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AEC RESEARCH and DEVELOPMENT REPORT

PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT FOR NOVEMBER 1966

DIVISION
OF
BIOLOGY AND MEDICINE
PROGRAMS

DECEMBER, 1966

BATTELLE-NORTHWEST

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PACIFIC NORTHWEST LABORATORY

MONTHLY ACTIVITIES REPORT

NOVEMBER 1966

on

AEC Division

of

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MONTHLY ACTIVITIES REPORT

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AEC DIVISION OF BIOLOGY AND MEDICINE PROGRAMS - R. S. PAUL

RADIATION EFFECTS - GENERAL

Mechanism and Treatment of Gastrointestinal Radiation Effects - M. F. Sullivan

Rats were injected with lethal doses of the radiomimetic substance, nitrogen mustard (HN2), after cannulation of the common bile duct. The development of diarrhea seemed to be delayed, up to day 4, but at that time animals began to die with all of the symptoms present after a high whole body radiation dose. The gut contents were suggestive of excessive fluid loss. Sections of the gut were taken for light and electron micro-scopy. The appearance of the mucosa in the electron microscope was similar to that described after an X-ray dose of about 3 kR. Subcellular changes apparent were: loss of microvilli, mitochondrial vacuolization, enlarged vacuolated golgi apparatus, and enlarged nuclei. The damage was very severe suggesting that lower doses of HN2 should be employed in future studies.

TOXICITY OF RADIOELEMENTS

Factors Affecting the Toxicity and Metabolism of Radionuclides - M. F. Sullivan

Pregnant rats were injected with ionic or colloidal ^{239}Pu and with ^{237}Np or ^{233}U at 15 or 19 days of gestation. At sacrifice 24 hours later, less than 0.1% of the injected dose was found in the fetus, but a substan-tial quantity of plutonium and neptunium was found in both the placenta and fetal membrane. The concentration of ionic ^{239}Pu exceeded that of colloidal ^{239}Pu by better than a 2:1 ratio. The effect of pregnancy on the behavior of deposited ^{239}Pu is presently being studied.

Rats maintained on a low potassium diet were injected with ^{137}Cs. The cesium body burden was almost completely retained for the 25 days that it was followed. Rats placed on the low potassium diet at the time of

^{137}Cs injection lost about 20% of the injected ^{137}Cs by the 12th day post-injection. Thyroxin accelerated ^{137}Cs loss, but stable potassium given daily from the 12th day post-injection had no effect on ^{137}Cs retention.

Mathematical models were developed for the passage time of intestinal contents through the GI tracts of adult and six-day-old rats. These models will be useful for calculating radiation doses received by the alimentary tract from ingested radionuclides.

Factors Affecting the Toxicity and Metabolism of Radionuclides in Aquatic Organisms - R. E. Nakatani

Because little or no data are available on the elemental composition of the freshwater mussel, Anodonta californiensis, the following metals: Na, K, Ca, Mg, Fe, Mn and Cu, in addition to Zn, are being determined as part of a study of zinc metabolism in these bivalves.

The distribution of ^{65}Zn in the eyes of Columbia River fishes is being studied, by "compartment", to provide background information for controlled laboratory work on the biochemistry of zinc in fish eyes. The ^{65}Zn content of the eye is highly localized, occurring primarily in two melanin-rich fractions, the iris and the choroid. Stable zinc analyses show a good correlation with ^{65}Zn content of iris tissue, but no such correlation was found with the choroid.

Effects of Radiostrontium in Miniature Swine - J. L. Palotay

A female Pitman-Moore swine, aged 87 months, was sacrificed following a few days' rapid deterioration in condition. The animal had been on daily feedings of 125 uCi ^{90}Sr since the age of 14 months. Definitive diagnosis awaits histopathological reports on submitted tissues.

Implementation of several new whole body counting techniques for ^{90}Sr bremsstrahlung measurement in swine is under way. Calibrated bremsstrahlung standards consisting of bones randomly mounted in paraffin were obtained from the Radiobiology Laboratory of the University of California at Davis.

Inhalation Studies - W. J. Bair

Fatty acid synthesis in lung tissue was studied in rats sacrificed one day after 800 or 1000 R X-irradiation. Compared with unirradiated controls, the incorporation of acetate-^{14}C into long chain fatty acids was increased 10-300% after 800 R and 0-50% after 1000 R. The 800 R data agree with the

results of earlier studies. The smaller effect after 1000 R is probably related to the time of sacrifice which did not allow time for recovery processes to develop after the larger dose.

Studies were initiated to determine the effectiveness of chelating agents on the mobilization of $^{239}PuO_2$, in vitro. A suspension of $^{239}PuO_2$ particles was placed on a Sephedex G-25 (coarse) column (40 cm x 1 cm) and an attempt at elution was made with two chelators. Alpha-lipoic acid was about 3 times more effective than DTPA in removing the ^{239}Pu from the column, although the total amount removed was only about 1% of the $^{239}PuO_2$ loaded on the column.

Two dogs died about three months after inhalation of $^{239}Pu(NO_3)_4$. The gross pathology was similar to that seen after inhalation of lethal quantities of $^{239}PuO_2$. Death was due to respiratory insufficiency. Although radiochemical analyses are not complete, gross survey of the tissues indicated that the major portion of the ^{239}Pu in the body was retained in the lungs. The only clinical sign observed which was different from those seen after inhalation of $^{239}PuO_2$ was a leukopenia rather than a lymphopenia. These results represent the first reported deaths in experimental animals following inhalation of $^{239}Pu(NO_3)_4$ and are particularly significant in that they were pulmonary deaths.

Planimetry of whole body scans of dogs which inhaled $^{147 + 148m}Pm_2O_3$ particles indicate lung retention half-times of 250-700 days. This method, while laborious, appears to satisfactorily quantitate lung retention of gamma emitting radionuclides, obviating the need for serial sacrifice and radiochemical analysis. This method appears to be more accurate than chest counts with one, two, or three stationary crystals, because of the difficulty in reproducibly positioning animals for such counts.

Space Nuclear Systems Studies - R. C. Thompson

Three dogs were exposed to air-borne 50 μ plasma jet fired $^{238}PuO_2$ spheres. Deposition occurred in the lung area; however, present techniques do not permit an estimation of percentage deposition. Clearance from the lungs appeared to be complete after 24 hours. Gastrointestinal tract passage was complete in 2 dogs after 48 hours, but one dog retained ^{238}Pu particles for over one week. Particles recovered from the feces were coated with an alcohol-soluble substance but appeared to be unchanged in shape. One of three dogs given single 150 μ $^{238}PuO_2$ particles by intubation about three months ago finally cleared the particle.

Histograms of the fecal output of ^{238}Pu microspheres from the recently fed swine were completed. The output patterns, compared to earlier results, merely emphasized the variability of results. There is a bimodality in one case, but not in the others. Two of the swine had definite periods of maximum output, but one continued to excrete ^{238}Pu particles at a high level throughout the two-week observation period. This latter swine was the one which had considerable activity remaining in the gastrointestinal tract at necropsy, 14 days after particle feeding.

Thermoluminescent dosimeters implanted in one of these swine indicated doses of 200 to 2500 mR along the tract, the lowest dose being in the stomach and the highest at the ileocecal junction. This low energy X-ray dose is probably an indication of the residence time of the particles and thus is related to the alpha dose to the lumen of these organs.

Lead particles were used to simulate PuO_2 particles in resuspension studies. Particles of various sizes were dusted onto clean glass slides and exposed on the bottom of a wind tunnel. The air velocity was increased in small increments until about 1/2 of the particles on the slide were blown off. This measure of wind velocity required for resuspension was plotted against particle size. The curve shows a minimum velocity between 25-30 miles/hr for Pb particles of 30-40 microns. From this point the "resuspension velocity" slowly increases as particle size increases; for example 32 and 40 miles/hr velocities for average diameter particles of 70 and 160 microns, respectively. The curve rises sharply as the particle size decreases. For example, 42 miles/hr and more than 60 miles/hr for average 10 and 6 micron particles, respectively. None of the 4 micron particles were removed by a velocity of 63 miles/hr which is the maximum for the wind tunnel.

TOXICITY OF RADIOELEMENTS

Uranium Ore Inhalation-Radiochemical Studies - R. W. Perkins

The urinary excretion pattern of ^{238}U and some daughters from 4 beagle dogs during the course of an 8-day chronic inhalation exposure to uranium ore dust was defined. The urinary excretion of $^{234-238}$U, ^{230}Th, ^{210}Pb and ^{210}Po were determined. The results indicated a high excretion rate of uranium relative to the daughters but also indicated that 8 days is not a sufficient period of time to establish equilibrium between uptake and urinary excretion.

MOLECULAR AND CELLULAR LEVEL STUDIES

Cellular Regulatory Mechanisms - W. H. Matchett

The synthesis of protein and RNA was examined in studies on log phase cultures of Neurospora crassa. Preliminary results indicated that large differences in the rate of growth bring about very small differences in the ratio of RNA to protein. This would seem to be at odds with observations in bacteria. It is to be emphasized that these results are very preliminary and require confirmation and extension before any conclusions can be drawn.

It was reported previously that 3-amino-1,2,4-triazole (3AT) inhibits the uptake of tryptophan in Neurospora crassa. We have now shown that 3AT inhibits the uptake of most, if not all members of the "tryptophan" family of amino acids. Uptake of leucine and phenylalanine, both members of the tryptophan transport family, is inhibited to a degree which is inversely proportional to their affinities for the tryptophan transport site. Continuation of these studies will, hopefully, result in a method for labeling and studying the reactive site for tryptophan uptake.

The 3AT mediated derepression of tryptophan synthetase synthesis was shown to be mimicked by growing cells in the presence of anthranilic acid. Just as 3AT appears to cause intracellular accumulation of imidazoleglycerol phosphate, anthranilic acid causes intracellular accumulation of indoleglycerol phosphate. The structural similarity of imidazolglycerol phosphate and indole glyceril phosphate suggests that these compounds may have a similar function in affecting the control of tryptophan synthesis. In future experiments we will test the hypothesis that each of these compounds interferes with, or inhibits completely, bio-synthetic reactions concerned with the generation of charged tryptophan sRNA.

Characterization of Radiation-Induced Free Radical Reactions in Aqueous Systems - D. R. Kalkwarf

The effect of gamma radiation on dilute aqueous solutions of nitrobenzene was studied by measuring their ESR spectra in a flow system after they emerged from a Gammacell 200. Spectra obtained from deaerated $10^{-1}M$ nitrobenzene solutions in aqueous 0.1M NaOH consisted of 54 lines which correspond in number and intensity to the spectrum for the nitrobenzene radical-anion. Saturation of the solution with nitrous oxide, which reacts selectively with hydrated electrons, reduced the signal intensity by 90% indicating that the radical was formed by addition of a hydrated electron to nitrobenzene. Addition of selective hydroxyl-radical scavengers, e.g., methanol or sodium formate, increased the signal intensity by a factor of

5. None of the spectra obtained from these solutions revealed the presence of a second type of radical. Hyperfine splitting constants for the three types of protons in the radiation-induced radical were found to agree within 1% with literature values for the radical produced by either electrolytic reduction or photolysis. The splitting constant of 14.1_1 gauss due to the nitrogen nucleus was significantly higher, however, than the value of 13.6_5 reported for the radical formed by photolysis in ethanol solution or the value of 10.3_2 for the electroreduction product of nitrobenzene in acetonitrile. This apparent solvent effect on the unpaired spin density at the nitrogen nucleus was examined further by irradiating nitrobenzene in an aqueous $0.1\underline{M}$ NaOH - $1.0\underline{M}$ Na_2SO_4 solution. No change in the nitrogen splitting constant was observed, however, in this more intense ionic atmosphere.

Both of the FDA-approved artificial food colorings, FDC Blue No. 1 and FDC Blue No. 2, have been shown in this laboratory to exert substantial radioprotective effects on agarose jellies. In previous experiments, the protective agent was incorporated in the jelly prior to irradiation by adding it to a molten aqueous solution of the polysaccharide and allowing the jelly to form on cooling. A more generally practicable technique for incorporating substances into biological systems, however, is by diffusion so this method was tested on the jellies. If either FDC Blue No. 1 or FDC Blue No. 2 were inserted into a preformed 0.2% jelly by diffusion to give a final dye concentration of $1 \times 10^{-3}\underline{M}$, the radiation dose required to liquefy the jelly was extended by a factor of 6. Identical factors were obtained if the same concentration of dye was incorporated while the jelly was molten. These results also provide further evidence that the protective action of these dyes is radical scavenging rather than strengthening the chemical structure of the jelly.

ENVIRONMENTAL RADIATION STUDIES

Terrestrial Ecology - R. E. Nakatani

Forest floor samples of leaf litter plus attendant mosses and microorganisms were collected from various locations in the Cascade Mountains in September, 1966. Gamma-ray spectrometric analyses of the litter samples were evaluated for ^{137}Cs. Concentration (dry wt basis) varied over a five-fold range with the lowest concentration (11 pCi/g) coming from forest-type characteristic of dry regions, i.e., Ponderosa pine, and the highest concentration (59 pCi/g) coming from a cedar-hemlock stand of a high rainfall area in which the forest floor supported a dense stand of mosses. The stands having the greatest amount of ^{137}Cs per square meter of forest floor (~ 100 nCi/m^2) were two high elevation fir-hemlock stands near the summit of White Pass. The significance of these data is in the

relatively small difference (two-fold) in total ^{137}Cs per m^2 of forest floor in forest stands with great differences in total annual precipitation, i.e., Ponderosa pine vs. Douglas fir and cedar-hemlock forests. The total amount of ^{137}Cs present in leaf litter depends upon the efficiency of tree leaves in intercepting and retaining ^{137}Cs, the quantity of leaves produced annually and their rates of microbial decomposition when deposited on the soil, as well as total amounts of ^{137}Cs present in the atmosphere. The data indicate that the high altitude fir-hemlock stands have accumulated, over the years, the greatest amounts of ^{137}Cs per m^2 of forest floor.

Columbia River Ecology - R. E. Nakatani

The concentrations of ^{51}Cr, ^{65}Zn and ^{59}Fe in plankton, periphyton, caddis fly larvae, and shiners were evaluated for three sampling periods extending from mid-September to late October. The concentrations of these isotopes are leveling off following reattainment of radioactivity lost during the reactor shutdown. Changes during October were not nearly as marked as those from mid-September to early October.

Six aerial surveys of local chinook salmon spawning were made between Richland and Priest Rapids Dam during the period October 6 to November 23. No spawning was evident on October 6. Spawning was well under way by October 21 and reached its peak by November 2. A total of 3,100 salmon nests was observed. This is the largest number since surveys were begun 20 years ago and greatly exceeds the previous maximum of 1,770 observed in 1965. All major spawning areas were heavily seeded, particularly the section near Midway which accounted for over 40 percent of the total.

Temperature Effects in Metabolism of Aquatic Organisms - R. E. Nakatani

Further experiments on the effects of high temperature on the metabolism of fish tissues have shown that the optimum temperature for red muscle in vitro is far above the lethal temperature ($26°C$) for the whole animal. The highest rate for conversion of acetate-1-C^{14} to $^{14}CO_2$ by red muscle from $18°$ acclimated trout was measured at $38°C$, the highest temperature studied. The turnover of acetate by red muscle at $38°$ is more than twice that of the liver. These studies indicate that the lethal temperature of the fish is not a function of energy production in tissues such as the liver or muscular system.

Earth Sciences - W. A. Haney

Geologic mapping in the Horse Heaven Hills eastward from Wallula Gap disclosed further evidence of a major Oregon source of the basalt flows of the Columbia River Basalt Plateau. The stratigraphic section above the Elephant Mountain flow rapidly thickens eastward from one flow to possibly more than 10, totalling 750 feet in thickness. The section thickening and the decreased amount of folding eastward indicates that the Horse Heaven Hills from Wallula Gap to their junction with the Blue Mountains are dominantly an accumulation of the basalt flows that poured into and in part through a structural low existing in the area.

The flows above the Elephant Mountain flow of lower Pliocene age probably extend upward well into Pliocene time. They thus must overlap in time with some sediments of the Ringold Formation, recently redated as Pliocene in age. Diversion and local ponding of the Columbia River that resulted in deposition of the Ringold Formation sediments was initially, at least, more the effect of lava flows than of uplift of the Horse Heaven Hills, traditionally believed to be the cause of deposition.

Termination of many of the flows in the Wallula Gap area probably resulted from decreases, previously noted, in the amounts of basalt emitted with time. Encroachment of the flows on a Columbia River (Ringold) floodplain also could have inhibited their northerly spread. One flow was mapped as pinching out, others appear to terminate in flow breccias containing pillows and palagonite that previously may have been considered to be fault breccias.

A technique for obtaining quantitative information from remote sensing systems has been developed. Infrared imagery data on magnetic tape (collected over the Project by the Northern Forest Fire Laboratory, Missoula, Montana) were plotted as contours of equal voltage levels (uncorrected) on a cathode-ray tube. This permitted the data to be processed as fast as it was generated. The technique is not limited by the dynamic range of the recording equipment as are other display systems used in remote sensing. Plots of such information on the Gable Mountain waste cooling waters swamp showed that infrared radiation differences which were not detectable on photographic recordings of the data were easily discernible by this technique.

Several refraction seismic test lines were shot adjacent to well 699-63-90 (near the west end of the Gable Butte outcrops). The subsurface glaciofluvial material here consists of sand, silt and numerous boulders. As noted during the G.S.I. survey several years ago, such locations on the Project are difficult record areas where refraction first arrivals are not clear and seismic energy attenuation is very high.

These initial refraction lines were run to develop techniques that would give the best records. Excessive explosive charge sizes were required where offsets (shot to detector distances) of more than 25 feet with a detector spread of 25 feet were used. A 300 foot offset with 50 foot detector spread required twenty pounds of nitro-carbo-nitrate (ammonium nitrate primed with fuel oil) and one booster; and even then the records were not particularly good. Much of the problem appeared to be due to the relatively low propagation rate of the ammonium nitrate (less than 7000 ft/sec). Indications were that use of a dense, high velocity explosive would improve records because of the short impact pulse and high brisance. A small amount of "Flex-X", a plastic military demolition explosive, was available for test use on one seismic line. Excellent records were obtained from tests conducted with this explosive. The glaciofluvial-Ringold interface was easily detected. Shot to detector distances were not great enough to receive refractions from the basalt, but if the proper energy pulse can be put into the ground, resolution of the Ringold-basalt interface should be easily accomplished.

The transport equation, which relates molecular diffusion and hydro-dynamic dispersion to adsorption to describe the movement of contaminants within a ground water flow regime, was developed in curvilinear coordinates. This allows description of the dispersion tensor in terms of longitudinal and transverse dispersion coefficients in addition to simplifying the boundary conditions required to solve boundary value problems. The equation is written in finite difference form using the Crank-Nickalson approximation in order to obtain a numerical solution. The existing two-dimensional transient computer program is being modified to handle the equation.

The formulation is completed for modifying the Steady Computer Program to allow use of the del-ln k vector field instead of the permeability distribution to obtain new flow system potential patterns. This is a significant improvement in over-all efficiency for steady flow systems.

If the permeability, K, is used as previously done in Steady, then the permeability integral is numerically evaluated in the "Stream Program" to get the K distribution. The K distribution was subsequently differentiated in the Steady program resulting not only in inefficiency but also allowing numerical inaccuracies to enter. Such a procedure was originally required since the permeability integral is valid only along streamlines.

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Aerosol concentration at the above flow rate is at least 500 particles per cubic centimeter, which is more than an order of magnitude higher than can be prepared using a generator of the Whitby design.

Radioactive Fallout Rates and Mechanisms - R. W. Perkins

A high volume portable air sampler has been built on a ladder truck with 8 sampling heads ranging from 0.25 to 10 meters above the ground. The flow rate through each of the sampling heads is approximately 10.8 cfm, sufficient to sample separations plant iodine at some distance from the stack. Each head is equipped with a fractionation pack to separate particulate, inorganic and organic forms of radioiodine. During a recent unusually high radioiodine release, measurements were made at the base of the stack and at a distance of 5 miles from the stack. At the 5 mile sampling point the portion of the total radioiodine associated with the inorganic fraction had decreased by about twofold while the particulate and organic fractions increased by about fourfold and twofold, respectively. The measurements of radioiodine as a function of height up to 10 meters will be used in estimating radioiodine deposition velocity.

The natural concentration of the cosmic-ray produced radionuclide ^{24}Na (15 hr half-life) in the atmosphere was measured for the first time. Measurements were made on two separate air filter samples taken at Galena Pass, Idaho (elevation 8,752 ft) on October 18 and 19, 1966. The observed ^{24}Na concentrations correspond to production rates of 13 and 23 x 10^{-9} nuclei per gram of air per second. These concentrations are 3 to 6 times those predicted by Lal (reported to be good to a factor of 2 to 3) and may reflect some rapid mixing of nuclei from the upper troposphere. These measurements demonstrate the feasibility of using the short-lived cosmic ray produced radionuclides in studying short-term atmospheric mixing processes.

Fresh fallout from the Chinese nuclear test of October 29, 1966 arrived here 6-7 days after the detonation and was clearly indicated by the high concentrations of ^{140}Ba-^{140}La, ^{132}Te-^{132}I and ^{99}Mo. The observed air concentrations of the radionuclides were similar to those observed at this location following the previous three Chinese nuclear tests.

The rare earth element europium has been evaluated as a possible tracer for precipitation scavenging processes. Neutron activation analyses of several precipitation samples from the Cascade Mountains showed a europium background of one-tenth or less that of the silver tracer currently used. It should thus be a very sensitive tracer of atmospheric processes.

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Precipitation Scavenging Studies - R. J. Engelmann

Three field tests to measure the washout of silver iodide particles
by rain were conducted at the Rimrock Lake experimental site. The rain
samples were submitted for radiochemical analysis.

Fallout Phenomenology - R. J. Engelmann

The observational error estimate of the Montgomery Stream Function
for a single observation was revised from the previous value of 0.064 x
10^7 cm^2 sec^{-2} to about 0.03 x 10^7 cm^2 sec^{-2}. This was done by removing
variations due to different observing times and locations and by omit-
ting some of the 50 observations in order to obtain a "balanced" statis-
tical design. It was found by referring the surface pressure to a single
pressure-height curve, that errors attributed to different locations may
be reduced by half. These error studies show that surface pressures
used with radiosonde data should be reported to 0.1 millibar accuracy for
optimum use in isentropic analysis. Unfortunately, both the Northern
Hemisphere Data Tabulations of the U. S. Weather Bureau and the twice
daily teletype transmissions, record surface pressures to whole milli-
bars. In addition, at least some radiosonde stations are now using
inaccurate aneroid barometers to measure these surface pressures.

Transport and Diffusion - C. E. Elderkin

Dual tracer experiments continued. Four diffusion tests, three in
unstable conditions and one in stable, were made using ZnS and fluore-
scein as tracers. During the first test fluorescein was released from
65 feet and ZnS from 5 feet; during the other three tests the tracer
sources were reversed. The data are being analyzed to compare elevated
and ground releases in identical conditions. Previously, comparisons
could be made only for expected similar conditions determined on the basis
of stability classification.

Operation Mountain Iron (Air Force Sponsored) - C. E. Elderkin

Attempts to determine the factors involved in crosswind spread of
a continuous plume led to the use of a running mean average technique (Hay-
Pasquill). The source point wind direction fluctuations are averaged over
time intervals specified by t/β, where t is the travel time to the point
in question and β is the ratio of Lagrangian to Eulerian scales of tur-
bulence. Then the variance of the resulting running average through the
test period is calculated, yielding the effective turbulent intensity
causing crosswind dispersion. The product of this intensity and the travel

time gives the standard deviation of the plume. The value of β has been estimated by a number of investigators with various results. Most recently it has been proposed that β is inversely proportional to the turbulence intensity. Though this relationship has not been firmly established, some experimental data have tended to lend support. Results from previous Hanford diffusion tests have indicated that such an inverse relation is expected.

The comparison of estimated plume spread at Vandenberg AFB with filtered wind record variances, using the Hay-Pasquill technique with β inversely proportional to turbulence intensity, shows a significant improvement over all previous attempts to relate the plume widths to wind variability. Briefly, nearly 3/4 of the data are compressed to within a factor of 1.5 of the mean predicted values. Most of the remaining data, generally consisting of complete tests, are being investigated individually for their anomalous behavior. It appears likely that untypical meteorological conditions prevent this group from coinciding with the main group.

MARINE SCIENCES

Physical Chemistry of Ocean Solutions - R. W. Perkins

Five milliliter polyethylene vials were evaluated for neutron irradiation of sea water salts at a position near the outer edge of the graphite reflector of a production reactor. A two-day irradiation of polyethylene containers filled with sea salts did not seriously damage the container and produced very little interfering radionuclides from fast neutron reactions. Although the neutron flux at this location is 0.1 to 0.01 of that in the reactor core, it is sufficient to produce 10 to 12 daughter radionuclides in measurable quantities where salts from 10 to 20 milliliters of sea water are used.

RADIOLOGICAL AND HEALTH PHYSICS

Whole Body Counting - R. W. Perkins

A whole body counter consisting of six 9-inch diameter by 4-inch thick NaI(Tl) crystals in hexagonal array was completed and is presently in use at the University of Washington on the whole body calcium study. The crystals face the center of a circle, the diameter of which may be adjusted from 17.5 to 21.5 inches. A fiberglass reinforced contoured bed which holds the patient can be moved along the center axis of the detector circle at a constant rate or with an exponential decay drive

which corresponds to the decay rate of a short-lived radionuclide under study. The background of the counter for the measurement of the 3.1 MeV ^{49}Ca gamma ray is reduced only by 30% with lead shielding and a shield will therefore not be used at the University of Washington. The initial phase of the study will involve calibrations of the counter by neutron irradiation of cadavers, counting, and subsequently measuring the total Ca by chemical means. Subsequent studies will be conducted on patients suffering from diseases which cause abnormally high or low calcium content of the body.

Radiation Dosimetry - W. E. Wilson

A programmed P(Z) distribution generator (PDG) was interfaced into the PDP-8 computer and an operational program was written. Following program debugging the PDG is expected to generate, from a given P($\angle$Z) single event spectrum, an event spectrum with any average number of events.

Instabilities are still present in the twin absorbed dose calorimeter which may be the result of drifts in the jacket control. Independent monitoring of jacket control shows that the system is capable of controlling the temperature of the sensing thermistors very well, but that these thermistors do not perfectly represent the jacket temperature. Calculations show that we are getting about as much sensitivity as we can expect without improving the vacuum.

Film Dosimetry Calibration Laboratory Study - C. M. Unruh

A detailed presentation of the statistical models used for data handling and evaluation on the film dosimetry calibration laboratory was made to DBM staff visiting. A visit to the calibrations facility provided an opportunity for first hand observation of the calibration jigs and radiation standards equipment.

The test data analysis programs and computer instructions for analyzing test data were completed. Thirteen sets of performance data from commercial, commission and military film dosimeter servicing groups were readied for computer analysis. To date, 29 film dosimeter processors have provided film for test exposure. Ten additional processors are scheduled to participate in the month of December. Data from 15 AEC sites, 15 commercial processors and 9 military installations are being used in the study.

RADIATION INSTRUMENTS

Radiation Detection and Measurement Instrument - W. G. Spear

Field tests commenced with the animal physiological function radio-telemetry system. Blood pressure, temperature, and respiration transducers were surgically implanted in an experimental animal. Several hours of data were recorded when the sheep accidentally broke the cable connection to the transmitter, prematurely terminating the experiment. Future efforts will include modification of the transmitter to reduce the gain of the blood pressure channel, making it more compatible with the transducers.

In consultation with Biology on possible configurations of the rodent activity monitor, it was decided that reliable data would be assured by using an accelerometer to measure energy directly. Behavioral studies will require some position and time data, derived from readouts of positioned light sensors. The composite system will be built in stages to facilitate evaluation and to spread total system cost over several experiments.

Electronic circuitry for the experimental tidal air volume monitoring system was nearly completed. Measured information, to be presented on a digital printer, will be total number of breaths per experiment, the volume per breath, and the total volume (both in cubic centimeters) per experiment. Transducer tests, recently initiated, indicated that an increase of the transducer dynamic range is probable when a standard, more accurate than the Harvard pump, is available for calibration purposes. Various sizes of Venturi meters are being tested simultaneously for linearity checks and particle deposition.

Laboratory tests and calibration of the gamma monitor portion of the experimental neutron-gamma, mixed field dose rate measuring system was essentially completed. Resolution of minor electronic feedback difficulties will allow final calibration tests to be initiated. All solid state circuits are used in the developmental instrument, the neutron detector consisting of five lithium-foil covered surface barrier diodes imbedded in a polyethylene moderator. A large air-equivalent wall ionization chamber is used for gamma measurements. Provision for joint or separate operation of the instrument is provided.

Initial experiments were conducted with the solid state detector spectrometry system after replacement of faulty electrical feed-throughs in the associated vacuum jacket. Comparison will be made with experimental data obtained prior to feedthrough replacement. At that

time, leakage currents for the detector feedthrough and for the guard ring feedthrough were about 1.1 and 6.3 nanoamperes, respectively. Contemplated improvement of the systems operation is not definite; however, satisfactory performance was noted during operation of a germanium detector within the unit.

Radiological Chemistry - R. W. Perkins

A satisfactory technique was developed for the neutron irradiation of large tissue samples in the reactor core. Two to five gram samples of tissues are freeze dried in polyethylene containers, then irradiated directly in these containers inside a second polyethylene container for 30 minutes in the quickie facility. Preliminary measurements with blank polyethylene ampoules showed very little background interference.

A 5-inch NaI(Tl) well crystal with a 26-inch diameter by 30-inch thick anticoincidence shield, built 7 years ago, was reworked in an effort to improve its response. The 1/8-inch thick inorganic light reflector was removed, the under-surface polished and covered with aluminum foil, and the old 5-inch DuMont phototubes replaced with RCA 8055 tubes. The effect of this treatment was a 23% reduction in the background and a 10% improvement in anticoincidence shielding as measured at the ^{60}Co full energy gamma ray peaks. A full experimental evaluation of a 36-inch diameter by 36-inch thick plastic phosphor anticoincidence shield, presently under construction, will be performed to optimize conditions for maximum light output with its accompanying improvement in anticoincidence shielding.

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