6. Inspects and maintains machinery and work area in a clean, safe, and orderly condition.
7. Performs other related duties as directed.

JOB DESCRIPTION

DATE:

December 1, 1969

Job Code 32007

JOB TITLE:

Paste and Green Anode Processor

DEPARTMENT:

Carbon Plant

PRIMARY FUNCTION:

Control and operate those machines necessary to mix crushed coke and pitch in correct proportions. Maintains a continuous flow of paste from the weightometer through the anode press.

MACHINES AND EQUIPMENT USED:

Therminol boilers, continuous paste mixers, anode presses, conveyors, weightometers, and paste cooling equipment.

SUPERVISION RECEIVED:

Carbon Plant Supervisors

DIRECTION EXERCISED:

None

DUTIES:

1. Start and operate therminol boilers and maintain correct temperature, flow, level.
2. Starts and inspects regularly; weightometers, mixers, paste cooling equipment, anode presses, and conveyors, and otherwise monitors system to detect system malfunctions.
3. Checks regularly the output and accuracy of weightometers and maintains record of same.
4. Regulates mixers to run at maximum speed compatible with proper paste and mix consistency.
5. Inspects and maintains continuous flow of paste from the weightometers to the anode press.
6. Checks and maintains a regular temperature of the paste and anodes and records the results.
7. Checks and maintains a regular pressure at the press to assure good quality, weight and measure of anodes, and regular check of anode height.
8. Adjusts paste and green anode conveyors and assists employees of the anode paste plant to assure a continuous flow of paste.
9. Controls flow of reclaimed paste into mixers.
10. Maintains equipment and work area in a clean and orderly manner, and conform to department and plant safety rules.
11. May assist maintenance personnel in the event of emergency service and repair.
12. Performs other related duties as directed.

JOB DESCRIPTION

DATE: December 1, 1969 Job Code 31908
31909

JOB TITLE: Baking Furnace Operator

DEPARTMENT: Anode Baking Ovens

PRIMARY FUNCTION: Controls and regulates the heating of the anode baking furnace in accordance with specified anode baking temperature curve, that the temperature rise and fall in the baking chambers conforms to the curve.

MACHINES OR EQUIPMENT USED: Manifolds, burners, time relays, valves, temperature recorder, thermo couples and related flue cooling equipment.

SUPERVISION RECEIVED: Carbon Plant Supervisors

DIRECTION EXERCISED: None

DUTIES:

1. Relocates, with the assistance of the Crane Operator, the burner and exhaust manifolds by making routine mechanical connections and disconnections.
2. Installs air locks (seals) behind the primary air feeder manifold and hooks up manifold to the appropriate outlets on the partitions between the furnace chambers.
3. Lights gas burners and adjusts manual fuel regulating valves during manual pre-heating period. Sets and adjusts time relays for subsequent regulation of heating cycle.
4. Checks gas and anode temperatures on drum recorders according to a prescribed time schedule and makes any operating adjustments necessary to comply with the heat curve.
5. Makes optical pyrometer checks according to a time schedule to ensure that the temperature is equalized in all seven partitions and makes any necessary burner adjustments.
6. Checks and equalizes the draft across seven partitions according to a given schedule and makes any necessary adjustments to fume exhaust manifolds dampers and fans.
7. Sweeps partitions regularly and reports any irregularities indicating that a partition should be changed.
8. Maintains complete and accurate records of baking furnace operation.
9. Locate and place anode and gas thermo couples as assigned.
10. Places and operates flue cooling equipment as assigned.
11. Maintains work area in a clean and orderly manner and observes plant and department safety rules.
12. Periodically collect and graph data on temperature variations.
13. Performs other related duties as directed.

APPENDIX D

1967 AND 1968 SURVEYS

A SURVEY OF THE

INTALCO ALUMINUM REDUCTION PLANT

AT

FERNDALE, WASHINGTON

BY

WASHINGTON DEPT. LABOR AND INDUSTRIES

AND

U. S. PUBLIC HEALTH SERVICE
OCCUPATIONAL HEALTH FIELD STATION
SALT LAKE CITY, UTAH

Report prepared by:
Russel H. Hendricks, Ph.D.

July 19, 1967

SURVEY OF THE INTALCO ALUMINUM REDUCTION PLANT AT FERNDALE, WASHINGTON
May 17 - 18, 1967

At the request of Dr. Lester A. Hansen, Chief, Industrial Hygiene Section, Division of Safety, Washington State Department of Labor and Industries, Mr. D. A. Holaday and Mr. R. H. Hendricks of the U. S. Public Health Service, Occupational Health Field Station, Salt Lake City, Utah, accompanied Dr. Hansen and Mr. Thomas Kenney in a brief survey of the Intalco Aluminum Reduction Plant at Ferndale, Washington.

In the investigation conducted on May 17 and 18, 1967, of some environmental factors in the working areas of the Intalco Aluminum Plant, data was obtained on sulfur dioxide and fluoride concentrations in the air of the pot rooms. Urine samples were collected from 25 employees for fluoride analyses. This data is summarized in Tables I, II, and III. In addition a walk-through inspection of several departments of the plant was made. This included the casting and the anode sections.

Sulfur Dioxide Concentrations

Sulfur dioxide analyses of the air in the pot room 4, building 2, were made with a portable Thomas Autometer. The data obtained is given in Table I. This investigation served the dual purpose of determining the SO₂ exposures of the employees in the pot room under favorable conditions and at the same time to determine the proper louvre setting for the maximum ventilation. It will be noted that the SO₂ concentrations ranged from 1.6 to about 8.0 ppm when the louvres were set to direct the air down and towards the center of the room. The louvres were then changed to direct the air up so that the air movement in the center and to the

TABLE I

Operation of SO₂ Autometer at Intalco Plant, Building 2,
Room 4, Between Pots 191 and 192.

Date	Approximate Time	Sampling Period in Minutes	SO ₂ ppm	Remarks
5/17/67	11:10 A. M.	30	1.6	Wind from the bay. Louvres were set to direct air down and to center of room. Optimum conditions for air movement through building.
		30	2.5	
		30	3.2	
		30	4.1	
	2:30 P. M.	30	2.8	" "
		30	4.2	" "
		30	2.9	" "
	5:40 P. M.	10	6.6	" "
5/18/67	8:40 A. M.	10	7.9	" "
	9:50 A. M.	30	5.5	" "
	10:20 A. M.	20	39.0	Louvres set to direct air upward. Sampling between 2 cells that had a break in the crust.
	10:40 A. M.	20	15.5	Louvre changed to direct air down and to center of room.
	11:00 A. M.	15	10.0	" "

far side became more stagnant. This was reflected in a short time in an increased SO₂ concentration up to 39.0 ppm. By reversing the set of the louvres the concentration fell to 15.0 and then 10 ppm SO₂. It will be noted that the sampling was done between pots 191 and 192 and about midway between the windows and the opposite wall. During the latter sampling period there was a break in the crust of the pots and copious fumes were being evolved. However, the external air movement into the building was favorable for good ventilation. The pot room to the east probably had higher gas concentrations because the separating partitions prevented free air movement.

The generally accepted TLV value for an 8-hour exposure to sulfur dioxide is 5.0 ppm.

Hydrogen Fluoride Concentrations

Greenberg-Smith impinger samples were collected to determine the concentrations of fluorides in the pot room air. The data is given in Table II. Because of the high concentration of large particles in the air the samples were filtered and the data given indicates the soluble fluorides. These samples represent 96 up to 285 cubic feet and are integrated over several hours. The fluoride concentration range from 0.9 up to 2.8 ppm.

The ACGIH Committee on Threshold Limit Value has set 3 ppm of HF as the TLV. In their 1962 documentation of these values they quote the following:

"Guidance in the selection of the threshold limit for hydrogen fluoride was originally obtained from the experimental studies of Ronzani,

who found no injurious action of fluoride in animals exposed for 30 days at 3 ppm HF despite the fact that fluorosis of the bone had been reported by Roholm to occur among cryolite workers after prolonged exposure. Since these early reports (1909 and 1937 respectively) much evidence, both experimental and occupational, has accumulated to confirm the suitability of the 3 ppm limit. Stokinger et al found animals tolerated 7 ppm HF with only mild irritation of the respiratory tract in repeated daily exposures. Patty found 22 ppm gradually irritating to the mucous membranes and 120 ppm irritating to the skin. An unpublished industrial medical study on hundreds of workers exposed to fluoride for periods of up to 30 years showed 20 of 265 workers with increased density of x-ray picture of pelvic ligaments when the average daily F excretion in the urine was 9.6 mg., but that only 2 of 402 workers with a daily urinary output of F of 6.3 mg. showed the pelvic changes. Reduction of the exposure to a urinary F output to 1.5 to 2 mg. F per day was not expected to result in any changes of health significance. The F concentrations in the environment resulting in the urinary F values (1.5 to 2 mg. F per day) ranged from 1 to 4 ppm F, of which about 50% was particulate, 50% gaseous. Thus it appears that the 3 ppm limit for fluoride is securely based on experience from industrial and animal exposures. Evidence to the contrary is the statement of Elkins that nosebleeds occur among workers exposed to 0.4 to 0.7 mg. F/m³ and that sinus trouble was experienced in others exposed to 0.1 to 0.35 mg/m³."

TABLE II
GREENBERG-SMITH IMPINGER SAMPLES

Date	Sample	Location	Time	Cubic Feet	Soluble F ⁻ ppm
5/17	1	Bldg. 2, Rm. 4, between pots 191-192.	11:13-4:36	230.	0.94
	2	Bldg. A, Rm. 1, Sec. 3 at aisle.	4:25-9:15	285.	2.82
5/18	3	Bldg. A-2, Room 3	8:52-10:28	96	1.12
	4	Bldg. 2, Room 4	9:00-10:36	96	2.04

Urine Fluoride Determinations

It is recognized that urinary fluoride data is of great value in evaluating the health hazard of a group of workers with fluoride exposures. Consequently, urine samples were obtained from 25 representative employees in the exposed group. The analytical data is given in Table III.

The average length of service of these employees was only about 10 months and the average fluoride level was about 5.0 mg. per liter of urine.

The Hygienic Guide on Fluoride-Bearing Dusts and Fumes prepared by the American Industrial Hygiene Association states that levels above 4 mg. of fluoride ion per liter of urine are indicative of excessive exposure.

Patty, in the 2nd Edition of Industrial Hygiene and Toxicology, has reviewed the literature pertinent to this subject. He lists the symptoms of a group of severely exposed workers who have a mean urinary fluoride concentration of 16.0 mg/liter. In those with less severe exposure the

mean concentration was 4.81 mg/liter with a range of 1.78 to 11.67 mg/liter. (This exposure group data corresponds quite closely to the data obtained at the Intalco Plant even though their exposure averaged only 10 months.) A slight degree of fluorosis was found in those exposed for 2½ years and more definite signs were found in those exposed nearly 5 years. Moderate fluorosis appeared in those exposed 11 years. The most severe cases were those of men who had 21 years of exposure. Patty concludes: "To provide some factor of safety, some industrial physicians regard the maximum permissible exposure as one that will not cause the mean daily urinary output to exceed 4 mg."

In addition to the above investigations a brief walk-through inspection was made of the aluminum casting and anode manufacturing departments. It appeared that the casting area offered no environmental health problems. On the other hand, we became apprehensive of some conditions in the anode section, particularly the pitch handling areas. The odor, fumes and heavy deposits of organic material on the employees' clothing and person and on the walls and equipment of this relatively new area, gave unmistakable evidence of high employee exposures to organic particulates and fumes. The possible exposure to fairly high concentrations of carcinogenic compounds such as benzpyrene and related substances is real. Coal tar pitch volatiles contain a large quantity of lower molecular weight polycyclic hydrocarbons. As these compounds sublime in the air there is an increase of benzpyrene and other higher weight polycyclic hydrocarbons in the tar and the fumes. Polycyclic hydrocarbons of this high molecular type are known to be carcinogenic and pose a hazard. No "safe" limit of exposure

TABLE III
URINE FLUORIDE DETERMINATIONS

Sample Number	Bottle Number	Name	Job Description	Length of Service	Analysis Mg F/L
8513	1	Ernest Beilner	Pot line operator	12 mo.	4.2
8514	2	Glen Chase	" "	12 mo.	2.7
8515	3	Jerry Darkis	" "	12 mo.	1.2
8516	4	Delmar Jackson	" "	5 mo.	2.9
8517	5	Dick Hamilton	" helper	2 mo.	2.9
8518	6	D. Fahlstrom	Scrubber-fume control	8 mo.	3.8
8519	7	Dave Emley	Pot line operator	12 mo.	3.1
8520	9	Glen Lowe	Fume control	11 mo.	3.1
8521	10	John Ring	Pot line operator	12 mo.	11.3
8522	11	Walt Stieber	Lead man (also past operator)	14 mo.	6.1
8523	12	Tony Olason	Helper, pot line	6 wks	6.2
8524	13	Henry Macedon	Helper, pot line	1 mo.	3.7
8525	14	J. Schelinski	Pot line operator	7 mo.	5.7
8526	15	Ray Dubois	" "	12 mo.	3.8
8527	16	D. Bradstock	Oiler	15 mo.	3.6
8528	17	Ev. Sweitzer	Oiler	15 mo.	10.0
8529	18	F. E. Russel	Mechanic	12 mo.	1.2
8530	19	H. P. Kassner	Pot operator (10 yr. prev. exp.)	11 mo.	6.2
8531	20	H. Skinschol	Helper	4 mo.	4.2
8532	21	Vern Johnson	Maintenance	12 mo.	6.1
8533	22	Darrell Cole	Pot Operator	12 mo.	8.0
8534	24	Clyde Miller	Scrubber (fume control)	5 mo.	4.8
8535	25	Jack McCommack	Lead man - operator	12 mo.	4.6
8536	26	R. G. Ericson	Scrubber mechanic (12 mo. pot room)	19 mo.	4.7
8537	27	J. Young	Maintenance	14 mo.	8.8

has been set for carcinogens, but a limit of 0.2 mg. of benzol soluble components of coal tar pitch per cubic meter of air is recommended by the ACGIH. A limit of 0.2 mg/m³ of the total components present should minimize exposure to these carcinogens.

Recommendations

1. It is recommended that the ventilating louvres along the outside walls of the pot rooms be set to direct the air down and across the room so the fumes from the pots will be more effectively exhausted.
2. A low sulfur pitch should be used in the anode paste to reduce the SO₂ exposures. Although the SO₂-HF synergistic effect has not been delineated it is highly probable that the HF exposures and resultant health effects will be potentiated by the high SO₂ exposures.
3. It is recommended that the exposures to the carcinogenic compounds in the anode section be investigated and that the exposures be maintained within the suggested limits. Improved ventilation and materials handling practices are in order.
4. It is highly recommended that an adequate medical surveillance program be established. Urinary fluoride determinations on all exposed personnel should be determined each quarter or at least semiannually. In addition physical examinations including chest and pelvic X-rays should be taken of the exposed employees on a regularly scheduled basis. It is suggested that this be done about every three years. This program will monitor the severity of the exposure and would be invaluable to the industry should litigation arise at a later date.

Operation of SO₂ Autometer at Intalco Plant, Building 2, Room 4, Between
pots 191 and 192.

Date	Approximate Time	Sampling Period in Minutes	SO ₂ ppm	Remarks
5/17/67	11:10 A. M.	30	1.6	Wind from the bay.
		30	2.5	Louvers were set to direct air down and to center of room. Optimum conditions for air movement through building.
		30	3.2	
		30	4.1	
	2:30 P. M.	30	2.8	" "
		30	4.2	" "
		30	2.9	" "
	5:30 P. M.	10	6.6	" "
5/18/67	8:40 A. M.	10	7.9	
	9:50 A. M.	30	5.5	
	10:20	20	39.0	Louvers set to direct air upward. Sampling between 2 cells that had a break in the crust.
	10:40	20	15.5	Louvre changed to direct air down and to center of room.
	11:00 A. M.	15	10.0	" "