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RADIATION PROTECTION DEPARTMENT
REPORT FOR AUGUST 1965
BNWC-8-8-F

A. R. Keene

August 1965

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RADIATION PROTECTION DEPARTMENT
REPORT FOR AUGUST 1965

AUTHOR

A. R. Keene

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RADIATION PROTECTION DEPARTMENT
REPORT FOR AUGUST 1965

Organization

Professor Ben B. Ewing, University of Illinois, completed his stay as a Summer Professor.

Laboratory Experience

A violent reaction in a hood, with subsequent fire and spread of contamination involving two rooms in the Plutonium Fuels Laboratory, occurred on August 23, 1965. The fire was quickly extinguished by fire protection personnel and cleanup efforts were initiated immediately. Ten staff members in the Reactor and Materials Technology Department and one Babcock & Wilcox employee on an extended training assignment were exposed to airborne plutonium oxide. Two of the eleven persons were treated with DTPA and were temporarily restricted from plutonium work until evaluation of any possible plutonium deposition is completed. The other nine employees received minor contamination.

There were no new plutonium deposition cases confirmed by evaluation of bioassay data during the month. There are currently eight Battelle-Northwest employees at Hanford who have received internal plutonium depositions evaluated at 25% of the maximum permissible body burden of $0.04 \mu\text{Ci } ^{239}\text{Pu}$ with bone as reference.

Environmental Evaluation

Concentrations of radioactive materials in the air, water, and foodstuffs of the Hanford environs were at the expected levels during the month and indicated no unusual conditions. Air samples obtained outside of the Plutonium Fabrication Pilot Plant (308 Building) immediately after the fire indicated that no release of plutonium to the environs occurred.

Nuclear Safeguards

Procedures for the controlled release of airborne contamination for the PRTR containment vessel and storage basin were reviewed. Comments resulted in eliminating the need for a deliberate release from the storage basin.

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P-2

BNWC-8 8 F

Temporary limits for the containment vessel were derived which will not result in any environmental consequence greater than those used as criteria for establishing ventilation containment trip limits.

An outline for the PRTR Final Safeguards, Supplement Number Eight, Batch Core Operation, was issued for comment. This supplement will describe the chemical shim system for control of the large excess reactivity to be charged in the batch core, and will propose limits designed to assure that fuel element cores are not molten during equilibrium operation. An initial draft of the physics description was completed.

Work was resumed during the month on the analog model for transient heating of fuel. Modifications have been incorporated in the model to make the program more adaptable to the equipment. Initial steady state power and temperature distributions are presently available from the STHTP (steady state heat transfer code) computer code.¹ Both the analog transient model and the present Tiger V setup will be used to obtain transient temperatures for the various postulated accident cases. One additional method is being considered for use in analyzing the transient temperature distributions for slow transients. This involves the use of presently available steady state temperature distributions which would reduce the amount of analyst time required for obtaining the results from computer code.

The oscillator experiment in the Plutonium Recycle Critical Facility (PRCF) was successful and plans are under way to use the same equipment, with some modification, in the PRTR as soon as the high power density tests are completed in the rupture loop.

The flux level of the PRCF was caused to oscillate sinusoidally by a rotating poison having a peak-to-peak worth of 0.207 mk. A frequency range of 0.03 to 8.75 cycles/sec was covered at a power level of 12 watts. From a transfer function plot of amplitude versus frequency a value of 7.1038 ± 0.154 was obtained for R/L . This compares with a value of 6.3 that was obtained by noise analysis of a similar core loading. Vibration problems that caused difficulty in the initial tests were eliminated by added bushings along the rotor shaft and more support to the motor stand.

A manuscript draft of the High Temperature Lattice Test Reactor, Final Safeguards Analysis was distributed for comment. A preliminary reliability

¹ D. T. Aase, "PRTR HPD Core Fuel Temperature Study," BNWC-23, April 26, 1968
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analysis has been started based on the scope design of the safety system. The vendor, Astrodata, plans to submit the safety system detail drawings during early September. Power is supplied to the vertical safety rod electromagnetic clutches only; if the power supply is energized by two system normal signals. Two separate, independent, safety logic circuits would prevent the system normal signals from energizing the power supply if any of the following were to occur:

- Either of two auxiliary nuclear safety channels out of limit in either level, or period, or not on scale
- Criticality monitor out of limit
- Manual scram activated
- Digital computer supplied:
 - Period out of limit
 - Level out of limit
 - Computation not performed correctly
 - Reactor environment out of limit.

Dosimetry Studies

The study of the effects of predosing on LiF thermoluminescent phosphors was continued. Predosing to 1,000 R of ^{60}Co radiation produced an increase in sensitivity of 2.5 to 3 times. Predoses to 5,000 R did not significantly increase the sensitivity over that noted at 1,000 R. The thermoluminescent dosimeter reader was remodeled with the addition of new heater contacts and a new regulated current source for phosphor heating. A check on the reproducibility of the system utilizing 20 calibrated exposures of 100 and 200 mR and 25 mg samples of the LiF phosphor indicated a reproducibility of about $\pm 10\%$ at the 95% confidence level.

A study to develop a packaging concept for using LiF for hand dosimetry was begun. The initial studies attempted to provide a measured quantity of LiF permanently encased within small 1/4" diameter glass discs. Fabrication difficulties resulted in non-uniform distribution of the LiF within the glass. New techniques to improve the uniformity of the distribution are being investigated. In the fabrication of these dosimeters, all glass work was performed by the Battelle-Northwest Optical Shop.

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F-4

BNWC-8 8 F

Twelve fission fragment neutron dosimeters were exposed on a plutonium fluoride hood at the Weapons Fabrication Building. Similar exposures using the Hanford film badge neutron dosimeter resulted in film with gamma and x-ray doses sufficient to darken the entire emulsion and, consequently, prevented the evaluation of neutron dose by track counting. As expected, no gamma radiation interference was observed in the fission fragment neutron dosimeters. The intermediate and thermal neutron energies were measured by fissions produced in a ^{235}U foil and a cadmium-covered ^{235}U foil in the fission fragment dosimeter. The fission neutron dose contributions above 0.4 MeV were measured with a neptunium oxide foil. As an additional spectrum breakdown fast neutron exposures above 1.3 MeV were measured with a ^{238}U foil. The results for five of these dosimeters exposed under conditions found at the plutonium fluoride hood are summarized in Table I. The data in Table I shows that about 70 to 90% of the dose reaching the dosimeters was delivered by neutrons with energies above 1.3 MeV and, therefore, is recorded by the NTA film used in the Hanford film badge neutron dosimeter.

TABLE I

Dose Distribution by Energy Groups

Dosimeter	Neutron Dose in mrad				Total
	>1.3 MeV	0.4 to 1.3 MeV	Epicadmium	Thermal	
# 2	120 $\pm 17\%$	10 $\pm 24\%$	0.8	0.2	130 $\pm 15\%$
# 4	40 $\pm 11\%$	15 $\pm 25\%$	0.7	0.1	55 $\pm 15\%$
# 5	65 $\pm 9\%$	20 $\pm 8\%$	0.8	0.2	85 $\pm 9\%$
# 9	100 $\pm 26\%$	55 $\pm 18\%$	0.4	0.1	155 $\pm 23\%$
#12	145 $\pm 21\%$	90 $\pm 22\%$	0.7	0.2	235 $\pm 21\%$

The setup and performance study of a new fluorometer glass dosimeter reader was completed. Evaluation indicated that the long-term stability of the reader is superior to that of our previously used readers. The adaptability of the new reader to glass dosimeters of various sizes and shapes is excellent in that only a simple dosimeter holder is required to convert from one dosimeter size to another.

Radiological Development

The study of low level plutonium air concentrations was continued by collection of weekly samples from the Plutonium Metallurgy Facility and the

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Plutonium Development Laboratory. The evaluation of samples was continued by placing new detectors in service on two multi-channel analyzers. Approximately 100 air samples are now being evaluated to determine particle size distribution and to identify their isotopic composition.

A number of air samples were evaluated for plutonium content. These samples were taken at locations upwind and downwind of the Plutonium Development Laboratory during and immediately after a hood rupture. No detectable amounts of plutonium were found in any of the samples although significant amounts of radon and thoron natural radioactivity was easily detected. Air samples were obtained from the laboratory and particle size analysis studies are in progress; however, the high gross activity on the air sample filters and the presence of both uranium and plutonium make the particle size analysis difficult.

A large area proportional counter for low energy beta counting of air samples was assembled for air sample evaluation as needed.

Two criticality verification instruments were installed and are in routine operation. The third instrument soon to be installed is undergoing a final performance evaluation and study. Installed instruments are located in 314 and 328 Buildings. By examination of the charts on these instruments, one can determine if a high neutron flux has occurred at the instrument location. The spacing and geometry of the detectors for this verification system was designed to provide an instrument within 800 feet of any possible criticality location. At this distance, the neutron flux at the detector location will be sufficient to provide a distinct and clearly recognizable chart peak. The instruments are adjusted so that they routinely count cosmic ray neutron background and the occurrence of a small number of counting peaks on the chart record assures instrument operation. A paper describing the design, use, and location of these instruments is being prepared.

Test water sample collection with the prototype seven-day continuous water sampler continued under field conditions in the Columbia River. This sampler utilizes a capillary tube to meter the flow from the sampling chamber. As the air flows from the chamber, water is admitted through a filtered orifice to provide the sample of interest. The advance in the development of this sampling device is the use of gravity coupled with underwater positioning of the sampling chamber to yield a system which can collect a uniform sample without electrical or other power of any type.

A water sampler with 24 separate collection bottles was designed to provide individual water samples on a wide variety of time schedules. This sampler,

for example, will collect one liter of water each hour for a 24-hour period and provide the 24 separate water samples for analysis. By adjustments of the timing mechanism, sampling duration can be adjusted to meet desired requirements of sampling and water volume.

The shielding requirements for the transport of some Shippingport fuel elements from Chemical Processing Department to the Radiometallurgy Building were calculated at the request of the Ceramics Research Section. A minimum of 9 inches of lead is required for the transport cask.

Environmental Studies

REACTOR EFFLUENT EFFECT ON COLUMBIA RIVER WATER QUALITY - 02

A study of the relative importance of different mechanisms causing low radioactivity in Kennewick sanitary water was pursued by Dr. B. B. Ewing, Professor of Sanitary Engineering, University of Illinois, during his summer assignment. Data on suspended vs. dissolved nuclide partition was obtained from the joint U.S.G.S.-Radiological Chemistry Section studies. With this data, ground water flow data from special well samples, and a reasonable assumption as to water velocity through the river bed above the Ranney well collectors, Dr. Ewing was able to account for observed concentrations of nuclides measured in the Kennewick water by filtration and decay in the river bed. These results indicate uniform distribution (within 10%) of effluents in the river at Pasco-Kennewick, and no effect on the distribution from the Yakima River or upstream ground water dilution.

MECHANISMS OF ENVIRONMENTAL EXPOSURE - 02

Arrangements were completed for starting whole-body counting of Richland school children in September. The initial schedule is for Sacajawea school, where about 210 students will be contacted. This program will utilize new diet forms and participation certificates revised on the basis of experience gained in Benton City in the Spring.

NUCLEAR FACILITY MONITORING GUIDE - 04

Early in the month a copy of the first complete draft of the "Nuclear Facilities Monitoring Guide" was sent to each of six power reactor sites (Pathfinder, Elk River, LaCrosse, Dresden, Indian Point, and Yankee) for review and comment. Each plant was visited later in the month and the comments were discussed with appropriate personnel. Important systems design descriptions and operating data were also obtained during the visit. No major modifications are needed as a result of the review.

Outside Consultations

I. C. Roberts discussed the status of the "Nuclear Facility Monitoring Guide" with the AEC Division of Reactor Development, viz., J. Lieberman, W. Belter, H. Bernard and W. Regan in Washington, D. C.

Technical surveillance and programmatic advice were furnished to General Electric, IPD, in support of the annual river cooling campaign.

Work was continued on the oscillator response characteristics of IPD facilities. This work, started some time ago, is being continued in order to improve analytical capability to support use of the strong motion seismic recording system currently under procurement by Battelle-Northwest under the Q2 program.

R. T. Jaske and J. P. Corley gave a presentation of current program work to the Temperature Task Force of the Columbia Basin Interagency Committee (CBIAC) on August 6 in Portland, Oregon.

R. B. Hall consulted with General Electric, NRD Fuels, on effluent measurements problems.

P. W. Hildebrandt, Washington State Department of Health, met with R. F. Foster and members of AEC-R100 on August 18 to discuss recent developments concerning an article on malignancy rates in Oregon.

H. G. Hicks, AEC-R100 Nuclear Safety Branch, met with J. P. Corley and J. R. Eovington on August 5 to discuss river travel times to the new plant boundary, as well as the potential availability of environmental boats and crews for emergency warning service to river users in the event of a plant emergency.

Consultation on radiological matters was provided to AEC Idaho Falls Operations Office, at the request of AEC-R100, during the filming of several scenes for a movie entitled, "Radiological Assistance Team".

Staff Activities

P. C. Friend visited Lt. Colonel A. M. Burner at the Wright-Patterson Air Force Base, Dayton, Ohio, to discuss personnel dosimetry equipment and procedures. Later in the month, Colonel Burner visited the Battelle-Northwest facilities to inspect personnel dosimetry equipment with emphasis on the mechanized film dosimetry processing system.