HEALTH PHYSICS DIVISION

QUARTERLY REPORT FOR PERIOD ENDING FEBRUARY 28, 1949

K. Z. MORGAN, DIRECTOR

F. WESTERN, ASSISTANT DIRECTOR

OAK RIDGE NATIONAL LABORATORY

OPERATED BY
CARBIDE AND CARBON CHEMICALS CORPORATION
FOR THE
ATOMIC ENERGY COMMISSION
POST OFFICE BOX P
OAK RIDGE, TENNESSEE

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O A K R I D G E N A T I O N A L L A B O R A T O R Y

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This report covers the activities of those groups in the Health Physics Division primarily engaged in Applied Research or Development. More or less routine activities of the Survey-Monitoring Section are covered in the Laboratory Weekly Progress Report.

INSTRUMENT DEVELOPMENT

The resignation of one member of the group and the assignment of another full-time to the physical preparation and teaching of a laboratory course in instrumentation for the A. E. C. - N. R. C. fellowship course in health physics has reduced the effective size of the group to four men.

Re-engineering of the performance characteristics of the Walkie-Poppy (portable alpha survey meter) is considered complete except for some modification of the probe to permit satisfactory operation in an ambient of 100% relative humidity.

The principal effort of the group is presently directed at the development of satisfactory survey instrumentation for fast neutrons. Three possible methods of measurement are being studied:

A. Proportional counting of recoils to exclude effects of gamma radiation;
B. Fission counting; and
C. Ionization, by modifications of the Chang and Eng.

It is tentatively planned to continue the development of a chamber and preamplifier for low level alpha counting as a completely battery operated, dessicated and singly housed unit to avoid spurious counts due to power line transients, voltage variations, and high humidity.

WASTE DISPOSAL STUDIES

A preliminary report by L. R. Setter, "Discharges of Radioactivity into White Oak Creek and the Clinch River, January 1 to November 27, 1948" Central Files Number 48-12-293, was issued December 30. Further studies of the White Oak Creek drainage system from the points of view of both rates of discharge of radioactive materials and control of rate of flow of water, have been made.

Studies on the distribution of radioactive materials in Clinch River fish, taken in a preliminary survey last October, have continued, with emphasis upon methods of identification of the principal radioisotopes involved. Difficulties stem primarily from the low levels of activity involved and from uncertainties

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as to the histories of the fish relative to location in the river. In view of these difficulties, it is planned to make the next series of studies on fish taken from White Oak Lake.

Plans for an experimental plant for the study of relationships between radioactive wastes and water and sewage treatment plants have been completed and forwarded to the AEC for consideration. A series of studies, on a laboratory scale, of the problems is under way. General plans have been made, in cooperation with other groups, by which data on filtration at the K-25 water plant and specimens of water, sediment and filter sand scrapings from representative water plants downstream on the Clinch and Tennessee rivers can be obtained.

The office of Biology and Medicine of Oak Ridge Operations of the AEC has coordinated discussions leading to plans for an initial ecological survey of the White Oak drainage system by a Biological Studies Section of the Health and Safety Division of the T. V. A. It is believed that such a study might disclose any significant radioactive effects to date on the life of the system and would form a basis for comparisons in possible future studies of the region.

Detailed descriptions of the activities of the Waste Disposal Studies Group appear in monthly reports for December, January, and February written by R. J. Morton primarily for distribution within the Health Physics Division .

EDUCATION AND TRAINING

The program of the Education and Training Section is unchanged since the issue of the last quarterly report. A group of nine medical officers of the Armed Forces who have been receiving basic scientific training at regional AEC training centers is scheduled to arrive April 1 for six months field training in health physics.

THEORETICAL PHYSICS

Evaluation of Slow Neutron Tolerance

Progress has been made in estimating upper and lower bounds for the collision densities in tissue, following the method outline in the report of last quarter. Present estimates indicate that the maximum collision density is at least on the order of two times and not substantially more than four times the incident flux. The method for a rather precise estimate of the lower bound is well in hand and such an estimate should be forthcoming within a few weeks.

Evaluation of Fast Neutron Tolerance

A study has been undertaken of the effect of fast neutrons impinging upon a phantom and to determine the energy spectrum of neutrons at different depth for the purpose of evaluating tolerance.

The preparatory work has been completed and further work on the problem is contingent upon the availability of the computation machine.

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Evaluation of Bremsstrahlung Effects in Solutions of Radioactive Substances

The investigation is limited to Bremsstrahlung effects in the low energy region (for electron energies ≤ 3 Mev) which are of particular interest in determining the spectral distribution and the total energy of gamma rays produced in storage banks with solutions of beta ray emitting substance. Approximate evaluations have been made by Parker (Radiation Hazards of Bremsstrahlung - MDDC1012) who completely neglected collision losses in evaluating Bremsstrahlung effects. The purpose of this investigation is to obtain more accurate results.

At present the plans are to use an averaging process for the ionizing collisions and to use its cross section for radioactive collisions from Heitler (Quantum Theory of Radiation - page 170). The validity of the method is at present being investigated.

Recalculation of Various Gamma Ray Cross Sections

The calculation of the cross sections for the photoelectric effect, Compton scattering, and pair production of gamma rays in H, C, N, O, A, Al, Cu, Ag, Sn, Pb, Ta, U, air, water, tissue have been computed from the theoretical formulas of Heitler (Quantum Theory of Radiation, pp 124-5; 157; 2017), for energies from .01 Mev. to 1000 Mev. The various graphs and tables are now ready for drafting and a detailed report on the project is being written.

EXPERIMENTAL PHYSICS

The time of two persons has been spent in continuation of a project for an agency outside the Atomic Energy Commission. It is anticipated that our participation in this project will be completed within the next six weeks.

The current phase of study of the problem of particulate radioactive contamination of the atmosphere is nearing completion with the writing of a report summarizing observations over the past nine months. Routine observations of particulate contamination of the atmosphere will be made by the Survey-Monitoring Section of the Health Physics Division. Some consideration has been given to the desirability of establishing a small, long range program in the field, but definite plans have not been formulated.

A series of tests on the pocket ionization meters presently in use for monitoring of exposure of personnel to hard gamma radiation has been made to obtain an indication of their reliability under conditions of high radiation intensity. With levels of radiation obtainable from a two gram radium source, and within the accuracy of the minometer commonly used to read such meters, errors due to lack of saturation at high rates of exposure have not been found.

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Analyses of Body Fluids for Radioisotopes

One person is presently engaged in cooperation with the Radiobiochemistry Group of the Biochemistry Section of the Biology Division, in the development of methods of analyzing body fluids for below tolerance concentrations of some of the beta-gamma emitting radioisotopes considered most hazardous in ORNL operations. In addition to chemical difficulties, problems associated with such analyses included uncertainties in ratios of quantities excreted to concentrations in critical tissues and lack of instrumentation for reliable counting at the low levels of activity involved.

A method of analysis for uranium, developed to meet the need for a method sufficiently sensitive for monitoring significant body content of U^{233}, has been put into routine operation. The method consists essentially of the following steps:

(1) Heating of urine in 0.1 N HCl to destroy urea.

(2) Separation of anions by Dowex-50 cation exchange resin.

(3) Elution of total cations in 6 N HCL.

(4) Evaporation to a convenient volume in HNO_3.

(5) Diethyl ether extraction of the uranium from a solution which is 2 N in HNO_3 and 2.0 M in $Al(NO_3)_3 \cdot 9 H_2O$.

(6) The ether is stripped with water which is evaporated to dryness.

(7) A repeated extraction similar to step (5) above in which the volume of the feed is held to 10 ml; concentration of $Al(NO_3)_3 \cdot 9H_2O$ is 2.5 M and the acidity in HNO_3 is 0.2N.

(8) The ether is evaporated to dryness over $\sim$ 1/2 ml H_2O.

(9) The liquid is transferred to a platinum plate and is evaporated to dryness.

(10) The alpha activity is counted on a standard linear amplifier alpha counter.

The overall efficiency of the above procedure has been checked with U^{233} tracer. A recovery of 80 to 85% can be expected.

During the past six months 158 uranium analyses have been made on urine specimens. An average alpha activity of 0.43 cts/min. above background has been found in the samples analyzed to date. Eleven samples gave a value of greater than 0.82 c/m/500 ml of urine. The highest value was 1.66 cts/min. A group of un-

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exposed personnel had an average urine count of 0.34 counts/min. so there was no significant difference between the potentially exposed and the control group. With utilization of Chauvenet's criterion the limiting value of 0.82 counts/min. was obtained thus excluding the eleven highest values over 0.82/counts/min. The probability of counts occurring by chance that are three standard deviations greater than the mean of controls (greater than 0.79 counts/min.) is 0.003. Therefore, it seems likely that most of the potentially exposed persons to U^{233} did not have appreciable amount of U^{233} in their systems but that the persons with the highest readings did have some U^{233} in their systems. Our knowledge concerning the tolerance of U^{233} is very limited but the present evidence is that no one in the laboratory has as yet fixed in his system quantities of U^{233} greater than the maximum permissible amount.