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QUARTERLY REPORT
CONTAMINATION CONTROL - COLUMBIA RIVER
JULY - SEPTEMBER 1968

I. INTRODUCTION

It is the purpose of this report to present data obtained from the routine reactor effluent radioactivity monitoring program as well as the results obtained from the research and development program directed toward the reduction of effluent radioactivity.

II. PERTINENT ASPECTS OF REACTOR OPERATION

A. General

Samples of effluent are obtained each weekday during operation and analyzed for P-32, As-76, Np-239, and Cr-51. The Zn-65 concentration in the effluent from each reactor is obtained from a weekly composite sample. The above nuclides are monitored because:

1. Phosphorus-32 and Zn-65 are the nuclides of Hanford origin which are of significance in fish, shellfish, and foodstuffs.
2. Arsenic-76 and Np-239 are responsible for most of the dose received by drinking water derived from the Columbia River.
3. Chromium-51 is the nuclide released in the greatest quantity downstream of the Hanford plant, but its contribution to dose is relatively small.

B. Phosphorus-32 and Arsenic-76

1. Concentration in Reactor Effluent

a. C Reactor

The alum feed rates at C Reactor were 18.9, 18.3, and 15.3 ppm during July, August, and September, respectively. The sodium dichromate feed rate was held at 0.5 ppm during the period, and pH of the coolant was maintained near 6.6. The P-32 and As-76 concentrations in the reactor effluent during recent months were:

	<u>Phosphorus-32</u> <u>pCi/ml</u>	<u>Arsenic-76</u> <u>pCi/ml</u>
September, 1968	10.2	60
August, 1968	13.9	110
July, 1968	15.2	115
July-September 1967*	15.1	95
July-September 1966*	9.0	90

*Three month average

Both the P-32 and As-76 values in recent months are comparable to those obtained during similar periods in prior years.

No tests were carried out during July-September.

b. K Reactors

The alum feed rates were 16.0, 15.9, and 14.9 ppm during July, August, and September, respectively, at KE Reactor and 9.9, 15.7, and 15.0 ppm at KW Reactor. The coolant pH was maintained at 6.6, and the sodium dichromate concentration remained at 1 ppm throughout the period at KW Reactor. At KE Reactor the sodium dichromate concentration was 0.5 ppm. The P-32 and As-76 concentrations in the K Plant effluents during recent months were:

	<u>Phosphorus-32</u>		<u>Arsenic-76</u>	
	<u>pCi/ml</u>		<u>pCi/ml</u>	
	<u>KE</u>	<u>KW</u>	<u>KE</u>	<u>KW</u>
September, 1968	7.3	10.4	45	80
August, 1968	5.8	10.6	60	60
July, 1968	3.8	14.2	75	40
July-September 1967*	8.6	7.1	65	75
July-September 1966*	4.9	6.9	50	65

*Three month average

The P-32 concentrations in the KE Reactor effluent are similar to those of prior years. On the other hand, the P-32 results from KW Reactor are higher than formerly experienced. The As-76 concentrations from both reactors are consistent with prior years.

Late in August a coolant turbidity test* was initiated at KE Reactor. The test was to compare the radioactivity resulting from coolant having a turbidity of 0.05 JTU with that resulting from 0.1 JTU turbidity coolant. Definitive results have not yet been obtained.

c. Long Term Trends

The long-term trends in P-32 and As-76 concentrations are shown in Figure 1.

1) Phosphorus-32

The release rates of P-32 averaged 12, 22, and 21 curies per day during July, August, and September, respectively.

*DUN-4313, "Production Test Authorization-142, Half Plant Test of Process Water Turbidity, 183 KE," G. W. Wells and R. G. Geier, August 14, 1968 (Unclassified)

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The 12-month average release rate at the end of September was 25 curies per day. This can be compared to a 12-month average of 28 curies per day as of the end of December 1967.

2) Arsenic-76

The release rates of As-76 averaged 130, 160, and 140 curies per day during July, August, and September, respectively. The 12-month average release rate at the end of September was 230 curies per day. This compares to a 12-month average of 270 curies per day at the end of December 1967.

C. Neptunium-239

1. Concentration in Reactor Effluent

The monthly average concentrations of Np-239 in the small and K Reactor effluent are shown in Figure 2.

2. Reactor Output

The 12-month average release rate of Np-239 at the end of September was 260 curies per day as compared to 280 curies per day at the end of December 1967.

D. Chromium-51

1. Concentration in Reactor Effluent

The monthly average concentrations of Cr-51 in the small and K Reactor effluent are shown in Figure 2.

2. Reactor Output

The 12-month average release rate of Cr-51 at the end of September was 510 curies per day. This can be compared to a 12-month average release rate of 820 curies per day at the end of December 1967.

E. Water Plant Operating Conditions

The changes made in coolant treatment since mid-1961 are shown in Table 1. No changes were made during the period.

III. RESEARCH AND DEVELOPMENT

A. Computer Model

A special trace element addition test was carried out in KE Reactor in which trace amounts of soluble arsenic and bromine compounds were

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were added to the inner flow channel of the fuel elements. By limiting the addition to the inner channel, the test was restricted to a region with one flow velocity, a simple geometry and a single temperature profile. With these restrictions in the experiment, fewer assumptions will be needed when the data are analyzed.

The addition of two compounds, one of which (arsenite) forms highly insoluble compounds with iron and aluminum, and the other of which (bromide) forms soluble compounds, was scheduled in order to determine the behavior of two compounds with different solubility properties under identical conditions. That there is a difference in behavior is seen from the effluent activities of the two compounds. The bromine activity achieves steady state in approximately 12 hours, whereas the arsenic activity requires nearly seven days. The implication is that, although the concentrations are too low to cause precipitation, the adsorption is significantly greater for the species forming the least soluble compounds.

Preliminary results show that the distribution of arsenic on the fuel element surfaces is consistent with the hypothesis that a large fraction of the arsenic interacts very rapidly with the fuel element surface.

In an attempt to estimate the deposition of the radioactive species in the effluent sampling line, sections of a special nylon tube used as the sampling line are being examined.

B. Water Quality Studies

Samples of Columbia River water were taken above the Hanford reactors and are being analyzed by neutron activation methods. Preliminary results indicate that the following trace elements can be quantitatively determined: Na, K, Rb, Cs, Au, Ag, Zn, Fe, Sc, Se, Sb, As, Br, Co, Cr, Hg, U, Sr, Ba, Mn, Cu, and possibly Cl and Th.

C. Water Treatment Pilot Plant

A ferrous-permanganate water treatment system is being evaluated in the Water Treatment Pilot Plant (WTPP) operation. The initial phase involves the addition of 0.50 ppm KMnO_4 and 3.38 ppm FeSO_4 at pH 6.6 to the raw water. During this evaluation the WTPP output will be put to drain; i.e., not used as reactor coolant. Samples of influent and effluent water will be analyzed for completeness of reaction of the additions and trace element impurities.

D. Deionized Water

Design specifications are being prepared for a water transport system to permit introduction of deionized water to the head end of the Water Treatment Pilot Plant. Production test authorization is being sought for studies utilizing this new capability.

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E. Film Studies

Studies were started on the rates of leaching of radionuclides from the film on corroded fuel element spacers. Preliminary results seem to show that initially much of the material is removed in the form of small particles of the film.

F. Water Filtration Studies

Media samples from the filters at the 100 KW water treatment facility were taken and the grain size distributions determined. The samples were removed from the filters by coring the media with a two-inch hand-operated core drill and slurring the media from the drill with a vacuum system. The media samples were dried, sieved, and weighed. Anthracite was separated from sand with an upflow sand washer for sieve sizes containing both media. The following table lists the effective sizes and uniformity coefficients which were determined according to Hazen's method.

100 KW Filter Media

e = effective size
u = uniformity coefficient

<u>Filter</u>	<u>Anthracite</u>		<u>Sand</u>	
	<u>e</u>	<u>u</u>	<u>e</u>	<u>u</u>
3 E	0.94	1.59	0.45	1.40
W	0.93	1.55	0.46	1.39
4 E	0.95	1.64	0.45	1.42
W	0.96	1.54	0.46	1.39
5 E	0.94	1.57	0.43	1.38
W	0.90	1.63	0.48	1.41
6 E	0.86	1.63	0.43	1.40
W	0.88	1.58	0.46	1.39
7 E	0.94	1.63	0.44	1.30
W	0.92	1.59	0.44	1.30
8 E	0.96	1.60	0.46	1.44
W	1.00	1.59	0.46	1.41
9 E	0.92	1.61	0.44	1.32
W	0.98	1.63	0.47	1.34
10 E	0.92	1.61	0.47	1.41
W	0.89	1.55	0.43	1.38
11 E	0.90	1.56	0.43	1.37
W	0.94	1.67	0.43	1.37
12 E	0.95	1.58	0.45	1.29
W	0.87	1.54	0.41	1.41
13 E	0.86	1.72	0.43	1.38
W	0.96	1.64	0.42	1.39
14 E	0.93	1.68	0.42	1.37
W	0.98	1.70	0.46	1.43
Mean	0.93	1.61	0.45	1.38

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Assuming specific gravities of 1.57 and 2.65 and porosities of 0.46 and 0.40 for anthracite and sand, respectively, the volume of each media sample was computed using the following equation:

$$\text{Volume} = \frac{\text{Total weight of medium}}{\text{Specific gravity} \times (1 - \text{Porosity})}$$

Using the ratio of the volume of anthracite to total volume of the sample, the depths of anthracite and sand in a 30-inch bed were computed. The data are shown in the following table.

Depth of Anthracite and Sand
in 100 KW Filters

<u>Filter</u>	<u>Anthracite, in.</u>	<u>Sand, in.</u>
3 E	24.4	5.6
W	22.8	7.2
4 E	24.6	5.4
W	24.7	5.3
5 E	23.7	6.3
W	27.0	3.0
6 E	24.7	5.3
W	24.3	5.7
7 E	25.3	4.7
W	24.8	5.2
8 E	24.3	5.7
W	24.4	5.6
9 E	24.9	5.1
W	24.6	5.4
10 E	26.3	3.7
W	23.7	6.3
11 E	24.5	5.5
W	23.7	6.3
12 E	27.0	3.0
W	24.5	5.5
13 E	23.5	6.7
W	22.9	7.1
14 E	23.9	6.1
W	23.5	6.5
Mean	24.5	5.5

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TABLE I

WATER PLANT OPERATING CONDITIONS

Alum Feed Rate Changes, ppm

Initially all reactors variable from 3 to 14.

7/1/61	C to 18	5/1/63	KE, KW variable 12 to 18
7/6/61	KE and KW to 18	2/1/65	KW to 8
9/6/61	KW to 8	8/20/65	KW to 3
10/6/61	KW to 12	10/15/65	KW to 6
12/6/61	KW to 18	1/12/66	KW to 9
3/9/62	KE and KW to 10	3/27/66	KW to 12
4/12/62	KE to 13	9/15/66	KW to 15
4/30/62	KW to 18	9/1/67	C to zeta potential control
5/21/62	KW to 20, KE to 18	11/8/67	KE and KW zeta potential control
9/1/62	KW to 18		
2/15/63	KE, KW Variable 6 to 18		
4/1/63	KE, KW to 12		

pH Changes

Initially all reactors 7.0

6/23/61	KW to 6.6	12/6/64	KE to 6.6
9/26/61	KE to 6.6	11/21/66	1/2 KW & KE to 6.8
3/1/63	C to 6.6	1/5/67	1/2 KW & KE to 6.6
9/25/64	KW, KW to 7.0	9/19/67	1/2 C to 6.2
12/5/64	KW to 6.6		

Dichromate Changes, ppm

Initially all reactors 1.8

9/29/60	1/2 C to 1.0	4/14/64	1/2 C, KE, KW to 1.0
7/1/61	KE to 1.0	9/19/67	C to 0.5
9/26/61	KE to 1.8	3/21/68	KE to 0.5
9/5/63	KE, KW to 1.4		

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FIGURE I

RADIOACTIVITY IN REACTOR EFFLUENT

FIGURE II

RADIOACTIVITY IN REACTOR EFFLUENT

NEPTUNIUM-239

CHROMIUM-51

END

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