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Health and Biology

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QUARTERLY PROGRESS REPORT

RESEARCH AND DEVELOPMENT ACTIVITIES

FOR OCTOBER - DECEMBER, 1950

by

H. M. Parker, Manager
HEALTH INSTRUMENT DIVISIONS

REPOSITORY DOE-Office of General Counsel

COLLECTION Hanford Downwinders Litigation

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1. INTRODUCTION

This fifth quarterly report of the research and development activities of the Health Instrument Divisions, Hanford Works, as before includes some items charged to control, but included for general interest. Such are identified as "not (0/0)".

The immediately previous report of the series was numbered HW-19146, 12/16/50. Obsolete problem assignment numbers are shown in parenthases, where this adds to continuity.

Internal regrouping in the development division led to the modified order of reporting the various group activities.

2. PERSONNEL

	Biology Division			Development Division		
	9/30/50	12/31/50	Net Increase	9/30/50	12/31/50	Net Increase
Supervisors	7	7	0	5	5	0
Scientific & Technical	33	39	6	17	22	5
Non-technical	20	23	3	2	3	1
Clerical	4	4	0	1	1	0
Total	64	73	9	25	31	6

3. LABORATORY FACILITIES

The isotope storage addition to the biology laboratory was still incomplete. Completed was the temporary addition to the control laboratory, which will indirectly free a little laboratory space for development work.

The meteorological field stations, held up by prolonged technical discussions on the relative merits of two forms of instrumentation, may be further held up by the impending unavailability of either.

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4. PROBLEM ASSIGNMENTS PROGRESS - BIOLOGY DIVISION
(H.A. Kornberg, Division Head)

A. Analysis (R.C. Thorburn, Group Head)

Problem 677.10 - Radioactivity in Carcasses

Two analytical methods for the determination of radium in body ashes were investigated. Preliminary runs on radon separation with use of a proportional counter are promising. Separation of radium was the other method tried.

Problem 677.11 - Alpha and Beta Analyses of Organic Material (A.C. Case, R.F. Palmer, W.H. Breymen, R.C. Thorburn)

Methods for the determination of radioiodine and radiostrontium in vegetation were tested and applied to routine control.

A method for the determination of radiosodium, phosphorus, and iron plus rare earths in aquatic organisms was developed. This procedure was incorporated into the aquatic biology program on a periodic basis to determine if the observed changing ratio of Na^{24} and P^{32} in aquatic organisms is rhythmic.

A colorimetric method for the determination of thorium using pararsenic acid as the precipitating agent and dye was tested and modified for water, and vegetation samples.

A method for the separation of carrier-free radioisotopes using ionic migration in an appropriate medium was successfully applied to a Sr^{90} . Y^{90} mixture. Negative results were obtained with rare earth mixtures.

Problem 677.12 - Radioelements in Organisms in Pile Effluent (A.C. Case)

Algae and plankton samples were analyzed for all radioelements. Results showed the presence of radiosodium, copper, zinc, rare earths, tin, phosphorus, iron, cobalt, arsenic, uranium, and plutonium. Radiocalcium, cadmium, titanium, manganese and antimony were tentatively identified. Tests for radiocarbon, sulfur and polonium gave negative results. Samples of fish and snails were analyzed and comparable results obtained.

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Problem 677.11 - Physical Processes Affecting Methods for Isotope Use
(R.C. Thorburn, A.C. Case)

Geometry studies, and coincidence loss determinations were made on the MGPC-2A counters. Studies on the coincidence loss of the beta counters were started. Self-absorption studies were made with radiophosphorus mounted as the molybdate, strontium sulfate, sodium sulfate, and yttrium hydroxide.

An investigation was made of the effect of counting plate rims on the counting rate of plutonium samples.

Problem 677.14 - Waste Disposal Methods for Biological Specimens

No progress.

Problem 677.15 - Physical Chemical Methods for Dosimetry due to Deposited Isotopes

No progress.

B. Aquatic Biology (R.F. Foster, Group Head)

Problem 689.01 - Effect of Pile Effluent Water on Aquatic Organisms (act 060)
(R.F. Foster, P.A. Olson)

Limited monitoring studies made during the summer with rainbow trout were concluded on October 25. The fish under the most severe condition of 5% uncooled area effluent water were slightly smaller, and showed a slightly greater mortality than the controls.

On October 26, full-scale monitoring was resumed with 45,000 chinook salmon eggs. These eggs were distributed among twenty troughs. The uncooled area effluent series constitutes the regular monitoring procedure. The cooled area effluent series when compared with the uncooled series will more clearly define the temperature effect. The pile influent and pile effluent series on comparison should indicate any effect of radioactivity. Carbon filtration and cooling of the effluent become necessary to equalize the residual chlorine changes and the temperature differential between the two waters. The 5% strength solutions are in duplicate since borderline effects are expected to occur at this level. The river water control tests triplicate.

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By the middle of December, all salmon eggs had hatched. The results through the incubation period are summarized in Table 1.

TABLE 1

EFFECT OF PROCESS WATERS ON CHINOOK SALMON EGGS

Condition	Strength	Temperature °C	Water Activity (μc/cc)x10^6	Egg Activity (μc/g)x10^6	Percent Mortality
River water control	100%	8.0	2.4	26	4.5
	1%	8.0	11	44	5.6
Uncooled Area	2%	8.5	19	76	5.3
Effluent	5%	9.5	41	173	6.1
	10%	11.0	88	421	12.2
	2%	8.0	19	99	4.4
Cooled Area	5%	8.0	41	204	4.1
Effluent	10%	8.0	84	323	4.5
Pile Influent	2%	8.0	2.4	--	4.0
carbon-filtered	5%	8.0	2.4	--	3.6
	10%	8.0	2.4	14	4.1
Cooled	2%	8.0	14	28	5.1
Pile effluent	5%	8.0	30	48	4.4
carbon-filtered	10%	8.0	55	73	4.3

A significantly high mortality occurred only under the severest condition - the 10% uncooled area effluent.

Activity densities of the pile effluent water are somewhat lower than those of comparable dilutions of area effluent, due to selective absorption in the filter. This greatly alters the egg-water activity ratio in the two test groups.

Problem 689.16 - Biological Chains (F.A. Olson, B.F. Foster)

The experiment testing the effect of retention of trout in 5% pile effluent and feeding radioactive algae to one group continues. Some, but not all, of the fish are maturing and will spawn during the next quarter to complete one generation of study. Table 2 summarizes the current data, which appears

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below:

TABLE 2

GROWTH OF TROUT - EFFECTS OF EFFLUENT WATER AND OF RADIOACTIVE FOOD

Condition	Food	Size in grams	Activity density (μc/gram) x 10^5 Fish	Water
River water	Normal diet	451	5	0.2
River water	10% control algae	409	(not sampled)	0.2
5% effluent	Normal diet	450	84	5.7
5% effluent	10% basin algae*	474	230	5.8

*Average activity of algae when fed was 340 x 10^{-5} μc/g.

Poor growing conditions and repeated draining of the 107-F retention basin eliminated the original source of active algae. Substitute algae maintained in a laboratory pond was only one-third as active, and the activity density of the fish eating this algae decreased accordingly. Scales were the most active tissue sampled. The fish were nearly four times larger than reported for the last quarter, and no retardation of growth appeared to result from the 5% strength effluent water or the active diet.

Problem 689.17 - Radiobiological-Ecological Survey of the Columbia River
(J.J. Davis, D.W. Watson, C.C. Palmiter, R.W. Cooper, O.L. Cooper)

The activity density of the plankton from the 13 established shore stations increased consistently with reduced river flow to reach an all time high of 15 x 10^{-3} μc/g during December in the vicinity of Hanford. The activity of most other forms, including the fish, declined with temperature from peaks attained during September. The following values were observed for December: Bottom algae, 2.4 x 10^{-3} μc/g; midge larvae 2.7 x 10^{-3} μc/g; caddisfly larvae 2.3 x 10^{-3} μc/g; and small fish, 2.6 x 10^{-4} μc/g. Most of these forms were about twice as active as observed one year ago while plankton was four times as active.

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For large fish, a maximum activity density of 3.1×10^{-3} $\mu c/g$ was found during October in the scales of a sucker taken at Hanford; with 0.3×10^{-3} $\mu c/g$ being the maximum value observed for flesh.

Delivery was obtained on a 30-foot power boat during December. This boat will be used for some plankton collections and for developing methods for obtaining bottom-dwelling forms from the deeper parts of the river.

Problem 68).04 - Control of Algae in Retention Basins (R.F.Foster, C.C. Palmiter)

Concrete test blocks coated with anti-fouling paints which had been suspended in a retention basin for nine months were removed on December 28, when it became apparent that the growth of algae on control blocks was waning. Although about 62 grams of algae per square foot remained on the unpainted blocks, no visible growth appeared on any of the painted blocks. A U.S.Navy formula called "Boxalin" appeared the most durable of the four brands tested. A larger scale test with "Boxalin" is being set up.

C. Biochemistry (J. Katz, Group Head)

Problem 687.18 - Relative Biological Effects via Biochemical Systems (M.E. Getzendaner, E.A. Kornberg)

The destruction of dilute aqueous solutions of riboflavin (0.01 $\mu g/ml$) subjected to X-irradiation has been assayed by using Streptococcus zymogenes. The results are:

Total Dose, roentgens	Percent Destroyed
0	0
1,000	6
3,000	33
6,000	27
10,000	86
15,000	98

In this experiment, the riboflavin solution was prepared by using freshly distilled water which had been kept under nitrogen. When water stored under oxygen was used in preparation of a riboflavin solution which was then irradiated with 6,000 roentgens, the amount of vitamin destroyed was only 19%.

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Problem 687.17 - Absorption of Pu from the G.I. Tract (J.Katz, C.W. DeLong)

The chronic oral administration of plutonium to 160 rats was initiated early in November. The experimental animals were divided into 4 groups of 40 rats each. Each group received per feeding, 1 ml of Pu^{238} (+ 4) - nitrate at the following dosage levels: 1×10^{-6} µg/ml, 3×10^{-6} µg/ml, 1×10^{-5} µg/ml, 3×10^{-5} µg/ml, respectively. Forty additional control rats are receiving 1 ml of water. All solutions fed to the rats are adjusted to pH 2. The test is to run for 700 feedings.

Problem 687.20 - Tritium Biological Investigations (R.C. Thompson, C.W. DeLong, E.A. Kornberg)

Human inhalation of tritium oxide

Two liters of air saturated with water vapor at 35° - 36° C, and containing approximately 790 µc tritium oxide, were inhaled by a volunteer. The moisture in the next 10 exhalations was collected in a U tube immersed in a dry ice-acetone bath, and was submitted for analysis.

Samples of urine obtained one day after inhalation contained a maximum of 23.9 µc/liter tritium oxide.

Two days later, this same volunteer inhaled 610 µc of tritium oxide. Samples of urine obtained the first day contained 30.3 µc/liter; 25 days later, urine contained 6.9 µc/liter tritium oxide. The biological half-life was calculated to be approximately 13 days. Ninety percent of the inhaled tritium oxide was retained beyond the first 10 breaths.

The tritium oxide found was as follows:

Exhalation No.	1st test µc tritium	2nd test µc tritium
1	31.5	25.1
2	17.1	21.0
3	15.5	10.4
4	9.2	9.6
5	7.5	9.4
6	3.1	5.0
7	3.6	6.2
8	7.1	4.6
9	6.8	4.8
10	7.9	--
11	--	6.3

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Part one of an experiment to determine the retention of tritium oxide in mice was completed. Each of 31 mice received 13 daily intraperitoneal injections of 93 μc of tritium oxide. Serial sacrifice of the animals from one day after the first injection to 31 days after the last injection was carried out. The tritium in body water obtained by azeotropic distillation of carcasses with benzene, and in the water obtained by combustion of the residue was determined for each mouse.

The following data were obtained:

1. Tritium in body water attained a maximum of 150 μc/mouse at the end of the injection period, but decreased to 0.1 μc/mouse or less after 31 days.
2. The initial half-time for loss of tritium from body water was 1.1 days, but after 31 days the remaining activity was exhibiting a half-time of 10 to 15 days.
3. The tritium in the water obtained by combustion of carcasses (bound) attained a maximum activity of 15 μc/mouse at the end of the injection period, and was reduced to about 0.6 μc/mouse 31 days later.
4. The major portion of the bound tritium exhibited a half-time of about 3 days. That remaining at the end of the experiment was being lost with a half-time of 30 days.
5. One day after the first injection, 3% of the total tritium in each mouse was bound. This value increased to 10% on the last injection day, and to 90% 31 days after the last injection.

It is clear that bound tritium contributed significantly to the total irradiation received by each mouse. From the last injection until total excretion, the irradiation dose calculated from the total tritium curve (that in body water plus that bound) is about 1.5 times as large as the dose calculated on the basis of the 1.1 day half-time for body water.

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Due to the long biological half-life of the bound tritium, an extension of the experiment is now in progress.

A litter of mice born to a mother which had received tritium oxide is being sacrificed at intervals. There is evidence that the extent of binding of tritium is much greater in the young than in mature mice.

The retention of tritium in rats is also being investigated.

The percutaneous absorption of the vapor of tritium oxide has been investigated in two rats. The procedure involves exposing to a measured area of shaved abdominal skin the tritium oxide present in a cup suspended in a small closed chamber. Of the two animals, No.7-2 showed 0.12 to 0.53 $\mu c/min/cm^2$ of exposed skin per μc in each cm^3 of tritium oxide vapor (infinite reservoir), and No.7-4 showed 0.44 to 1.0 $\mu c/min/cm^2$. Both results were obtained by analysis of cardiac blood.

Previous attempts to measure percutaneous absorption of tritium oxide placed directly on the skin of a rat and of some young pigs are deemed non-contributory.

Problem 687.21 - Possible Therapeutic Agents for Radiation Damage
(J. Katz, P.L. Hackett, C.V. DeLong)

In order to evaluate the sensitivity of tissues, metabolites, and enzymes toward various types of radiations, preliminary work on this project has been initiated. Warburg vessels and manometers have been calibrated and biochemical procedures pertaining to this work are being investigated.

Problem 687.22 - Percutaneous Absorption of Radioelements
(J. Katz, R.C. Thompson, C.V. DeLong)

Work not started.

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D. Botany (J.W. Porter, Group Head)

Problem 688.02 - Separations Area Control Plot (not 060) (A.A. Selders)

The maximum activity densities in alfalfa grown in the plot during this quarter were 3.4×10^{-2} and 3.4×10^{-3} $\mu c/gm.$ of dry leaves and stem tissue, respectively. Corresponding values for Russian thistle were 4.5 and 0.9 $\mu c/gm.$

A Russian thistle plant, growing where plants had shown background readings ($< 7.6 \times 10^{-5}$ $\mu c/gm.$) in previous years, attained activity density values during October of 2.2 and 3.0 $\mu c/gm.$ of dry matter in leaves and stems, respectively. This is apparently a successful application of biological monitoring to underground travel of active materials.

Problem 688.23 - Agricultural Field Station (J.W. Porter, J.F. Cline)

Treatment samples of soil and vegetation taken during the past 3 months have had average activity densities of less than twice those of control samples.

Calculations were made of the quantity of radioactive elements that will be present per cm^3 of agricultural field station soil when the rate of addition will equal the rate of physical decay. These supported the present intent to close the station after not more than one additional growth season.

Problem 688.24 - Translocation of Radioelements in Plants (J.M. Mullins, A.A. Selders)

The uptake of yttrium by Red Kidney bean plants growing in nutrient solution of pH 6.0 was proportional to the concentration of Y in ranges of 0.0001 to 50 p.p.m. Higher concentrations of Y have not been used, mainly because it was found in one experiment that at 50 p.p.m. of Y in nutrient solution, the plants showed definite symptoms of toxicity.

The absorption and translocation of Y to leaves of bean plants grown in nutrient solutions containing 0.154 μc Y^{91}/liter, a total Y concentration

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of 0.0001 p.p.m. and adjusted to pH 4.0, 5.0, 6.0, and 7.0, respectively, were directly proportional to the hydrogen ion concentration. At pH 4.0, the bean plant concentrated Y in the leaves by factors of approximately 10 and 100 times in fresh and dry tissue over the concentration in the nutrient solution. The growth period was 4 days, and the Y concentration of the solution was 0.0001 p.p.m. Trifoliate leaves of bean plants grown four days in a nutrient solution at pH 6.0, containing 0.1 p.p.m. of Y, did not concentrate this element.

A study made of the mobility of Y, using the phloem injection technique, showed that a nutrient medium (root medium) at pH 4.0 resulted in the translocation of Y to other leaflets at the same stem location as the leaf into which Y was introduced. In a nutrient medium at pH 7.0, and in the presence of varying yttrium, borate and phosphate concentrations, Y was not translocated.

Problem 688.25 - Tritium Botanical Investigations (J.W. Porter, J.F.Cline) Roots of Red Kidney bean plants were kept in nutrient solution containing tritium oxide, and the plant tops exposed to darkness or to light for varying periods of time. Tritium contents were determined for water of transpiration, plant water, and water of combustion. Preliminary results indicate the tritium oxide concentration of the plant water, when plants are exposed to light, approaches equilibrium with the concentration in the nutrient solution in about 24 hours. In plants exposed to darkness, equilibrium between the tritium oxide concentration of plant water and of nutrient solution is not reached in 72 hours. The tritium content of the organic constituents of plants exposed to light or to darkness increases with time, indicating a continual incorporation into the plant; the rate of incorporation in the light is greater than the rate of incorporation in darkness.

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Problem 688,26 - Effects of Radiation on Plant Life

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E. Physiology (M.H. Joffe, Group Head)

Problem 698,27 - Biological Effects of Active Particles (M.H. Joffe)

Inactive.

Problem 698,28 - Bone Metabolism of Radioelements (M.H. Joffe)

Pretreatment of the experimental animals is in progress. They are being bled at approximately twice-weekly intervals, the corpuscular elements centrifuged off, and the plasma reinjected. This provides the stimulus needed for the bone marrow to become active and hyperplastic in these adult animals. Administration of plutonium will be carried out when the peripheral blood shows evidence of bone marrow activity, and after a section of rib is taken for histological study.

Problem 698,29 - Techniques in Autoradiography (N.L. Doskum)

Inactive.

F. Zoology (K.E. Herde, Group Head)

Problem 690,03 - Biological Monitoring (not 060) (R.L. Browning, W.E. Hanson, K.E.Herde)

Waterfowl

A steady decline in activity densities of waterfowl was noted as a result of replacement of the resident population with the large migratory flights from Canada. Few of the resident population have been taken for sampling, as evidenced by a sharp drop in thyroid activity density.

Banding of ducks was initiated, and the preliminary difficulties overcome. The banding returns from both ducks and geese for this year are expected shortly.

In cooperation with the Washington State Game Department, work was completed for a nesting study of Canada geese. Nesting platforms were erected on two islands above the 300 Area that have failed in the past to produce

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broods of geese. Results will be available next May, when nesting will have been completed.

Upland Wildlife

A comprehensive survey of thyroid activity density in ring-necked pheasants taken in Eastern Washington during the hunting season was completed. Maximum activity density found was 0.013 μc/gram in a specimen from the Twin Bridges Area. Detectable levels were found at a distance of 200 miles from the source of I^{131}.

Thyroid activity densities in specimens taken within the environs of the Hanford Works showed an increase in both maximum values found and percentage of specimens whose thyroid activity density exceeded the MPC for I^{131} (based on 300 mrep/week).

Problem 690.30 - Toxicology of I^{131} in Stock Animals (L.K. Bustad, K.E. Herde, D.E. Warner, P.L. Haskett, M.H. Weeks, N.G. Farnham, T.W. Galbraith, R.C. Thorburn, N.L. Dockum, J. Katz)

All lambs were weaned during this period. Weight gains for lambs before and after weaning are as follows:

WEIGHT FOR EWE LAMBS OF GROUP I A

Sheep No.	Weaning Date	Weaning Wt. in kg.	Wt. in kg. 12/23/50
2	9/7/50	29.4	41.2
3	9/22/50	18.6	14.6
4	9/26/50	31.0	28.8
05	9/20/50	29.8	44.2
06	9/15/50	20.6	24.4
6	9/15/50	17.4	18.6
8	9/26/50	28.2	21.6
09	9/15/50	36.4	29.4
12	9/12/50	35.6	45.4

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AVERAGE WEIGHT GAIN FROM WEANING UNTIL 12/17/50 FOR EWE LAMBS

Group No.	IA	IB	II	III	IV
No. of Ewe Lambs	7	7	6	15	15
Weaning Average	27.4	29.3	31.0	32.3	28.4
Present Average	28.4	34.9	39.9	38.6	36.9
Gain	1.0	5.5	8.9	6.3	6.3

AVERAGE WEIGHT GAIN FROM BIRTH UNTIL WEANING AGE (120 DAYS)

Group No.	IA	IB	II	III	IV
No. of Lambs	16	14	22	24	24
Average Wt. gain in lbs.	24.2	25.7	30.8	28.5	27.8

It was generally observed that the early lambs gained better than those lambed late in the season. The lambs in Group IA (240 μc/day) and Group II (0.15 μc/day), were the earliest lambs. Many in Group IB (5 μc/day), Group III (0.005 μc/day), and in Group IV (control), were dropped late in the season, hence the apparent inconsistencies in the weight gain noted. The gains exhibited by the lambs are very satisfactory, except for Group IA level. Four members of this higher-level group have lost weight since weaning, two others have shown little or no gain, while three have made satisfactory gains.

The animals within the main experiment appear very thrifty except for some members of Group IA. Here, many of the original ewes show a chronic blemished condition. Some of the lambs of the same feeding as Group IA, however, display more deleterious effects. Over half of the members exhibit a clumsy and lethargic attitude together with a stiffness in gait and

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muscular weakness. In addition, frothing about the mouth and drooling has been noted in a few individuals.

Thirteen lambs weaned from mothers of Group IA and themselves placed on a similar regime have displayed a wide variation in thyroid activity. Three lambs have shown no detectable uptake, three others have less than 10% of the daily feeding increment deposited, while yet another three individuals have between 10% and 50% uptake. Four lambs exhibited a nearly typical deposition of between 100% to 120% of the daily increment. All thyroid activities have declined since reaching a maximum. The ewes of Group IA displayed a gradual decrease in thyroid activity during October and November and attained apparent equilibrium in December.

Necropsies were performed on one typical member of each group of weaned lambs. Autopsies of lambs from ewes of Groups IB, II, III, and IV, were grossly negative. Visible lesions ascribable to radiation damage were noted only in lambs whose mothers were in Group IA. Grossly this damage was restricted to the thyroid and surrounding tissue. Here, the outstanding findings were a diminution in thyroid glandular tissue, together with periglandular edema that extended to surrounding tissue. Hemorrhage in and around the thyroid was an inconstant finding.

One ewe of Group O (1800 μc/day) for 5 months became prostrate and expired during this period. The presence of abscesses in the lungs and upper respiratory tract, lymph nodes, and one lobe of the thyroid, was very striking. The thyroid consisted essentially of a shrunken fibrous band. One lamb that had been "grafted" to a Group O ewe was sacrificed at weaning age. At that time the lamb was unable to ambulate and exhibited severe [illegible] edema. The thyroid approximated that of the ewe just described.

A supplementary pilot experiment with I^{131} using high and low single doses to two ram lambs was completed during this period. One animal, Group V (280 mc of I^{131}) reached a maximum deposition in the thyroid of about 200 mc by the 15th hour after feeding. By three days, this animal had eliminated 99% of the deposited I^{131} from the thyroid at the rate of a 16 hour biological half-life. After the third day, the rate of elimination from the gland averaged a 5.3 day biological half-life.

The other animal was fed a tracer dose of 23 μc of I^{131}, of which, at peak concentration, about 19 μc was deposited in the thyroid 24 hours after feeding. It was eliminated at a fairly constant biological half-life of 4.5 days.

The ram lamb of Group V was sacrificed 6 weeks after feeding. Gross lesions observed included a thyroid gland that was normal in size, but very dark blue in color and of very firm consistency. The liver presented some light-colored areas that extended into the depths of the liver.

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2. PROBLEM ASSIGNMENTS PROGRESS - H. I. DEVELOPMENT DIVISION
(C. C. Gamertsfelder, Division Head)

A. Physics (W. C. Roesch is Chief Physicist)

Problem 678.10 Moderated Slow Neutron Detector - Inactive

Problem 678.11 Recoil Proton Coincidence Analyzer (J.S. Reddie) - Inactive

Problem 678.12 Beta Dose-rate from a Distant Source (W. C. Roesch)

Some progress has been made in correlating the readings of a CP meter placed at various distances above a uranium disk with the beta surface dose of the disk.

Problem 678.13 Tritium Measurements (W.C. Roesch, J.S. Reddie, I.T. Myers)

The possibility of using a Landsverk analysis unit as a breath analyzer has been investigated. It was found possible to operate the instrument in such a way as to be able to reproduce background to within 15%. Introduction of uncontaminated breath was found possible but a considerable time was required for establishment of equilibrium. Several methods of determining the sensitivity of the system were tried. The best result is probably 13 microroentgens per division; background of the system is about 24 microroentgens per hour. Only one contaminated breath sample has been tried. It was low in activity but should have been detectable if the breath had been saturated with body water. Tests of the system with water vapor containing tritium have contaminated the system. Analysis of the effect of increasing the volume on the sensitivity of the system indicated that such an increase would be difficult so it was not attempted. A report is being prepared on the measurement of tritium oxide, as the vapor, in an ionization chamber.

Investigation of the detection of tritium as vapor in counting systems continues. Considerable quantities of water vapor may be added to a system and still have it count reasonably well. Contamination causes trouble.

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Problem 678.14 Neutron Spectra by Nuclear Emulsion Techniques (E.C.Watson)

Inactive.

Problem 678.15 Gamma Energy Dependence of Ionization Chambers (I. T. Myers, E. C. Watson)

A graphite thimble chamber was completed. Its leakage, capacitance, and sensitivity were determined. These are enough to permit its use for dosage determination. When such determinations are made for standard radium sources, it is found to read 9% low. This discrepancy is now being studied.

Preliminary calibrations of pocket chamber and film badges were made for the gamma rays from N-16. When compared to the graphite thimble chamber, the pencils are about correct while the shielded film reads high by a factor of about two. A Victoreen thimble chamber indicates considerably higher doses than it should as compared to the graphite thimble chamber. The more obvious causes for such a discrepancy were found not guilty.

Problem 678.16 Thin Window Counter Investigations (J. S. Reddie)

A report covering simple ways in which the life and reliability of counter tubes can be increased has been prepared. Checks of the behaviour of a counter tube placed in operation with such methods in October 1949 indicate that the tube is still in good condition and in control.

Problem 678.17 Water Tank for Neutron Calibrations--Inactive

B. Instrument Development (F. L. Hiesmacher, Group Head)

Problem 692.31 Alpha Scintillation Counting - (G. E. Driver)

The alpha scintillation counter for survey monitoring was completed and partially field tested during this period. Some additional follow-up work is needed to insure complete de-bugging but the instrument is considered far superior to air proportional counters by the users. As it [redacted]

now stands, the alpha detector is a zinc sulfide screen, shielded from light by about 0.6 mg/cm^2 aluminum in the form of three sheets of sign painters' "Dutch Leaf". An RCA 5819 photomultiplier senses the light flashes and feeds an amplifier whose frequency response has been adjusted to reject noise pulses by capitalizing on the long phosphor decay time. A counting rate meter with a maximum error of 15% in 3 decades up to 50,000 c/m and a variable audio output complete the signal channel. External controls consist of two power switches, (line and high voltage), a one range selector, and volume control. The audio pitch is adjusted with an internal control not available to the user. When last laboratory tests were run, geometry for plutonium was 12% and background about 0.2 c/m.

Suitable laboratory equipment was designed for careful investigation of scintillations from plutonium solutions. Construction was completed near the end of this period.

The scintillation counter for plutonium pieces is in the field where some difficulty has been encountered in the form of defective cables and high backgrounds. The second trouble was caused partially by phosphor contamination which occurred during testing.

Problem 698.32 Experimental Alpha Counting - Inactive.

Problem 698.33 Sample Changer (M. Wilhelmsen)

The card mounted sample changing mechanism has been completed and tested briefly to investigate the effects of minor changes in the mechanism. It has been found necessary to apply D. C. brake to the transfer motor to eliminate over-travel and this is the greatest change from the first design. Development work is nearly complete and field tests will be run early in 1951.

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Problem 692.34 Portable Slow Neutron Equipment (M. Wilhelmsen)

Following successful field testing of a portable slow neutron counter-counting rate meter, a "prototype design" was evolved. Field tests indicated no need for detector or circuit changes, but engineering and layout of the circuit and mechanical elements was needed if more instruments were to be built. These parts of the work were done with the object of providing maximum practicable accessibility of components and stages for maintenance, ease of decontamination and utilization of standard commercial items instead of home-made ones wherever possible.

Problem 692.35 Fast Neutron Measurement - Inactive.

Problem 692.36 D. C. Amplifier - Inactive.

Problem 692.37 Beta Scintillation Counting - Inactive.

Problem 692.38 Atmospheric Monitoring - Inactive.

Problem 692.39 Soft Beta Counting - (R. G. Clark)

A search was started to find a suitable gas or gas mixture to be used at atmospheric pressure for counting soft beta particles. To date, literature has been reviewed, experimental equipment designed and built, and a few published results confirmed. Helium-isobutane serves fairly well for geiger counting, and argon-methane for proportional counting.

Problem 692.40 Hand Counter - Inactive

Problem 692.41 Tritium Instrumentation (P.C. Althoff, R.G. Clark, M.I. Lipanovich)

An experimental proportional counter for monitoring tritium in air was completed and placed in field service. A second probe was designed and constructed to render detector operation less clumsy. Field performance of the instrument has been rather successful. Inherent drawbacks are the use of large quantities of methane and poor flow control. The first is

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intended to be aided by gas studies now in progress and the second by engineering also in process. The explosion hazard is a serious drawback. Surface monitoring work was not entirely trouble-free and various methods for limiting signals to provide better operating plateaus were investigated. A diode limiter in the probe was found successful and one such unit is in service.

The limiting characteristics of the NICC model 162 amplifier were studied critically. A diode limiter was found necessary to prevent overloading. Several other commercial pulse amplifiers of sensitivity in the desired range have been purchased and will be tried in service. Design drafting of a high sensitivity ion chamber system for monitoring tritium in air was completed. The 80 liter ion chamber and pressurized balanced chamber will permit measuring tritium down to about 10^{-6} $\mu c/cc$ with a Beckmann RXG micromicroammeter.

Work done in this group and the experience of other groups indicated the inadvisability of substituting higher sensitivity current measuring instruments for the Beckmann RXG micromicroammeter. Tests with vibrating reed type devices indicated long term temperature drifts on the more sensitive ranges.

Problem 692.42 Pile Shield Monitoring - Inactive.

C. Industrial Hygiene (F. E. Adley, Group Head)

Problem 699.04 Plant Assistance Non-Medical not (060). (W. E. Gill)

Of interest to all laboratories using benzol, as in the TBA process, were the findings that amounts of benzol vapor well below the nuisance limit in air, had a significant effect on the percentage of organic sulfate in the urine of laboratory personnel, indicating a potential chemical hazard. The problem was eliminated in the subject laboratory by restricting the use of benzol to the essential process operation, and substituting tri-sodium phosphate for all cleaning steps. [redacted]

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Problem 699.20 Development of Improved Thermal Precipitator

Inactive.

Problem 699.22 Study of General Atmospheric Contamination (F. E. Adley)

The data in the study of natural atmospheric particulate background at the Hanford Works was compiled during the past quarter and a report on the findings was submitted in a document entitled "Natural Atmospheric Particulate Background at the Hanford Works". The factors investigated in this study were the degree and type of natural suspended solids as related to wind velocity and ground surface moisture content. These factors were evaluated by various types of quantitative air sampling, particle size evaluation, dust counts, and sedimentation sampling. The results are directly applicable to the study of the active particle problem.

Problem 699.60 Air Mask Tests (F. E. Adley)

Tests were undertaken wherein the various masks to be used in a tritium-contaminated atmosphere were subjected to atmospheres of carbon monoxide and the individual air flow and pressure characteristics for each device were determined. Following compilation of these data the operating characteristics and the capacity of the relevant air supply system were tested. By correlation of these two investigations it was possible to see that the major portion of the units were supplying insufficient protection. Correction of this situation may now make it possible to determine whether the intake of tritium by laboratory workers is predominantly by inhalation or by percutaneous transmission.

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D. Geology (R. E. Brown, Group Head)

Problem 693.43 Ground Water Studies (M. W. McCoaign,)

The main effort was still concentrated on the region between the Columbia River and the Works Laboratory area. Sensitive reaction of the ground water level to sudden river changes promoted by warm rains in the snowfield area was noted.

The water table rose rapidly by 4.5 feet for a total change of 9 feet since June, beneath Area 2. Such changes, if continued, may force major changes in waste disposal practice.

Problem 693.44 Waste Disposal - Field Investigation Area 1

No activity density higher than 0.025 $\mu c/gm$ in earth materials around a crib disposal facility was recorded. The test contamination of ground water decreased according to calculated trends.

Problem 693.45 Waste Disposal Field Investigations Area 2 (L. F. Rolph, R. E. Brown)

Beta gamma activity density in sediments 20 feet below a disposal point ranged from 6×10^{-4} $\mu c/gm$ to 9×10^{-4} $\mu c/gm$. There was no alpha contamination at the test point. Movement of the test contaminated ground water was significantly accelerated by the modified water table gradient.

Problem 693.46 General Geologic Studies (M. W. McCoaign, R. E. Brown)

Soil temperatures at depths of 4 and 10 feet continue to be taken biweekly, as previously noted. Operations of the U. S. Geological Survey sub-contractor, Stanbery and Robinson, are being followed and samples are being routinely obtained from the wells drilled. Ground water and geologic information from these wells will be added to existing information when complete.

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Problem 693.47 Waste Disposal Investigations - Works Laboratory Area (M. W. McCone)

The ground water survey is approaching completion. From this, the effect of the McNary dam on this location will be calculable. Ground water beneath a special crib for disposal of soluble uranium wastes continued to increase in activity, without the addition of further waste. The free mobility of uranium wastes in contrast to the experience with plutonium was again demonstrated. In this case, combined studies by the soil science and geology groups may contribute to an understanding of the processes involved.

E. Meteorology (M. L. Barad - Group Head)

Problem 694.53 Statistical Studies of Diffusion (200 Mile Scale) (G. R. Hilst, M. L. Barad)

The coordination of site survey and meteorological observations has been discussed. It appears that a tracer technique will be satisfactory up to a maximum range of 50 miles.

A program for studying the trajectories of plant effluent has been organized. It will be put into operation on January 1, 1951. Upper-air data received via teletype will be employed in the construction of air trajectories. The analysis will provide a statistical means of determining the areas likely to be affected by the release of plant effluents. The relationship between the trajectories and the larger-scale synoptic patterns will be studied.

Problem 694.54 Diffusion Experiments 50 Mile Scale (M. L. Barad)

The aerosols chosen for use in field studies of diffusion are (1) an oil-fog and (2) a fluorescent pigment.

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An M-2 smoke generator has been received on loan from the Chemical Corps. Studies of diffusion at ground level have been planned and will be conducted until such time as the elevator system in the Meteorology tower has been modified so that the elevator may carry personnel and equipment to various levels of the tower. Then oil-fog will be generated aloft, and qualitative and quantitative measurements of oil-fog concentration at various downwind points will be attempted.

An attempt is being made to borrow generation and sampling equipment, for use in the pigment studies, from an agency which has developed such equipment to the point where field studies are feasible. The plan is to make drawings of this equipment locally and to have the equipment manufactured locally.

Problem 694.55 Wind Tunnel - Stack Characteristics (M. L. Bared)

A report has been submitted on the effect of the speed of flow through a stack on the turning of the axis of smoke effluents having the same density as that of the ambient air. The title of this report is "The Effect of the Speed of Emission on the Rise of a Plume of Stack Gases."

Problem 694.56 Particle Pick-up (O. R. Hilst and M. L. Bared)

Detailed plans for the design and construction of the portable masts have been submitted by this group. The group has assisted Project Engineering personnel in the actual design of the mast. Coordination between this group and the Industrial Hygiene Group has resulted in recommendations for the air sampling equipment to be installed on the mast.

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Problem 694.57 Emergency Conditions (G. R. Hilst, M. L. Bared)

The trajectory technique developed under Problem 694.53 will be used to determine the probable trajectories of highly active clouds which might be produced under disaster conditions.

A preliminary program for the analysis of the data of the wind station network has been prepared. Increased coverage of the reservation by the network has been proposed.

Problem 694.58 Micrometeorology (G. R. Hilst, M. L. Bared)

A paper has been prepared on the vertical temperature changes occurring in the formation of radiation fog in this area. The paper was prepared for presentation at the annual meeting of the American Meteorological Society in New York in late January.

F. Soil Science

Apparatus was accumulated for conventional measurements in the field of soil science. The program itself was not advanced sufficiently to make a significant report.

G. Methods (J. W. Healy, Section Chief)

Problem 691.19 Electrodeposition Methods for Plutonium (L.C. Schwendiman)

Yields obtained upon direct ozonization of an acidic spike solution with subsequent treatment to produce a basic plating bath have been low although greater than 90% of the plutonium is oxidized. Yields above 90% can be obtained by delivering a small aliquot of the ozonized spike solution directly to a prepared plating bath. For this reason, the interest in ozone as an oxidizing agent has decreased and efforts are devoted to the use of NaOCl.

A 5% NaOCl solution appears capable of oxidizing 97% of the plutonium to the +6 state. A modification of the plating cell to provide a positively

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charged platinum sleeve around the inner diameter of the glass vial has resulted in a decreased plating on the glass and increase in yield of 5 - 10%. Overall yields, including some samples extracted by the TTA process, were between 80% and 90%.

Problem 691.20 Alpha Film Studies for Low Level Plutonium
(L. C. Schwendiman, D. W. Brite)

Some preliminary work on the sensitization of nuclear track film by organic dyes was carried out. Methyl violet decreased the sensitivity. Eosin gave apparently larger tracks, but also resulted in a red background which tended to minimize the value.

Data on the effects of an air versus argon atmosphere on the fading of the latent image were obtained over a period of six weeks. There was no fading and no difference between the two conditions within the fluctuation encountered in the data.

Problem 691.21 Fission Film Studies - Inactive

Problem 691.22 Counting Procedures for Tritium (P. L. Koehmstedt)

An apparently satisfactory method for measuring tritium oxide samples as hydrogen at atmospheric pressure in an Eck-Krob Geiger Counter shell was developed. A multivibrator quench circuit for use at voltages up to 3000-4000 volts was developed by the Instrument Development Group. Plateaus in this equipment were generally on the order of 150 volts with about 10% slope per 100 volts. A manifold for filling one tube while another is counting has been built and is in operation. Calibration values of about 17 c/m per μc/liter, with a reproducibility of about 10-20% were obtained. Backgrounds were reproducible at 80-85 c/m within the counting error.

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Problem 691.23 Constant Monitor for Tritium Oxide (J. F. Homstead)

A series of experiments was carried out to determine the feasibility of measuring the tritium content of air by drying the air, burning any hydrogen to water, and collecting the water. Test runs on a combustion train using liter quantities of hydrogen gave recoveries in excess of 95%. Several blank runs with no hydrogen added gave values of hydrogen content of the atmosphere comparable to those quoted in the literature (0.01 - 0.015% by volume).

Consistently low yields (10-50%) were obtained with runs using tritium as a tracer. No explanation of this loss has yet been found.

Problem 691.24 Separations Plant Stack Monitor - Inactive.

Problem 691.25 I^{131} Measurements - Inactive.

Problem 691.26 Purification of Lanthanum - Inactive.

Problem 691.27 Naturally Active Materials in Water (F. L. Kochmstedt, L. C. Schwendiman)

A colorimetric method for the analysis of samples for thorium using 2-hydroxy-3, 6-disulfonaphthalene azobenzene 2-arsonic acid, is being adapted from a process in use at the Oak Ridge National Laboratories. The color system used appears stable for at least one day. Known interfering ions are uranium, zirconium, lanthanum, fluoride, sulphate, and phosphate.

Some work has been carried out in evaluating a self-absorption correction factor for K^{40} in several salts. In each case, the estimated number of beta particles from unit mass of the potassium has been higher by 30-40% than the values quoted in the literature. Studies of several scattering effects are being made in an attempt to explain this discrepancy.

Problem 691.28 Diffusion Experiments - Inactive.

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Problem 691.29 Strippable Coatings -- Inactive.

Problem 691.30 Extraction of Air Samples - Inactive.

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