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RESEARCH
AND
DEVELOPMENT
REPORT

PACIFIC NORTHWEST LABORATORY
MONTHLY ACTIVITY REPORT
FOR SEPTEMBER 1951

DIVISION
OF
BIOLOGY AND MEDICAL PROGRAMS

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Nuclear Technology
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PACIFIC NORTHWEST LABORATORY
MONTHLY ACTIVITIES REPORT
SEPTEMBER 1966

on

AEC Division

of

Biology and Medicine Programs

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October, 1966

NOTICE: PRELIMINARY REPORT

This report contains information of a preliminary nature prepared in the course of work under Atomic Energy Commission Contract AT(45-1)-1830. This information is subject to correction or modification upon the collection and evaluation of additional data.

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MONTHLY ACTIVITIES REPORT

SEPTEMBER 1966

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

RADIATION EFFECTS - GENERAL

MECHANISM AND TREATMENT OF GASTROINTESTINAL RADIATION EFFECTS - M. F. Sullivan

The Symposium on Gastrointestinal Radiation Injury was successfully concluded. Research results indicated that in the absence of bile the intestine is altered both morphologically and functionally. They also indicated that passage time for G.I. contents in juvenile rats differed from that in adult rats, suggesting that calculations for radiation doses from ingested radioisotopes be altered to compensate for this physiological variation.

TOXICITY OF RADIOELEMENTS

FACTORS AFFECTING THE TOXICITY AND METABOLISM OF RADIONUCLIDES IN AQUATIC ORGANISMS - R. E. Nakatani

Autoradiographs of freshwater mussels (Anodonta) exposed to ^{65}Zn showed 3 tissues which appear to concentrate the largest amounts of this isotope. These are (1) the kidney, (2) the blood cells, especially those contained in the heart, and (3) an unidentified tissue, found mainly in the gills and mantle. Epithelial cells from different tissues were found to accumulate ^{65}Zn in strikingly different patterns. The outer mantle epithelium concentrated ^{65}Zn at the tip and base of the cells; the kidney epithelium accumulated ^{65}Zn in the upper half of the cells; and the intestinal and rectal epithelium concentrated ^{65}Zn approximately half way between the tip of the cells and the nuclei.

EFFECTS OF RADIOSTRONTIUM IN MINIATURE SWINE - J. L. Palotay

A female miniature swine died at age 2 years following a nine-day illness characterized by intermittent vulvar discharge of fresh blood.

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This was a first-generation animal and had been fed 31.25 $\mu\text{Ci/day}$ ^{90}Sr from weaning to 12 weeks of age, 62.5 $\mu\text{Ci/day}$ from 12 weeks to 6 months of age and 125 $\mu\text{Ci/day}$ for the 18 months prior to death. A reduced RBC count, PCV and Hb was noted as well as an absolute neutrophilia on two blood samples taken during the illness. The WBC count was slightly elevated compared to previous values obtained on this animal. Initially the bleeding seemed to respond to administration of systemic coagulants.

Necropsy disclosed a distended uterus containing a large amount of blood, some of which was not clotted. The source of this blood could not be found. The endometrium had no ulceration or mucosal hemorrhage and, in fact, did not even appear inflamed. There were numerous areas throughout the intestinal tract, each about 1 cm in diameter, which had the appearance of organized hemorrhage extending from the subserosa through the mucosa. An area about 2 cm in diameter of similar appearance was found in the pancreas along with interlobular fatty material suggesting an earlier localized hemorrhagic pancreatitis. There appeared to be a slight increase in splenic parenchyma. Numerous small (1-3 mm) raised reddish-yellow foci were found on the kidneys, and the adrenals were somewhat smaller than normal and marked with hemorrhage in some areas. The costal marrow was grossly normal in appearance. The carcass was pale in general with mild icterus of the mesenteric lymph nodes.

Although some of the lesions observed in this animal are suggestive of those seen in some cases of leukemia, the general impression is that these are probably centers of extramedullary hematopoiesis rather than predominately early myeloid forms. These are no doubt due to the intermittent copious hemorrhage from the genital tract and the inability of the bone, which is probably aplastic, to produce quantities of blood needed to replace that lost. Definitive conclusions must be postponed pending a report from histopathology.

Several coats of fiberglass cloth and resin were applied to the embalmed ^{90}Sr pig to provide mechanical strength and an air barrier. Attenuation of the ^{90}Sr bremsstrahlung was less than 5%. Evaluation of various counting geometries will start when time on the whole body counter is available.

Examination of direct marrow preparations of a 44 month-old pig which had been on a regimen of 125 μCi $^{90}\text{Sr/day}$ revealed consistent chromatid gaps or breaks in an acrocentric chromosome of Group II. Peripheral blood cellular levels were chiefly characterized by an elevated platelet level and a low cellular alkaline phosphatase score.

EFFECTS OF RADIOIODINE IN SHEEP AND SWINE - J. L. Palotay

Protein-bound iodine (PBI) determinations on 21 normal Hanford Miniature Swine gave a range of 2.3-4.8 $\mu\text{g}/100$ ml serum with an average of 3.0 $\mu\text{g}/100$ ml serum. Ten Hanford Miniature Swine were given 2 mCi ^{131}I in a single (ablative) dose and five were given 10 μCi ^{131}I in a single (tracer) dose. These animals are being monitored daily.

INHALATION STUDIES - W. J. Bair

Preliminary data on the total lipid content of rat lungs following exposure to 1000 R upper body X-radiation are shown below:

<u>Days Postexposure</u>	<u>Lipid Content of Irradiated Rat Lungs (% of Control Values)</u>
1	116
2	69
4	70
10	132
35	100

In an earlier experiment 800 R caused an increase in total lipids on the first day postexposure, followed by apparently complete recovery. The significance of the difference in response to 1000 and 800 R X-radiation may become clearer when all of the analyses are completed.

SPACE NUCLEAR SYSTEMS STUDIES - R. C. Thompson

Three female Hanford Miniature Swine were each given ca. 0.8 Ci $^{238}\text{PuO}_2$ microspheres (decontaminated) orally and confined in metabolism cages until their sacrifice 14 days later. There were two sites of particle retention in the first pig, one in the jejunum and the other in the distal colon. The second pig had many particles in the stomach and throughout the remainder of the intestinal tract. The third pig had apparently passed all particles. No gross pathology was seen in any of the animals.

There is no explanation at present for the extreme retention of particles in the second case. These particles were not associated with ingesta, being found on the mucosa. Some would wash off with the mucus but many would not. There were no grossly visible pathological changes to explain the retention. The animal was eating, drinking and excreting normally during the confinement period, eliminating the possibility of general gastroenteric inactivity. There was no evidence of coprophagy.

The third p. contained several thermoluminescent dosimeters which had been implanted at various sites along the intestinal tract two weeks prior to microsphere administration. These were easily found and removed at necropsy. No adverse tissue reaction to these implants was found. Integrated dosages to these sites will be computed following processing of the dosimeters.

Hematological studies suggest that lymphopenia may be developing in 3 dogs which have been carrying single $\sim 150 \mu$ $^{238}\text{PuO}_2$ spheres in their lungs for about 3 months. Development of lymphopenia in these animals would be a significant finding in that it would indicate that the lymphopenia which occurs in animals that have inhaled $^{238}\text{PuO}_2$ is due to the plutonium in the lung, as we have suspected, rather than to plutonium translocated to the bronchial and mediastinal lymph nodes, as proposed by others.

Calculations were made of the terminal velocities of plutonium oxide and aluminum oxide particles of various sizes, and of impaction angles for a variety of horizontal wind velocities, preparatory to wind tunnel studies of particle deposition and resuspension.

BIOLOGICAL SYSTEMS MODEL DEVELOPMENT - G. E. Driver/W. J. Bair

A tentative model for disposition of inhaled plutonium dioxide was established. This very preliminary model, which fits the data from our dog studies, conflicts in certain details with the model of the ICRP Lung Dosimetry Task Force. Additional dog data will be utilized to refine the model.

MOLECULAR AND CELLULAR LEVEL STUDIES

CELLULAR REGULATORY MECHANISMS - W. H. Matchett

Methionine stimulates the synthesis of RNA in cells of E. coli without increasing significantly the rate of growth of the cells. It does appear, however, that methionine causes a very small increase in the rate of growth (i.e., about 5-7%) which is barely detectable. Thus, the possibility existed that the cells under investigation were partially auxotrophic for methionine and that the relief afforded by addition of exogenous methionine could explain the increased synthesis of RNA. We tested this possibility by taking advantage of the fact that the strain of E. coli used in these studies is sensitive to leucine. Added leucine reduces the rate of growth of the cells by 30%. The presence of added

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leucine causes the cells to exhibit partial auxotrophy for isoleucine, a compound which will completely reverse the leucine effect. Methionine (without relieving the growth inhibition) increases the relative rate of synthesis of RNA in leucine inhibited cells to the same extent as is observed in uninhibited cells. This finding eliminates the possibility of a partial methionine auxotrophy.

Several possible transportless mutants of Neurospora crassa were tested for their ability to grow on tryptophan. The results suggest that these mutants are extremely leaky or the frequency of reversion is very high. Attempts to use tryptophan analogs in the medium to prevent selection of revertants are presently under way.

The search for a second class of transport mutants was initiated. The process involves the use of tryptophan analogs. The tryptophan mutant td-201 was irradiated and incubated in indole plus 4 and 6-methyl tryptophan. Only cells incapable of transporting these normally inhibitory analogs will be able to survive. Mutants prepared in this manner are under investigation.

An investigation of the metabolic control of tryptophan synthesis in N. crassa is being performed using the herbicide 3-amino-1,2,4-triazol (3AT) which causes alteration in the normal control mechanisms. The results of the administration of the compound to logarithmically growing cells of a tryptophan auxotroph of Neurospora in the presence of tryptophan are reductions of the growth rate, derepression of tryptophane synthetase, and inhibition of the tryptophan induced synthesis of kynureninase. In the presence of 3AT and indole the tryptophane auxotroph does not exhibit derepression of tryptophan synthetase until most of the indole is exhausted from the medium. These results have led us to postulate that 3AT is inhibiting the action of tryptophane as a small molecule effector in metabolic control. The indole experiment indicates that tryptophane synthesized endogenously from indole is metabolically different from exogenously supplied tryptophane as far as control mechanisms are concerned. It has been demonstrated previously that endogenously synthesized tryptophan is preferentially used for protein synthesis in N. crassa. Our recent work is directed toward elucidation of the differences in these two "types" of tryptophan in Neurospora, and also toward more precise definition of the control mechanism in tryptophan synthesis.

CHARACTERIZATION OF RADIATION-INDUCED FREE RADICAL REACTIONS IN AQUEOUS SYSTEMS - D. R. Kalkwarf

Several radiation-induced radicals have been found to react rapidly with molecular oxygen even at trace concentrations so that additional

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precautions were taken to prevent air seepage into the irradiated flow system used to generate and detect these radicals. A Plexiglass enclosure was constructed around the flow-line connections to the aqueous sample cell of the ESR spectrometer so that these critical joints could be bathed with a continuous flow of helium. Re-examination of the radicals produced in irradiated p-nitrobenzoate with this new safeguard in operation showed that a new radical could now be detected whose ESR spectrum was superimposed on the more intense spectrum of the p-nitrobenzoate radical anion. Because of the overlap of spectral lines, the structure of this new species is uncertain; however, it appears to increase in concentration outside the radiation field at the same rate as the short-lived component in the decay of the p-nitrobenzoate radical anion, and could well be a subsequent rearrangement product of this latter radical.

ENVIRONMENTAL RADIATION STUDIES

ESKIMO FOOD CHAIN STUDIES - R. E. Nakatani

Shadow-shield counter measurements of ^{137}Cs body burdens in Anaktuvuk Pass residents during July were as follows:

<u>Category</u>	<u>Age</u>	<u>No.</u>	<u>^{137}Cs Body Burden (nCi)</u>	
			<u>Mean</u>	<u>Maximum</u>
Adults	> 21 yrs	25	1090	2130
Minors	15-20	7	770	1210
Children	4-14	30	290	620

Control Adults		19	1060	2100

These values are essentially the same as those obtained with the portable lap counter, reported last month, except for the children category. Portable counter values averaged 500 nCi, compared to a lower average of 290 nCi from the shadow-shield counter. This difference emphasizes the need to re-check calibration factors, particularly for children where significant growth may occur between the periods of measurement.

Preliminary results of ^{137}Cs measurements in lichen samples collected in the summer of 1966 at Anaktuvuk Pass show an appreciable decrease from 1965 samples. More samples are being processed, but these early results suggest the beginning of a downward trend in ^{137}Cs concentrations in the

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lichen-caribou-man food web. Residents of Anaktuvuk Pass, Arctic Village and Ambler are again being measured during September-October.

TERRESTRIAL ECOLOGY - R. E. Nakatani

Cesium-137 derived from worldwide fallout was measured in the vegetation of a mountain bog. Sedges were the dominant vascular plants of the bog. The ^{137}Cs content of new growth sedge was highest in samples collected from plots with standing water and lowest from plots near the margin of the bog without standing water. Sedges growing in water averaged about 15 pCi $^{137}\text{Cs}/\text{g}$ dry weight as compared to an average of only 5 pCi/g for those plants growing out of water. Mosses and detritus were also collected from the same plots as were the sedges. The highest ^{137}Cs accumulations (36 pCi/g) were measured in moss and detritus samples collected near the bog margins and the lowest values were measured in plots with standing water. These data suggest that the ^{137}Cs content of sedges is not totally derived as deposition from the atmosphere but is being derived secondarily from the bog substrates.

PLANT UPTAKE OF RADIONUCLIDES - F. P. Hungate

In an effort to determine the extent to which plant roots transport radionuclides down into the soil profile, plants were grown on a column of soil to which ^{137}Cs was added to the top layer. Following growth during which plants were watered in some instances from the top and in some instances from the bottom of the soil, sequential samples of the soil were taken together with the contained roots and analyzed for ^{137}Cs content. During the first two weeks of growth there was no apparent increase of movement in those pots containing plants as compared with a control series containing no plants, indicating that at least during early growth of barley little or no cesium is moved into the deeper root zones.

COLUMBIA RIVER ECOLOGY - R. E. Nakatani

Near normal river flows permitted frequent sampling of the littoral zone to determine the uptake of radionuclides accompanying the startup of reactors during the week beginning August 21 (See table). Reactors had been shut down for about 6 weeks. In a two-week period the concentrations of ^{51}Cr and ^{65}Zn increased 20-fold or more in plankton, periphyton and caddis fly larvae. The change in ^{59}Fe concentration was about half that of ^{51}Cr and ^{65}Zn . The increase initially was quite rapid, followed by a decrease in rate of accumulation at the end of two weeks. By the first part of September, the concentrations of radionuclides in river organisms were approaching the previous seasonal highs observed in May.

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RADIONUCLIDE CONCENTRATIONS IN RIVER ORGANISMS

(pCi/g wet weight)

Date	Plankton			Periphyton			Caddis Fly Larvae			Stainers		
	⁵¹ Cr	⁶⁵ Zn	⁵⁹ Fe	⁵¹ Cr	⁶⁵ Zn	⁵⁹ Fe	⁵¹ Cr	⁶⁵ Zn	⁵⁹ Fe	⁵¹ Cr	⁶⁵ Zn	⁵⁹ Fe
8-23-66	220	503	146	22	109	61.1	Bkg	80.8	34.9			
8-24-66	877	623	201	131	261	104	14.1	118	43.5	Bkg	26.0	Bkg
8-25-66	1440	1130	217	578	558	217	99.9	160	49.3			
8-26-66	3020	2190	331	1210	621	222	228	401	82.0			
8-27-66	1280	1790	201	1530	868	289	229	384	68.4			
8-29-66	2730	2600	462	3960	1825	889	641	746	150	Bkg	62.0	27.6
8-30-66	2310	1770	438	3330	1370	550	472	592	136			
8-31-66	2780	1720	310									
9-1-66	2650	2770	261	4960	1750	628	648	830	132			
9-2-66	2230	2290	218							38.4	130	25.4
9-6-66	4350	4030	683	4940	1960	663	1010	1420	253	Bkg	232	31.1

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TEMPERATURE EFFECTS ON METABOLISM OF AQUATIC ORGANISMS - R. E. Nakatani

Using a thermistor temperature probe (response time of less than two seconds) inserted into the deep white muscle mass immediately below the dorsal fin, results have been obtained which show that the rate of heating in the deep white muscle tissue of trout is greater than the rate of cooling when a fish acclimated to a particular temperature is quickly transferred to a new environmental temperature. Trout, each weighing about 80, 300 and 1500 gms, were used in these experiments. Factors influencing the rate of heating and cooling were (1) the mass of the animal, (2) the increment of temperature change, (3) the activity of the animal, and (4) the circulatory rate. The effect of circulatory rate was shown by using dead fish and fish anesthetized with quinaldine or MS-222. A reduction in the circulatory rate slows the heating and cooling rate. The relative role of the gills and the rest of the body in heating and cooling of the animal appear to be about equal. However, more critical experiments must be performed before definite statements can be made.

It has generally been assumed that an acute temperature change of more than 5°C is lethal for trout. We have subjected trout of three different size groups to temperature changes of 13°C with no ill effects. This interesting observation will be explored further.

EARTH SCIENCES - W. A. Haney

Sections of the Hanford Project were scanned with airborne infrared imaging equipment (U. S. Forest Service, Missoula) and the data obtained are now being processed. The information will be used to determine thermal distribution in waste ponds, above waste storage tanks and in the Columbia River. The rapid-scan data were scope-displayed, film and magnetic-tape recorded. Excellent qualitative but limited quantitative information is available from the film. Computer methods are being developed for obtaining a more exact quantitative evaluation of the information recorded on the magnetic tape. Recent advances in infrared sensing techniques indicate a strong potential for application in radioactive waste disposal, hydrology and other earth sciences related research.

In the solution, by continuous methods, of ground water boundary value problems a large set of patched non-linear simultaneous equations must be solved. Work was started during the month toward development of a two-step method for solution which involves an initial linearization so that a full coefficient matrix can be written. A set of values of the unknown is obtained as starting values through use of one of the several available linear solution methods. Subsequently, the non-linear set of equations is solved iteratively from the linearized starting values. The

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iterative improvement will use Liebertsein's extension of the accelerated successive replacement methods for non-linear equations.

The GENORO program was modified to incorporate the capability to evaluate a set of four canonical boundaries surrounding a region without performing a fit within the region. Previously it was necessary to generate a set of new coefficients for a function in order to evaluate the transferred boundary influences.

Preparations are being made to carry out selected refraction surveys on the Project. Initial work will be done primarily to determine basalt depths at critical locations for hydrologic boundary information. The first information will be obtained at the west end of the Gable Butte structure. A refraction line will be run to determine if the basalt bedrock protrudes above the water table at this location. A computer program is being prepared to permit fast reduction of this and similar seismic data and for solution of simple or complex refraction equations.

Hydraulic tests are under way in a number of recently drilled monitoring wells. Of special interest are the aquifer constants at these locations and what interconnections, if any, might exist between aquifers above basalt bedrock and those interstratified between the upper basalt flows.

An initial fitting of the water table surface indicates that an accurate fit is obtainable. The standard deviation for a portion of the surface extending from 200 East Area to the Columbia River was ± 0.38 feet.

ATMOSPHERIC RADIOACTIVITY AND FALLOUT

RADIOISOTOPES AS PARTICLES AND VOLATILES - L. C. Schwendiman

Monodispersed uranyl nitrate particles were generated with the spinning disc generator and passed through a heated quartz tube in order to form UO_3 particles. Dehydration and denitration of uranyl nitrate nominally occurs at $260^\circ C$, but the reaction kinetics are not known. The uranyl nitrate particles were passed through a 4-foot horizontal quartz tube of 11 mm inside diameter which was externally heated by tube furnaces. The entrance flow rate was 0.2^4 cfm and the exit air temperature from the tube was greater than $425^\circ C$. The entrance and exit velocities were 0.98 and 2.3 ft/sec, and hence the tube residence time for particles was between 4.1 and 1.7 seconds. This technique was used to produce monodispersed aerosols from 2 to 8 microns in diameter.

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Sampling errors associated with sampling monodispersed aerosols at a 0.3 flow ratio of subsokinetic to isokinetic flow rates were determined for a 17 mph windspeed. These data show the same sampling error trends earlier reported for a flow ratio of 0.3 which was obtained at a windspeed of 10 mph. The sampling error ratio is defined as the ratio of the weight of particles collected in the sample probe as compared to the weight of particles initially in the air sampled.

This ratio increases linearly with particle size from unity for particles of zero size (extrapolated) until non-linearity is exhibited at a particle size of 10 microns. The ratio is a non-linear function of particle size from 10 to 16 microns. Above 16 microns the ratio is constant at 3.33 for both windspeeds. This means that particles greater in size than 16 microns move in straight lines and do not follow the motion of the air deflected around the sampling probe.

The quantities of 2 micron particles entering the probe are 36% and 32% greater than the amount of particles originally in the air sampled for 17 and 10 mph windspeeds, respectively. Similarly, the quantities entering the probe for 10 micron particles are 178 and 161 percent greater. These data for a sampling ratio of 0.3 indicate that the sampling error is relatively independent of windspeed for velocities from 10 to 17 mph. However, the average sampling error is already 3.34 for 2 micron particles and increases up to 3.33 for particles which are 16 microns in diameter and greater.

FALLOUT PHENOMENOLOGY - R. J. Engelmann

The standard observational error in the Montgomery stream function was computed to be $\pm 0.064 \times 10^7 \text{ cm}^2 \text{ sec}^{-2}$ for the 300° isentropic surface. This means that errors in the stream functions used in trajectory calculations on isentropic surfaces will be less than 0.064×10^7 68% of the time. These errors can have a large effect in the low wind speed case when the trajectory end point is made to satisfy the energy equation, but will not be detrimental to trajectories constructed in the high wind speed case. Data used in calculating this standard error were from hourly radiosonde releases at four sites during two seven-hour periods. In all, there were 50 radiosondes used in the calculations, released within a radius of four miles. The data were adjusted to remove hourly variations of the stream function; however, the effects of variations of 15 minutes and less in the release times were not removed. Despite the large efforts expended elsewhere in isentropic work, a definitive error analysis of this kind has not been previously made.

ATMOSPHERIC TRACERS - R. W. Perkins

Preliminary experiments are being conducted in the development of a noble gas atmospheric tracer technique for real-time measurements. In these experiments possible radiation detectors are positioned in the center of large neoprene balloons and the counting efficiency and count rate as a function of source volume for noble gas radionuclides are determined. These experiments have shown that a detector is insensitive to ^{85}Kr (0.68 MeV beta max.) at distances beyond six feet from the detector and to ^{133}Xe (0.35 beta max.) beyond 1.75 feet. These experiments will define both the counting efficiencies and sensitive gas volumes for several detectors and will thus serve as a basis in detector selection for use in the real-time field studies of atmospheric diffusion.

RADIOACTIVE FALLOUT RATES AND MECHANISMS - R. W. Perkins

Two air filter samples representing the first month of operation of our sampling station in Rio de Janeiro have been received. Preliminary analysis showed the presence of ^{131}I , and other short-lived nuclear bomb debris presumably from the recent French nuclear test. Although the general fallout radionuclide concentrations are much lower in the southern Hemisphere their concentrations appear to be sufficient to measure most of the radionuclides being studied here and in Point Barrow, Alaska.

Although the environmental behavior of radionuclides which are washed from the air by rain water has been the subject of many studies, the environmental behavior of most radionuclides is not well known, particularly in areas of high rainfall. The Olympic Peninsula with an annual rainfall which varies from 40 inches near the coast to 200 inches at the Olympic peaks provides a natural study area for measuring the fate of the fallout radionuclides. An environmental sampling program was conducted to provide information on the fraction of the various radionuclides in rain water which actually arrive in the rivers draining the peninsula and also the uptake of the radionuclides by the flora and fauna of the area. Following the receipt of permission from the Olympic National Park superintendent and with the help of park naturalists samples of the major flora of the area were collected along with river water and river sediments. The information from these samples will be supplemented by measurements of radionuclides in the air and rain, and in animals as supplied by the park game protector. By multidimensional spectrometric analysis of these samples it will be possible to define much of the behavior of about ten of the fallout radionuclides.

Analyses of ten groups of salmon collected from Alaska during the past summer are complete. The average levels this year are only 20 to 40% lower

than last year, indicating that except for radioactive decay the concentrations have remained constant. A joint study with Dr. Aase of the Arctic Health Research Center, Anchorage, Alaska, is planned which will define the transfer of iron between mother and fetus in iron deficient Eskimos. The study will utilize the natural high concentrations of ^{55}Fe in the natives and measure its transfer to the fetus by sampling umbilical cord blood after birth. Mother and subsequent infant blood samples will provide the necessary information for determining transfer rates and build-up rates in the infant.

PRECIPITATION SCAVENGING STUDIES - R. J. Engelmann

The natural backgrounds of the tracers used for rain and snow scavenging tests have been determined for the 1965-1966 Rimrock series. (Table 1) Backgrounds were averaged for three different cases: samples collected in bags upwind from the source tower; samples collected in bags downwind from the source tower; and recent clean snow taken from the top of the snowpack. A snow surface was present during all tests. The snow surface has, in general, a smaller tracer content than precipitation collected in samplers lined with plastic bags. The reason why this should be is not clear.

The outdoor experimental site at Rimrock Lake in the Cascades was improved with the addition of a 5 x 7 building about 200 feet from the tower. This building will be used for equipment storage between tests, and as protection from the weather when developing rain samples, photographing snow crystals, and recording raindrop electrical charge. Track, pulley, and winch were mounted on the tower to support an elevator for tracer generation equipment. The elevator substantially reduces the amount of climbing needed during field tests.

TABLE 1

NATURAL CONTENT OF TRACERS IN PRECIPITATION
DURING RIMROCK 65-66 SERIES

<u>Tracer</u>	<u>Precipitation</u>	<u>Samples Upwind From Source (g/ml x 10¹¹)</u>	<u>Samples Downwind From Source (g/ml x 10¹¹)</u>	<u>Recent Snow From Snowpack (g/ml x 10¹¹)</u>
AgI	Snow	--	2.0	1.1
	Rain	6.3	6.9	1.6
Sc	Snow	--	0.03	0.1
	Rain	2.0	3.5	0.15
Cs	Rain	8.6	11.8	2.5
I ₂	Snow	21.0	30.0	13.4
	Rain	--	--	25.3
Br ₂	Snow	200.0	150.0	86.0

TRANSPORT AND DIFFUSION - C. E. Elderkin

Two field tests were conducted over the wake diffusion grid, in neutral to slightly unstable conditions. During these tests, a full complement of Self-Orienting Samplers (SOS) were in use. These samplers orient the sampling filter into the wind regardless of wind direction, an important point for sampling in non-uniform wind fields, such as are observed in the lee of buildings: at a given point the wind direction can vary 270 degrees or more in a few seconds. Detailed comparison of SOS and stationary samplers will be made, but a cursory examination indicates an average exposure on the SOS which is 5 to 10 times greater than that observed on stationary samplers when both are exposed side by side within one building height downwind, about 15 meters. At 50 meters, the SOS indicates twice the exposure of stationary samplers, and at 100 meters no appreciable difference was expected, since at that distance the wake flow is aligned with the free flow. The Real-Time Sampler, positioned in the lee of the building, was also fitted with a self-orienting head for these two tests. This will allow accurate measurement of short-term fluctuation of concentration in the lee of a building, as well as average exposures.

Two flight operations were conducted in the Hanford area with tracer generation from the base of the 200 foot tower and sampling with the aircraft using the recently modified bulk and real-time samplers. One operation was conducted under neutral to stable conditions and the resulting plume was quite narrow and confined near the ground. Cross-wind integrated concentrations of the bulk and real-time samplers were well related. A second operation included surface and tower sampling and the aircraft sampling provided significant measurements out to eight miles.

Lateral and vertical dimensions of the tracer plume as well as instantaneous and cross-wind integrated concentrations can presently be provided with the airborne system. Additional refinements, however, are required for increased precision and reliability considered necessary for routine, operational use.

In the course of using the zinc sulfide real-time sampler as an airborne sensor, several problems have been encountered. As a result, a major redesign effort for the airborne real-time sampler was commenced. This effort is directed towards solving three major deficiencies; (1) ambient noise due to particulate matter other than zinc sulfide makes the analysis of the data difficult, (2) free water in the atmosphere completely blanks out any zinc sulfide signal and has caused instrument failure, and (3) the photomultiplier current drifts. In essence, these difficulties will be overcome by use of selective filter media to screen out unwanted radiation spectra and to isolate the electronics from direct contact with the atmosphere. The use of filter media does result in a loss of available light energy at the face of the photomultiplier; therefore, it is necessary to insure that as much of the phosphorescence as possible arrives at the chamber containing the tube. This will be accomplished by realigning the air stream to provide minimum distance between the irradiation chamber and the photomultiplier tube.

RADIOLOGICAL AND HEALTH PHYSICS

WHOLE BODY COUNTING - R. W. Perkins

Experiments were conducted at the University of Washington cyclotron to determine if this instrument could be used to generate a reasonably uniform and a sufficient neutron flux over an area the size of a man. This was essential for the measurement of total body calcium in a planned study of bone decalcification diseases with the University medical doctors. By bombarding a beryllium target with deuterons at the exit part of the cyclotron the desired conditions were met. The neutron flux was constant

over a two foot wide area, varied by only 9% over a vertical distance of 5.5 feet and was sufficiently uniform over the thickness of the body. On delivering 0.1 rad to a phantom a sufficient amount of ^{49}Ca was generated in the skeleton to permit its precise measurement with our planned multiple crystal whole body counter. With these observations, the technical feasibility of the study is assured and phantom calibrations studies can begin in the near future.

RADIATION DOSIMETRY - W. E. Wilson

Assembly of the absorbed dose calorimeter was completed. Tests indicate the thermopile output (temperature difference between cells) was strongly dependent on changes in jacket temperature. Changing the location of the thermopile terminals reduced this dependence some but did not completely cure the problem. Oscillations appearing in the thermopile output, which were correlated with the room temperature variations, were eliminated by improving the styrofoam insulation surrounding the calorimeter. Long term changes in jacket temperature still have a severe effect on the thermopile output. At least part of this is due to the different time constants of the two absorbers. The absorber with the short time constant follows more closely the temperature fluctuations of the jacket than does the absorber with the long time constant. A step temperature change of 0.1°C in the jacket induced a temperature change of 0.06°C between the two absorbers. A possible solution is to increase the time constant of the jacket control to the point where the slow absorber could follow it closely. However, to improve the results significantly would require an order of magnitude increase in the jacket constant which is already four hours.

The design of tissue equivalent ion chambers for use with 14 MeV neutrons was completed. These chambers will have 2.5 mm walls, the minimum necessary for 14 MeV proton equilibrium, and should have a range up to ~ 20 Rads. A new jig for the reader was constructed, and the input electronics of the reader is being overhauled to improve noise rejection.

RADIATION PHYSICS - W. E. Wilson

The lifetime of the $3^1\text{P} \rightarrow 2^1\text{S}$ transition at 501.6 nm in parahelium was measured as a function of pressure. The dependence on pressure and the maximum observed lifetime of 73 nsec agree very well with other experiments reported in the literature. The 3^1P level can decay also to the ground state (1^1S) by emission of a 53.7 nm resonant photon. Imprisonment of this resonance radiation adds considerably to the observed lifetime of 3^1P level; the lifetime should be just a few nsec in the limit of zero pressure. At pressures below 0.01 torr, however, the spectral emission was too low in intensity for satisfactory data taking. Therefore,

we were unable to go to pressures low enough to avoid imprisonment of the resonance radiation.

All spectral lines from energetic protons on nitrogen gas have been accounted for. These spectra are due to the N_2 second positive system, N_2^+ main system, and $NO \gamma$ system (nitrogen third positive); also, some very weak oxygen lines are observed. Preliminary lifetime measurements of the N_2 second positive and N_2^+ main systems were made. The lifetime of the $NO \gamma$ system is much longer than the time interval between proton bursts from our present chopper. We will need a slower repetition rate in order to make this measurement.

The minimum time resolution obtained with the system to date is 3.25 nsec FWHM. This can also be expressed as an apparent half-life of 0.82 nsec measured at one-fifth of the maximum of the prompt distribution curve. The resolution depends primarily on the focus of the proton beam; the TAC and analyzer contribute about 0.5 nsec and the phototube an estimated 0.2 nsec to the total resolution.

FILM DOSIMETRY CALIBRATION LABORATORY STUDY - C. M. Unruh

To establish the present capabilities of both AEC and commercial film processors, film badge dosimeters were requested from the various processors. These dosimeters are to be exposed by Battelle-Northwest to several type, spectra and levels of radiation. As of September 30, 1966, fourteen sets of film were received from the processors. Of these, eleven were exposed and returned for evaluation and three sets are being exposed. Final evaluations were received from three of the processors. Twelve other processors have agreed to provide film badge dosimeters for the study.

The study was continued to determine the reproducibility of results and the position effects for each of our sources used in exposing film from industrial and government processors. Exposures were made during September using the cobalt-60 source.

RADIATION INSTRUMENTS

RADIATION DETECTION AND MEASUREMENT INSTRUMENTS - W. G. Spear

Further laboratory tests demonstrated that the incorporated minor circuitry changes definitely improved the stability of the animal physiological function radio-telemetry system, and the received recording equipment was successfully adapted to the main receiver chassis. Field tests

with the completed system, which will monitor and telemeter the respiration rate, pulse rate, and temperature of free-ranging animals, will be initiated as soon as Biology Department personnel have selected and prepared the test animal.

Modifications were partly completed on the inhalation chamber, which is to be employed in the experimental tidal air volume measurement investigations, and the necessary transducer linearity tests were initiated. Emphasis on development of the signal conditioning electronic circuitry resulted in completion of all single breath control and scaling circuits, except for that employed in resetting. The planned total breathing measurement chassis will employ an essentially similar configuration except for triggering and reset. The breath registering circuitry is finished except for the print-out drive and control. If the transducer tests demonstrate adequate linearity, the system will be ready for fabrication and assembly in initial experimental form.

Initial requirements were established for the experimental rodent activity measurement system being developed in cooperation with the Biology Department. In view of the timing requirements in particular, it appears that infrared detection techniques will provide the most suitable and reliable method for sensing the physical movements of the caged rodents. The planned six-cage system, which will incorporate a considerable number of sensors, requires a rather extensive amount of data handling and readout equipment, if conventional techniques are to be used. In view of this complexity and probable cost, computer techniques are being explored.

A completed comprehensive review of representative electrical anesthesia techniques served to describe the strengths and weaknesses of the considerable investigations in this area of direct interest in the performance of animal experiments, where chemical anesthesia techniques are contraindicated by specific experimental requirements. A topical report summarizing the results of the study was prepared for release.

Calibration and evaluation tests were partly completed on the experimental mixed-field, neutron-gamma dose rate monitoring system, which employs all solid state circuitry, a large ionization chamber for gamma measurements, and a neutron detector consisting of five lithium-foil covered surface barrier diodes imbedded in a 10-in. diameter polyethylene moderator. Minor modifications are being incorporated as the testing progresses to assure that final operation will be fully acceptable for direct field use.

Initial designs were established for a revised cryostat system for use with the solid state detector spectrometry system for which a cooled,

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field effect transistor input circuit is being fabricated. The planned addition of an anticoincidence Compton "blanket" assembly will serve to considerably improve the overall system sensitivity. Modifications are also being incorporated in the electronic circuitry to improve the system resolution.

RADIOLOGICAL CHEMISTRY - R. W. Perkins

An evaluation of the Ge(Li) diode spectrometer for fallout studies has demonstrated the diode's usefulness in this area where high counting efficiency is normally considered to be essential. The spectrometer cannot detect all of the radionuclides which are measured on air filters with the multidimensional gamma ray spectrometer using sodium iodide detectors but it measures some additional ones. For example, the ten radionuclides ^7Be , ^{54}Mn , ^{65}Zn , ^{95}Zr , ^{95}Nb , ^{103}Ru , ^{106}Ru , ^{125}Sb , ^{141}Ce and ^{144}Ce can be measured from a direct count of an air filter on the Ge(Li) diode. The ^{95}Zr and ^{95}Nb cannot be differentiated and the ^{65}Zn cannot normally be measured with the multidimensional spectrometer. Also, the ratios in which ^{103}Ru to ^{106}Ru and ^{141}Ce to ^{144}Ce can be measured with the diode are less restrictive than with the multidimensional analyzer. The measurement of air filters on the diode will supplement the multidimensional analyzer measurements by increasing the number of radionuclides which can be observed and the sensitivity for some measurements.

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