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SCINTILLATOR CORRELATION

AND

COLUMBIA RIVER RADIATION SURVEY

MARCH - APRIL, 1959

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by

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SCINTILLATOR CORRELATION AND COLUMBIA RIVER RADIATION SURVEYMARCH - APRIL, 1959INTRODUCTION

The purpose of the work documented herein was to correlate a new sensitive scintillator for the measurement of gamma dose rates from the reactor effluent isotopic spectrum in the Columbia River. Previous scintillation devices lacked the desired sensitivity for estimating these dose rates.

SUMMARY

A portable scintillation device was calibrated against ionization chambers over essentially the full range of dose rates from the reactor effluent spectrum in the Columbia River. A river survey was then made, combining scintillator readings with pulse pencil and portable instrument readings from 1-1/2 miles above the reactors to about 57 miles downstream. Dose rates ranged from about .018 mr/hour background to 2.5 mr/hour over the effluent bubbles and 15 mr/hour on one island. Dose rates were 0.1 to 0.2 mr/hour at downstream locations.

CORRELATION OF SCINTILLATORS

River surveys were attempted with a scintillator using a 100 pound 17-inch crystal, but its poor sensitivity and the rough correlation against pulse pencils left much to be desired. Data from the surveys of May⁽¹⁾ and August, 1958, are not included here.

A scintillator was subsequently devised and used which employed a 5-inch plastic crystal with a 5-inch photomultiplier tube.⁽²⁾ A transistorized count rate meter contributed to portability. The meter was connected to an Esterline-Angus spring-driven recorder. This handier, more sensitive device, with an improved method of calibration, apparently gave reliable results on a survey made in March and April of 1959.

The average count rate output of the 5-inch scintillator was related to dose rate by actual operation on the river simultaneously with charged Victoreen Models 208 and 239 Stray Radiation Chambers. The amount of exposure to the Victoreen chambers was then determined by measuring the amount of current required to recharge them with the Hanford Pulse Pencil Reader.⁽³⁾ Correlations inside the hull of a fiberglass boat were determined by averaging the charted scintillator count rate over the measurement period against Victoreen chamber measurement.

The pencil reader and a portable power supply were placed on shore near the location to be measured. Chambers were charged, placed in lead casks, removed from the casks and exposed over an effluent bubble or downstream location from .1 to 1.5 hours, returned to the casks, and taken back to shore for measurement.

Comparisons of scintillator count rates against chamber readings were made over several of the reactor effluent release points, the Hanford AEC boat dock, Richland boat docks, Pasco Filter Plant inlet and off Sacajawea Park at the junction of the Columbia and Snake Rivers.

A curve of count rate versus chamber measurements, Figure 1, Appendix A, was drawn from these data. Future measurements of count rate can be converted

to an estimate of exposure rate from penetrating radiation at any point on the river. It is necessary to assume that the energy spectrum of radiation is the same as during the calibrations, and that no change in composition occurs regardless of flow conditions or distance downstream from the reactors. It must also be assumed that the relative response of the instruments do not vary with the change in the spectrum. A curve generated by the points measured on the river has the same non-linearities observed as when the scintillator was checked against a radium source.

Dose rates read from Figure 1 may be questionable below about .03 mr/hour. The lowest point on the curve is the average background level obtained 1/2 and 1-1/2 miles upstream of the reactors, and upstream from the mouths of the Snake and Yakima Rivers since August of 1958. Background radiation was measured with gamma pulse pencils inside polyethylene bottles. These were exposed in weekly periods on the river surface. The background dose rate on the river was about .018 mr/hour from natural sources and fallout. None of the figures and tabular data in Appendix A has been corrected for background.

MECHANICS OF THE RIVER SURVEY

Figure 2 illustrates the section of the Columbia River surveyed in March and April, 1959. Hanford river miles are numbered and islands are lettered for identification.

Gamma pulse pencils in sets of five, for estimates of dose rates to gonads, were placed three feet high on stakes on both banks at each river mile from 1-1/2 miles above the most upstream reactor to Hanford at Mile 20. From Mile 20 downstream, pencils were placed at each mile on alternate shores. At least one group of pencils was placed on each island. Portable instrument readings were made at stake locations. During the traverses of the river to set pencil stakes, the scintillator was constantly operating in the boat, and higher indicated dose

rates were checked with Samson and CP instruments. Some readings were missed due to difficulties caused by high wind and waves. Pencils on three foot high stakes were exposed for six days, and during this time, island surveys were made with portable instruments.

DISCUSSION OF SURVEY DATA

Table I lists data obtained on the March - April, 1959, survey. Scintillator measurements in the boat over the effluent bubbles ranged from 0.6 to 1.8 mr/hour average levels to a maximum of 2.5 mr/hour with the scintillator held outside the boat. Dose rates decreased quickly with river dilution, depletion and decay, until at Hanford, about six miles below the most downstream reactor, the dose rate level was about .06 mr/hour through the boat and about 0.1 mr/hour outside of the boat. Dose rates over the river continued to decrease and approached background below Pasco. However, 0.1 mr/hour remained on the plant shore and on the shores of some islands as far down the river as Richland, based on pencil results. Dose rates are lower downstream of Richland because of the diluting and diverting effect of the Yakima River which joins the Columbia directly below Richland.

The accumulation of foam and debris in backwater frequently causes higher dose rates. Readings along the walkway at one large Richland boat dock are usually 0.2 mr/hour and occasionally readings ten times that high are observed around docks for short periods during certain wind conditions.

Table II lists pencil dose rates from the routine program wherein pencils are exposed in the river for weekly periods in plastic bottles. A few of the results are noted in the "Remarks" column of Table I as a rough correlation to the three foot high pencil dose rates.

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APPENDIX A

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FIGURE 1

CORRELATION OF 5" SCINTILLATOR COUNT RATE AGAINST
IONIZATION CHAMBER MEASUREMENTS
The radiation source was the reactor effluent spectrum in the
Columbia River.

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FIGURE 2
THE SECTION OF THE COLUMBIA RIVER
SURVEYED MARCH-APRIL, 1959

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TABLE I

COLUMBIA RIVER SURVEY DATAMARCH 17 - 24 AND APRIL 17, 1959

Columbia River flow averaged about 100,000 cfs
 March 17 - 24 and 125,000 cfs on April 17, 1959.

PORTABLE INSTRUMENT READINGS

Columbia River Locations	GM c/m	Samson Thru Boat mr/hr	Scintillator Thru Boat mr/hr	Remarks	Pulse Pencils 3' above shore mr/hr
1 1/2 miles above 100-B	< 200		.018	.018 mr/hr B.G. on river pencils Aug. 1958 - March 1959	.02
1/2 mile above 100-B	< 200		.018		.018
100-B Area Mile 0	< 200		.018		.018
100-B-C Effluent Bubble	2000	< 1 on CP	.6		
Mile 1 100-B-C Effluent Plume	< 200		.018		.02
Off-Plant Shore	< 200		.25		.018
Mile 2	300		.018		.018
100-B-C Effluent Plume			.021		.035
Off-Plant Shore	400		.08		
100-K Effluent Bubble	3-6000	< 1+2 mrad on CP	.029	Peaks to 1.5 mr/hr on scintillator.	.027
Mile 3 100-K Effluent Plume	< 200		.029		.043
Off-Plant Shore	< 200	.24	.27	.32 mr/hr on chamber outside boat.	
Mile 4	250		.018		.039
100-K Effluent Plume		.22	.024		.046
Off-Plant Shore	200		.24		
Mile 5	< 200		.018		.047
100-K Effluent Plume		.19	.029		.049
			.22		

(Table I Continued)

PORTABLE INSTRUMENT READINGS

Columbia River Location	GM c/m	Samson, Thru Boat mr/hr	Scintillator Thru Boat mr/hr	Remarks	Pulse Pen- cils 3' above shore mr/hr
Off-Plant Shore	200		.02		.02
Mile 6	200		.035		.061
100-K Effluent Plume	200	.14	.16		
Off-Plant Shore	250		.02		.03
Mile 7	4000	2 on CP	.07	Edge of 100-D Area spillway from waste water filters.	> .135
100-D Effluent Bubble	8000	1.5	1.4	1.6 mr/hr peak.	
100-DR Effluent Bubble	10,000	1.6	1.56 av.	1.8 mr/hr peak on scintillator. 1.65 mr/hr on chamber outside boat.	
Off-Plant Shore	200		.02		.036
Island B	800	1 on CP	.13	15 mr and 18 mrad on 100-D effluent jets and mud.	> .135
(From Boat)	(From Boat)				
Mile 8	< 200				.035
100-D-DR Effluent Plume		.14	.27	.12 mr/hr from P.C. and KE, KW effluent with D-DR shutdown.	
Off-Plant Shore	< 200		.02		.018
Island C	500 av.		.07		.06
Island D	500 av.		.06		.074
Mile 9	200	.06	.06		.058
Off-Plant Shore	200		.025		.018
Mile 10	200	.04	.05		.04
Island E	200-900		.06		.08
Island F	200-900		.04		.04
Off-Plant Shore			.06		.07
100-H Effluent Bubble	5000	1 mr/hr on CP*	.65	* on August 1958 Survey.	
Mile 11	4000		.29		> .135
100-H Effluent Plume			.28		
Island G	600		.045		.08
Off-Plant Shore	200		.035		Lost
Mile 12	300		.05		.046
100-H Effluent Plume			.23		

(Table I Continued)

PORTABLE INSTRUMENT READINGS

Columbia River Location	GM c/m	Samson, Thru Boat mr/hr	Scintillator Thru Boat mr/hr	Remarks	Pulse Pencils 3' above shore mr/hr
Off-Plant Shore	200		.024		.055
Mile 13	500		.05		.10
Off-Plant Shore	200		.024		.05
Mile 14	500		.08	White Bluffs .077 mr/hr on river pencils.	.10
Off-Plant Shore	200		.029		.04
100-F Area Spillway	2500	2.0	.25	over spillway.	> .135
100-F Effluent Bubble	10,000	1.5 • 2.5	1.5 • 1.8	Estimate 2.5 mr/hr peaks on scintillator held outside boat.	
Mile 15	250				.06
100-F Effluent Plume		.65	.6		
Island H	350				Est
Off-Plant Shore	< 200				.05
Mile 16	500	.08	.08		
Island I	500				> .135
N. Side Island J	350				.02
Off-Plant Shore	250				.02
Mile 17	350		.075		.10
Island K	350				.06
Off-Plant Shore	250				.073
Mile 18	300		.07		.073
Off-Plant Shore	250				.057
Mile 19	250		.065		.074
Off-Plant Shore	< 200				.046
Mile 20	350		.06	Hanford .11 mr/hr on routine river pencils.	.127
Off-Plant Shore	350				.055
Mile 21	300		.055		.074
Mile 22 - Off-Plant	200				.039
Mile 23	250				.046
Mile 25 - Off-Plant	150				.06
Mile 26	250		.045		.06
Island L	250			.09 mr/hr on routine river pencils.	.12
Mile 27	< 200				.032
Island M	600			Off-Plant side.	.054
Mile 28 - Off-Plant			.04	Ringold.	
Island N	3000			Off-Plant side.	.066
Mile 29	< 200				.045

(Table I Continued)

PORTABLE INSTRUMENT READINGS

Columbia River Location	GM c/m	Samson, Thru Boat mr/hr	Scintillator Thru Boat mr/hr	Remarks	Pulse Pencils 3' above shore mr/hr
Island O	600				
Mile 31-1/2	500		.028	Power line crossing.	.13
Mile 31-1/2 - Off-Plant	200		.025	Swimming, fishing.	.05
Island P	400				.045
Mile 32	350			Heavy wind and waves caused scarcity of scintillator and hand instrument data.	.05
Island Q	350		.025		.07
Mile 33 - Off-Plant	200				.045
Island R					
Mile 34	300				.06
Mile 35 - Off-Plant	250				.05
Mile 36					.08
Island S	3000		.023		.055
Mile 37 - Off-Plant	350				.04
Mile 38			.023	Below 300 Area.	.11
Island T	400				.095
Island U	500				.04
Mile 40			.023	Richland Ferry Cab. .039 mr/hr, pencils.	
Mile 40 - Off-Plant					.04
Mile 41			.022		.05
Island V	400				
Island W	700 av.		.022	Nelson Island, 2000 c/m on mud.	.11
Richland Docks	2500-21,000		.021	Samson - 0.2 mr/hr on patches of foam & debris. .07 mr/hr on routine river pencils.	.11
Island Y	400-2500		.02	Island opposite Columbia Park. .07 mr/hr, routine river pencils.	.03
Pasco Pumping Plant	300		.022	.05 mr/hr, routine river pencils.	
Sacajawea Park	200		.018	.03 mr/hr on routine river pencils.	

TABLE II

DOSE RATE MEASUREMENTS IN THE COLUMBIA RIVER

Units of mr/hour

(Measured weekly with pocket dosimeters in plastic bottles - floating or submerged.) Background rate of ~.018 mr/hr is included in readings.

Period 1958	<u>White Bluffs</u>		<u>Hanford</u>		<u>Ringold</u>			<u>Richland</u>		<u>Pasco</u>		<u>Kenne- wick</u>	<u>Fin- ley</u>
	Plant Side	Oppo Side	Plant Side	Plant Side	Plant Side	Plant Side	Isl	Plant Side	Opposite Side	Plant Side	Opposite Side	Plant Side	Plant Side
April	.09	.05	.1		.06	.05		.05		.04		.02	.02
May	.07	.03	.07		.05	.02		.03		.04		.02	.02
June	.05	.02	.04		.04	.02		.03		.04		.03	.02
July	.08	.03	.08		.07	.06		.07		.04		.03	.02
August	.08	.04	.11		.07	.04		.05	*.07	.04		.03	.02
September	.10	.05	.13		.08	.07		.05	*.07	.04	*.04	.03	.02
October	.16	.08	.14	*.2	.12	*.17	.08	.08	*.08	.04	*.05	.03	.02
November	.12	.05	.13	*.17	.11		.05	.08	*.07	.04	*.05	.04	.02
December	.16	.06	.14	*.19	.10	*.14	.07	.09	*.08	.05	*.06	.04	.03
1959													
January	.09	.07	.12	*.16	.09	*.12	.06	.08	*.07	.07	*.06	.04	.03
February	.08	.07	.11	*.14	.09	*.11	.06	.07	*.07	.07	*.07	.03	.03
March	.10	.07	.11	*.09	.07		.06	.06	*.06	.06	*.05	.03	.02
AVERAGE	.10	.05	.11	*.06 0.16	.08	*.04 0.14	.05	.06	*.07	.05	*.05	.03	.02

* Refers to submerged pencils.

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