ORNL 227
PROGRESS REPORT

HEALTH PHYSICS DIVISION

QUARTERLY REPORT FOR PERIOD ENDING NOVEMBER 30, 1948

K. Z. MORGAN

OAK RIDGE NATIONAL LABORATORY

OPERATED BY
CARBIDE AND CARBON CHEMICALS CORPORATION
FOR THE
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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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ORNL-227
November 30, 1948

HEALTH PHYSICS DIVISION

QUARTERLY REPORT FOR PERIOD ENDING NOVEMBER 30, 1948

K. Z. Morgan

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

Considerable progress in providing suitable laboratories for the Instrument Development Section has been made. An additional electrical engineer joined the Section November 1, making a total of six members.

A purchase requisition for the development and production of 20 units of an improved oscilloscope, Hazeltine Model 1421, was issued November 8. Of these, 10 units are to be distributed outside Oak Ridge National Laboratory by the AEC Radiation Instrument Branch. This instrument is to be adapted to photographic and visual observation of random pulses with extremely short rise time.

Efforts to interest one of the larger manufacturers in a contract for the development of the Walkie-Poppie (Portable Alpha Survey Meter) were not successful. Progress in the development of this instrument within the section has been made. At the present state, the Walkie Talkie will detect a source of approximately 135 dpm, and will operate through a range of 700 volts probe potential. The latter feature eliminates the necessity for voltage regulation and may eliminate the necessity for a voltage adjustment control. A pre-amplifier has been built within the probe, and the amplifier has been simplified. Work on the improvement of the high voltage supply is in progress. Three interim models are to be constructed for field testing and criticism by the Survey Monitoring Section.

The improvement of instrumentation for the detection of Pu in body fluids is in progress. An alpha amplifier has been made and has the following measured characteristics:

Max. output - 24 volts to scope or scaler
Max. input - for distortion less than 20% the maximum input at 50 KC is 0.8 millivolt.
Gain - 3×10^4 at 50 KC

The noise level at input is approximately 30 microvolts. This corresponds to a noise level of 1 volt at output.

Alpha Chamber and Preamplifier work indicates the necessity for improvement in that field. Some work is being done to realize the best signal to noise ratio in a combined alpha chamber and preamplifier. This is considered to oe a part of the overall low background alpha counting problem of the Urinalysis Laboratory.

A Keleket Alpha Scaler, Model K-262 is being examined and tested by this section for reliability and accuracy. The installation of another unit of this model in the Urinalysis Laboratory has reduced somewhat the pressure on the project discussed above.

Instrument decontamination by the removal of a peelable plastic coating has been demonstrated and the materials and procedure given to the Survey-Monitoring Section.

Work by the Chemistry Division on an Alpha Sweep Pulse Analyser is being adapted to the needs of Health Physics to provide a suitable instrument for the rapid analysis of alpha contamination resulting from Laboratory operations.

In addition to uncompleted projects listed in the last quarterly report, work in progress includes improvement of instrumentation for the measurement of fast neutrons in a gamma field.

A detailed discussion of the activities of the Instrument Development Section is given in a quarterly report by Wm. M. Hurst.

WASTE DISPOSAL STUDIES

The organization of this section as covered by the current budget has been completed. During the past quarter, Comdr. R. B. Krum has joined the group for half-time; and one Research Assistant, one Chemical Engineer, and one Chemist have been added to the group. A laboratory for the analysis and processing of samples, in connection with surveys and experiments, has been completed; and provision made for the counting of such samples in the divisional counting room.

The preliminary surveys of Watts Bar Reservoir mentioned in the previous quarterly report have been completed and the data have been tabulated in preparation for a report on this project. These included the collection of water, sediment, and algae samples from ten stations during September, with cooperation of the TVA Stream Sanitation Branch. During October fish from these areas were collected and examined with cooperation of the Fish and Wildlife Section of the TVA.

Considerable study has been given to measurement of water runoff and radioactivity in the White Oak Creek drainage system. A report covering an analysis of runoff data collected by the Area Monitoring Group during 1948 has been prepared by L. R. Setter and will be released soon. A study of two small floods on November 19-20 and again on November 28-29 is in progress. These studies are of special interest because of the artificially regulated and sometimes low stream flows in Clinch River and the fact that Watts Bar Reservoir is used as a source of water supply at several points some miles down stream.

Preliminary laboratory studies of water and waste treatment processes have been begun. These include, at present, coagulation and absorption experiments. Guided by the results obtained, systematic laboratory-scale experiments with a variety of processes are anticipated.

Detailed descriptions of the activities of the Waste Disposal Section during the past quarter are given in monthly reports for September, October, and November, written by R. J. Morton.

Preliminary plans, estimates of cost and a definite proposal have been made for an experimental plant to study water and sewage treatment methods and equipment. If provided, the plant will allow intensive study of conventional water and sewage treatment plant units and processes, both on a laboratory and pilot plant scale. Interviews with manufacturers' representatives and with several sanitary chemists and sanitary engineers have been had in the development of plans for the experimental plant.

Problems of instrumentation are recognized as basic in waste disposal studies. Especially important is the development of instruments for field use in: (1) scanning of fish; (2) detection of radioactivity in wet masses of material such as muds and algae; (3) detection and delimitation of radioactive materials in streams and other surface waters; and (4) continuous monitoring of water or liquid effluents to detect and measure radioactivity. A special instrument for the scanning of fish was completed through cooperation of the Experimental Physics Section and the Research Instrument Shop of this Division and was used in the preliminary fish study. With further improvement this instrument should prove generally useful in the Waste Disposal program. A blanking die and spinning tool were completed by the Research Instrument Shop to make metal counting dishes. A preliminary trial indicates that these have definite advantages and they will be produced from several metals and in quantities as needed.

On two occasions officials of the TVA have visited the Division and conferred with representatives of the Laboratory and of the Atomic Energy Commission concerning the basis of a cooperative agreement for a future long range program of Waste Disposal Studies. It is expected that a general agreement for such a program will be formulated during December or January.

Dr. Paris B. Stockdale, a consultant to the Oak Ridge office of the Atomic Energy Commission is beginning an active program of geological studies in this and surrounding areas. The Health Physics Division is especially interested in these studies as they may give information on the underground flow of water in this vicinity. The Waste Disposal Group has had several discussions with Dr. Stockdale and expects to cooperate more closely as his studies progress.

PERMISSIBLE INTERNAL DOSE FROM RADIOISOTOPES

In cooperation with the sub-committee of the National Committee on Radiation Protection, dealing with this problem; the laboratory has employed Dr. C. H. Perry to serve as working secretary of the sub-committee. Working

under the direction of the Director of the Health Physics Division, who is Chairman of the sub-committee, it will be Dr. Perry's assignment to keep up with all reports dealing with this subject; to collect the data, ideas, and interpretations from persons interested in this problem, and to maintain a current list of permissible internal dose values. These lists of prepared information regarding the various radioisotopes will give the maximum permissible amounts in the body, the maximum permissible concentration in air and in water and the concentration in urine, feces and expired air that corresponds to the maximum permissible amount in the body. This requires the evaluation of vast amounts of available data as well as the obtaining of additional pertinent data from biological laboratories in various parts of the country. The following outline is somewhat categorical and lacks of detail, however it gives some indication of the scope of the assignment:

A. Catalog Present Research Data
1. Make search for both published and unpublished documents which contain data pertinent to the general problems of permissible internal dose, and to catalog these data.

B. Review and Evaluate Present Research Data
1. The distribution, fixation and toxicity of the various radioisotopes will depend largely upon the physical and chemical form in which they are administered to the animal or person. This is an example of one of the many items which require evaluation before being used in the calculation of the permissible internal dose.

C. Prepare Itemized List of Required Data
1. The accuracy of the calculation of the permissible internal dose of a given radioisotope will depend upon the accuracy of the data itself as well as the completeness of the data. For this reason it is mandatory that sufficient data be available so as to make it unnecessary to approximate in a critical calculation. For this purpose an itemized list of "required data" will be prepared, which will indicate what research is required.

D. Prepare List of Available Data
1. After the "required list of data" has been agreed upon as being pertinent, feasible and complete, prepare charts of the various isotopes, indicating the available data. These charts will automatically show which data are required in order that precise calculation of the permissible internal doses may be made.

E. Obtain Unavailable
1. After it has been determined that certain definite additional data are required, obtain the research assistance of the various biological laboratories to obtain these data which will be used in the calculations of the permissible internal doses.

F. Publish List of Permissible Internal Doses
1. After the acceptance by the committee of the various calculated permissible internal doses, these values are to be published with substantiating data.

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THEORETICAL PHYSICS

Evaluation of Slow Neutron Tolerance

Work is continuing on the slow neutron problem by seeking an approximate solution of the following equation:

$$f(x) = e^{-x} + \lambda \int_0^\infty E_1(|x - y|)\ f(y)\ dy$$

It has been proven that if a trial solution F(x) has the property that

$$F(x) \geqslant e^{-x} + \lambda \int_0^\infty E_1(|x - y|)\ F(y)\ dy\ , \text{for all } x$$

then F(x) lies everywhere above the true solution. Similarly if a trial solution

$$G(x) \leqslant e^{-x} + \lambda \int_0^\infty E_1(|x - y|)\ G(y)\ dy$$

for all x , the G (x) lies below the correct solution. This method, which seems to be new, gives in principle, a method of determining a band in which the correct solution must be up to the choices for F (x) as follows:

$$F(x) = 5.16$$

$$F(x) = Ae^{-\alpha x}$$

Some progress has been made in getting a closer upper band for the solution and this work is continuing.

Beta Ray Decay

A study has been undertaken to determine the angular correlation between the direction of electron and neutrino escaping from the nucleus during the beta ray decay. To determine such correlation, it is required to have a preliminary knowledge of the relativistic equation of an electron in Coulomb field subject to the condition that at infinity the electron behaves itself as an outgoing particle. From the survey of literature it appears that such an equation has not been derived yet and various approximate formulations are not applicable to the problem. A suggestion has been made to use the relativistic equation of the electron scattered by the field of a nucleus (Mott, Proc. Roy. Soc. A, 135 (1932) 429). The feasi-

bility of this suggestion is being investigated.

Technical Assistance

This section has supplied technical information needed for the recalculation of absorption coefficients for Compton effect, photoelectric effect, pair production for air, aluminum, carbon and oxygen. This work is continuing.

EXPERIMENTAL PHYSICS

The time of three persons has been spent upon continuation of a project for an Agency outside the Atomic Energy Commission.

Studies on the problem of particulate contamination of the atmosphere have continued through the quarter. A filter plant was installed in the pile exhaust system and put into operation November 15. A summary of observations by this division is given in a progress report by J. S. Cheka and H. J. McAlduff, ORNL-211, December 9, 1948. Work of the Chemistry and Physics Divisions on this problem is to be issued as ORNL-197.

During the study of general particulate contamination of the atmosphere, it was observed by a member of the Chemistry Division that the level of contamination in the Pile Building was much higher than in other buildings. Extensive monitoring of pile operations by a Health Physics Surveyor assigned to the 105 Area disclosed that, despite the low pressure at which the interior of the pile is maintained, most pile operations were dragging radioactive particles out into the surrounding atmosphere. Engineering work to correct this condition is in progress.

EDUCATION AND TRAINING

The first "Professional Health Physics Training Course" for persons holding National Research Council Technical Fellowships in this field, was initiated, November 30, with 10 students. This number represents half of those currently being trained in Health Physics under the Fellowship program; a similar group is being trained at Rochester.

After considerable negotiation; the course content and the organization for instruction have become firm, and are reviewed briefly here:

Because of the general inadequacy of the students' background in physics and mathematics, instruction has begun with a two-month period of group tutoring in these subjects. After January 1, 1949 the group will have formal lecture courses in physics, health physics and instrumentation, and will do laboratory experiments to supplement the instrument work. In addition to this they will work half time in the operating and research sections of the Health Physics Division.

The cooperation of the Oak Ridge Institute of Nuclear Studies and the University of Tennessee has been secured so that some of the courses may be taught in classrooms at the Institute building in Oak Ridge, and so that the burden of teaching the background physics and preparatory material are borne mainly by the staff members of the University.

The health physics and instrumentation course will be taught by staff members of the Health Physics Division, and the necessary laboratory experiments are being designed and equipment constructed within the Divisions' facilities.

It is expected that this initial presentation of the Professional Health Physics Training Program will last until November 1, 1949, though some of the students may leave earlier to enter upon formal graduate study for an advanced degree. It is impossible as yet to predict the probable size, or even the existence of such a course next year.

Other activities have included the continued training of five one year apprentices and several people who could spend only a shorter period here. We have continued to supply a seminar leader in health physics to each of the Oak Ridge Institute's radioisotopes training programs.

The only major future program of which we are at present well informed calls for the training of ten Army, Navy, and Public Health Service medical officers for four months, beginning approximately April 1, 1949. This course will be largely field work in health physics and instrumentation.

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