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HEALTH PHYSICS DIVISION

QUARTERLY PROGRESS REPORT

FOR

PERIOD ENDING OCTOBER 15, 1949

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
CARBIDE AND CARBON CHEMICALS CORPORATION
FOR THE
ATOMIC ENERGY COMMISSION

OAK RIDGE, TENNESSEE

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K. Z. Morgan, Director
F. Western, Assistant Director

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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

During this period one man has been transferred out the group and another has been transferred into the group but loaned 90% of his time to the Waste Disposal Research Section.

Fast Neutron Portable Survey Meter. A second experimental model of the simplified fast neutron portable survey meter has been made and is being routinely used with excellent results by Health Physics men in the reactor building. This model measures fast neutron fields ranging from 10 to 10,000 neutrons/cm^2/sec. Pulse counting by earphones is used for low values and the conversion factor is:

$$\text{counts per minute}/3 = \text{neutrons}/cm^2/\text{sec}.$$

High values are indicated on a single (modified logarithmic) scale rate meter. This design philosophy includes accuracy at approximately neutron tolerance levels, and only rough indications for higher values. Gamma fields, of 1 R/hr or less, have negligible effect. On a future model the logarithmic rate meter will be replaced by a linear scale three ranges meter for increased accuracy.

An AC operated (and portable) continuous duty version of the above is now being constructed. It will include a non-directional proportional counter, an RF-HV supply, a circuit lighting a lamp and operating an alarm relay when the flux density reaches tolerance level, and an output meter with linear scale, ranges 0-50, 0-1,000 and 0-10,000 neutrons/cm^2/sec. The proportional counter will be connected by a 10 ft cable permitting its use as a survey instrument. Two identical instruments are to be made.

Proportional counter development in relation to fast neutron measurements will continue with emphasis on:

1. Testing, by pulse analysis, their conformance to Gray principle.
2. Counter efficiency for various monoenergetic neutron fluxes.
3. Material and process controls required to duplicate characteristics.

This phase of the program is regarded as being the most important, as the fast neutron instrumentation must be based upon a complete and thorough knowledge of the proportional counter and its various possibilities.

A final objective of the program is the development of a fast neutron survey meter which considers both the flux density and pulse heights, and gives

an output meter reading in energy lost (in tissue) in ergs per gram, where the neutron energy range is anywhere between 0.1 and 10 Mev. Progress has been made such that an operating preliminary model of this instrument is expected before the end of December, 1949.

This version of the fast neutron meter is of immediate interest in connection with the shielding program of the Technical Division, to enable them to evaluate the effectiveness of various neutron shields in terms of permissible exposure to personnel.

A problem of measurements encountered in personnel monitoring neutron film calibration has been discussed, and a fast neutron meter for particular application to that calibration work will be made. It will include a smaller proportional counter, modified amplifier, battery operated, output meter to read in arbitrary units of n/cm^2. A major requirement is reproducible results at a relatively high neutron flux level.

A preliminary article by G. S. Hurst on the subject "Fast Neutron Measurements for Health Physics" was published in the September, 1949, (Vol. 2, No. 4) issue of Ra-Det. The interim model No. 2 fast neutron portable survey meter is described, sufficiently to permit other areas to duplicate that instrument, by G. S. Hurst, in his report "Portable Fast Neutron Survey Meter" ORNL 485.

Portable Alpha Survey Meter. Models of this instrument are now being field tested by the Health Physics Survey-Monitoring Section. Preliminary reports are favorable. A report describing the design, construction and required process controls is to be written.

Cathode Ray Oscilloscope, Hazeltine Model 1424. A contract for the development and manufacture of 20 improved oscilloscopes for ORNL and other groups discussed in Quarterly Reports of August 31 and November 30, 1948, and January 15, 1949, has been cancelled. At the time of cancellation it was concluded that the needs to be met by these oscilloscopes could be more economically met by the use of a combination of models now available and under development by other companies.

Scintillation Counter. The first application of this technique to some of our problems will be in the form of an instrument for low level alpha counting. The immediate problem is to achieve good counting efficiency with a low (3 counts per hour) background as has been reported from another (NYO) area.

Continuous Water Monitoring Instrumentation. The AEC, Office of Research and Medicine, Oak Ridge, is sponsoring an engineering purchase order for the subject apparatus. The specifications have been tentatively set at:

1. Detect gamma radiation, and beta radiation of energies higher than about 0.1 or 0.2 Mev.
2. Alarm at an arbitrary radiation level (presently not specified).
3. Operate 24 hr/day.
4. Sufficient models to only prove the design, performance and drawings to be constructed by engineering contract.

This work is at a low priority compared to the instrumentation listed in the preceding paragraph.

WASTE DISPOSAL STUDIES

During this period there has been no change in the permanent research staff of this section. Of the assigned personnel, two sanitary engineers from the U. S. Public Health Service and one from the U. S. Army have remained; a sanitary engineer of the Stream Sanitation Section, Tennessee Valley Authority, reported July 25, on loan to this group for a period of at least one year or longer.

Personnel assigned to this section from other groups within the Health Physics Division numbers 2.5 persons.

Water and Sewage Treatment Process. Good progress has been made in water and waste decontamination studies. A small model water treatment plant has been operated for three experimental runs of three to five days each, two to test the plant for normal water treatment results and one for efficiency in removal of P^{32} from turbide water. Much additional laboratory work has been done in order to extend the range and assist in the interpretation of results of these experiments. Progress reports on the first two runs have been prepared and released and a draft of the third report completed. A duplicate model of this semi-works water treatment plant, constructed of stainless steel and including a Spaulding type precipitator, has been completed.

Other studies of treatment processes have included a continuation of laboratory tests of ion exchange materials and preliminary work on domestic sewage using a small contact aerator constructed previously in the Health Physics Research Shop. The work on domestic sewage is directed toward studies both of the effectiveness of biological slimes in removal of radioactive materials from sewage streams and of radioactive hazards due to the accumulation by such slimes of radioactive materials in sewage lines.

Survey Studies of White Oak Lake and Clinch River. Studies of radioactivity of fish collected from White Oak Lake have been continued using the samples collected in May and another collection August 1 and 2. Samples from the latter collection were assayed to supplement the earlier analysis and also were prepared and sent to the Chemistry Division for chemical analysis, a report of which has been received. A number of laboratory experiments have been made upon fish tissues and similar material to determine the loss of activity during digestion with acid or ashing by heat. A special press has been designed and

constructed for distribution of such materials in counting dishes for assay after air or low temperature drying.

Tentative drafts of several reports on survey studies of conditions on White Oak Lake and Clinch River have been reworked and are practically ready for final revision and release. Also the entire survey program is being restudied and outlined with a view of improvement and selection of work assignments for the remainder of this fiscal year.

Instrumentation. In instrumentation the principal effort has been toward the development of continuous measurement and recording of both water levels to provide indicating recording and alarm instruments at the ORNL area. Investigation and cost estimates of equipment and construction necessary for such a system have been obtained and proposal with recommendations that the system be installed has been prepared and submitted.

Miscellaneous Activities. Members of the group have spent considerable time in cooperation with others engaged in related work. A second series of analyses of sewage samples collected by the Austin Company on August 7 was carried out by members of this group. The purpose was to determine the effects of various settling times upon the treatment processes to be employed in the Laboratory sewage treatment plant. Preliminary plans and design criteria for the sewer system and sewage treatment plant have been reviewed and discussed with representatives of the Engineering and Maintenance Division and the Austin Company.

A small amount of assay work has been done on samples collected from White Oak Creek in connection with the ecological survey being conducted by the Tennessee Valley Authority by arrangement with AEC, ORO. Also some continuing joint work with the K-25 Health Physics has been maintained, including discussion of problems of mutual interest, exchanges of information, and minor assistance in the examination of survey samples.

Detailed activities of the Waste Disposal Research Section are covered by monthly reports prepared for limited distribution by R. J. Morton.

THEORETICAL PHYSICS

Gamma Ray Absorption Coefficients. As a result of the participation of one member of this group in the Summer Shielding Session at ORNL, a report on these studies is being issued shortly with the Shielding Session report.

Determination of the Variation of the Charge of an Ion with Its Velocity. Graphs are being prepared showing the relationship between the nuclear charge Z of an ion, its electronic charge, ne, and the energy I_n required to extract the outermost electron from the ion.

Determination of Energy Loss of Particles. This investigation is concerned with evaluation of excitation and ionization losses of particles having velocity βc with $\beta < Z/137$ where Z is the atomic number of the stopping substance. Preliminary estimates have been made and the work is in progress.

EXPERIMENTAL PHYSICS

The Experimental Physics Group has been brought up to its former strength of three members by the transfer of one junior physicist from the Instrument Development Section.

Backgrounds. The variation of the radon and thoron content of the atmosphere for the past two months has been continuously recorded by a moving filter monitron unit. This unit collects the particulate matter containing the active deposit of radon and thoron from the air at a rate of about six cubic feet per minute. The filter moves under two alpha counting chambers so that the activity of the particulate matter is counted at intervals of 20 minutes and 4½ hours after it is collected. The alpha count at 20 minutes after collection is due mainly to its short life active deposit of radon, while the 4½ hour delayed count is due mainly to its longer life active deposit of thoron. Calibrating the instrument by measuring the radon content of air samples directly and comparing the result with the filter count indicated that 530 ± 20 counts per minute from the filter was equivalent to a concentration of 10^{-9} microcuries of radon per cc of air.

The records for the past two months show that a typical condition is represented by a concentration of 0.15×10^{-9} μc/cc of radon during the day and a building up of radon concentration over night during the normal temperature inversion period to a maximum of 0.7×10^{-9} μc/cc in the morning when the inversion breaks. Values as low as 0.07×10^{-9} μc/cc during the day and 1.0×10^{-9} μc/cc in the morning are not unusual. An example involving an inversion is shown in the following figure. In cases when we have no temperature inversion during the night, the radon does not build up and remains more or less the same as the concentration during the day.

The thoron concentration is expected to follow the same typical variation; however, the records do not show as marked a variation due to long half life of ThB (10.5 hrs) which does not have time to come to equilibrium with the changing thoron content but lags behind with dampened magnitude of variation. The thoron radon ratio assuming the same efficiency of active deposit collection appears to be about 3 percent.

Distribution of Gaseous Activity from X-10 Stacks. A project to study the attenuation of stack gases from X-10 to K-25 was described briefly in the last

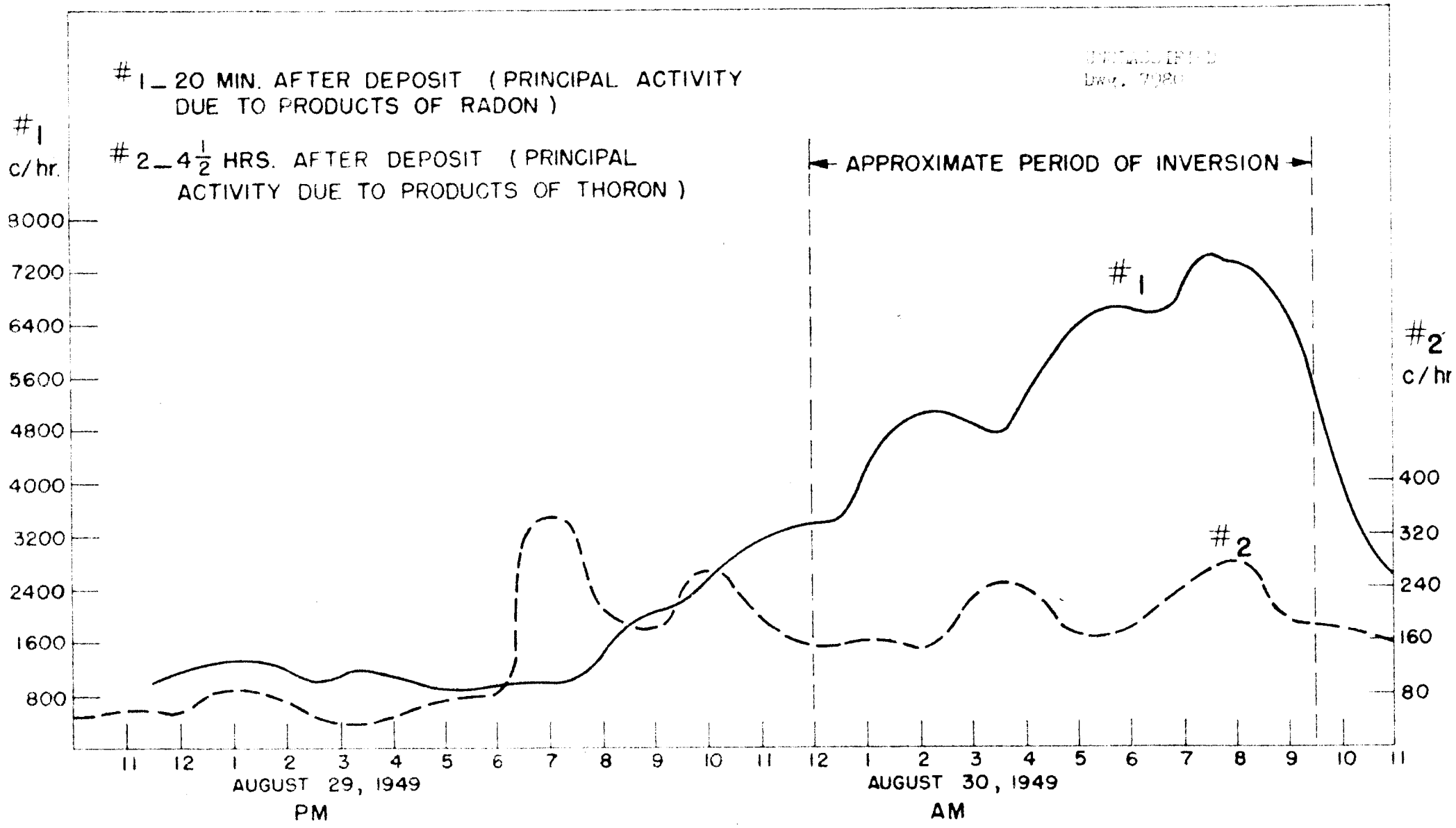

ILLUSTRATION OF VARIATION OF NATURAL RADIOACTIVE CONTENT OF ATMOSPHERE DURING 24 hr. PERIOD

quarterly report. One unit of the experimental apparatus was located in the vicinity of K-25, but due to unfavorable location and experimental difficulties, little progress has been made. It is now planned to accelerate and improve the studies by use of three movable units, each of which will be independent with its power supplied by a gasoline generator. Apparatus to operate these units is being assembled. Continuous records will be obtained from (1) moving filter monitrons giving the alpha and beta activity of particulate matter, (2) air conductivity apparatus giving the ionization of the air, and (3) G-M counters in anticoincidence registering the gamma activity. These units will permit observations not only in the direction of K-25 but in other directions of interest. Data obtained from these observations will be correlated with the data obtained by the AEC Weather Bureau Meteorological Project in which data on atmospheric activity is being studied in connection with meteorological conditions by use of balloon borne G-M counters.

Consultant Service to the Geological Survey. Approximately one month's time of two people in the section was devoted to the Geological Survey as consultant service for the purpose of design and operation of instruments aboard an aircraft (DC-3) for aerial prospecting for uranium. A test strip in the red desert of Wyoming was run and the activity record from flights at 500 feet above ground correlate well with ore deposits containing 0.01 percent U_3O_8. At 1000 feet some correlation but weak response was obtained. Flight at 250 feet gave marked responses over twice background level. These records were obtained from air conductivity apparatus and G-M counters connected in anti-coincidence. No shielding was used with the counters. Tests made in the laboratory show that 1 inch lead shields weighing 180 pounds covering the G-M counters will reduce background by a factor of six so that improved response is expected with use of the shield on the next test run which is scheduled the last week in October.

SPECIAL PROBLEMS

Changes of personnel of this group include the addition of Dr. H. K. Richards in the capacity of Section Leader. One associate physicist formerly assigned to this group but primarily concerned with instrumentation for the Waste Disposal Research Section has been transferred to the Instrument Development Section. An associate physicist recently employed by the Division has been assigned to this section.

Neutron Monitoring. Work on the problem of neutron monitoring by means of films supplementary to that in MDDC-890 is in progress. The experimental data for fast fission neutrons show a tract density of recoil protons about 15% above the calculated values, possibly due to instability of the Victoreen meters. Exposure to a Po-Be neutron source gave experimental values 3.5 times those expected. The discrepancy was apparently due to the fact that the high energy neutrons from this source produced recoil protons in a paper wrapping with sufficiently large ranges to give tracks in the film. Evidence for this hypothesis was obtained by experiments in which a bare film, exposed with the emulsion toward the source gave the calculated value as did a film shielded by 1 mm Cd from protons formed in the wrapper, while a film exposed, emulsion to source, fully wrapped, and another one exposed bare, emulsion away from source, showed 3.8 respectively, 4.3 times the calculated values. Studies to determine the possibility of using calibrated Po-Be sources to calibrate NTA films for exposure to fission neutrons indicated that, for NTA films of emulsion #42243475666 (30 μ) and #42301014406 (40 μ), one week's tolerance of fission neutrons (2.9×10^7 nf/cm^2) as determined by Victoreen measurements were obtained by exposure of 1.52×10^7 and 1.53×10^7 Po-Be neutrons, respectively.

Studies on the blackening of commercial films of various types by fast neutrons are underway. Evaluation of results have been made difficult by irregular dark areas in the irradiated film.

Atmospheric Contamination. In cooperation with another laboratory an investigation of a method of estimating contamination of the atmosphere by non-gaseous radioactive materials is in progress. The method consists essentially of collecting large quantities of rain water, concentrating the radioactive materials in the water by addition of aluminum sulphate and analysing the concentrated material for radioisotopes of interest. For this purpose rain water

is being collected from the middle western section of the Health Physics Building. A preliminary scrub of the roof and intermediate trough with stiff brushes and water has been made and collected in a 300 gal tank. Surveys of the roof prior to the scrub revealed many high spots of radiation particularly in the trough. The maximum reading obtained was 5½ mr/hr. After scrubbing most spots had been decreased in radiation intensity by at least a factor of 10. Analytical procedure on the scrub sample has been rather difficult because of the large amounts of solids present. Three collections of rain water of volumes ranging from 250 gal to 300 gal have been made. Analyses on the three runs have not been completed.

Studies on β Radiation. The construction of an improved extrapolation chamber combined with a vibrating reed electrometer was completed during this quarter. This instrument is now being used for beta absorption, beta scattering and determination of the surface dosage of uranium.

Studies on β absorption and angular distribution of scattered β's are being made with the use of a G-M counter.

URINALYSIS

An exploratory sampling of β-γ activities in urine from laboratory employees handling large quantities of β-γ emitting materials has been started. Seven persons who are believed not to be exposed to significant radioactive hazards have been used as controls. The average activity above background found in 24 hr samples for the seven persons was 1.1 c/m with a maximum activity of 2.2 c/m. Among samples from personnel working with β-γ materials occasional activities of the order of magnitude of 50 c/m for a 24 hr sample have been found. Decay studies indicate that a large fraction of such activities may be due to Sr^{89}.

Although the procedure for analysis of body fluids for low tolerance concentrations of some of the beta-gamma emitting radioisotopes have been developed to provide quantitative recovery of Sr, Ba, Y and La, some additional changes were found desirable before routine analyses could be carried out. Since a large fraction of the samples studied contained beta-gamma activities only slightly above the background of the counter, it was desirable to eliminate all activity introduced by carriers and chemical reagents used in the analysis.

Lanthanum and yttrium carriers were found to give some beta-gamma activity. It was possible to remove the impurities in these carriers such that the activity remaining was less than the statistical error of counting. Impurities can be removed from yttrium by precipitation procedures and from lanthanum by use of a cation exchange resin column. Use of Na_2CrO_4 as a reagent in the final precipitation instead of K_2CrO_4 was found necessary. Activity from K^{40} which was not removed by the limited wash of the final precipitate was sufficiently high to warrant the change.

CONSULTATION AND RADIATION PROTECTION ENGINEERING

During the past quarter the senior member of this group has spent one month on loan to Los Alamos Scientific Laboratory and has spent two days as consultant to Y-12 and one day to K-25. It is estimated that during the quarter members of this group have considered an average of three problems per day in consultation and liason with persons within the Division, within the Laboratory and outside the Laboratory.

The group has undertaken long range critical studies of Health Physics functions at ORNL for the purpose of recommending changes or improvements to increase the efficiency and effectiveness of the functions. A report on the progress of this study during the past six weeks has been presented to the Director of the Division.

Closer liason between Health Physics and persons responsible for the design and construction of new laboratory facilities will be effected by membership of one of this group on the ORNL Building Committee. Members of the group operating as individuals through the past quarter have for various reasons failed to keep abreast of the rapid progress of the building program. It is anticipated that with all three members of the group participating as a team in an organized effort these difficulties will be remedied. Inspection of the 900 Area reveals that advice recommending designs which would eliminate the possibility of splatter from "hot" sinks and positive pressures in the "hot" waste system has not been heeded. Although much good design has been incorporated, this group feels that it has failed because of the persistence of these two items.

An inspection by this group of the lead shielding installed in the 900 Area discloses cracks where the lead panels butted against steel supports. These cracks result from inability to fill channels with molten lead. Collimated leaks at these points were of the order of those which would be produced by 2 in. of lead missing in a 6 in. shield.

A problem receiving consideration by this Division and other laboratory groups is that of formulation and administration of a reasonable policy covering the issue and handling of clothing for radiation protection. One phase of this problem involves such items as the choice of materials, the possible use of dyes for identification and procedures in decontamination or disposal procedures. Pilot studies of decontamination have been made in beakers using

coverall cloth dyed with yellow Rit. Such studies show that the presence of dyes does not make decontamination more difficult. In these studies it was found that commercial detergents were considerably inferior to the presently used laundry solution employing citric acid followed by igapl. A commercial soap was found to be considerably better than the detergents but inferior to the citric acid procedure.

A course in basic physics and health physics (totalling 20 hrs) has been conducted for the benefit of ORNL personnel engaged in shipping radioisotopes. The objective is an explanation of the shipping regulations to enable these persons to better perform their work.

PERMISSIBLE INTERNAL DOSE

During this period calculations were made and the Subcommittee of National Radiation Protection Committee has agreed upon a tentative maximum permissible concentration of $C^{14}O_2$ in controlled areas (plant atmospheres). The tentative level is 10^{-7} μc $C^{14}O_2$/cc air.

Approximately 225 key persons in the United States were notified of the committee's recommendation concerning the $C^{14}O_2$ level.

A table of 24 radioisotopes has been prepared and sent to the committee members. This table consists of all pertinent information to enable the members to arrive at a recommended level for each of the isotopes. The particular isotopes are those which are common to the normal body metabolism and only those which have half-lives >11 hr. The isotopes are:

H^3, C^{14} Na^{22}, Na^{24}, P^{32}, S^{35}, Cl^{36}, K^{40}, K^{42}, Ca^{45}, Ca^{47}, Ca^{49}, Mn^{52}, Mn^{54}, Mn^{56}, Fe^{52}, Fe^{59}, Fe^{55}, Cu^{67}, I^{125}, I^{126}, I^{130}, I^{131}, I^{133}.

EDUCATION AND TRAINING

The education and training in Health Physics during this period included programs for the following groups or persons:

1. The nine NRC Fellows who have been here for a period of one year beginning November 1, 1948, and who completed their training October 8, 1949.

2. Eight medical officers for a six months period, beginning April 11, 1949.

3. Fourteen officers from the Armed Forces engaged in a three year program in radiation and assigned to this Laboratory for eight weeks of field training from July 7, to September 1, 1949.

4. One person from the AEC Installation at Rochester, New York, for special training for one month.

5. One Naval Officer who completed a more or less formal training period of approximately one year working with the Special Problems group.

6. Six personnel from the Brookhaven Laboratory for a period of ten days for field training.

7. Nine NRC Fellows (the number will be increased at least to ten and perhaps more) who began, on October 5, 1949, a training period of one year.

Substantial contributions to the training program have been made by other laboratory groups and personnel—field work training by the Operations and Production groups, lectures on special subjects by members of other divisions and the AEC.