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HEALTH INSTRUMENT DIVISIONS

QUARTERLY PROGRESS REPORT

RESEARCH AND DEVELOPMENT ACTIVITIES

FOR JANUARY - MARCH, 1951

REPOSITORY DOE-Office of General Counsel

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APRIL 16, 1951

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QUARTERLY PROGRESS REPORT

RESEARCH AND DEVELOPMENT STATISTICS

FOR JANUARY - MARCH, 1951

by

W.H. Parker, Manager
HEALTH INSTRUMENT DIVISION

April 10, 1951

HANFORD WORKS
Richland, Washington

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1. INTRODUCTION

This sixth quarterly report of the research and development activities of the Health Instrument Divisions, Hanford Works, is compiled from the separate reports of division heads and group heads; and as before includes some items charged to control, but included for general interest. Such are identified as "not (060)".

The fifth report of the series was numbered HW-19977, January 15, 1951.

2. PERSONNEL

	Biology Division			Development Division		
	12/31/50	3/31/51	Net Increase	12/31/50	3/31/51	Net Increase
Supervisors	7	7	0	5	5	0
Scientific & Technical	39	39	0	22	24	2
Non-technical	23	27	4	3	5	2
Clerical	4	3	-1	1	2	1
Total	73	76	3	31	36	5

3. LABORATORY FACILITIES

Construction of the isotope storage addition to the biology laboratory was essentially completed. Not yet installed were the shielded saves and hoods.

The conversion of the so-called train shed adjoining the biology laboratory to specialized laboratories was authorized and final design begun. This will complete the main biology laboratory within the allotted funds.

Design of the aquatic biology laboratory was completed, with construction bids to be opened shortly.

The previously mentioned discussions on relating series of two forms of instrumentation for meteorological field stations was resolved by purchasing one [redacted]

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kind for the outer ring of stations, and the other for the inner ring. In this manner, operating reliability will be assured in the stations of poor accessibility on the Wahluke Slope. More detailed records on the stations within the reservation will be feasible, at the expected expense of additional maintenance.

The construction of the control and development laboratory was 5% complete at the close of the period.

4. PROBLEM ASSIGNMENT PROGRESS - BIOLOGY DIVISION (M.A. Lornberg, Division Head)

A. Analyses (R.C. Thornburn, Group Head)

Problem 677.10 - Radioactivity in Carcasses (R.F. Palmer, W.H. Brayman)

Several methods for separating Ra from bone ash for direct counting were investigated. The most promising consisted of dissolving the ash in 30% H_2O_2 and HNO_3 followed by a sulfate precipitation using dimethyl sulfate undergoing hydrolysis with Ba as a carrier. Six samples analyzed with this method gave values of around 10^{-13} μg of Ra/g of ash, a value comparable with Hursch's results at Rochester.

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

A more sensitive method for the determination of I^{131} in large organic samples was developed, tested and applied to routine use. It consists of fusion in Na_2CO_3, solution in HNO_3, and precipitation with $AgNO_3$. Methods of analyzing biological samples for Cm in the presence of Pu were investigated. Preliminary results indicated good separation by precipitation of Cm on LaF_3 after oxidation of Pu to the +6 state, or by coprecipitation of Pu on $BiPO_4$ and recovery of Cm from the supernate by carrying on mixed lanthanum hydroxide and fluoride. Separations were also effected with TTA extractions and with an ion column using Dowex-50 as the resin and citrate solutions as the eluant.

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Investigations as to the possibility of counting tritium incorporated in liquid scintillation media gave negative results.

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

Five samples of fish fed on snails raised in diluted pile effluent, one plankton sample, and two river algae samples were analyzed for radioactive constituents. Isotopes of Cu and As made up the bulk of the short-lived beta emitters in these samples of algae. The remaining constituents were similar to those previously reported.

Problem 677.11 - Physical Processes Affecting Methods for Isotope Use (A.C. Case, R.J. Palmer, W.E. Brayman, R.C. Thorburn)

A study of losses due to coincidences during counting of beta samples was made. Losses for the five counter sets varied from 0.5%/1000 counts/minute to 1.5%/1000 counts/minute with an average loss of 1.0%/1000 counts/minute.

Buildup studies for several Ra samples (mounted with $BaSO_4$) were made. Good reproducibility and agreement with theoretically expected buildups were observed, indicating they can thus be counted to increase sensitivity.

To check the efficiency of the vibrating reed electrometers when used for measuring tritium, two samples of the gas were divided into aliquots of known volume, pressure and temperature, converted to the oxide, diluted and measured. An average efficiency for the electrometer of 60% ± 4.0% was obtained, confirming previous calibrations. Preliminary experiments using the Traserlab windowless flow counter indicated the possibility of counting high level liquid samples. A counting rate of 0.44 c/m/μc/liter was observed.

Problem 677.14 - Waste Disposal Methods for Biological Specimens - Inactive

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

Inactive.

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

Problem 689.01 - Effect of Pile Effluent on Aquatic Organisms (not 060)
(R.F. Foster, F.A. Olson)

Routine monitoring studies were continued with the subjection of young chinook salmon to various dilutions of plant waters. The fish had completed their larvae development and commenced to feed by the first of February. Toward the end of the quarter, growth necessitated reduction of the number of fish in each trough to 1,000. Conditions were abnormal during 3 weeks in January when the reactor was shut down for maintenance. Results experienced from the time of hatching to the end of the quarter are summarized in Table 1.

TABLE 1

EFFECT OF PROCESS WATERS ON CHINOOK FRY AND FINGERLING

Condition	Strength	Temperature °C	Water Activity (μc/cc)x10^6	Activity (μc/g) x 10^6 Fry	Activity (μc/g) x 10^6 Fingerlings	Av. Wt. g	Percent Mortality from Hatching
River water control	100%	4.0	3.0	15	23	0.61	4.3
Unaccled Area Effluent	1%	4.0	13	35	76	0.64	2.8
	2%	4.5	25	56	78	0.62	3.8
	5%	3.5	54	177	243	0.78	3.5
	10%	3.5	98	891	308	0.69	48.5
Cooled Area Effluent	2%	4.0	23	50	81	0.60	3.8
	5%	4.0	52	110	140	0.53	5.0
	10%	4.0	96	134	961	0.43	7.5
Pile Effluent carbon-filtered	2%	4.0	3.0	150	230	0.58	3.9
	5%	4.0	3.0	150	230	0.51	4.4
	10%	4.5	3.0	150	230	0.39	47.3
Cooled Pile Effluent carbon-filtered	2%	4.0	16	66	107	0.57	5.9
	5%	4.0	38	97	169	0.50	5.8
	10%	4.5	63	198	177	0.37	43.9

* Estimated same as river water.

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A slight but probably significant increase in mortality occurred at the 5% concentration in every case. The retardation of growth in the cooled water groups is a more sensitive index of damage at this concentration, however. In most cases, the 10% concentrations have caused near 50% mortality by this time. The slight mortality in the 10% cooled area effluent may possibly result from the cooler temperature and the presence of other wastes which tend to dilute the pile effluent. Concentrations of 2% or less seemingly do not affect the young salmon. Growth and mortality patterns are quite similar in comparable dilutions of the pile influent and pile effluent, indicating that the small amount of radioactive material deposited is not a major factor contributing to the observed effects.

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

The long term retention of rainbow trout in 5% strength pile effluent water with feeding of radioactive algae to one group was continued. Apparently, few fish in either control or treated lots will mature and spawn this year, necessitating a continuation of the test. The practice of sacrificing specimens to obtain tissue samples for determination of activity density was discontinued in favor of removal of scale samples from live fish. This permits repetitive determinations on the same test animals. Table 8 summarizes the current data.

TABLE 8

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

Water Condition	Food	Size in grams **	Activity Density (ma/g) x 10^2 Fish Bones	Water
River water	Normal diet	457 (451)	4	0.3
River water	10% control algae	436 (409)	7	0.3
5% effluent	Normal diet	450 (450)	38	6.5
5% effluent	10% active algae*	449 (475)	65	7.7

* Average activity of algae when fed was 812 x 10^{-3} μa/g.

** Average weight of 36 fish is quoted. Values in parentheses are corresponding weights at the end of the previous month.

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Growth of the fish was practically nil during the quarter due to cold water conditions. Food intake was very low and consequently the activity density of the fish on the active algae diet has diminished to near that of the other group held in 3% effluent.

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

Routine collection of bottom organisms was inhibited during the greater part of the quarter by unseasonably high water and fluctuating levels. Conditions were more stabilized by the end of the quarter permitting sampling for activity density determinations. But areas selected for quantitative study remained beyond reach. Small fish and plankton were consistently collected. Floats were placed at 11 of the collecting sites during February, and algae growths are now becoming established on them. Sampling from the floats will supplement bottom collections.

A crude "slip type" dredge for obtaining bottom samples from the depths of the river was tested from the Survey boat with promising results. Standard plankton collecting equipment is being adapted for use on the boat and new equipment is also being developed to suit requirements. The activity density of fish and bottom organisms was only 1/2 to 1/5 that observed last quarter. Minimum values are ordinarily obtained at this season when minimum temperatures prevail. At the end of the quarter, the following activity densities were recorded: bottom algae 1.5×10^{-3} $\mu c/g$; midge larvae 1.3×10^{-3} $\mu c/g$; and juvenile fish 6×10^{-5} $\mu c/g$. The activity density of the plankton continued to increase with that of the water, and the average for March of 1.7×10^{-2} $\mu c/g$ was a new high. This represents nearly a 3-fold increase over values obtained one year ago, and a 5-fold increase over 1949.

For large fish, a maximum activity density of 4.1×10^{-4} $\mu c/g$ was found in the bone of a white fish. Flesh did not exceed 3.0×10^{-5} $\mu c/g$.

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Problem 68.04 - Control of Algae in 107 Retention Basins (not 060)
(R.F. Foster, C.C. Palmiter)

The large scale test of anti-fouling paint has not yet started due to difficulties in procuring the desired brand of paint.

C. Biochemistry (J. Kats, Group Head)

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

A suboptimal culture medium for L. Casei in which the concentrations of many of the nutrilites were greatly reduced is now available. Satisfactory growth response occurs at 30°C provided the incubation period is extended to 40 hours. It was found that the growth response of L. Casei in tubes containing 0.16 μg of riboflavin plus 200 μc of tritium oxide is approximately equal to the growth response in tubes containing only 0.10 μg of riboflavin but no radioisotope. During the 40 hour incubation period, a total of approximately 500 kilorep was delivered to the culture medium in each tube. Apparently the presence of the tritium oxide brought about only 10/16 or 62% of the expected growth.

Problem 687.19 - Absorption of Pu from the G.I. Tract (J.Kats)

The Pu^{238} obtained for this experiment was discovered to contain several short-lived alpha emitters. After removing these impurities, new feeding solutions were prepared and the daily oral administration of Pu was resumed, using an entirely new group of rats. Both the experimental and control animals appear to be in good health. Procedure used in these feedings is greatly as outlined in the previous report.

Problem 687.20 - Tritium Biological Investigations
(W.D. Thompson, O.W. Balang, M.E. Gotschalaner)

Retention and Distribution of Tritium in the Rat

Investigations on the retention and distribution of tritium oxide injected intraperitoneally into rats indicated that during the first 33 days, the

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body-water activity continued to be lost with a biological half-time of 3.0 to 3.5 days.

Twenty-four hours after the injection of tritium oxide, 1% of the administered dose was present in the tissue-bound state. Of a total of 14 different tissue samples analyzed at this time, the liver contained the largest amount of bound tritium (3.4 μc/g wet tissue), while muscle had the lowest amount (0.17 μc/g wet tissue). After 6 days, the total bound tritium in rats increased to 1.5% of the injected dose while a 5-fold increase in the bound tritium in muscle and a 2-fold rise in that found in fat and small intestine was observed. By the 20th day, however, most of the tissues differed by no more than a factor of 2 in activity density, and exhibited a biological half-life of 5 to 7 days. Fifteen percent of the tritium remaining in the carcass at this time was in the tissue-bound state. This corresponds to 0.5% of the total administered activity. Of this bound tritium, about 45% is in muscle, 20% is in fat, and 20% is in the skin. The body lipids and fat-containing tissues show a high concentration of bound tritium and a long biological half-life.

A group of 40 rats each received a total of 100 mc of tritium oxide by intraperitoneal injection. After a cooling period of several months, these animals will be sacrificed and their tissues will be used for the chemical identification of long-term tritium-binding compounds.

Retention and Distribution of Tritium in the Mouse

The earlier short-term experiment was described in Document HW-80058. In the long-term experiment it was found that 30 days after cessation of the administration of tritium oxide, the biological half-life of bound tritium was approximately 15 days; it increased to approximately 30 days one month later. Ninety days after the last administration of tritium oxide, no

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activity was detectable in body-water, but the biological half-life of bound tritium was of the order of 60 days. Approximately 0.02% of the activity originally injected still remained in the body of the mouse at this time.

Percutaneous Absorption of Tritium

Percutaneous transmission of tritium oxide as saturated vapor was measured, with results shown in Table 3.

The ready transmission rate was ~ 2.5 μg H_2O per cm^2 skin per minute. The total transmission rate, by delayed sampling, was on the order of 5 μg per cm^2/min. The difference was presumably real and due to reservoir action of the skin.

TABLE 3

PERCUTANEOUS TRANSMISSION OF TRITIUM LABELED WATER VAPOR*

Animal	Exposure: Specific Activity Curie/g H_2O	Exposure: Time Hours	Sample: Type	Sample: Time Hours	Skin Absorption μg H_2O per cm^2/min.
22 rats	0.15	1	Blood	Immediate	2.7 ± 1.3
7 rats	0.15	1 repeated 4 consecutive days	Blood	Immediate	2.3 ± 1.1
			Blood	18 hrs. after each exp.	4.2 ± 1.2
			Body-water	18 hrs. after last exp.	5.3 ± 1.2
4 young dogs	1.5	1	Blood	Immediate	2.8 ± 0.7
2 adult dogs	1.5	1 for 5 days	Blood	Immediate	8.5 ± 0.8
1 man	0.8	1	Urine	7 hrs. later	~ 5.6

* It is assumed that tritium oxide is a legitimate tracer for ordinary water. This is not apriori evident for light isotopes in essentially physical processes, but the differences are probably small.

† Saturated at ~ 30%, i.e., natural equilibrium in the exposure chamber between the room (25°) and the skin (~ 33°).

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Problem 687.21 - Possible Therapeutic Agents for Radiation Damage (R.L. Hackett, J. Katz)

No progress.

Problem 687.22 - Percutaneous Absorption of Radioelements (J.Katz)

No progress.

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

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

No further useful information is expected from the tests in the plot, and the problem is terminated.

Problem 688.03 - Agricultural Field Station (J.F. Cline, J.W. Porter)

The average activity density of 59 soil samples taken from the treatment plots during the past 3 months was 1.8×10^{-5} $\mu c/g$ of dry soil, ranging from 5.5×10^{-6} to 3.9×10^{-5} $\mu c/g$.

Problem 688.24 - Translocation of Radioelements in Plants (J.E. Rediske, A.A. Selders)

Russian thistle and tomato plants, grown for 4 days in nutrient solution of pH 6.0 and containing 0.0001 p.p.m. total Y and 0.85 μc of Y^{91}/liter, absorbed and translocated to the leaves significantly more Y (approximately 3 times as much) than red kidney bean and wheat plants. In this experiment, the thistle and tomato plants concentrated Y approximately 5 times on a dry-weight basis. They did not concentrate Y on a fresh-weight basis.

The uptake of Sr from nutrient solutions of pH 6.0 by red kidney bean plants was found to be directly proportional to the concentration of Sr in the range of 0.0001 to 100 p.p.m. of Sr. The concentration of Sr within the trifoliate leaves of bean plants grown 4 days in these nutrient solutions was 50 to 100 times that of the original nutrient solutions.

A phloem injection study showed that the pH of the nutrient solution (root medium) has no significant effect on the translocation of Sr from the injected leaf to other parts of the plant. In contrast, the translocation

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of Sr was increased, in other experiments, when the pH of the nutrient solution was held constant and Ca and Mg were removed separately from the nutrient solution. It was concluded that Ca and Mg inhibit the translocation of Sr. The inhibitory effect of Mg was less pronounced than that of Ca.

Problem 6B8.25 - Tritium Botanical Investigations (J.F. Cline, R.O. Marshall, J.W. Porter, G.W. Smith, D. Weinberger)

The incorporation of tritium into the water and organic matter of red kidney bean plants exposed to light or darkness and grown in nutrient solution containing tritium oxide was found to increase very rapidly up to 24 hours after exposure. Thereafter, the increase in activity density was consistent with an asymptotic approach to the activity density of the nutrient solution.

The activity density of tritium in the water and organic matter of plants exposed to light was higher than those of the same fractions from plants kept in the dark. After 24 hours, the concentrations of tritium in the water and organic matter of plants exposed to light were 70% and 5%, respectively, of that in the nutrient solution. In the corresponding fractions of plants kept in the dark, the concentrations of tritium were 23% and 0.9%, respectively, of that in the nutrient solution. By refinement of the work it should be possible to determine accurately to what extent light accelerates the plant metabolism as compared with the obvious increase in "pump action" in the light.

In a single experiment in which a vein of a trifoliate leaf of a red kidney bean plant was cut, and then placed for 30 minutes in a small cup containing tritium oxide, it was found that at the end of 3 hours the tritium oxide had moved upwards and downwards in the plant. A small portion had entered the nutrient solution in which the roots were growing.

Chlorella pyrenoidosa cells were exposed to tritium oxide (in nutrient solution) in the presence of light for 5 and 15 minutes. At the end of these

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time periods, the algae had a total tritium content of 0.1 - 0.5% of the total tritium to which they were exposed. The major portion of these tritiated cellular components dissolved in hot alcohol.

Chloroplast preparations from clover or bean leaves were found to reduce the dye 2,6-dichlorobenzenoneindophenol in the presence of light. These preparations are more active at 12° than at 25° C, and they lose only a small amount of activity when subjected to dialysis. They are inactivated by precipitation with dioxane or by solution in 0.1 or 1.0% dref solutions, but they are stable when stored in the cold in 15% methyl alcohol for periods of 1 to 2 weeks. The most active preparations thus far obtained reduced approximately 75 μg of dye/mg of chloroplast suspension in 15 min. at a temperature of 12°C and under a light intensity of 2500 f.c.

Escherichia coli, Aerobacter chroococum and Aerobacter vinelandii have marked hydrogenase activity. Chlorella pyrenoidosa and Pseudomonas (species unknown) did not exhibit activity. However, when Chlorella p. was exposed to hydrogen for several hours, it developed marked activity and, therefore, it apparently has an adaptive hydrogenase.

The pH optimums for the hydrogenases of intact Escherichia coli, Aerobacter chroococum and Aerobacter vinelandii were 6.5, 7.5 and 7.5, respectively. The temperature optimums were approximately 38° C.

Methylene blue, oxygen, and triphenyltetrazolium chloride each acted as acceptors of hydrogen for the hydrogenases of the above organisms. As much as 1.5 ml of methylene blue (1:850 dilution) was used per 2 ml of cell suspension without toxicity to the organisms, and with uptakes of hydrogen approaching the theoretical amounts.

Sodium fumarate and potassium nitrate did not act as hydrogen acceptors for the hydrogenase system of Aerobacter vinelandii. However, when a compound such as methylene blue was introduced into the system, hydrogen was trans-

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ferred to fumarate and nitrate. Therefore, it appears that the oxidation potential difference between these compounds and hydrogenase was too great for the reaction to proceed by a single step, but when a compound of intermediate oxidation potential was introduced into the system, the reaction proceeded in two steps.

Attempts to prepare a cell free hydrogenase of Aerobacter g. have not been particularly successful. This organism has a gummy, polysaccharide coat which interferes with efforts to remove the hydrogenase from the cell. Acetone dehydration of E. coli, however, has been more successful. A dry powder possessing hydrogenase but not dehydrogenase activity has been obtained.

In an experiment to determine the uptake of tritium gas by Aerobacter rinelandii, the gas was converted to the oxide at the rate of 1.4 μc/mg of protein N/hr. when air containing 50 mc/liter, at 20° C, was passed through the bacterial suspension at the rate of 1 liter/hour. In another experiment in which a stationary gas was used, approximately 90 mc of gas was converted to the oxide in 20 hours from 0.5 c of tritium contained in an air volume of approximately 2 liters. At the end of the experiment approximately 3.5 mc were present in the bacterial cells. Whether the latter activity developed through bacterial metabolism of the formed oxide or the direct incorporation of tritium is debatable, but the former possibility seems more probable.

Problem 688.26 - Effects of Radiation on Plant Life
(J.W. Porter, J.E. Bedkem, A.A. Bolders)

The growth of E. coli was approximately 30% less than that of controls in 24 hours, when the cells were grown in an inorganic medium containing approximately 0.2 gm of carrier phosphorous and 1000 μc of P^{32}/liter of solution.

The uptake of phosphate ions, in 2 hours, by excised barley roots was significantly less in solutions containing 100 μc/liter of P^{32} than the uptake

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by controls. At 1000 μc of P^{32}/liter of solution, the uptake of this ion was approximately 10 times less than that by control roots exposed to 2 μc of P^{32}/liter of solution.

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

Problem 608.27 - Biological Effects of Active Particles (M.H. Joffe)

A litter of young strain A mice was received through the courtesy of the Laguna Honda Home Oncology Laboratory, and the population will be fostered until sufficient experimental subjects are available for mass exposure.

Problem 608.28 - Bone Metabolism of Radioelements (M.H. Joffe)

Successful rib resections were done on two animals, one normal and one which had been bled into an anemia. The latter animal showed an increase of 30% in number of blood cells and amount of hemoglobin in the course of 1 week, indicating that bone marrow is stimulated and functioning. Microscope slides of the rib are being processed for examination. The normal animal, upon complete recovery from the operation, was given 2.0 mc Pu^{239} by vein (0.11 micrograms /# body weight).

Problem 608.29 - Techniques in Autoradiography (N.J. Dockum)

No report.

Problem 608.30 - Inhalation Studies with Tritium (M.H. Joffe, R.C.Thompson)

An apparatus was constructed by the Instrument group of the Development Division to measure the concentration of tritium before and after passage through the respiratory system of a living animal, but modification of the system is still needed.

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

Problem 609.21-Biological Monitoring (not 060)
(R.L. Browning, W.O. Ransom, K.E. Kerie)

A marked decrease in thyroid activity densities of upland wildlife samples was noted during this period. Maximum thyroid activity density found during

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this quarter was 9.0×10^{-3} μc/g in a rabbit.

All waterfowl samples were below the chronic MPC for radiophosphorus. Maximum bone activity density found was 1.1×10^{-3} μc/g.

The distribution of ingested radiophosphorus in tissues of waterfowl and its translocation during cooking was investigated during the quarter. A total of 6 ducks was fed an average of 0.25 μc P^{32}/g of body weight and sacrificed at intervals up to 42 days. Separate samples of bone and muscle containing P^{32} were used to determine extent of radioactivity transfer from one tissue to the other during boiling.

An experiment dealing with the uptake and concentration of radioelements by animal and vegetable tissues boiled in pile effluent water was completed. Results of this trial indicated that sorption by certain vegetables and meat is nearly equal during gentle boiling. However, as the liquid approaches complete evaporation, the uptake by the vegetables is greatly accelerated; while the uptake by muscle continues at a fairly constant rate.

A system of monthly census of waterfowl populations was instituted during January. Results are to be used as an indicator of the faunal population of the project at various periods of the year. Similar censusing of other animal forms of this area will be accomplished to furnish a total population figure for the Hanford Works.

Banding of wild waterfowl was discontinued midway in this quarter due to the decline of population as the northward migration started.

Problem 699.30 - Toxicology of I^{131} in Black Animals (F.L. Hackett, W.J. Weeks, R.O. Farnham, F.V. Galbraith, R.C. Thorburn, N.L. Dockum, J. Katz, D.E. Warner, L.E. Busted, K.E.Harris)

Five necropsies were performed on we lamb members of the 840 μc/day level. Prior to death, these animals displayed weight loss, a stupid and lethargic attitude, a stiffness in gait, muscular weakness, and slight to moderate

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alopecia. Some of these animals also displayed some difficulty in prehension and mastication, together with periods of gastrointestinal distress. The fecal pellets were usually larger and drier than normal. Postmortem examination revealed thyroids that consisted essentially of shrunken fibrous bands.

Shallow, irregular ulcers were noted in the oral cavity in 3 of the ewe lambs. Esophageal and gastric involvement was evident in 2 animals. Two animals also demonstrated a gelatinous material subcutaneously. One ewe lamb was completely blind with bilateral keratorhexis.

In an attempt to define the extent of thyroid damage and the extent of reparative progress after damage, a supplementary study was initiated in which 9 ram lambs were placed on a feeding regimen containing 480 μc I^{131}/ram/day. The animals were divided into 3 experimental groups of 3 rams each. One group is being maintained on the isotopic feeding for the entire period, while a second group is being sacrificed as thyroidal damage is revealed by a drop in external counting rate using an ionization chamber counter. Coincident with the sacrifice of the second group, the feeding of I^{131} is being discontinued with the third group. After 6 weeks on the I^{131} feeding regimen, 6 test animals exhibited a drop in external thyroid counting rate. Frequent bleeding is accomplished for determination of the relative quantities of protein-bound iodine, radioactive protein-bound iodine, and radioactive inorganic iodine in the serum.

Preliminary data reveal promising correlations between the ratios of various iodine fractions and the functional status of the thyroid gland.

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2. DETAILED ASSIGNMENTS PROGRAM - M.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.D. Reddie) Inactive

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

Problem 678.13 - Tritium Measurements (W.C. Roesch, I.T. Myers)

A method of obtaining pulse height distributions of tritium beta particles in hydrogen in a proportional counter using methane and argon as the counting gas has been worked out. The activity of liquid samples as obtained by this method was 60-70% lower than the Control Laboratory values.

A report on the measurement of tritium in liquid samples was prepared.

Problem 678.14 - Neutron Energy Spectra by Nuclear Emulsion Techniques
(K.C. Watson)

Nuclear track films were exposed to Po-B, Po-Be, and Ra-Be sources, and range spectra prepared from the data so obtained. The results for Po-B and Po-Be agree with those obtained by other workers. Po-Be and Ra-Be showed practically the same spectra, which contradicts a result of another investigator; this matter is being checked thoroughly.

Problem 678.15 - Gamma Energy Dependence of Ionization Chambers
(I.T. Myers, K.C. Watson, J.D. Reddie, W.C. Roesch)

The errors in the graphite thimble chamber reported last quarter were traced to use of the voltage measuring device on an inaccurate range.

A series of thimble chamber type instruments with walls of graphite, aluminum, copper, silver and lead, was prepared. They appeared to work satisfactorily. Interpolation between the graphite and aluminum-walled chambers provides the reading for an air wall chamber. The response of these various chambers relative to that of an air wall chamber to a Co-60 source has been measured and found in agreement with the Bragg-Gray principle. Some investigations of the effect of wall thickness have been made. By using different

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gases in these chambers, it is possible to determine the average energy per ion pair for secondary electrons relative to the same quantity for air.

The response of Dupont 552 films to different energy gamma rays is being investigated. Films are removed from their packets and placed between plates of polystyrene, graphite, aluminum, copper, silver, and lead. It is suspected that several exposures to date have been affected by scattering. Calculations based on the Bragg-Gray principle are only partially successful in explaining the data collected.

A method of determining gamma energies in the range 10 to 100 Kev by absorption measurements with a geiger counter has been developed. Absorption is provided by close fitting cylindrical sleeves of polyethylene, aluminum, or copper. This method has been employed in a systematic survey of a production process involving such emissions, which are not readily registered by conventional monitoring.

The energy sensitivity of the above counter system was investigated theoretically, and fair agreement found with the only available experimental data.

Problem 678.16 Thin Window Counter Investigations - Inactive

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

Problem 678.11 - Alpha Scintillation Counting (G.E. Driver)

The scintillation counter for alpha survey monitoring has been in field service throughout this report period. It was first used in a "self-service" personnel monitoring station and later in a cart for survey monitoring. Except for screen breakage, no maintenance work was required after initial debugging, most of which concerned the use of positive high voltage for the photomultiplier. Those who use the instrument are pleased with its sensitivity and background, but object to the shape and weight of the probe. Since these are dictated by the photomultiplier dimensions, another probe which will use a 1P21 instead of a 5819 has been designed and is being constructed.

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Problem 6[illegible].11 - Sample Changer (M. Wilhelmsen)

The card transport mechanism was changed somewhat to eliminate slippage and consequent movement of the sample during counting.

Problem 6[illegible].4 - Portable Slow Neutron Equipment (M. Wilhelmsen)

A second instrument was built in the local construction shop and difficulties due to component placement corrected. The development work is now [illegible]. In its final form, the instrument weighs about 10 pounds; has 4 feet of cable on the detector which is a ½ inch diameter BF_3 counter built locally; has a time constant of about 1 seconds; on each of its three ranges (1000, 10,000 and 100,000 c/m) is thoroughly reliable according to calibration tests. The design and layout provide for maximum practicable component accessibility, and resultant ease of maintenance.

Problem 6[illegible].12 - Fast Neutron Measurement - Inactive

Problem 6[illegible].36 - D.C. Amplifier - Inactive

Problem 6[illegible].37 Beta Scintillation Counting (G.E. Driver)

A successful counting system with an anthracene crystal and 5819 photomultiplier was completed. A Nuclear Measurements Corporation amplifier and scaler were used after the high voltage supply was inverted. The instrument was tested as a thyroid monitor and found to give about 25,000 c/m/μc at 2 cm from a small source.* For localization work on animals or people, the probe had too little side shielding, and a better design was developed and is under construction.

To date, nearly all local work has been done with anthracene crystals. A rough comparison with a calcium tungstate crystal shows local results to agree very well with published data on the two detections. Crystals for further comparisons are on order.

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* Background under these conditions was about 100 c/m.

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Problem 6[illegible].30 - Atmospheric Monitoring (P.C. Althoff)

A new system for continuous air monitoring with a minimum amount of equipment was developed and is being tested. The former system consisted of two complete units which alternately monitor radioactive buildup and decay of airborne beta emitters caught on filter paper. The new system uses two probes and filters (of necessity) and two air pumps because of the pump maintenance problem. A switching system was devised whereby one scaler and one chronolog register recorded all data. The detectors count alternately for 10 minute periods and the pump operates alternately for adjustable periods up to 12 hours. In normal usage, the pumping cycle will be three hours on and three hours off.

Problem 6[illegible].32 - Soft Beta Counting (R.G. Clark)

A systematic investigation of gases for atmospheric pressure beta counting was completed. To date, there has been no desirable gas found which in combination with air is successful for counting soft beta particles. Methane with its attendant hazards is still in use in the field.

Problem 6[illegible].40 - Hand Counter - Inactive

Problem 6[illegible].41 - Tritium Instrumentation (M.I. Lipsovich)

Four commercial amplifier scalers were studied to determine their usefulness with proportional counters for tritium. As is to be expected, there is a correlation between the dynamic range and useful operating region of such units. The NLCC Model 168 has the shortest dynamic range (about 30 to 1) of all amplifiers tested and, as reported previously, is not usable without the addition of some limiting system. The Tracerlab pulse amplifier has the widest dynamic range found, but has the drawback of requiring a separate chassis. The Nuclear Measurements Corporation amplifier has an intermediate range (about 500 x 1) and is the most successful instrument yet employed. A Nuclear Instrument Development amplifier scaler was also tried, but its overall performance was unsatisfactory.

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Problem 692.42 - Pile Shield Monitoring - Inactive

Problem 692.61 - Biological Instrumentation (R.J. Dorvart)

A balanced chamber system for monitoring tritium absorption from air inhaled by animals was designed and tested. Tritium contaminated air is drawn through an upstream ionization chamber by the animal's normal respiratory processes and exhaled through a downstream chamber. Voltage polarities applied to the chamber walls are opposite so that the difference current is a direct measure of tritium absorption. Difficulties in the gas flow system and those due to moisture effects in the downstream chamber have yet to be resolved. In its present state, the system will detect slightly more than 0.1% difference in activity for 100 μc/cc of original gas.

An ion chamber for measuring absorption of tritium by enzymes was also designed and is under construction.

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

Problem 692.48 - Atmospheric Contamination in Metal Fabrication (R.H. Scott, W.H. Gill, R.B. Perry, F.E. Adley)

The study of Kersey bag filters was completed during March. These performance tests were conducted on the two pilot units which operate in series as air cleaners in the process exhaust ventilation system for Burnout and Furnace rooms.

The analyses indicated that uranium particulates entering the bag filters from the Burnout room had a mass median of 0.6 micron. The combined atmospheres from the Burnout and Furnace rooms had a mass median of 1.2 micro. The mass median of the first bag filter effluent was found to be slightly less than that for the influent with the fan operating at a normal speed.

The efficiency of a single Kersey unit against contaminated atmospheres from the process exhaust system ranged from 90.8% to 98.7%. The presence of the second filter unit in series produced an overall efficiency ranging from 99.7% to 99.99%.

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Data compiled from a study of workers' exposures to uranium and their urinary excretion of the metal was analyzed, and it was found that despite careful sampling no positive correlation was evident between these two factors. Two factors felt to have a possible effect on the rate of excretion and to make the interpretation of such excretory values difficult are:

(1) personal habits such as negligence in washing hands and face which may predispose to accidental ingestion of contamination while working, smoking, and/or eating,

(2) dietary changes which affect the system's acidity with an accompanying influence on the rate of elimination of metal from the body.

More intensive study permitting consideration of these variables should indicate their respective significance.

The study of atmospheric contamination in metal fabrication necessitated information on the form of uranium oxide which was suspended in the air. Such data could be conveniently obtained by x-ray diffraction. Difficulty was experienced in transferring collected samples, which were largely metal fume in the submicroscopic range, to fine glass fibers used in diffraction techniques. Accordingly, a method was developed for depositing airborne particulates directly on such glass fibers by electrostatic precipitation. In this manner, the fibers can be taken from the sampling instrument and placed directly in the camera of the diffraction unit.

<u>Problem 699.59 - Development of Improved Thermal Precipitator</u> - Inactive

<u>Problem 699.58 - Study of General Atmospheric Contamination</u> - Completed

<u>Problem 699.60 - Air Mask Tests</u> (F.E. Adley)

Completed and reported in Document HW-19873, 12/6/50.

<u>Problem 699.66 - Process and Laboratory Ventilation Requirements</u> (F.E. Adley, E.E. Beck)

Measurement of pressure drop and air flow were made for various fiberglass filter media.

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Several tests were conducted on a typical hood by means of air velocity measurements and smoke tests. This was done for various combinations of open hood doors. The effect was studied, also, of a person working in the open hood face and also walking by hood openings. Minimum control velocities were determined.

The effect of external drafts from air supply louvers and open room doors was also investigated for a particular process. Such tests indicated that excessive drafts occurred from this method of introducing air into the cell room and were creating considerable turbulence at hood faces with an accompanying loss of hood air into the cell room.

Although these matters appear to be conventional industrial hygiene control procedures, the distinguishing feature is that the radioactive dust or gas operation requires much more efficient control than the typical industrial dust or gas operation. For this reason, work in these fields is somewhat reluctantly charged to research and development codes.

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

Problem 691.43 - Ground Water Studies (M.W. McConiga)

The water table survey centered between the Columbia River and the Works Laboratory Area was extended laterally as more sampling points became available.

The water table rise below Area 8 leveled off in February and March, suggesting that a new elevation equilibrium may have been attained.

Problem 691.44 - Waste Disposal - Field Investigation Area 1

The beta-gamma activity in 9 sediment samples ranged from less than the significant level to 5.8 μc/kg. No alpha activity was detected in any of the samples taken. The maximum activity decreased again from that reported in the last two quarter periods of 1950; however, beta-gamma activity is apparently confirmed present in test holes previously uncontaminated.

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Otherwise, the contaminated ground water body beneath the area continued to decrease in activity and presumably in size, although the two wells now showing alpha and beta-gamma activity do not permit adequate control for conclusive statements. Well B-1 is expected to show beta gamma contamination for at least 1 more year at the present rate of decrease of activity, and Well B-2 for a period at least several times as great.

Problem 691.45 - Waste Disposal Field Investigation Area 2 (L.P. Rolph, R.E. Brown)

No significant change in status.

Problem 691.46 - General Geologic Studies (M.J. McConiga, R.E. Brown)

No significant report.

Problem 691.47 - Waste Disposal Investigations - Works Laboratory Area (M.J. McConiga

Routine sampling and water table investigations were made during the quarter as in previous quarters, on a weekly basis. There was no new finding of report interest.

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

Problem 694.51 - Statistical Studies of Diffusion (200 Mile Scale) (M.L. Barad, G.R. Hilst, F.W. Nickels, I.L. Winter)

A technique of computing the probable trajectories of air of highly active clouds under emergency conditions was applied in the analysis of meteorological data during this quarter. The technique employed and the January results appear in Document HW-20508.

Problem 694.54 - Diffusion Experiments 20 Mile Scale (M.L. Barad, G.R. Hilst)

In an investigation of the NO_2 problem, it was found that ground concentrations of NO_2 are not likely to exceed the toxicity level of 25 ppm for more than a few seconds at a time.

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

This problem is closed, with some phases to be covered in Problem 694.56.

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Problem 694.56 - Particle Plume (G.R. Hilst, M.L. Bared)

No progress.

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

Work done is included in Problem 694.53.

Problem 694.58 - Micrometeorology (M.L. Bared, G.R. Hilst, P.W. Nickola, I.L. Winter)

The Fleagle-Parrott paper on the vertical temperature profile in turbid air has been applied to cases of fog observed at the Meteorology building. An investigation of the wind profile in strong winds was conducted. The group computed roughness parameters, the shearing stress near the ground, and the value of the exponent in the power law describing the wind profile. Double theodolites were employed in pilot balloon studies in which the objectives were to find the winds aloft without assuming fixed rates of balloon ascent and to study the wind profile in the first 4000 feet.

F. Soil Science (D.W. Rhodes in charge)

Problem 679.61 - Typical Properties of Hanford Soils (D.W. Rhodes)

Samples of the soil profile of new test holes were analyzed for pH, carbonate, particle size distribution, and cation exchange capacity. A saline soil with high carbonate content (2.5%) and exchange capacity of 2-8 milliequivalents per 100 gm soil was typical. The soil would be classified as a sand with a clay content of 1-7%. Moisture content was well below the specific retention of the soil.

Problem 679.62 - Gross Reaction of Fission Products with Soil - Inactive

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

Problem 691.19 - Electrodeposition Methods for Plutonium (J.J. Schwendiman)

Preliminary attempts were made to translate the laboratory method of plating on 7 mm diameter discs into a routine control procedure. While promising, there are still problems arising from the uncertain area or uniformity of plating. A new plating cell to define area precisely was designed.

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Problem 691.20 - Alpha Film Studies for Low Level Plutonium
(L.C. Schwendiman)

Each nuclear track plate is used for measuring six of the electrodeposited samples, 1 blank stainless steel plate, and a source of known disintegration rate so that the film efficiency may be obtained. The film is read under 440 power magnification by passing a strip of film 4 mm long past the edge of a 0.07 mm slit in the eyepiece of the microscope. The tracks, under dark field illumination, are then counted as they pass the edge of the slit. A stop has been designed for the micrometer stage to allow exactly 4 mm to be traversed without constantly referring to the scale.

The results obtained to date on the test at the biomssay laboratory are given in the following table. All spiked samples had 3.2 d/m of plutonium added.

Type Sample	# Values	Average	Standard Deviation
Spiked Urine	70	2.96 d/m	0.40 d/m
Blank Urine	26	0.039 d/m	0.080 d/m
Blank s.s. plate	20	0.011 d/m	0.009 d/m
Film Efficiency	20	0.489	0.076

The yield for the spiked urine samples (approximately 90%) is undoubtedly a minimum since many of the plates were larger than the nominal 7 mm diameter. An attempt to measure the actual diameter and correct each of the individual values resulted in a figure of 3.39 d/m or an overall yield of about 100%. The blank urines listed above were run without segregation of glassware. Recent data with glassware used only for blank samples and precautions to reduce cross contamination indicated that the blank urine samples approach the value given for the blank plate. The reasons for the high standard deviations of the spiked samples and the film efficiency are not now known.

Problem 691.21 - Fission Film Studies

Inactive - will not be resumed if 691.19 and 691.20 are successful.

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Problem 671.22 - Counting Procedures for Tritium.
(F.L. Roehnstedt, L.D. Schwendiman, J.D. McCormack)

The hydrogen counter using the multivibrator quench circuit has been turned over to the Control laboratory for routine use. This unit uses commercial thin window glass GM shells in a lead pig as internal counters to measure the counting rate from a filling of hydrogen generated from the sample by a reaction with calcium. A copper manifold, with a system of lights to indicate which of the two GM tubes is connected to the high voltage system, has been used to eliminate loss of time due to broken glassware. It was found that washing the interior of the GM tube with water followed by an alcohol and an ether rinse frequently resulted in improved operation.

With this equipment operating at atmospheric pressure, plateau lengths of 300-400 volts with a slope of about 3 %/ per 100 volts were obtained. Threshold voltages were on the order of 2800 volts. The backgrounds were consistent at 20-30 c/m with sensitivities of 19-20 c/m per μc/liter. There have been some indications of coincidence losses and possible contamination above 100-200 μc/liter in the sample.

Studies of the soft activity found in water recirculated through a reactor have indicated that it is due to tritium. This activity follows the water on distillation, in acetylene produced from calcium carbide, and in hydrogen produced with calcium with no apparent concentration or reduction of activity density. Electrolysis of the water produces hydrogen with activity about 18-20% as great as the hydrogen produced in the calcium reaction. This agrees with results obtained on known tritiated water and with experimental experience with deuterium. The yield of tritium is incompatible with generation from the very low lithium content or from deuterium in ordinary water. The work should clearly be repeated with heavy water, to check the published cross-sections.

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A manifold has been assembled for filling geiger counters with various mixtures, primarily for an attempt to calibrate absolutely a sample of tritium at the levels employed here. Three GM counters of various lengths have been constructed from brass tubing with lucite ends similar to those used by Libby at ANL. Preliminary runs with alcohol-argon filling have given reasonable plateaus up to 250 volts in length.

Problem 691.83 - Constant Monitor for Tritium Oxide (J.F. Hanstead)

Some tests were made of commercial drying tubes for the collection of tritium oxide from the atmosphere. Efficiencies close to 100% were obtained when flow rates of several liters/minute were used through properly prepared beds of silica gel. Some evidence was obtained to indicate that tritium gas is oxidized with magnesium perchlorate as the drying agent. Preliminary results indicate that this effect is only on the order of a few percent for silica gel.

Problem 691.84 - Separations Plant Stack Monitor - Inactive

Problem 691.85 - I^{131} Measurements - Inactive

Problem 691.86 - Purification of Lanthanum - Inactive

Problem 691.87 - Naturally Active Materials in Water
(V.L. Kothstedt, L.J. Schwendiman, D.W. Brite)

The thorium analysis procedure has been prepared for water samples containing no interfering ions. A procedure for dissolving soil samples consisting of a treatment with HF followed by a sodium peroxide fusion has been investigated along with methods for separating the thorium from rare earths, zirconium, sulphates, and phosphates.

Further investigation of the self-scatter effect with small precipitates in an attempt to explain the high value for the K^{40} activity has led to inconclusive results, presumably due to difficulties with obtaining uniform source spreading with small precipitates. Studies with KCl and potassium salts

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indicate a possible scatter effect. Studies with Sr^{90}-Y^{90} and lead sulphate indicate no self-scatter. Procedures are being devised for the electroplating of lead so that uniform source loadings may be obtained.

Problem 691.28 - Diffusion Experiments - Inactive

Problem 691.29 - Strippable Coatings - Inactive

Problem 691.30 - Extraction of Air Samples - Inactive

Problem 691.64 - Calibration of Windowless Beta Counters
(L.C. Schwendiman, J.D. Mackenzie)

A PC-2B Nuclear Measurements proportional counter was investigated for a short period. The preliminary results indicated good reproducibility from day to day with about a 50% geometry.

Attempts to get a Tracerlab windowless counter working have been discouraging. The results fluctuate widely from day to day with no apparent cause. A Maher-Harper or Maher-Pickering quench circuit is being tried to see if it will overcome these difficulties.

Problem 691.65 - Study of Group Analyses (W.B. Silker)

A survey of possible isotopes that could contribute to the reactor effluent activity along with an estimate of the possible interference of these isotopes in each analysis was made.

Problem 691.66 - Solubility Analysis of Noble Gases - Inactive

Problem 691.67 - Analysis of Gross Beta Emitters - Inactive

Problem 691.69 - Dilution of Reactor Effluent in the Columbia River
(J.J. Kneeland)

This problem was started in cooperation with the Site Survey Group to study the rate of dilution of the pile effluents in the river. Most of the time has been spent in marking the river at the locations where traverses are to be made, making soundings to obtain bottom contours, and preparing the sampling and measuring equipment. Several traverses for activity and river velocities were measured at the end of the period but results are not available.

RM Parkerview

L. M. Fisher
Manager
[redacted] FUELS [redacted] DIVISION

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