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OF WATER COAGULATION CHARACTERISTICS
AS AFFECTS REACTOR EFFLUENT RADIONUCLIDES

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PRELIMINARY INVESTIGATION
OF WATER COAGULATION CHARACTERISTICS
AS AFFECTS REACTOR EFFLUENT RADIONUCLIDES

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April 15, 1965

PRELIMINARY INVESTIGATION
OF WATER COAGULATION CHARACTERISTICS
AS AFFECTS REACTOR EFFLUENT RADIONUCLIDES

INTRODUCTION

Several theories have been advanced regarding the structure and characteristics of the aluminum hydroxide molecule when produced from alum in the water treatment process. The Water Treatment Task Force initiated this test to exploit a theory that increased adsorption of soil-leached elements, present in Columbia River water, by the floc particle would occur when the precipitate was formed in its terminal pH state.

A half-plant test was initiated at H Reactor Plant wherein the total sulfuric acid for pH correction was added with the alum to evaluate its affect on reactor effluent radionuclides.

SUMMARY

A substantial reduction in reactor effluent activity was achieved by this preliminary test. During phase four of the test, P^{32} and As^{76} were reduced 40 and 49 percent, respectively. Reductions may also be possible with other radionuclides. The Water Treatment Task Force plans to extend this test to its full potential, since it is recognized that many gains may be made in reducing contamination discharge, operating economies, and water treatment technology.

DISCUSSION

Physical Plant and Treatment Process

This test was started at H Reactor Plant on November 7, 1964, and was terminated on February 5, 1965.

183-H was divided into plant halves from the raw water inlet through the clearwells. The downstream water flow from the clearwell to the reactor remained as a loop system, with the exception of the process water cross-tie valves in 190-H being closed. A balanced pumping configuration was maintained in 183 and 190 pumping stations.

The normal water treatment process at 183-H consists of the addition of alum (from bauxite) in the raw water inlet flume. Approximately 12 ppm of 93% sulfuric acid is added to the bauxite chambers to sustain the exothermal reaction, and reduce the water pH to 7.0 at the sedimentation basin inlet. A coagulation aid (polyacrylamide) in the normal amount of 0.01 ppm is fed to the water stream at the filter bed inlet. The pH is further reduced to 6.6 by a supplemental feed of 10-12 ppm 93% sulfuric acid at the filter discharge flume. Chlorine is injected equally to both plant halves to maintain a residual of 0.05 ppm.

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Throughout the test, the control or east (near) plant half was operated under the normal or forementioned conditions. Changes to the treatment process on the test or west (far) plant half consisted of:

1. Adding sulfuric acid through the bauxite feeder to maintain a water pH of 6.6 (22-24 ppm).
2. Removing sedimentation basins No. 3 and 6 from service during the period of November 7, 1964, to January 10, 1965, and utilizing the other six basins. The remaining plant halves were operated normally and identically.

Water Treatment and Reactor Operating Experience

Throughout the test period, alum dose rates (approximately 15.5 ppm), filtered water pH (6.6), and filter wash cycles were maintained the same on both plant halves. Filtered water turbidity increased slightly (less than 15%) in the test half over the control half. It was necessary to feed approximately twice the amount of coagulation aid (Magnafloc) on the test half over the control half to produce comparable water quality and operating characteristics. Sodium dichromate concentrations were maintained at 0.9 ppm (190-H addition) on both sides of the plant.

No abnormal operating characteristics were observed on either reactor half during the test period.

Test Phase Categories

In order to compensate for plant variables, reactor film phenomena and revisions to test modes, the data is presented in four phases, thus:

- Phase 1 - (10/2/64 to 11/8/64, 5 weeks) This five-week period preceding test initiation was selected to establish a base for the differences in reactor plant operating characteristics.
- Phase 2 - (11/9/64 to 12/13/64, 5 weeks) During this period, a pronounced increase in P^{32} discharge occurred in the test side.
- Phase 3 - (12/14/64 to 1/10/65, 4 weeks) A substantial reduction in P^{32} concentration was experienced in the test side.
- Phase 4 - (1/11/65 to 2/7/65, 4 weeks) No. 3 and 6 sedimentation basins were returned to normal service.

Reactor Effluent Radionuclides

P^{32}

<u>Test Phase</u>	<u>% Variance in Test Half Over Control Half</u>
2	+ 21
3	- 18
4	- 40

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In analyzing these data, a postulation could be made that the reactor deposits containing parent isotopes of P^{32} are of such a characteristic that considerable operating time is required to induce a reduction through water treatment variables.

An interesting observation is the correlation of the test side with the K Areas, and the control side with the other small reactors.

Test Phase	pc/ml*		Ratio Test - H K Areas	pc/ml*		Ratio Control-H Small Reactors
	Test Side - H	K Areas		Control Side - H	Small Reactors	
1	8.0	5.1	1.57	8.0	5.9	1.36
2	12.6	8.2	1.54	10.4	9.3	1.12
3	9.7	6.0	1.62	11.9	10.6	1.12
4	9.8	6.1	1.61	16.3	13.4	1.22

* 10^{-12} curies/milliliter

As⁷⁶

An immediate reduction of this radionuclide was experienced on the test side. The diminishment continued throughout the test until a total reduction of 49% was achieved during phase 4. This experience would lend one to believe that the reactor deposition characteristics are entirely different than those of P^{32} .

Test Phase	% Variance in Test Half Over Control Half
2	- 20
3	- 36
4	- 49

Cr⁵¹

Since this parent isotope is principally HAPO-induced, no substantial reduction was anticipated.

With few exceptions throughout the test period, reactor effluent was analyzed as a composite sample, and plant half results are not available. Consequently, a thorough evaluation can not be made of the test situation; however, the data justifies a review. A notable reduction was experienced in H Reactor when compared to the other small reactors.

Test Phase	% Variance in H Over Other Small Reactor Averages	Net % Reduction
1	- 10	
2	- 32	- 22
3	- 36	- 26
4	- 25	- 15

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It is a matter of conjecture if the test produced these results; however, further investigations are merited.

Np²³⁹

These data, as with Cr⁵¹, were obtained from reactor composite samples and do not present valid test results. The reductions, as with Cr⁵¹, justify further investigation.

<u>Test Phase</u>	<u>% Variance in H Over Other Small Reactor Averages</u>	<u>Net % Reduction</u>
1	- 17	
2	- 19	- 2
3	- 22	- 5
4	- 26	- 9

Zn⁶⁵

A study was not made of this radionuclide since the concentration determination is from a bi-monthly composite sample, and the results are relatively small numbers.

Zeta Potential

The Zeta potential on the test side remained at neutral to low positive mv (average 1.18), with negligible exceptions, throughout the test. The control side was predominantly negative mv (average -2.78).

Supplemental Zeta exploration on December 11, 1964, indicated that some of the primary factors influencing the potential are:

1. Alum dose rate.
2. The manner in which the floc particle is formed.

	<u>Test Side</u>	<u>Control Side</u>
Alum - ppm	15.6	15.6
pH - Head House	6.6 (Alum and Acid together)	7.0
Zeta Potential - Treated Water	+ 8 mv	- 7 mv
pH - Filter Floor	6.6	6.6
Turbidity - ppm		
Filter Flumes	.007	.004
Clearwell	.006	.004

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(Continued)	<u>Test Side</u>	<u>Control Side</u>
Zeta Potential - Clearwell	$\pm$ 0 mv	Strong neg. mv
Visual Water Observations		
Subsidence Basin Outlet	Small floc particles	Large floc particles
Clearwells	Large separate particles	Small thick particles
Zeta Meter Observa- tions of Particles		
Clearwells	Large particles appearing to be sheared floc	Extremely small particles appearing to be colloids

J. W. Frymier
Water Treatment Task Force

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ZETA POTENTIAL STUDY
183-H 12/11/64

REACTOR EFFLUENT RADIOISOTOPES (Average Daily Concentration)

Period	Area						Period Average	
	B	C	D	DR	F	H	Small Reactors	KE (Exc. Test and Side of H) KW
					(N)	(F)		

P^{32} - pc/ml

10/5/64 - 11/8/64 (5 weeks)	1.	3.6	7.9	6.0	5.1	4.6	8.0	6.1	4.1	5.9	5.1
11/9/64 - 12/13/64 (5 weeks)	2.	6.2	10.5	9.1	9.0	10.5	10.4	7.7	8.7	9.3	8.2
12/14/64 - 1/10/65 (4 weeks)	3.	7.0	13.0	8.8	12.8	10.2	11.9	6.0	6.0	10.6	6.0
1/11/65 - 2/7/65 (4 weeks)	4.	8.4	16.1	12.9	-	13.4	16.3	6.7	5.6	13.4	6.1

As^{76} - pc/ml

10/5/64 - 11/8/64 (5 weeks)	1.	137	126	86	64	63	91	66	45	95	56
11/9/64 - 12/13/64 (5 weeks)	2.	146	151	90	79(1)	55	100	54	53	104	54
12/14/64 - 1/10/65 (4 weeks)	3.	104	119	69	82(1)	58	77	25	38	85	32
1/11/65 - 2/7/65 (4 weeks)	4.	70	98	49	-	58	59	17	23	67	20

C^{51} - pc/ml

10/5/64 - 11/8/64 (5 weeks)	1.	372	668	402	451	280	391	131	87	435	109
11/9/64 - 12/13/64 (5 weeks)	2.	463	1029	430	591	342	390	130	116	571	123
12/14/64 - 1/10/65 (4 weeks)	3.	361	896	408	712(1)	377	352	129	135	551	132
1/11/65 - 2/7/65 (4 weeks)	4.	376	982	399	-	432	408	141	113	547	127

Np^{239} - pc/ml

10/5/64 - 11/8/64 (5 weeks)	1.	164	143	77	105	85	95	95	35	115	52
11/9/64 - 12/13/64 (5 weeks)	2.	171	195	101	124	84	110	67	65	135	66
12/14/64 - 1/10/65 (4 weeks)	3.	170	195	100	138	89	107	36	49	138	42.5
1/11/65 - 2/7/65 (4 weeks)	4.	166	233	101	-	108	113	39	42	152	40.5

(1) Includes only period of 12/14/64 through 12/30/64.

DAILY REACTOR EFFLUENT RISER ANALYSES
(Units of pc/ml Corrected to Sample Time)

Reference: Reactor Effluent Analytical Data, routine report by
W. N. Koop, Process and Reactor Development, IPD.

p32

<u>Date</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>
October 1964								
5	2.2/3.5	11.6	8.0	-	2.5	7.1	7.9	-
6	2.9/3.6	9.3	5.7	(9.5/26.6)	4.5	7.9	8.0	-
7	2.0/6.0	8.8	6.0	-	4.5	6.5	-	-
8	1.9/6.1	8.8	-	-	4.8	8.6	-	-
9	1.9/4.6	7.5	-	5.5/5.0	5.0	6.4	-	-
12	-	-	7.7	-	3.4	6.9	5.9	-
13	-	-	6.7	2.1/2.3	4.9	6.0	5.0	-
14	-	-	-	5.6/4.4	4.8	-	5.9	-
15	-	5.7	-	3.1/2.4	4.4	-	(9.1)	-
16	-	5.8	-	3.7/3.4	-	6.6	6.6	-
19	6.2/4.7	5.8	-	3.6/6.0	3.7	7.8	-	-
20	3.8/3.4	7.6	-	-	4.1	9.2	5.5	2.0
21	4.4/3.5	-	-	-	4.9	9.3	6.9	4.0
22	5.7/4.4	-	-	-	4.5	9.3	6.2	4.1
23	4.0/3.7	-	-	6.1/6.5	4.8	8.3	3.8	3.8
26	2.9/4.3	-	-	5.6/6.1	4.6	-	5.8	-
27	-	-	-	-	4.2	9.5	5.9	5.1
28	-	-	-	-	4.7	8.9	3.6	3.3
29	3.6/4.4	-	-	5.9/6.0	3.3	6.5	9.4	4.4
30	3.7/3.9	9.9	-	7.2/9.1	2.9	7.0	8.4	5.3
November 1964								
2	4.8	8.7	-	3.9/8.4	7.2	10.6	7.9	-
3	-	6.6	-	4.2/8.5	4.6	10.3	4.8	-
4	3.6	6.5	4.3	6.5/9.2	5.4	-	7.4	-
5	-	7.6	5.6	8.1/8.7	7.5	-	7.8	4.5
6	-	8.1	6.2	5.1/7.7	-	-	6.3	4.6
9	6.3	7.5	8.5	7.7/9.7	5.7	9.8	10.6	6.7
10	7.5	-	7.7	8.1/8.6	6.6	13.7	7.0	5.8
11	6.7	-	7.5	9.2/6.4	4.6	14.1	6.6	7.7
12	4.1	8.6	7.6	6.5/6.8	5.6	13.9	10.4	6.8
13	5.2	-	-	7.1/8.4	6.1	17.1	6.2	5.0
16	-	11.0	13.7	8.8	6.0	12.0	-	6.8
17	-	11.6	11.2	9.6/7.5	5.5	11.6/17.1	-	7.5
18	-	9.0	9.0	8.7/6.7	20.8	10.9/22.4	-	15.3
19	-	10.2	-	8.2/7.0	-	9.3/9.9	-	6.4
20	4.0	12.9	-	-	-	11.2/12.3	-	8.2
23	4.9	14.3	8.4	-	-	7.3/12.4	9.4	8.5
24	5.1	-	-	-	7.0	8.3/37.1	7.4	-
25	6.0	-	-	10.3/10.3	11.0	8.9/14.3	7.7	8.2
30	15.0	3.0	-	9.3/9.6	12.6	8.0/10.7	8.4	-

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P32 (Continued)

<u>Date</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>
December 1964								
1	7.2	10.7	7.6	-	7.5	10.1/9.4	8.0	-
2	5.5	12.4	10.6	9.9/10.0	7.5	8.4/7.0	8.3	-
3	6.6	13.0	10.8	12.8/11.7	8.9	12.9/9.8	9.0	-
4	1.5	1.5	6.7	-	-	4.5/8.6	1.8	-
10	7.3	15.4	-	10.1/3.7	-	6.8/14.1	7.8	5.2
11	6.2	16.0	-	13.7/13.4	-	9.9/10.2	7.3	6.3
14	-	13.0	-	5.5/9.7	6.0	9.0/7.5	8.0	4.0
15	-	16.7	8.2	14.9/13.9	5.0	8.5/8.8	8.9	5.9
16	-	10.6	9.8	13.3/11.9	8.2	9.3/5.5	-	4.3
17	3.9	14.7	3.6	12.2/11.7	7.2	7.8/6.4	-	7.3
18	3.2	17.0	7.4	9.1/14.1	6.6	6.2/4.2	-	4.9
21	5.1	-	8.4	11.1/33.4	8.1	10.0/10.2	5.0	-
22	7.5	-	6.2	-	7.0	8.2/9.1	-	5.9
23	7.4	-	5.1	-	8.7	8.4/10.6	4.3	5.5
28	-	8.1	5.0	27.3	-	13.3	5.6	5.9
29	4.3	3.3	10.3	-	-	15.9/12.3	4.4	7.2
30	15.2	15.4	9.6	10.2/14.1	-	15.2/10.2	3.1	6.9
31	5.7	11.3	7.3	-	17.1	16.8/10.5	5.6	5.8
January 1965								
4	8.1	14.2	-	10.1	12.5	21.4/15.4	7.4	8.8
5	8.1	15.6	10.4	-	17.5	13.3/12.7	6.9	-
6	8.1	13.2	10.7	-	17.4	17.2/12.2	6.6	-
8	-	15.8	14.4/15.8	-	11.6	9.2/11.7	6.0	-
11	-	15.0	10.3/16.1	-	11.1	37.3/12.4	4.9	2.2
12	-	20.0	14.6/15.6	-	12.3	20.8/13.2	7.5	6.2
13	9.4	-	-	-	13.4	24.6/11.5	6.1	-
14	-	-	-	-	18.0	19.8/13.3	6.1	4.6
15	7.4	12.2	9.6/8.4	-	13.9	20.9/11.1	6.3	5.4
18	8.9	15.2	-	-	11.5	26.2/14.6	12.2	5.7
25	9.8	17.4	10.2/13.5	-	21.3	16.0/7.8	-	-
26	9.8	17.8	11.9/16.4	-	39.7	14.5/7.5	-	3.6
27	4.1	14.5	10.2/14.4	-	34.6	13.6/9.4	-	4.6
28	9.6	16.8	9.1/16.8	-	27.8	10.0/9.7	-	5.0
29	8.3	18.1	9.3/14.5	-	38.6	13.7/10.0	-	7.0
February 1965								
1	-	19.1	12.9/19.2	-	-	15.9/3.3	5.9	5.9
2	-	11.2	10.6/17.9	-	-	13.1/9.6	6.1	6.5
3	-	-	10.0/16.9	-	-	10.3/8.3	4.7	7.7
4	-	-	10.1/13.6	-	-	12.5/7.0	6.4	6.6
5	8.5	-	7.6/15.1	-	-	13.1/8.2	7.0	6.9

() - Excluded from Averages.

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DAILY REACTOR EFFLUENT RISER ANALYSES
(Units of pc/ml Corrected to Sample Time)

Reference: Reactor Effluent Analytical Data, routine report by
W. N. Koop, Process and Reactor Development, IPD.

As⁷⁶

<u>Date</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>
October 1964								
5	151/153	116	83	-	49	53	65	-
6	168/198	147	99	65/56	61	80	76	-
7	139/99	148	81	-	55	63	-	-
8	166/182	146	-	-	74	83	-	-
9	138/141	90	-	47/40	55	61	-	-
12	-	-	106	-	57	83	50	-
13	-	-	77	-	55	49	46	-
14	-	-	-	51/70	61	-	56	-
15	-	76	-	59/58	61	-	(174)	-
16	-	97	-	69/63	-	66	54	-
19	97/123	100	-	56/66	38	87	-	-
20	102/115	98	-	-	35	62	33	23
21	123/157	-	-	-	63	109	68	40
22	149/167	-	-	-	69	116	54	51
23	165/169	-	-	68/60	75	141	57	58
26	115/115	-	-	91/85	89	-	86	-
27	-	-	-	-	83	148	60	58
28	-	-	-	-	59	115	97	37
29	86/105	-	-	26/23	45	34	70	44
30	176/169	196	-	93/83	79	149	103	68
November 1964								
2	138	154	-	89/95	83	158	99	-
3	-	82	-	52/45	71	120	81	-
4	77	76	40	35/39	41	-	47	-
5	-	178	116	103/98	69	-	71	36
6	-	91	62	57/54	-	-	59	34
9	176	125	88	70/69	30	86	76	81
10	93	-	75	58/68	44	82	56	40
11	114	-	80	62/61	96	90	58	47
12	129	120	90	82/60	48	98	62	53
13	121	-	-	72/73	39	72	61	50
16	-	79	45	54	36	54	-	45
17	-	96	52	75/55	45	75/49	-	30
18	-	181	70	94/59	60	83/76	-	59
19	-	113	-	81/47	-	90/65	-	58
20	77	142	-	-	-	64/87	-	58
23	144	203	133	-	-	125/99	74	90
24	186	-	-	-	56	130/91	61	-
25	134	-	-	-	61	226/226	50	72
30	124	138	-	142/77	57	91/53	37	-

DECLASSIFIED

As⁷⁶ (Continued)

<u>Date</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>
December 1964								
1	120	175	62	55/62	53	92/55	58	-
2	150	117	61	55/62	73	117/55	37	-
3	241	222	115	156/120	70	108/70	47	-
4	183	208	209	-	-	161/88	63	-
10	160	129	-	81/75	-	47/36	36	23
11	203	211	-	130/128	-	86/62	37	33
14	-	52	-	23/32	26	24/16	12	13
15	-	152	58	97/88	57	78/44	37	45
16	-	-	59	93/75	58	69/58	-	29
17	111	165	70	98/119	75	120/50	-	44
18	119	180	64	105/85	69	91/57	-	50
22	138	-	88	-	82	95/71	-	45
23	113	-	68	-	51	87/49	24	30
28	-	97	88	86	-	76	25	42
29	74	111	88	-	-	90/52	28	39
30	88	101	73	-	32	86/50	26	46
31	86	92	70	-	32	76/43	26	33
January 1965								
4	127	147	-	-	75	98/57	25	41
5	89	104	49	-	75	75/44	28	-
6	97	120	54	-	69	70/43	15	-
8	-	104	77/56	-	49	26/31	27	-
11	-	-	198/60	-	44	58/38	21	24
12	-	109	72/67	-	53	59/36	20	21
13	72	-	-	-	58	69/29	16	-
14	-	-	-	-	32	51/25	16	5
15	85	91	48/44	-	62	48/38	24	19
18	70	-	44/49	-	48	77/36	27	23
25	70	80	44/53	-	36	56/24	-	-
26	78	88	49/61	-	73	63/31	-	17
27	60	72	32/24	-	47	39/22	-	6
28	95	90	51/39	-	84	58/32	-	20
29	88	117	58/58	-	103	75/34	-	27
February 1965								
1	-	135	60/43	-	-	67/35	15	25
2	-	99	62/37	-	-	54/29	19	25
3	-	-	56/35	-	-	52/25	10	31
4	-	-	58/27	-	-	51/19	12	29
5	83	-	48/39	-	-	60/28	12	51

() - Excluded from Averages.

DECLASSIFIED

DAILY REACTOR EFFLUENT RISER ANALYSES
(Units of pc/ml Corrected to Sample Time)

Reference: Reactor Effluent Analytical Data, routine report by
W. N. Koop, Process and Reactor Development, IPD.

Cr⁵¹

<u>Date</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>
October 1964								
2	393	743	447	456	300	(142)	112	-
5	405	788	404	-	203	293	170	-
6	423	425	(101)	296	158	484	94	-
7	492	388	(163)	-	231	(32)	-	-
9	379	455	-	203	162	264	-	-
12	-	-	429	-	298	371	115	-
13	-	-	470	450	348	(1170)	116	-
14	-	-	-	430	300	-	107	-
15	-	443	-	(1040)	299	-	(1200)	-
16	-	604	-	750	-	326	118	-
19	421	790	-	447	318	426	-	-
20	400	857	-	-	279	350	94	35
21	377	-	-	-	216	387	130	88
22	410	-	-	-	310	400	114	87
23	287	-	-	392	245	469	124	79
26	225	-	-	463	297	-	121	-
27	-	-	-	-	293	390	123	81
28	-	-	-	-	265	480	120	91
29	299	-	-	352	313	415	142	109
30	353	(91)	-	549	336	-	142	116
November 1964								
2	326	(261)	-	543/(106)	262	334	284	-
3	-	829	-	480	356	470	141	-
4	397	868	304	490/459	381	-	108	-
5	-	794	344	(9790)/380	-	-	125	-
6	-	694	415	523	-	-	141	100
9	450	850	416	576/522	326	390	(499)	108
10	416	-	429	548	290	456	148	106
11	441	-	449	540	309	356	151	122
12	426	962	473	550/559	341	473	(499)	126
13	485	-	-	594/557	346	464	120	123
16	-	1130	-	532	360	454	-	118
17	-	1090	468	631/240	368	402	-	132
18	-	-	481	315/551	(533)	437/434	-	122
19	-	892	-	579	-	387	-	117
20	285	972	-	-	-	412/331	-	123
23	337	1060	463	-	-	449	142	169
24	361	-	-	531	301	388	121	-
25	357	-	-	-	307	(805)	129	125
30	409	996	-	(789)	353	407	128	-

DECLASSIFIED

Cr⁵¹ (Continued)

Date	B	C	D	DR	F	H	KE	KW
December 1964								
1	442	978	238	-	-	377	140	-
2	441	1080	435	682	373	298	114	-
3	391	880	449	707	333	392	108	-
4	438	1090	370	(499)	-	396	161	-
7	477	1240	440	880	409	-	122	65
8	431	851	455	729	373	-	137	77
9	464	1150	457	767	-	-	81	123
10	469	1100	-	821	-	209	148	99
11	885	1180	-	(147)	-	286	(41)	(7)
14	-	1040	-	718/641	364	242/256	161	114
15	-	(570)	384	688	345	330	152	125
16	-	(125)	399	666	407	334	-	(1620)
17	211	1300	330	683	371	327	-	120
18	447	1000	379	696	377	(122)	-	(297)
21	405	-	355	950	423	329	120	-
22	447	-	(135)	-	369	407	-	(384)
23	415	-	409	-	362	375	108	135
28	293	757	418	649	-	383	128	138
29	287	791	417	-	-	358	127	141
30	344	905	426	779	-	(1190)	144	145
31	412	846	451	-	284	409	124	142
January 1965								
4	355	990	-	-	381	420	131	151
5	356	810	341	-	458	368	118	-
6	353	946	407	-	408	395	127	-
7	-	829	492	-	384	-	114	-
8	-	677	504	-	347	(1310)	118	-
11	-	918	536	-	426	581	127	90
12	-	1010	532	-	474	622	155	106
13	279	-	-	-	426	377	139	-
14	-	-	-	-	329	391	129	65
15	332	736	296	-	445	387	141	94
18	362	-	364	-	415	401	128	114
19	348	990	-	-	433	-	137	126
20	345	885	-	-	463	-	139	-
21	348	958	(187)	-	436	-	144	-
22	361	954	449	-	423	-	143	91
25	413	1020	363	-	482	397	-	-
26	431	1020	368	-	(7790)	484	-	71
27	499	1110	366	-	(4960)	381	-	108
28	440	1130	371	-	(1620)	377	-	126
29	412	876	345	-	(2990)	349	-	122
February 1965								
1	-	1040	415	-	-	412	160	147
2	-	1110	371	-	-	383	138	134
3	-	-	562	-	-	325	140	142
4	-	-	359	-	-	344	137	141
5	247	-	292	-	-	321	157	132

() - Excluded from Averages.

DECLASSIFIED

DAILY REACTOR EFFLUENT RISER ANALYSES
(Units of pc/ml Corrected to Sample Time)

Reference: Reactor Effluent Analytical Data, routine report by
W. N. Koop, Process and Reactor Development, IPD.

Np²³⁹

<u>Date</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>
October 1964								
2	177	166	112	142	89	51	55	-
5	173	149	(33)	-	(23)	79	58	-
6	(29)	(2)	-	-	-	15	-	-
7	(45)	(5)	-	-	(21)	(4)	-	-
8	(28)	(22)	-	-	(14)	(21)	-	-
9	(28)	(11)	-	(4)	(6)	(19)	-	-
12	-	-	74	-	84	116	59	-
13	-	-	92	93	93	(1910)	58	-
14	-	-	-	106	82	-	55	-
15	-	99	-	139	80	-	91	-
16	-	120	-	126	-	86	65	-
19	168	147	-	119	66	114	-	-
20	178	156	-	-	73	96	55	13
21	176	-	-	-	50	104	70	33
22	194	-	-	-	83	107	59	37
23	181	-	-	96	69	120	75	37
26	122	-	-	108	79	-	71	-
27	-	-	-	-	80	115	77	37
28	-	-	-	-	77	127	72	41
29	119	-	-	78	63	87	68	37
30	150	84	-	60	58	-	52	31
November 1964								
2	(76)	(95)	-	117/65	107	96	75	-
3	-	166	-	99	206	133	87	-
4	169	159	53	127/99	(264)	-	93	-
5	-	167	56	(589/306)	-	-	65	-
6	-	159	77	99	-	-	89	50
9	186	167	92	129/103	78	105	94	66
10	171	-	90	126	88	117	103	62
11	179	-	96	121	81	98	109	69
12	174	193	99	132/103	88	123	96	73
13	196	-	-	133/109	86	119	89	70
16	-	183	-	105	84	115	-	71
17	-	199	113	121/61	90	116	-	80
18	-	198	111	72/103	117	135/112	-	78
19	-	174	-	134	-	116	-	79
20	125	197	-	-	-	128/98	-	78
23	147	231	91	-	-	127	61	96
24	183	-	-	123	57	111	57	-
25	162	-	-	-	70	(1510)	55	68
30	170	196	-	142	81	114	54	-

DECLASSIFIED

Np²³⁹ (Continued)

<u>Date</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>DR</u>	<u>F</u>	<u>H</u>	<u>KE</u>	<u>KW</u>
December 1964								
1	181	200	78	-	-	118	59	-
2	(99)	212	99	120	84	88	45	-
3	158	189	104	126	81	117	42	-
4	179	199	107	(72)	-	117	84	-
7	173	205	112	160	90	-	43	35
8	156	161	108	158	82	-	49	40
9	177	196	108	175	-	-	42	41
10	172	199	-	171	-	60	50	40
11	191	202	-	(50)	-	83	(225)	(79)
14	-	179	-	133/105	75	81/60	50	41
15	-	221	63	156	77	97	44	46
16	-	(45)	83	130	81	99	-	(175)
17	103	208	87	123	83	97	-	42
18	286	197	88	135	77	(43)	-	(98)
21	177	-	87	161	92	104	35	-
22	187	-	(46)	-	112	98	-	83
23	176	-	95	-	77	114	30	46
28	249	153	113	138	-	123	37	45
29	127	180	110	-	-	136	35	48
30	147	219	125	160	-	(289)	55	37
31	85	199	119	-	84	124	31	50
January 1965								
4	176	222	-	-	100	126	30	53
5	165	184	110	-	98	112	24	-
6	159	194	98	-	105	121	32	-
7	-	188	106	-	93	-	30	-
8	-	(139)	109	-	90	(1570)	33	-
11	-	201	117	-	105	(524)	37	29
12	-	197	114	-	107	(821)	41	34
13	(130)	-	-	-	101	114	37	-
14	-	-	-	-	112	116	33	26
15	162	(156)	87	-	107	109	38	32
18	166	-	100	-	107	114	36	37
19	171	261	-	-	115	-	40	42
20	165	215	-	-	113	-	38	-
21	174	215	(65)	-	106	-	39	-
22	166	221	99	-	109	-	38	31
25	166	227	101	-	106	99	-	-
26	184	227	107	-	(1830)	113	-	17
27	175	231	92	-	(464)	103	-	23
28	172	289	88	-	(233)	103	-	33
29	167	221	85	-	(373)	101	-	33
February 1965								
1	-	259	102	-	-	145	41	53
2	-	268	98	-	-	120	41	58
3	-	-	113	-	-	114	39	71
4	-	-	126	-	-	116	41	74
5	129	-	85	-	-	113	45	81

() - Excluded from Averages.

UNCLASSIFIED

ZETA POTENTIAL

H AREA

<u>Date</u>	<u>Near (Control)</u>	<u>Far (Test)</u>
December 1964		
7	0	0
8		
9		
14		
15	0	+ 6.2
21	+ 9.0	+ 3.5
22	0	- 4.5
23	0	- 5.3
29	+ 6.3	- 8.8
30	0	0
January 1965		
4	+ 5.3	+ 1.0
5	- 5.2	+ 2.7
6	- 8.8	+ 7.5
7	-	-
8	- 3.2	+ 4.0
11	- 10.0	+ 5.0
12	- 3.7	+ 5.4
13	- 4.5	+ 4.2
14	- 4.0	+ 4.7
15	- 4.4	+ 3.2
18	- 3.8	+ 9.5
19	0	- 13.0
20	- 5.5	+ 10.0
21	0	0
22	- 5.5	0
26	0	0
27	- 1.2	0
28	- 3.4	0
29	0	0
February 1965		
1	- 5.8	- 4.8
2	- 7.5	0
3	- 4.7	0
4	- 5.5	+ 3.6
5	- 4.0	0
8		
9		
10		
Average	- 2.78	+ 1.18

DECLASSIFIED

H WATER PLANT OPERATING CHARACTERISTICS

-23-

RL-REA-922

Date	Raw Water		Bauxite Feed ppm		Coag Aid ppm		Treated		pH		Filt. Water Turb		Backwash Cycle Hrs		Sod. Dich ppm	Cl Res ppm
	Turb ppm	Temp °C	E	W	E	W	E	W	E	W	E	W	E	W		
11/7/64	5.7	16.2	15.8	15.5	.0035	.0035	7.02	6.62	6.62	6.62	.0045	.006	6.7	6.7	.93	.05
8	5.8	15.4	15.6	15.5	.004	.004	7.01	6.61	6.61	6.61	.004	.0055	6.7	6.7	.95	.05
9	5.0	15.1	16.1	15.6	.004	.004	7.03	6.61	6.61	6.62	.004	.006	6.7	6.7	.95	.05
10	5.0	14.6	15.6	15.4	.004	.004	7.01	6.62	6.62	6.62	.004	.0075	6.7	6.7	.97	.05
11	5.0	14.3	15.6	15.6	.004	.004	7.05	6.64	6.64	6.64	.005	.0075	6.7	6.7	.93	.05
12	5.0	14.0	15.6	15.5	.004	.004	7.04	6.64	6.64	6.64	.005	.0075	6.7	6.7	.97	.05
13	5.0	13.9	15.4	15.5	.004	.004	7.05	6.63	6.63	6.63	.006	.008	6.7	6.7	.96	.05
14	4.6	13.1	15.3	15.1	.004	.004	7.03	6.62	6.62	6.62	.005	.007	6.7	6.7	.97	.05
15	4.4	13.2	15.3	15.0	.004	.004	7.04	6.64	6.64	6.64	.005	.008	6.7	6.7	.96	.05
16	4.5	12.6	15.2	15.0	.004	.004	7.05	6.63	6.63	6.63	.0055	.008	6.7	6.7	.96	.05
17	3.5	12.5	15.1	15.1	.005	.005	7.04	6.65	6.65	6.64	.005	.009	6.7	6.7	.96	.05
18	3.6	12.1	15.4	14.9	.006	.006	7.03	6.65	6.65	6.65	.005	.008	6.7	6.7	.95	.05
19	3.8	11.7	15.8	15.1	.007	.007	7.05	6.65	6.65	6.65	.0055	.0075	6.7	6.7	.95	.05
20	4.2	12.4	15.4	15.2	.006	.006	7.07	6.63	6.63	6.63	.0055	.0065	6.7	6.7	.96	.05
21	3.9	12.7	15.5	15.6	.009	.009	7.05	6.62	6.62	6.62	.005	.007	6.7	6.7	.95	.05
22	4.9	13.5	15.4	15.5	.009	.009	7.04	6.63	6.63	6.63	.004	.005	6.7	6.7	.94	.05
23	6.3	13.6	15.4	15.5	.009	.009	7.05	6.63	6.63	6.63	.005	.006	6.7	6.7	.94	.05
24	5.0	12.6	15.2	15.3	.009	.009	7.04	6.64	6.64	6.64	.005	.0055	6.7	6.7	.91	.05
25	Down														1.00	.05
26	Down														1.02	.05
27	7.5	11.5	15.6	15.6	.008	.008	7.04	6.63	6.63	6.68	.006	.007	6.7	6.7	.91	.05
28	5.3	11.4	15.5	15.5	.008	.008	7.03	6.64	6.64	6.64	.006	.007	6.7	6.7	.93	.05
29	8.2	12.7	15.2	15.6	.008	.008	7.03	6.65	6.65	6.66	.006	.006	6.7	6.7	.87	.05
30	9.6	12.5	15.3	15.5	.008	.008	7.06	6.66	6.66	6.66	.006	.007	6.7	6.7	.92	.05
12/1/64	11.3	12.0	15.5	15.6	.008	.008	7.06	6.64	6.64	6.64	.006	.006	6.7	6.7	.92	.05
2	10.2	11.6	15.5	15.5	.008	.008	7.07	6.65	6.65	6.65	.006	.007	6.7	6.7	.85	.05
3	6.9	11.5	15.3	15.4	.009	.009	7.05	6.66	6.65	6.65	.006	.007	6.7	6.7	.90	.05
4	7.0	10.9	15.1	15.5	.009	.009	7.08	6.65	6.65	6.67	.0055	.007	6.7	6.7	.90	.05
5	9.7	10.3	15.7	15.7	.009	.009	7.08	6.65	6.65	6.65	.005	.006	6.7	6.7	.93	.05
6	Down														.90	.05
7	Down														-	.08
8	Down														-	.05
9	Down														-	.05
10	8.9	10.9	15.8	16.0	.009	.009	7.04	6.66	6.66	6.66	.005	.006	6.7	6.7	.99	.05
11	6.8	11.0	15.0	15.4	.010	.010	7.09	6.67	6.67	6.67	.0055	.0065	6.7	6.7	.95	.05
12	Down														.89	.05
13	Down														.72	.07

RECEIVED

11

H Water Plant Operating Characteristics (Continued)

Date	Raw Water		Bauxite Feed ppm		Coag Aid ppm		Treated		pH		Filt. Water Turb		Backwash Cycle Hrs		Sod. Dich ppm	Cl Res ppm
	Turb ppm	Temp °C	E	W	E	W	E	W	F	W	E	W	E	W		
12/14/64	5.4	11.4	15.2	15.4	.009	.020	7.04	6.66	6.66	6.66	.005	.0055	6.7	6.7	.93	.05
15	5.3	9.9	15.4	15.6	.009	.018	7.05	6.65	6.65	6.65	.005	.005	6.7	6.7	.95	.05
16	5.1	7.2	15.6	15.8	.009	.018	7.06	6.73	6.73	6.73	.005	.005	6.7	6.7	.93	.05
17	5.7	6.7	15.4	15.8	.009	.018	7.04	6.66	6.66	6.66	.005	.005	6.7	6.7	.88	.07
18	8.3	7.3	15.6	15.8	.009	.018	7.08	6.67	6.67	6.67	.0055	.005	6.7	6.7	.86	.05
19	6.1	7.9	15.4	15.7	.009	.018	7.10	6.66	6.66	6.66	.005	.005	6.7	6.7	.88	.05
20	6.5	8.7	15.6	15.5	.009	.018	7.12	6.62	6.62	6.62	.006	.007	6.7	6.7	.87	.05
21	7.5	7.3	15.5	15.6	.009	.018	7.08	6.60	6.60	6.60	.007	.007	6.7	6.7	.88	.05
22	7.9	6.9	15.5	15.6	.009	.018	7.03	6.65	6.65	6.65	.007	.0075	6.7	6.7	.88	.05
23	5.0	8.9	15.4	15.5	.009	.018	6.98	6.64	6.64	6.64	.008	.007	6.7	6.7	.88	.05
24	6.0	8.0	15.0	15.2	.010	.020	7.03	6.65	6.65	6.65	.0055	.0055	6.7	6.7	.90	.05
25	5.0	8.9	15.1	15.3	.010	.020	7.04	6.60	6.60	6.60	.006	.006	6.7	6.7	.88	.05
26	5.0	8.5	15.3	15.4	.009	.018	7.02	6.63	6.63	6.63	.007	.007	6.7	6.7	.83	.05
27	5.5	7.9	15.3	15.5	.009	.018	7.02	6.63	6.63	6.63	.0065	.006	6.7	6.7	.85	.05
28	5.3	8.1	15.3	15.4	.009	.018	7.04	6.66	6.66	6.66	.007	.007	6.7	6.7	.92	.05
29	6.0	7.1	15.3	15.4	.010	.020	7.04	6.64	6.64	6.64	.006	.006	6.7	6.7	.93	.05
30	6.5	7.3	15.2	15.5	.010	.020	7.08	6.65	6.65	6.65	.006	.006	6.7	6.7	.95	.05
31	5.1	6.9	15.4	15.3	.010	.020	7.06	6.64	6.64	6.64	.006	.006	6.7	6.7	.92	.05
1/1/65	4.5	6.5	15.0	15.2	.010	.020	7.06	6.66	6.66	6.66	.006	.006	6.7	6.7	.93	.05
2	5.6	6.2	15.6	15.3	.010	.020	7.08	6.66	6.66	6.66	.006	.006	6.7	6.7	.97	.05
3	5.3	7.4	15.0	15.3	.010	.020	7.10	6.63	6.63	6.63	.0055	.006	6.7	6.7	.93	.05
4	4.7	6.5	15.6	15.3	.009	.019	7.03	6.65	6.65	6.65	.006	.006	6.7	6.7	.97	.05
5	4.5	5.5	15.7	15.4	.009	.018	7.08	6.63	6.63	6.63	.006	.0055	6.7	6.7	.92	.05
6	5.4	6.3	15.6	15.3	.009	.018	7.04	6.64	6.64	6.64	.006	.006	6.7	6.7	1.00	.05
7	Down	Down													1.23	.05
8	6.3	6.3	15.5	15.3	.009	.018	7.06	6.65	6.65	6.65	.006	.006	6.7	6.7	1.07	.05
9	4.6	6.5	15.4	15.1	.010	.020	7.04	6.66	6.66	6.66	.005	.005	6.7	6.7	.95	.05
10	4.0	7.5	15.2	15.2	.010	.020	7.03	6.64	6.64	6.64	.006	.006	6.7	6.7	.95	.05
11	4.0	7.1	15.0	15.1	.010	.020	7.02	6.63	6.63	6.63	.0055	.005	6.7	6.7	.90	.05
12	4.2	6.6	15.0	15.0	.010	.020	7.02	6.65	6.65	6.65	.005	.005	6.7	6.7	.85	.05
13	4.9	6.1	15.4	15.4	.010	.020	7.04	6.64	6.64	6.64	.006	.0055	6.7	6.7	.93	.05
14	10.0	6.2	15.3	15.4	.010	.020	7.05	6.63	6.63	6.63	.005	.005	6.7	6.7	.93	.05
15	5.4	6.8	15.3	15.3	.010	.020	7.01	6.64	6.64	6.64	.006	.006	6.7	6.7	.95	.05
16	5.0	7.6	15.3	15.3	.010	.020	6.98	6.62	6.62	6.62	.007	.007	6.7	6.7	.97	.05
17	4.8	7.6	15.3	15.3	.010	.020	6.97	6.62	6.62	6.62	.006	.005	6.7	6.7	.90	.05
18	4.8	7.3	15.3	15.3	.010	.020	7.01	6.65	6.65	6.65					1.00	.05
19	Down	Down													1.78	.05
20	Down	Down													2.31	.05

RECEIVED

H Water Plant Operating Characteristics (Continued)

Date	Raw Water		Bauxite Feed		Coag Aid		Treated		pH		Filt. Water Turb		Backwash Cycle Hrs		Sod. Dich ppm	Cl Res ppm
	Turb ppm	Temp °C	E	W	E	W	E	W	E	W	E	W	E	W		
1/21/65	3.8	8.0	15.0	15.0	.010	.020	6.97	6.65	6.65	6.65	.055	.005	6.7	6.7	.97	.05
22	5.0	6.7	15.0	15.2	.010	.020	6.95	6.62	6.62	6.62	.050	.0055	6.7	6.7	.95	.05
23	6.6	7.8	15.2	15.4	.010	.020	6.95	6.61	6.61	6.61	.006	.006	6.7	6.7	.96	.05
24	6.8	8.0	15.1	15.1	.010	.020	6.95	6.62	6.62	6.62	.006	.005	6.7	6.7	.94	.05
25	6.9	6.8	15.4	15.3	.010	.020	6.97	6.63	6.63	6.63	.006	.005	6.7	6.7	.97	.05
26	7.3	6.2	15.4	15.4	.010	.020	7.02	6.64	6.64	6.64	.005	.005	6.7	6.7	.96	.05
27	6.2	6.4	15.2	15.2	.010	.020	7.02	6.63	6.63	6.63	.006	.005	8.0	8.0	.92	.05
28	6.8	6.3	15.3	15.6	.010	.020	6.91	6.63	6.63	6.63	.006	.0055	8.0	8.0	.97	.05
29	5.0	7.2	15.1	15.1	.010	.020	6.90	6.62	6.62	6.62	.006	.005	8.0	8.0	.92	.05
30	7.0	9.0	15.3	15.4	.010	.020	6.98	6.63	6.63	6.63	.005	.005	8.0	8.0	.86	.05
31	6.0	8.6	15.3	15.6	.010	.020	6.94	6.64	6.64	6.64	.0055	.005	8.0	8.0	.85	.05
2/1/65	6.0	8.4	15.3	15.5	.010	.020	7.01	6.67	6.67	6.67	.005	.005	8.0	8.0	.90	.05
2	11.0	6.8	15.1	15.3	.009	.015	7.01	6.68	6.68	6.68	.005	.005	8.0	8.0	.87	.05
3	12.0	5.9	15.2	15.1	.009	.015	7.02	6.63	6.63	6.63	.005	.005	8.0	8.0	.87	.05
4	10.0	6.4	15.3	15.2	.009	.015	7.02	6.63	6.63	6.63	.005	.005	8.0	8.0	.90	.05
5	11.1	5.7	15.1	14.9	.009	.015	6.96	6.63	6.63	6.63	.007	.007	8.0	8.0	.92	.05

DECLASSIFIED

END

**DATE
FILMED
9/28/92**