

CLASSIFICATION

UNCLASSIFIED

701872

DOCUMENT IDENTIFICATION NO.

BNWL-CC-1992

BATTELLE NORTHWEST  
BATTELLE MEMORIAL INSTITUTE PACIFIC NORTHWEST LABORATORY  
POST OFFICE BOX 999 / RICHLAND, WASHINGTON 99352

COPY AND SERIES NO.

DATE

January 13, 1969

TITLE AND AUTHOR

PROGRESS REPORT ON O2 RESEARCH AND DEVELOPMENT  
MISSION 10 - COLUMBIA RIVER STUDIES  
July - December 1968

J. F. Honstead  
Ecosystems Department  
and

R. T. Jaske  
Water and Land Resources Department  
Pacific Northwest Laboratory

CONTRACT

- 1830  
 - 1831

PROJECT NO.

RESERVED FOR TECH. INFO. USE

NAME	COMPANY	LOCATION	NAME	COMPANY	LOCATION
<u>External</u>			<u>Internal</u>		
1	W. S. Bryan	AEC-RL	32	J. P. Corley	BNW 3705/300
2	W. E. Lotz	Fed/700	33	R. F. Foster	326/300
3-26	M. R. Schneller	Fed/700	34	J. F. Honstead	3702/300
27	R. B. St. John	Fed/700	35	R. T. Jaske	713/300
			36	J. K. Soldat	3702/300
			37	R. E. Burns	324/300
29-31	R. G. Geier	DUN 1760-D/100-D	38	C. E. Elderkin	622R/200-W
			39	J. M. Nielson	329/300
			40	D. W. Pearce	3706/300
			41	W. L. Templeton	1704-F/100-F
			42	C. M. Unruh	3706/300
			43	E. C. Watson	622R/200-W
			44-46	Central Files	
			47-51	Extra	

WSU Tri-Cities Campus  
REPOSITORY PNL Public Reading Room  
COLLECTION Columbia River  
BOX No. Open Shelving  
FOLDER \_\_\_\_\_

ROUTE TO	PAYROLL NO.	COMPANY	LOCATION	FILES ROUTE DATE	SIGNATURE AND DATE
<del>Bill Plancy</del>	<del>30032</del>		<del>LS</del>		

Approved for Release

Date 3/15/90

UNCLASSIFIED

Columbia River  
5.1.90 (DR-PC)

Acc # 8749

## INFORMATION CONCERNING USE OF THIS REPORT

### PATENT STATUS

This document copy, since it is transmitted in advance of patent clearance, is made available in confidence solely for use in performance of work under contracts with the U. S. Atomic Energy Commission. This document is not to be published nor its contents otherwise disseminated or used for purposes other than specified above before patent approval for such release or use has been secured, upon request, from the Chief, Chicago Patent Group, U. S. Atomic Energy Commission, 9800 So. Cass Ave., Argonne, Illinois.

### PRELIMINARY REPORT

This report contains information of a preliminary nature prepared in the course of work under Atomic Energy Commission Contract AT(45-1)-1830. This information is subject to correction or modification upon the collection and evaluation of additional data.

### LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

## PACIFIC NORTHWEST LABORATORY

RICHLAND, WASHINGTON

operated by

BATTELLE MEMORIAL INSTITUTE

for the

UNITED STATES ATOMIC ENERGY COMMISSION UNDER CONTRACT AT(45-1)-1830

6886000

UNCLASSIFIED

BNWL-CC-1992

PROGRESS REPORT ON O2 RESEARCH AND DEVELOPMENT  
MISSION 10 - COLUMBIA RIVER STUDIES  
July - December 1968

by

J. F. Honstead  
Effluent Studies  
Ecosystems Department  
ENVIRONMENTAL AND LIFE SCIENCES DIVISION

and

R. T. Jaske  
Water Resources Systems Section  
Water and Land Resources Department  
ENVIRONMENTAL AND LIFE SCIENCES DIVISION

Pacific Northwest Laboratory  
Battelle Memorial Institute  
Richland, Washington

January 13, 1969

0009890

UNCLASSIFIED

UNCLASSIFIED

BNWL-CC-1992

PROGRESS REPORT ON O2 RESEARCH AND DEVELOPMENT  
MISSION 10 - COLUMBIA RIVER STUDIES  
July - December 1968

P R E F A C E

Mission 14 - Columbia River Studies, includes, at this time, a sub-program on "Effluent Activity Reduction" carried out by Douglas United Nuclear, Inc., and two sub-programs "Mechanisms of Environmental Exposure" and "Effects of Reactor Effluent on the Quality of Columbia River Water", carried out by Battelle-Northwest. This semi-annual report is confined to the sub-programs assigned to Battelle-Northwest.

Both of the sub-programs covered in this report are concerned with the impact of Hanford effluents on the environment -- especially the Columbia River. The "Mechanisms of Environmental Exposure" studies constitutes an invaluable complimentary program to the more routine environmental surveillance program because it provides new or improved knowledge of how and in what quantities radioactive contaminants reach people and contribute to their overall radiation dose. Thus, it provides guidance for the routine sampling and measurements and also provides an improved technical base from which dose calculations can be made.

The "Effects of Reactor Effluent on the Quality of Columbia River Water" has been more concerned with heat and toxic chemicals than with radionuclides per se and has dealt especially with the physical processes that affect the distribution and dissipation of heat and chemical additions. Through a combination of field measurements and mathematical modeling a capability is being developed for predicting the downstream effects of a variety of acute or chronic releases under a wide range of river and weather conditions.

0009891

UNCLASSIFIED

UNCLASSIFIED

2

BNWL-CC-1992

PROJECT TITLE Mechanisms of Environmental Exposure  
RESPONSIBLE MANAGER R. F. Foster  
PRINCIPAL INVESTIGATOR J. F. Honstead  
REPORTING PERIOD July 1, 1968 through December 31, 1968

	<u>FY-1968</u> <u>BUDGET</u>	<u>FY-1968</u> <u>ACTUAL</u>	<u>FY-1969</u> <u>BUDGET</u>	<u>JULY-DEC '68</u> <u>EXPERIENCE</u>	<u>FY-1969</u> <u>ESTIMATE</u>
COSTS (THOUSANDS)	100	100	75	45.5	75
SCIENTIFIC MANPOWER (MAN YEARS)	1.5	1.5	1.0	----	1.0

I. SCOPE AND OBJECTIVES

Various pathways may be postulated whereby members of the population living adjacent to the Hanford plant can receive radiation exposure as a result of the plant operation. This project is concerned with investigations designed to evaluate the mechanisms of exposure of population groups by various pathways. The study, for example, will try to evaluate the effect of effluents released to the Columbia River and to the atmosphere. Here the exposure estimates depend upon evaluation of the average and extreme dietary habits of members of the affected population to assess the average and extreme exposure possibilities.

These investigations will provide more precise estimates of exposure levels experienced by local residents and strengthen the confidence in effluent control provisions. The quantitative description of mechanisms of transfer of radioactive materials through various pathways may also be used to predict the effects of changes, such as new product operations or the release of additional plant areas for industrial or agricultural development.

II. PRIOR WORK

1. A magnetic-tape file of data was prepared for digital-computer application to investigate relationships between diet components and whole-body counting results. The file contains analytical data from the whole-body counter for  $^{24}\text{Na}$ ,  $^{40}\text{K}$ ,  $^{65}\text{Zn}$ , and  $^{137}\text{Cs}$ , as well as dietary data extrapolated from a diet questionnaire completed by each person measured on the whole-body counter. Correlations of body burdens with diet levels can identify exposure pathways. The results of radionuclide analyses of foodstuffs from the environmental

0009892

UNCLASSIFIED

UNCLASSIFIED

BNWL-CC-1992

monitoring program are also on the computer file. As additional whole-body counting and diet data become available they are added to the file.

2. A special study was designed and initiated to permit the accumulation of whole-body counting data for children to add to similar data routinely collected for Tri-City adults. The study was initiated in cooperation with local schools, and included obtaining a diet record and whole-body count from children volunteering to assist with this research. More than 4,000 children in elementary schools had participated in the study previously. Experiments were conducted to develop special calibration data for the whole-body counter to be used for data on children. It was found that calibration factors needed to be adjusted for children's body sizes.

3. A 12-month study designed to permit a statistical evaluation of fishing pressure on the Columbia River below the Hanford project was completed in early 1967. One Washington State Game Department Biologist was occupied full time with interviews of over 2100 fishermen. The results of the interviews were coded, key-punched and entered into a computer program in mid-1967 for statistical extrapolation of the data into characterization of the entire population of local fishermen.

4. Special studies were conducted to investigate the uptake and retention of radionuclides in certain locally-produced foodstuffs. Studies of fish consumption, seafood consumption and other foods were conducted and reported. The results provided estimates of some of the parameters required for calculating exposure from the consumption of these foods. The experiments included whole body counting measurements and excreta analyses to establish uptake and retention data.

### III. PROGRESS DURING REPORT PERIOD

1. The study to measure radionuclide body burdens of school children was continued and extended to a new community (Kennewick, Washington). Three elementary schools were visited with the Mobile Whole Body Counter during this reporting period, and the children were invited to participate in the study. Altogether about 1070 children ranging in age from 7 to 12 years volunteered for the project, completed the diet record, and were measured in the Whole Body Counter. This work concludes the elementary school phase of the study, and data from nearly 6000 children of Pasco, Kennewick and Richland have been entered in the magnetic tape file.

2. Initial contacts have been made at Richland Jr. and Sr. High Schools to obtain whole body radioactivity measurements for students in these secondary schools. Cooperation of the school officials and teachers has continued to be outstanding.

0009893



# UNCLASSIFIED

4  
BNWL-CC-1992

3. A study was designed to aid in definition of "Helping Sizes" as reported on the children's diet forms. Photographs were taken of various sizes of helpings of 24 representative foods. The photos will be used by home economics classes at Richland secondary schools to estimate visually the typical helping sizes consumed by members of the students' families.

4. Statistical analysis of the data collected on FY 68 on the influence of consumption of locally harvested game birds on human radiation doses from radionuclides of Hanford origin was completed. Several species of game birds had been collected from a wide geographical area centered on the Tri-City area with the help of the Washington State Game Department. Analysis of these birds revealed no detectable nuclides of Hanford origin in any samples collected more than a few miles from the Columbia River. The preliminary data from this study was utilized in the routine annual report of radiological conditions in the Hanford environs for 1967.

5. The file of dietary data compiled for 4,500 adult employees at the Hanford project and previously used to compute individual, annual, environmental radiation doses and distribution of doses, was employed to calculate these doses for the calendar year 1967. These results will also be reported in the routine annual report of radiological conditions in the Hanford environs.

6. A limited number of resident families from the Richland-Y area who claimed to eat Columbia River fish as their sole or principal meat supply, were measured in the Whole Body Counter. Only one individual had a detectable deposition of  $^{65}\text{Zn}$  and this burden was at the low level expected from routine consumption of Richland city drinking water.

## IV. EVALUATION OF EFFORT

This work continues to provide valuable guidance to the overall effort of evaluating the radiation exposure received by people living in the vicinity of the Hanford plant. With more exact data on the diets of local people, more realistic estimates on intake of radionuclides are possible. In effect, this results in lowering the dose estimates. Further, the whole body counts show that body burdens are generally lower than postulated from estimates of nuclide intake.

## V. FUTURE WORK

1. During the first half of 1969 the Mobile Whole Body Counter will be used to complete measurements of radioactivity in approximately 1000 secondary school children in Richland. If this does not prove to be a sufficient sample of this age group the study will be extended to other secondary school children in the 1969-1970 school year.

0009894



UNCLASSIFIED

5

BNWL-CC-1992

2. The study of "Helping Sizes" will be completed in 1969 and the results utilized to provide quantitative estimates of food consumption for children and adults whose dietary data is now on the magnetic tape file in terms of "number of helpings".

3. During the summer and early fall of 1969, whole body counting of fishermen and of residents of the area irrigated by Columbia River water will be emphasized.

4. A survey will be designed to permit measurement of radionuclides in the residents of fishing communities near the Pacific Coast in areas where local seafood receives radioactivity from the Hanford plant. The effect of stable isotopes concentration on radioisotopes uptake of various foodstuffs will be investigated from whole body counter and dietary data. Further study will be made to determine more precisely the direct, external exposure received by people swimming, boating, or water skiing on the Columbia River.

VI. TOPICAL REPORTS ISSUED

None

0009895





UNCLASSIFIED

BNWL-CC-1992

3. Continuous dye tests of effluent dispersion were completed for all reactors for at least three river flow rates. These releases provided approximate dilution factors as far downstream as the 300 Area over the range of river flow from 40,000 to 140,000 cfs. Short duration dye additions were completed at each reactor outfall for at least two river flow rates, providing approximate time of flow data as far as the 300 Area over the range of river flow from 40,000 to 100,000 cfs.
4. Temperature probing of all effluent plumes of the older operating reactors was completed and the data reduced to a mathematical model which describes the dimensions and temperature of the plumes over a river flow range of 40,000 to 200,000 cfs and for travel times up to 1,500 seconds below the outfall. Exploratory data in the region immediately below the discharges were taken.
5. Dissolved oxygen measurements made during temperature probing and in special cases failed to reveal any significant interaction between the thermal discharges and the concentration of dissolved oxygen in the Columbia River.
6. The input-output digital simulation model, originally developed for assessment of the effects of the Columbia River cooling program, was modified and improved to incorporate the effects of tributary streams and meteorological conditions on a regional basis. Additional modifications were made to permit modeling of radionuclide and chemical effluent discharges from any point on the Columbia or Snake River with resultant estimates of concentration and travel time as far downstream as Astoria, Oregon.
7. Special measurements taken during an extended period of plant shutdown indicate that temperature records for the 300 Area and Richland stations may not always reflect the true extent of the plant contribution to river temperature modification. Comparison of simulation modeling runs for various stations from Grand Coulee through Priest Rapids to Richland and Pasco indicate that measurements at 300 Area and Richland may be as much as 0.5° C high.

### III. PROGRESS DURING REPORTING PERIOD

1. Substantial progress in the refinement of computer simulation of the mixed discharge of the operating reactors below the plant was completed. The fundamental basis of the earlier COL HEAT simulation was completely audited and a new system involving superior treatment of transient variables was made operational. Features of this new system include reduction of truncation error in assignment of advected heat inputs to transient sections, on-line correction of river volumes and surface areas as a function of transient flow, and incorporation of side streams and intermediate reporting points at the option of the investigator. Routine operational error was reduced to a standard deviation from measured data of 0.30 degree Celsius.

0009897

2. Extensive use of the simulation system was completed in the course of analysis of the effects of the Washington State water quality standards on the operations of the plant. Simulations were made of temperatures at various points below the reactors and for various methods of data averaging to determine which combination minimized the production losses associated with the temperature difference limits.

3. Additional statistical studies were completed in support of studies of the regional effect of Hanford discharges on long term Columbia River temperature trends. Data available from other programs were used to estimate potential benefits from Canadian Dam construction to alleviate thermal effects of reactor operations. The estimate was made in relation to the 68° F (20° C) upper limit on temperature additions to the Columbia River. Weather data were analyzed statistically to identify significant features of an average and a warm year in relation to river temperatures.

4. Additional investigation of the mathematical modeling of the discharge plumes was initiated. The use of infra-red imaging of the actual discharges was started and computer processing of the resulting imagery accomplished. Three dimensional motion picture representation of the discharges was demonstrated. It was tentatively established that physical modeling of actual heated discharges as a guide to the development of a rational theory governing the dispersion of thermal discharges does not appear practical.

#### IV. EVALUATION OF REPORT

The comprehensive program concerned with temperature changes in the Columbia River and the relative significance of the Hanford reactors to the temperatures of the Columbia at points far removed from the plant boundaries has permitted the development of a level of technical achievement which is state of the art. The resulting mathematical simulation system was used in related AEC programs with a high degree of success and assisted in the establishment of the AEC as a leader in development of thermal analysis effects.

The ability of the plant to utilize the resulting analytical tools to effectively conduct self-analysis of effluent effects to a higher degree of sophistication than the associated regulatory agencies permitted hasty action to be forestalled and a moderate position developed in regulatory activity.

New knowledge concerning the thermal influence of relatively remote physical developments of the river both above and below the plant permitted insight into historical temperature trends in relation to fisheries resources. A factual basis for study of temperature trends in relation to various contributing sources of fisheries decline was established.



UNCLASSIFIED

BNWL-CC-1992

V. FUTURE WORK

Fiscal 1969

1. Primary emphasis will be placed on the development of improved versions of the plume dispersion models. By taking maximum advantage of new sophistication in infra-red imagery and related mathematical data processing. The research plan includes verification of the resulting model to the extent that the probability of fish involuntarily entering the mixing zone can be established.
2. The chemical and radiation version of the basic COL HEAT model will be developed to improve the longitudinal dispersion capability so that the computer system can recreate measured downstream concentrations as a function of time and space within a standard deviation of the instrument errors.
3. A limited amount of work will be carried out on the development of flow, temperature and heat energy predictive models fitted to annual data sets in order to explore the possibility of recreating temperature records for the river from historical meteorological data.

VI. TOPICAL REPORTS ISSUED

1. BNWL-CC-1931 (SECRET) - "1967 Columbia River Temperature Analysis",  
J. F. Honstead and R. T. Jaske

0009899

UNCLASSIFIED