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QUARTERLY REPORT
CONTAMINATION CONTROL - COLUMBIA RIVER
OCTOBER - DECEMBER 1968

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QUARTERLY REPORT
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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 food-stuffs.
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 15.6, 13.9, and 15.5 ppm during October, November, and December, 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:

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	Phosphorus-32 <u>pCi/ml</u>	Arsenic-76 <u>pCi/ml</u>
December 1968	9.9	95
November 1968	11.4	90
October 1968	10.7	95
October-December 1967*	13.5	140
October-December 1966*	10.4	95

*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 October and December.

b. K Reactors

The alum feed rates were 13.8, 13.0, and 12.1 ppm during October, November, and December, respectively, at KE Reactor and 13.8, 13.6, and 11.9 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:

	Phosphorus-32 <u>pCi/ml</u>		Arsenic-76 <u>pCi/ml</u>	
	<u>KE</u>	<u>KW</u>	<u>KE</u>	<u>KW</u>
December 1968	6.8	7.7	95	65
November 1968	6.7	4.7	75	70
October 1968	7.4	6.7	80	75
October-December 1967*	6.8	5.6	70	75
October-December 1966*	5.8	5.5	55	60

*Three-month average

The P-32 concentrations in the effluent from both reactors are similar to those of prior years. The As-76 concentrations from both reactors are also consistent with prior years.

Phase I of the half-reactor coolant turbidity test (0.1 JTU test side vice 0.05 JTU control side) was completed early in November and showed no difference in effluent radioactivity between the two sides. Phase II (0.2 JTU test side vice 0.05 JTU control side) has been underway for about two months and there is still no difference in effluent radioactivity.

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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 19, 16, and 19 curies per day during October, November, and December, respectively. The 12-month average release rate at the end of December was 24 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 210, 190, and 200 curies per day during October, November, and December, respectively. The 12-month average release rate at the end of December was 210 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 December was 270 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 December was 430 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.

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E. Water Plant Operating Conditions

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

III. RESEARCH AND DEVELOPMENT

A. Water Treatment Pilot Plant

Samples of raw water and effluent from the Waste Treatment Pilot Plant (WTPP) have been analyzed for iron to determine completeness of reaction of the additives. Under the initial conditions (0.50 ppm KMnO_4 , 3.38 ppm FeSO_4 , pH 6.6), the iron concentration found in filtered effluent was 2 to 3 times that found in filtered raw water, indicating that the reaction was not complete. On September 5 the conditions were changed to 1.25 ppm KMnO_4 , and pH 7.6. Under these conditions, the iron found in raw water and effluent were about equal. Two samples of process water taken from the flume at 183-KE were analyzed for iron for a comparison with the WTPP samples and were found to be about of equal iron content. Several samples of filtered raw water and effluent were prepared and irradiated for activation analysis. The results of the samples analyzed for trace element removal are inconclusive since the samples were taken before adjustments were made in the treatment process. However, even at the unadjusted conditions, there appeared to be some reduction in trace elements, especially Co and Ag, which were apparently reduced to about 1/10 and 1/2, respectively.

The concentrations of the additives FeSO_4 and KMnO_4 were increased to 6.76 ppm and 2.50 ppm, respectively. This was done to determine if higher additive concentrations would increase the efficiency of trace element removal. Analysis for iron in the raw water and basin effluent indicated that the additives are still reacting completely under these conditions. Samples of raw water and effluent at the above conditions have been taken and will be analyzed for trace element content.

B. Computer Program

In previous reports the buildup of radioarsenic and radiobromine as a function of time during the recent KE Reactor trace element injection test has been discussed. Mention has also been made of the radioarsenic concentration on the fuel elements discharged at the completion of the test.

During the past month the radioarsenic and radiobromine concentrations in the fuel element films have been determined. Data for the former are consistent with previous studies. Concentrations are roughly proportional to the product of neutron flux and parent isotope concentration. This supports the hypothesis that significant quantities of arsenic are in the film rather than on its

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surface. On the other hand, the same dependence cannot be seen for radiobromine due primarily to the large scatter in the data. This scatter is thought to be caused by the solubility of the bromides which permitted significant, and undetermined, amounts of bromide to escape into the water during the time the fuel elements were being stored. Because the amount appears to increase with distance downstream, bromine present is probably also primarily in the film rather than on the surface.

The amounts of radioarsenic in the film on the surface of the nylon tube used as the effluent sample line decreased slightly with increasing distance from the reactor. This is interpreted as being caused by the decrease of the amount of adsorbent surface ("crud" deposit) with position.

C. Water Quality Studies

The river water sample collected August 3, 1968, and irradiated August 8, 1968, was counted on the multidimensional gamma-ray spectrometer systems and the Na, K, Rb, Cs, Au, Ag, Zn, Fe, Sc, Sb, As, Br, Co, Cr, Se, Hg, Sr, Mn, and Cu contents determined. It is interesting to compare these latest results with those from the sample collected in early April: As an Zn contents are about the same; Sc, Sb, and Cu are higher by factors of about 2, 5, and 10, respectively; while Mn is one-tenth its earlier value.

Results from the analysis of a river water sample taken September 12, 1968, in parts per billion are: Na (1700), K (400), Rb (<1), Cs (1.2), Sc (0.004), Cr (<0.5), Mn (5.5), Fe (355), Co (0.3), Cu (0.3), Zn (47), Hg (0.6), As (1.7), Sb (0.4), Se (4.9), and Br (4.3). These concentrations are lower in the case of most of the elements than was found in the August sample except for manganese which was a factor of 10 higher. Concentration differences may be a result of actual variations in river water concentrations, loss of trace elements by adsorption onto container walls during the storage period, or loss of trace elements through precipitation scavenging during the storage period. The latter two possibilities become significant when the inner portion of the frozen water sample is used for analysis. Errors from these effects could be eliminated by immediate irradiation analysis after sampling. Thus, the above effects must be thoroughly investigated for any samples stored for any length of time.

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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	KE, 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 1.

RADIOACTIVITY IN REACTOR EFFLUENT

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Figure 2.

RADIOACTIVITY IN REACTOR EFFLUENT

NEPTUNIUM-239

CHROMIUM-51

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