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RADIOLOGICAL SAFETY AT USNRDL

ANNUAL PROGRESS REPORT HEALTH PHYSICS DIVISION 1 January to 31 December 1961

U.S. NAVAL RADIOLOGICAL DEFENSE LABORATORY
San Francisco 24, California

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INTRODUCTION

The operation of the Health Physics Division during the year can be divided into three main programs.

Under Program 1 - Health Physics personnel supported the general Laboratory Operations which included Laboratory consultation and monitoring for the various divisions, dosimetry, radiological services (including waste disposal), environmental surveys, and radiological safety instrumentation.

Under Program 2 - Radiological safety evaluations were made for various segments of the Laboratory, as well as outside agencies. Training in radiological safety regulations and procedures was also supplied under this program.

Under Program 3 - Health Physics personnel participated in support of the Naval Ordnance Testing Station (NOTS) PROJECT 173 and the HYDRA IIA Operation.

SUMMARY

The operation of the Health Physics Division is divided into three main programs: Health Physics Measures for Laboratory Operations, Rad-Safe Evaluations, and Special Operations.

Program 1.0 - HEALTH PHYSICS MEASURES FOR LABORATORY OPERATIONS

The Health Physics Division continued its regular monitoring services for various scientific divisions of the Laboratory. In 116 routine monitoring surveys conducted during the calendar year no significant uncontrolled radiation or contamination levels were observed. No significant radiological accidents occurred in 1961. Six minor contamination incidents occurred during the year; none involved personnel contamination and the contamination was quickly and easily removed.

The dosimetry service for the Laboratory, NRDL visitors, and various outside activities was continued. There were no exposures in excess of the MPE during the year. At Camp Parks the monthly deep dose exposures varied from 0.16 to 0.47 rad and the average exposure for the year was 0.30 rad. Surface dose exposures varied from 0.33 to 0.70 rad and the average exposure for the year was 0.50 rad. Accountability services for radioactive material and for cyclotron- and reactor-irradiated samples were continued.

Results of the environmental monitoring program reflected the resumption of nuclear testing by Russia in the fall of 1961. Aerosol concentrations during the last quarter of the year were nearly the highest ever recorded in this vicinity.

The collection and packaging of Laboratory radioactive waste materials continued. The total radioactivity in waste disposed of by licensed disposal firms was about 250 mc of mixed fission products.

The radiological safety instrumentation program included an investigation of the possibility of using the Laboratory vacuum system as an air sampler, fabrication of prototype aerosol alarm monitoring system, and

procurement of two major rad-safe monitoring units for the HYDRA II operation. Additional funds were requested for construction of a continuous monitoring system for the liquid waste hold-up tank.

Program 2.0 - RAD-SAFE EVALUATIONS

Laboratory assistance was given in the evaluation of a number of special radiological problems for the Laboratory and a number of outside activities. This assistance included preparation of a summary report on the Stationary Low Power Reactor (SL-1) incident of 3 January 1961 at NRTS, Idaho Falls, Idaho, the monitoring of facilities, the evaluation of a radiological trainer (Device X11F3), and rad-safe training programs.

Program 3.0 - SPECIAL OPERATIONS

Radiological safety support was given to two test operations conducted at the Naval Ordnance Test Station (NOTS), China Lake, California. Support was also provided during the preparatory and field phases of HYDRA IIA.

Program 1.0 HEALTH PHYSICS MEASURES FOR LABORATORY OPERATIONS

This program defines the direct health physics support of Laboratory operations. About 80% of the total effort available was spent on Program 1.0 assignments. The program is divided into five subgroups.

Project 1.1 LABORATORY CONSULTATION AND MONITORING

General

In 116 routine monitoring surveys conducted during 1961, no significant uncontrolled radiation or contamination levels were observed.

The annual monitoring survey of spaces within Bldg. 815 was completed. No significant radiation or contamination was observed in any Zone 1 area.

Chemical Technology Division

Irradiation programs were set up in three reactors: the GETR, WETR, and the University of Virginia reactor. These reactors were selected as substitute facilities to replace irradiation services previously available from the MTR.

Rad-safe support was provided to experimental operations involving sample irradiation in the MTR, GETR, Stanford reactor, WETR, and the University of California cyclotron, and processing the fission products formed. Samples of Lu-177, U-233, U-235, and Nd-147 were also used in experiments.

Support was provided to experimental operations involving the use of millicurie quantities of Sr-85 distributed in various aqueous media, and the use of Pr-143, Ce-144, Pr-144, Ti-144 and Sr-85 in millicurie quantities for ion exchange and tracer studies.

Continued surveillance of the tritium gas experiment indicated that adequate control measures were in effect.

Nucleonics Division

Test runs were made with the portable neutron generator. Monitoring surveys were made and adequate shielding was provided to bring radiation levels in the uncontrolled areas within the limits specified in 10CFR20.

Some preliminary runs were made with the Co-60 source (100c) in the NRDL South Gate Range. Monitoring surveys showed that the shielding berm is adequate for personnel working in the area. All sources in the area were relabeled with permanent weather-resistant metal plaques.

A new 40-mc Co-60 source and the 400-c Co-60 source were used in shielding experiments in the NRDL South Gate Range. The radiation areas were delineated and posted for each source. Preliminary evaluations were made of the Camp Parks Co-60 range and discussions were held regarding the sealed multicurie Co-60 sources to be used. Recommendations for the range were made on the location of perimeter fencing and access routes. Purchase orders were placed for 2000 c (GETR) and 3000 c (MTR) of Co-60.

Rad-safe support was provided to various experimental operations as follows:

a. A shielded container was modified to house a 30-curie Cs-137 source.

b. Monitoring support was provided during the movement of neutron sources.

c. Assistance was given in realignment of a Cs-137 source.

d. One Co-60 and two Cs-137 counting standards (0.01 μc range) were prepared for calibration of a deep-well detector. Nine point sources (μc range)--three each of Cs-137, Na-22 and Pd-109--were prepared.

e. A new experimental setup of the 760-gram Pu-Be neutron source in Bldg. 364 was monitored. The radiation areas were delineated and dosage control recommendations were made.

f. The GITR assembly was drop-tested from a helicopter. A 0.5-mc Co-60 source was taped to the detector to determine any changes in instrument response. No rad-safe problems resulted before or after the drop-tests.

Biological and Medical Sciences Division

Recommendations were made concerning equipment and procedures for the exposure of animals to tritium gas. When the exposure was started with 1.5 c, it was discovered that some of the gas had leaked from the glassware to the glove box when the tritium capsule was initially broken. Since no provision had been made to purge the glove box before termination of the experiment, the glove box atmosphere was allowed to remain contaminated until the end of the experiment. At no time did the room air show any tritium in excess of the 168-hour MPC (5×10^{-6} μc/cc). A gas-injection system was subsequently installed inside the glove box, to release quantitative amounts of tritium gas directly into the inhalation chamber. No air contamination was detected inside the glove box when the injection system was used. Recommendations were made concerning the tritium detector chamber being used in the glove box recirculation system.

Routine rad-safe support was provided for experiments involving millicurie quantities of C-14, tritiated thymidine, I-131, S-35, Ca-45, and P-32.

Discussions were held concerning the magnitude of the scattered radiation dose from the 1,000 kvp X-ray machine to shielded animals.

Rad-safe support was provided in connection with the use of TRIGA Mark F reactor to study the effect of pulsed reactor irradiation of animals.

Technical Services Department

Eighteen special work permits were issued during the year. The work involved decontamination of hoods, shielded containers, glove boxes, and handling drums of liquid radioactive wastes. Two of the special work permits were for decontamination and repair of hot cell facilities and equipment at Camp Parks.

Routine rad-safe support was provided for hood-filter changes.

Rad-safe assistance was furnished during the cleanup of the pump shack near Bldg. 364. Contaminated items were discarded as radioactive waste. A sump pump was installed in the waste tank pit to remove rain water.

Rad-safe assistance was furnished during a general cleanup of the waste-processing area. An old vapor compression unit was taken apart and monitored. The parts were released to salvage or discarded as radioactive waste. Other miscellaneous items were also checked for contamination and released to storage or packaged for disposal.

Camp Parks

TARGET COMPLEX STUDIES

A rough draft of the rad-safe report for the three target complex operations was completed and was under review at the end of the year.

WET FALLOUT STUDIES

The following experiments were completed:

Aerosol measurements were made within the center section of Bldg. 880 during the dispersal of 2 c of La-140 over an array of test plates. Nineteen air samples were taken during the night and early morning of the first test. The average air concentration observed was 1×10^{-9} µc/cc with a maximum of 4×10^{-9} µc/cc and a minimum of 2×10^{-10} µc/cc. (The 40-hour MPC for La-140 is 1×10^{-7} µc/cc.) The average radiation level measured at the surface of the test array plates was 3-5 mr/hr. A second experiment conducted several weeks later produced similar results.

During third experiment, the radiation level at 1 foot from the floor surface was 5-20 mr/hr with a maximum of 150 mr/hr at 1 foot from the disperser. The air sampling results were as follows:

Location	Number of Samples	Aerosol Concentration ($\times 10^{-10}$ µc/cc) Avg.	Max.	Min.
Inside Fallout Room near East Door	17	100	300	0.9
Adjacent spaces in North Gym (Bldg. 880)	16	2	5	0.02
Outside of Bldg. 880	8	0.005	0.01	0.001

(The 40-hr MPC for La-140 is 1×10^{-7} µc/cc.)

In another experiment, 500 mc of Zr-95 was dispersed over an array of test plates. The radiation level at 1 foot above the array of test plates varied from 3 to 10 mr/hr with a maximum of 15 mr/hr. The air sampling results were as follows:

Location	Number of Samples	Aerosol Concentration ($\times 10^{-10}$ µc/cc) Avg.	Max.	Min.
Inside Fallout Room near East Door	4	1	4	0.4
Adjacent spaces in North Gym (Bldg. 880)	1		0.6	

(The 40-hr MPC for Zr-95 is 1×10^{-7} µc/cc)

SURFACE DECONTAMINATION STUDIES

Paved-area decon studies were conducted using La^{140} tagged sand. The average radiation level was about 50 mr/hr at 3 feet, resulting in an exposure of about 200 mr to three persons. There were no significant rad-safe problems. This operation has been moved to the Target Complex Area.

Ten street-flushing experiments using 5-15 curies of La-140 per run were conducted in the Target Complex Area. The average radiation level in the test area was 50 mr/hr with a maximum of 100 mr/hr at 3 feet from the disperser. At the end of each test, the simulant was flushed into the sump at the lower edge of the test area and held there for decay. The average radiation level in the sump area during operations was 50 mr/hr.

ROOF WASHDOWN

Construction of the test area and equipment was completed.

An additional experimental facility to measure the efficiency of a water tank collecting system designed by NCEL was installed outside of Bldg. 880. This equipment is an adjunct to the roof washdown experimental program and is for a technical study to determine the efficiency of contamination removal from the roof washdown run-off by a baffle plate arrangement in the collecting tank.

Four test runs (2 curies of La-140) with the NCEL settling tank were monitored. The average radiation level in the working area

(4 feet from tank) was 5 mr/hr with a maximum reading of 50 mr/hr at the bottom surface of the tank. Twenty-five air samples were taken outside in the immediate tank vicinity. The average aerosol concentration was 1×10^{-12} µc/cc with a maximum of 6×10^{-12} µc/cc. The residue in the tank was removed and held for decay in the waste storage area. A total of 17,000 gallons of liquid containing 11 mc of La-140 (2×10^{-4} µc/cc) was released to the storm sewer. (MPC is 7×10^{-4} µc/cc.)

Four experiments were conducted within the center section of Bldg. 880 involving the dispersal of 5 curie batches of simulant tagged with La-140. (Specific activity was 100 µc/g.) Forty-eight air samples were taken (12 per test) near the personnel entrance door. The average aerosol concentration for all four tests was 9×10^{-10} µc/cc with a maximum of 3×10^{-7} µc/cc and a minimum of 1×10^{-12} µc/cc. Air samples taken exterior to Bldg. 880 during similar experiments indicated no detectable activity.

In a series of six tests, three 70-lb. batches of simulant containing 5 curies of La-140 per batch were used. During dispersal, the radiation level 3 feet from the dispersal system was 250 mr/hr. At the end of the run, the radiation level in the immediate test area was less than 1 mr/hr.

The air sampling results were as follows:

Location	Number of Samples	Aerosol Concentration ($\times 10^{-10}$ µc/cc) Avg.	Max.	Min.
Center Section of Gym	20	5	24	0.5

(The 40-hr MPC for La-140 is 1×10^{-7} µc/cc)

FALLOUT SHELTER EVALUATION

Fallout ingress experiments were conducted, using the prototype 100-man shelter at Camp Parks. High volume air samplers were used to measure the aerosol concentration in and around the shelter.

In nine experiments run in the third quarter of 1961, radiation and aerosol sampling surveys were made. The average radiation level inside the shelter was 2 mr/hr. The maximum radiation level at the base of the tower was 30 mr/hr. La-140 was used in the study.

The air sampling results were as follows:

Location	Number of Samples	Aerosol Concentration ($\times 10^{-10}$ µc/cc) Avg.	Max.	Min.
Downwind at 100 ft.	10	1	42	0.2
Downwind at 200 ft.	13	0.9	3	0.1
Crosswind at 500 ft.	7	0.3	1	0.05

(The 40-hr MPC for La-140 is 1×10^{-7} µc/cc)

Decontamination of the shelter was completed in the fourth quarter of 1961. Before decontamination the average radiation level inside the shelter was 2 mr/hr with a maximum of 50 mr/hr inside the base of the tower. Decontamination and decay reduced all levels to background. Three air samples taken in the tower entrance during decontamination showed concentrations of 1.0, 1.2 and 28 $\times 10^{-10}$ µc/cc.

SIMULANT PREPARATION

Shipments totaling 6,600 curies of Ba-140 were received during the year. Ba-140 is the source of the La-140 used to tag fallout simulants.

During the first quarter of 1961, two runs were made for wet fallout simulant, using 1 to 2 curies per gallon of solution. Two runs were made for dry fallout simulant using 0.5 c with 50 lb. of sand. The maximum radiation level observed was 35 r/hr at the surface of the small mixer (dry fallout). The average radiation level where personnel were working was 5 mr/hr (in front of hot cell). Personnel exposure ranged between 400 and 560 mr per month. The maximum aerosol concentration observed was 9×10^{-9} µc/cc and the average concentration was 7×10^{-10} µc/cc.

Four batches of simulant using 5-10 curies per batch were prepared during the second quarter of 1961. The highest radiation levels observed were 500 mr/hr at the furnace and 200 mr/hr at the small mixer. The average radiation level in the platform area varied from 20 to 40 mr/hr. The maximum monthly personnel exposure was 200 mr (deep dose) and 480 mrad (surface dose). The average exposure for the second quarter was 90 mr (deep dose) and 200 mrad (surface dose) per month.

The air samples taken during the second quarter showed the following:

Location	Number of Samples	Aerosol Concentration ($\times 10^{-10}$ µc/cc) Avg.	Max.	Min.
In front of Hot Cell	32	7	90	0.2
Furnace East of Hot Cell	13	30	120	0.5
Mixer Platform	12	20	140	0.2
Exhaust from Hot Cell	1	0.3		

Ten batches of simulant, using 10 curies per batch, were prepared during the third quarter.

Radiation levels during test operations were as follows:

Location	Number of Readings	Radiation Level (r/hr) Avg.	Max.	Min.
Rear Door of Hot Cell	14	1.6	8	0.03
Near Simulant Mixer	14	1.8	50	0.001
In front of Hot Cell	28	0.001	0.002	B.G.

The maximum monthly personnel exposure was 1100 mr (deep dose) and 1900 mrad (surface dose). The average exposure for the quarter was 350 mr (deep dose) and 730 mrad (surface dose) per month.

The preparation of fallout simulant with smaller particle sizes ($< 44\mu$) increased the aerosol control problem.

The air sampling results during the third quarter were as follows:

Location	Number of Samples	Aerosol Concentration ($\times 10^{-8}$ µc/cc) Avg.	Max.	Min.
Platform in rear of Bldg. 131	40	5	62	0.01
Inside Bldg. 131	37	0.3	2	0.001
Other samples in Bldg. 131 Area	22	0.1	20	0.001
Exhaust from Hot Cell		0.004		

Four calibration sources were made during the fourth quarter using 50 mc, 1 c, 4 c and 15 c of Ba-La-140.

Radiation survey results during the fourth quarter were as follows:

Location	Number of Readings	Radiation Level (r/hr) Avg.	Max.	Min.
Rear Door of Hot Cell	17	3.5	50	0.001
In front of Hot Cell	20	0.003	0.02	0.0001
Hot Cell Platform	19	0.01	0.06	0.002

The maximum monthly personnel exposure was 300 mrad (deep dose) and 700 mrad (surface dose). The average exposure for the quarter was 130 mrad (deep dose) and 330 mrad (surface dose) per month.

The air sampling results during the quarter were as follows:

Location	Number of Samples	Aerosol Concentration ($\times 10^{-9}$ μc/cc) Avg.	Max.	Min.
In front of Hot Cell	17	1	5	0.09
At Side of Hot Cell	3	3	32	0.5
Exhaust from Hot Cell	Equipment not operating			

RADIATION SOURCE CONFIGURATIONS

A special radiation exposure system consisting of a polyethylene tube and lead shield is under development. An incapsulated Ba-La-140 source is used. Methods of source incapsulation and source movement are being studied. Leak-testing of the prototype sources indicate that the incapsulation procedures used to date are inadequate. Air sampling results indicate that contamination is being released from the source-moving system. The system is being modified and additional rad-safe checks will be made. One of the initial applications of the system is in connection with the development of a "pinhole camera" for locating gamma radiation sources.

URANIUM DISPERSION TEST

One experiment which was conducted in the target complex involved the burning of 100 g of depleted uranium. No detectable surface contamination was found after the test. Air samples taken downwind averaged 6×10^{-11} μc/cc. (The 40-hr MPC for U-238 is 7×10^{-11} μc/cc.)

HYDRA TEST POND

Feasibility studies using the same amounts of activity and explosive as for the HYDRA I experiment at DTMB were conducted. Two test runs were made using Au-198. In the first test, about 10 mc of activity was released into 90,000 gallons of fresh water to check on the distribution of radioactivity on the pool and filter surfaces. The second test involved the detonation of a 1-pound charge containing 10 mc of Au-198 to determine if the radioactivity was absorbed by the explosion products. The charge failed to detonate properly and the radioactivity dropped to the bottom of the pond. Water concentrations of 1×10^{-4} μc/cc were observed. (Drinking water MPC for Au-198 is 1×10^{-3} μc/cc.) The radiation levels on the pond filter averaged about 5 mr/hr. No detectable aerosol concentration of Au-198 was observed. The pond is to be emptied and resurfaced to minimize the retention of radioactivity by the pond walls. The next test was scheduled for February 1962, again using Au-198.

ENVIRONMENTAL MONITORING

A total of 137 monitoring surveys were documented during the year. The following areas were monitored:

Area	Radiation Level (mr/hr) Avg.	Max.	Min.
Target Complex	0.3	500	0.03
Equipment and Simulant Storage	25	8000	0.03
Waste Area	0.3	200	0.03
Bldg. 131 Area (Hot Cell)	160	50000	0.03
Bldg. 880	2	250	0.03

A total of 563 environmental air samples were taken on the Camp Parks periphery. The average, maximum, and minimum concentration observed during each month was as follows:

Month	No.	Concentration ($\times 10^{-12}$ μc/cc) Avg.	Max.	Min.
January	45	30	130	0.4
February	39	3	7	0.4
March	51	9	66	0.1
April	51	5	20	3
May	59	2	20	1
June	36	1	40	0.1
July	40	4	20	0.1
August	45	1	10	0.4
September	35	7	10	3
October	58	10	45	4
November	62	15	60	1
December	42	10	20	1

PERSONNEL EXPOSURES

Personnel exposures during 1961 are tabulated below:

Month	Number of Measurable Exposures (> 40 mr)	Average Deep Dose (r)	Average Surface Dose (rad)	Maximum Deep Dose (r)	Maximum Surface Dose (rad)
January	12	0.30	0.36	0.50	0.80
February	15	0.16	0.39	0.56	1.80
March	18	0.13	0.22	0.36	0.72
April	12	0.25	0.31	1.65	1.65
May	13	0.10	0.16	0.26	0.33
June	4	0.12	0.19	0.35	0.48
July	7	0.10	0.17	0.18	0.57
August	22	0.21	0.27	0.70	0.72
September	14	0.47	0.73	1.14	1.88
October	13	0.15	0.30	0.48	0.73
November	1			0.07	0.38
December	10	0.11	0.19	0.30	0.70

During the year there were 252 visitors to Camp Parks radiation areas who required film badges. No detectable exposures (>40 mr) were observed.

Accidents

No significant radiological accidents involving Laboratory personnel occurred during the year.

Spills and Contamination Incidents

There was a minor spill of La-140 and Ce-144 in Room 682 on 16 January 1961. The only contamination observed was on the floor (OW reading of 2 mr/hr at 6 inches). The contamination was quickly and easily removed.

A minor spill of Cs-137 occurred in Room 640 on 12 July 1961. The maximum floor contamination observed was 50,000 cpm. There was no personnel contamination. The contamination was quickly and easily removed.

On 2 November 1961 about 250 μc of Rb-86 in solution was dropped in the hood and floor of Room 622. The maximum reading observed was 20 mrad/hr. The contamination was easily and completely removed.

On 28 November 1961 a small drop of an aliquot of a reactor-irradiated sample was tracked around the floor and associated corridors of Room 658 and 672. The maximum reading observed was 0.2 mrad/hr. A minor amount of shoe contamination was observed. All contamination was easily and completely removed.

On 12 December 1961 some animal waste, reading 0.5 mrad/hr, was found on the floor in the climatic chamber room (Room 552). The contamination was easily removed with paper towels. Some cages, reading 0.2 mrad/hr, were removed and held for decay. It was recommended that absorbent paper be placed in the bottom of such cages to facilitate decontamination.

On 15 December 1961, a routine wipe test on the Co-60 calibration source used by Central Instruments Branch personnel in Room 2125 showed contamination levels in excess of 0.005 μc. The required report was made to the AEC and the source was removed from service and replaced with a Cs-137 source (120 c) on loan from the Nucleonics Division. No Co-60 was observed in urine samples collected from three personnel who routinely use the Co-60 source.

Project 1.20 PERSONNEL MONITORING

Dosimetry

Film was processed for NRDL and outside activities as follows:

NRDL	Film Processed
Laboratory Personnel	7,480
Laboratory Visitors	2,121
Camp Parks	
Personnel and Visitors	1,304
Environmental Monitoring	453
Environmental Monitoring	821
Film Calibration	561
Special Test Exposures	23
Hydra IIA	41
RADCON Team (Controls)	8
Subtotal	12,712

Outside Activities	Film Processed
San Francisco Naval Shipyard	1,007
U.S. Naval Schools Command, T.I. Radiac Maintenance School and Dispensary	2,349
Inspector of Naval Material, San Francisco	297
NAD, Concord	1,060
USN Dispensary, 50 Fell St., San Francisco	101
NAS, Moffett	59
DPWO, 12ND	94
NSC, Oakland	327
NAS, Fallon	76
NAD, Hawthorne	97
12th U.S. Coast Guard	5
NAS, Lemoore	13
MSTS, Pacific	91
Subtotal	5,574
Grand Total	18,386

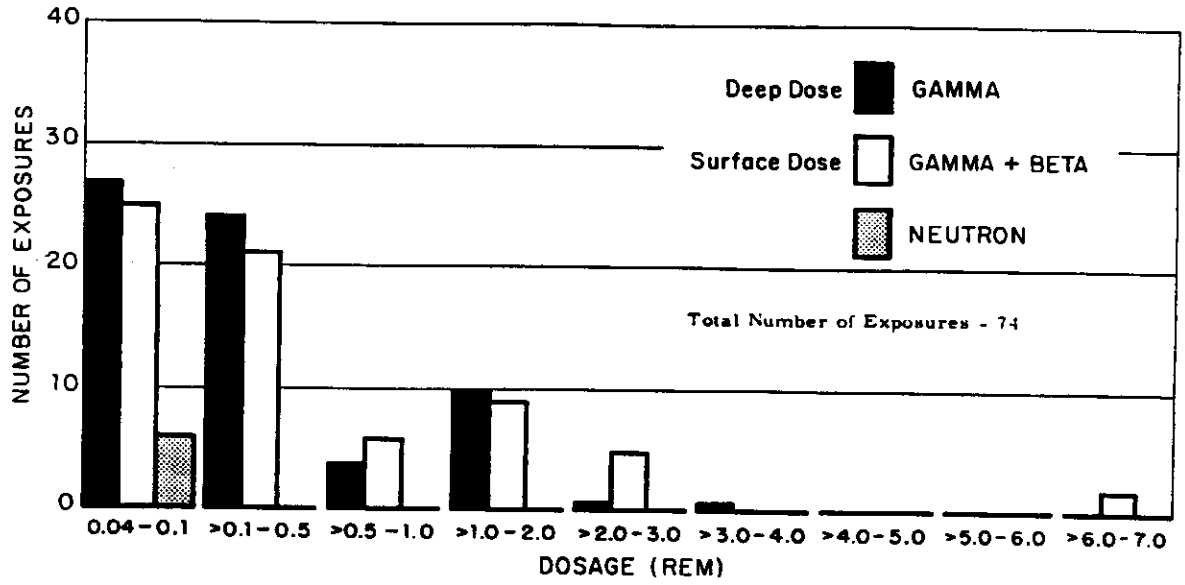
All exposures of NRDL personnel and visitors were below the quarterly MPE.

There were 141 measurable monthly exposures which were associated with the experimental program conducted at Camp Parks. The monthly deep dose exposures varied from 0.04 to 1.65 r; the average monthly exposure was 0.21 r. The surface dose exposures varied from 0.04 to 1.88 rad; the average monthly exposure was 0.33 rad.

A commercial film monitoring service provided 605 neutron films (512 for personnel and 93 for environmental monitoring) and 124 finger rings (β-γ) during the year. The maximum exposure observed during the year was 50 mrem (personnel), 980 mrem (environmental), and 2300 mrem (finger ring).

The accompanying bar graph presents the distribution of radiation exposures as indicated by film dosimeters worn by the 572 NRDL employees on board at the end of the calendar year 1961 (page 18). 13% of these personnel received detectable exposures ($\geq$40 mrem during any month). The average annual exposure per person was: deep dose - 55 mr (gamma and X ray), 0.2 mrem (neutron); surface dose - 84 mrad. The maximum deep dose for the year was 3.03 r and the maximum surface dose was 6.86 rad. Both exposures resulted from operations at Camp Parks.

Over 90% of the NRDL employees have furnished information to complete AEC Form 4, "Occupational External Radiation Exposure History." Letters requesting a record of past radiation exposure have been sent to former employees. Division heads in the Scientific Department have been notified of the MPD of persons designated by them as possibly exceeding 1.25 rem per quarter. They have also been supplied with the names of those persons who have failed to complete the AEC Form 4.



Distribution of Film Badge Totals, NRDL, 1961

Bio-Assay Program

The following table summarizes the bio-assay results received from the Radiological Health Division during the year.

Division	Number of Samples Gross β-γ Analysis	Gross α Analysis	Specific Isotope Analysis	Results
Chem Tech	71	3	146 H^3	NSA*
Bio-Med	78		7 H^3	NSA
Nucleonics	51		6 SR-90	
			6 U-238	NSA
Military Evaluations	20			NSA
Engineering	12	1		NSA
Program Office	9			NSA
Naval Reserve Personnel	20			NSA
Health Physics	1		12 H^3	
			2 Br-82	NSA
Administrative Dept.	5			NSA
Scientific Dept. Staff	5			NSA
Logistic Support	3			NSA
Tech Info	3			NSA
Civilian Personnel	2			NSA
Military Personnel	3			NSA
Rad Health	4			NSA
Security	3			NSA
Medical Department	1			NSA
NavScolCom Personnel			14 Br-82	NSA

*Indicates no significant activity

Project 1.30 RADIOLOGICAL SERVICES FOR LABORATORY OPERATION

Accountability

The following table summarizes the radioisotope orders processed and shipments received during the year.

Division	Orders Processed	Shipments Received
Chem Tech	38 orders - 1029 mc	41 shipments - 2106 mc
Bio-Med	21 orders - 281 mc	53 shipments - 338 mc
Nucleonics	8 orders - 437 mc	9 shipments - 572 mc
Health Physics	3 orders - 110 mc	5 shipments - 159 mc
TOTALS	70 orders - 1857 mc	108 shipments - 3175 mc

The following reactor-irradiated samples were received:

Division	Radioactivity
Chem Tech	3 samples of U-233 with 2.5 c of f.p. 1 sample of U-235 with 3.0 c of f.p. 6 samples of Lu-177 - 101 c 3 samples of Lu-177 - 4395 c (HYDRA II) 10 samples of Br-82 - 11 c 1 sample of Nd-147 - 10 mc
Health Physics	10 samples of Br-82 - 11 c

In addition, seven reactor and two cyclotron-irradiated samples with an undetermined quantity of radioactivity were received by the Chem Tech Division.

The following multicurie quantities of radioactivity were ordered or received:

Division	Ordered	Received
Chem Tech	6600 c Ba-La-140 50 c H-3 550 c Xe-133	6600 c Ba-La-140 50 c H-3 550 c Xe-133
Nucleonics	9 c H-3 30 c Cs-137 20 c Pu-Be 5614 c Co-60	9 c H-3 30 c Cs-137 15 c Pu-Be 7.5 c Co-60
Bio-Med	5 c H-3	5 c H-3

In addition to the above, 100 pounds of depleted U-238 in metallic form was received by the Chem Tech Division.

The radioisotope inventory for the calendar year 1960 was completed and the list screened to reduce the large number of small sources that are seldom used.

A new Source Material License (SMB-376) was received. The license expires 31 July 1964 and authorizes the following possession limits:

Natural Uranium	20 kilograms
Natural Thorium	1 kilogram
Depleted Uranium	1100 kilograms

Byproduct Material License (4-487-3, Amendment #5) was also received. The license expires 31 August 1966 and authorizes the following possession limits:

Any byproduct material with Atomic Nos. 1-84, inclusive	5 curies of each, except:
	Ba-140 - 2000 curies
	Br-82 - 50 curies
	Cs-137 - 1000 curies
	Co-60 - 15,000 curies
	H-3 - 200 curies
	Ir-192 - 500 curies
	La-140 - 2000 curies
	Lu-177 - 2000 curies
	Hg-203 - 10 curies
	Sr-90 - 100 curies
	Xe-133 - 2000 curies
	Mixed FP - 100 curies

The renewal of the Special Nuclear Material License (SNM-35) and the Waste Disposal License (4-487-6) is still pending.

The following table summarizes the radioactive sources available in the Laboratory during the year.

Isotope	Number	
Co-60	63	1507 curies (1 mc to 680 c)
Cs-137	7	449 curies (0.8 c to 100 c)
Ra	12	1139 mg (0.1 mg to 500 mg)
Sr-90	42	3.3 curies (1 mc to 2 c)
Ra-Be	5	138 mg Ra (2 mg to 100 mg)
Pu-Be	3	162 g Pu (2 g to 80 g)
$Pu-F_4$	1	760 g Pu
H^3-Zr	9	5.9 curies H-3 (0.1 c to 2.6 c)
H^3-Ti	17	18.2 curies H-3 (~1 c each)

Three Co-60 sources (total of 7.5 c) were received from SPNS. They will be disposed of as radioactive waste since wipe tests indicated they were leaking in excess of acceptable limits.

At the request of the AEC, the two 80 g Pu-Be sources were sent to Mound Laboratory for re-encapsulation. New outer stainless-steel capsules were provided for each source. The plutonium content was not changed. Both sources have been returned and are being used by the Nucleonics and Engineering Divisions.

Additional information was supplied to the Division of Licensing and Regulation in connection with the pending renewal of Special Nuclear Material License, SNM-35.

C.8 mc of Na-22, 0.7 mc of C-14 inulin, 2.5 mc of Cl-36 and 75 mc of HTO was exported outside the U.S. for use in a Bio-Med Division research program. A report was made to the AEC in accordance with 10CFR30.

One 80 g Pu-Be source was received for calibration and transferred to the Charleston Naval Shipyard under Sect. 91b of the Atomic Energy Act.

Waste Disposal

Two concrete blocks (600 $ft.^3$, 24 tons) containing solid radioactive waste, and 118 55-gallon drums were removed by a licensed commercial waste disposal firm. Total radioactivity in the load was about 250 mc of mixed fission products.

Waste on hand at the end of the year included:

1 concrete block, partially full
18 drums, capped and ready for disposal
25 drums, packed and awaiting capping
21 drums, in the process of being packed
80 drums, liquid waste, awaiting transfer to the storage tank in Bldg. 364 area.

A total of 56 drums of stored liquid waste was found to have activity levels below the MPC and was dumped into the sanitary drain.

A technique for spray painting the radiation symbol and markings as required in 10CFR20 was developed. A compressed-gas-powered paint spray unit was acquired and a special kit containing a supply of properly colored paints and stencils was developed to permit the rapid marking of storage cans or contaminated equipment.

Waste disposal operating procedures were reviewed. Up-dated procedures were embodied in a memo and distributed to all maintenance personnel involved.

Decontamination Laundry

Ten laboratory coats were found to be contaminated during the year. β-γ contamination levels ranged from 7,000 to 20,000 c/m.

Project 1.40 ENVIRONMENTAL SURVEY

Air Monitoring

The graph on page 24 gives quarterly averages of the air sampling of outside air and Bldg. 815 air effluent. Environmental aerosol sampling of inside and outside air revealed a sharp increase in radioactivity following a Russian test series in late summer and fall. These data are consistent with those reported by other activities. At no time were levels recorded in either system which indicated release above the MPC for particulate radioactivity in the environmental air.

The concentrations observed during the last quarter of 1961 were nearly the highest ever recorded for this location. These levels were exceeded during two brief periods in March and October of 1958 when concentrations in the 10^{-10} μc/cc range were observed.

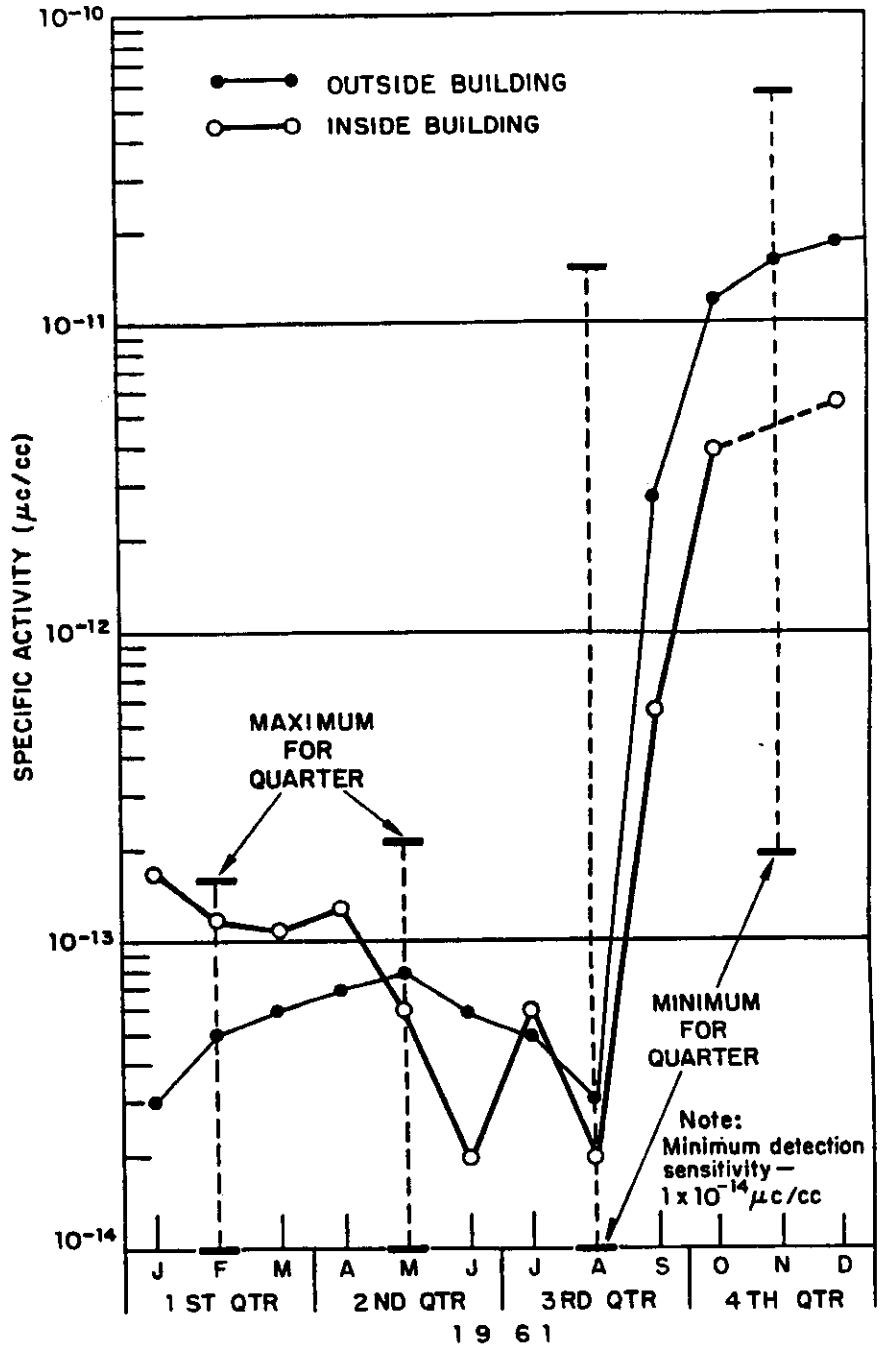
The earliest indications that bomb debris from the Russian tests was reaching NRDL occurred on 10 September 1961. The aerosol concentration was 2×10^{-13} μc/cc. The concentration decreased slowly over a period of 4 days and then increased slowly to a maximum concentration of 1×10^{-11} μc/cc on 22 September. A reading of 2×10^{-11} μc/cc was observed on 29 September; readings of 4 and 5×10^{-11} μc/cc were observed in October and November. The highest reading observed during the year was 5.6×10^{-11} μc/cc on 13 November 1961.

The 24-hour sampling and analysis of hood exhaust air for radioactivity continued during the year. The major portions of the samples were in the 10^{-14} μc/cc range. Higher concentrations were noted during the latter part of September because of the bomb debris from the Russian test series. A steady increase was noted, beginning on 22 September. A maximum concentration of 1×10^{-11} μc/cc was noted in early October.

All samples were well below the MPC's for radioisotopes currently used by the Laboratory. Fifty-five daily samples collected during the year were below the detection limit of 1×10^{-14} μc/cc.

Liquid Monitoring

Collection and analysis of water samples from Bldg. 815 liquid effluent collection system continued on a routine basis. Aliquots of 100 cc are taken from each tank sample for analysis. Aliquots of 1000 cc are used for the monthly pooled tank and tap water samples. A total of 640 routine samples were processed during the year.



USNRDL Environmental Aerosol Data for 1961

The total volume of liquid discharged per month and the average, maximum, and minimum β-γ concentrations observed during the year are shown graphically on page 26. (The concentrations include natural radioactivity and fallout.)

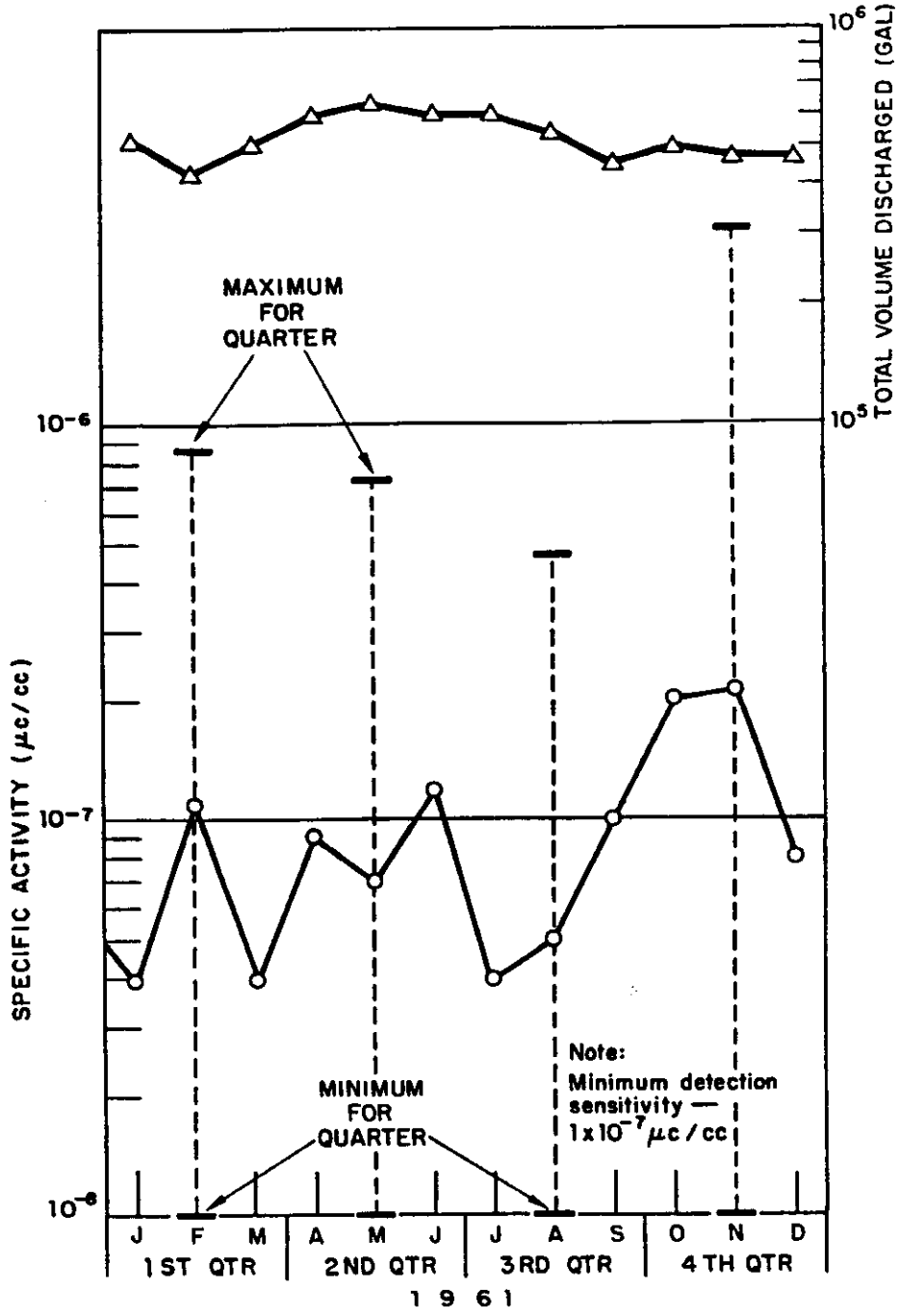
The average concentration of the liquid effluent discharged during the year was 0.07×10^{-6} μc/cc. (The MPC is 3×10^{-6} μc/cc.) The total activity released during the year is calculated to be about 2 mc. The total volume discharged was 6×10^{6} gallons. During the year the SFNS discharged 370×10^{6} gallons into the same sewer system. Therefore, the average concentration of liquid effluent from the SFNS is calculated to be 2×10^{-9} μc/cc.

An aliquot is taken from each tank sample processed and held as part of the monthly pooled effluent sample. In order to have each tank sample aliquot represent a proper proportion of the total volume discharged for the month (particularly since the tank volume discharged on a daily basis is variable) a 10 cc aliquot is taken from the tank sample for each inch of liquid depth in the tank.

In view of the MPC currently established in 10CFR20, it was decided to analyze only the gross β-γ activity of the monthly pooled samples. Aliquots of 100 cc/day of tap water are also taken for monthly gross β-γ analysis. (The average activity of the tap water may be considered as "background".) The results for the past year are as follows:

Month	Pooled Tank Effluent ($\times 10^{-6}$ μc/cc)	Pooled Tap Water ($\times 10^{-6}$ μc/cc)
January	0.02	NDA*
February	0.17	NDA
March	0.05	NDA
April	0.09	NDA
May	0.04	NDA
June	0.06	NDA
July	0.10	0.02
August	0.41	0.01
September	0.10	0.05
October	0.13	NDA
November	0.08	NDA
December	0.07	0.02

*NDA indicates no detectable activity ($<0.01 \times 10^{-6}$ μc/cc)



NRDL Water Effluent Analysis for 1961

In addition to the routine analysis of effluents and tap water the following determinations were made on rainfall during the year:

Date	Amount of Rainfall (inches)	Radioactivity Concentration ($\times 10^{-6}$ μc/cc)	Apparent Half-Life (days)
20 November	1.38	3.8	22
26 November	0.56	3.4	22
29 November	0.48	1.8	24
30 November	0.51	0.70	44

Radiation Intensity Monitoring

The uncontrolled spaces that were monitored by the use of film and the average accumulated dose per 24 hours were as follows:

Location	Average Daily Dose (mr/day) 1st Q	2nd Q	3rd Q	4th Q
Building 815				
Room 666 (hood)	<1	2	1	1
Room 682 (sink)	<1	<1	<1	1
Room 687 (E wall)	<1	<1	<1	<1
Room 595 (door)	2	2	2	7
Room 5153 (W wall)	3	3	2	6
Room 597 (outside wall)	2	2	2	1
Room 591 (E wall)	1	4	4	4
Room 579 (E wall)	15	-	6	5
Room 579 (W wall)	-	11	-	
Room 5149				
(N wall)	<1	<1	<1	<1
(E wall)	<1	<1	<1	<1
(S wall)	<1	<1	<1	<1
(W wall)	<1	<1	<1	<1

Average Daily Dose (mr/day) (continued)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 448	1	<1	-	
(outside wall)				
(passageway wall)	-	-	-	1
Fourth floor				
2nd increm.				
(N wall)	11	20	-	-
(E wall)	11	12	-	-
(S wall)	6	6	-	-
(W wall)	3	3	-	-
Room 2129				
(N wall)	<1	1	<1	<1
Room 2117				
(E wall)	4	3	3	2
Room 2177				
(S wall)	2	3	2	1
Room 2181				
(S wall)	3	4	2	2
Room 206				
(E wall)	<1	<1	<1	<1
Room 210				
(S wall)	1	<1	<1	<1
Room 185				
(Operator Bench)	1	<1	6	1
Room 166				
(S wall)	1	<1	1	<1
(W wall)	<1	<1	1	<1
Room 129				
(N wall)	<1	<1	<1	1
(E wall)	<1	<1	<1	<1
Room 123				
(N wall)	<1	-	<1	
(W wall)	-	<1		<1
Room 691				
(N wall - near floor)				<1
(E wall - near floor)				<1
(W wall - near floor)				<1
(Under Desk)				<1

Average Daily Dose (mr/day)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 110				
(N wall)	< 1	2	7	<
(E wall)	< 1	< 1	< 1	<
(S wall)	< 1	< 1	< 1	<
(W wall)	< 1	< 1	1	<

The controlled spaces that were monitored and the average accumulated dose per 24 hours were as follows

Average Daily Dose (mr/day)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 665 (hood)	112	22	< 1	<
Room 120				
(N wall)	-	3	1	1
(E wall)	1	< 1	1	
(S wall)	2	2	1	
(W wall)	32	3	1	
Room 4121-4129				
(N wall)	-	-	1	
(E wall)	-	-	1	
(S wall)	-	-	1	10
(W wall)	-		13	
Room 4125-4133-4181				
(N wall)	-	-	32	13
(E wall)	-	-	20	17
(S wall)	-	-	7	2
(W wall)	-	-	3	1

Average Daily Dose (mr/day) (continued)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 2125-2133				
(N wall)	-	-	5	5
(E wall)	-	-	11	15
(S wall)	-	-	7	7
(W wall)	-	-	3	3
Room 4128				
(N wall)	5	14	-	-
(E wall)	19	33	-	-
(S wall)	4	11	-	-
(W wall)	14	12	-	-
Room 4125				
(N wall)	10	6	-	-
(E wall)	9	3	-	-
(S wall)	6	11	-	-
(W wall)	2	20	-	-
Room 2125				
(N wall)	8	8	-	-
(E wall)	36	34	-	-
(S wall)	13	14	-	-
(W wall)	4	4	-	-
Room 1109				
(N wall)	13	12	9	13
(E wall)	62	39	35	32
(S wall)	74	81	73	72
(W wall)	20	14	21	17
Room 165				
(North A frame)	11	9	< 1	5
(E wall)	< 1	< 1	< 1	< 1
(South A frame)	11	10	< 1	5
(W wall)	< 1	< 1	< 1	< 1
Room 187				
(Control Panel)	3	1	7	4
Building 816				
(Passageway)	40	< 1	< 1	< 1
(Gate opposite tent)	-	2	< 1	< 1

Average Daily Dose (mr/day) (continued)

Location	1st Q	2nd Q	3rd Q	4th Q
Bldg. 364				
(N wall)	2	-	-	-
(Passageway)	-	4	-	-
(Door to Shop 67)	-	-	3	< 1
Bldg. 510A				
(Control Panel)	< 1	< 1	< 1	< 1
(South wall - inside)	< 1	< 1	< 1	< 1
(W wall - outside)	< 1	< 1	1	< 1
Bldg. 365				
(inside fence)				< 1
SHIELDING AREA				
Fence				
(South of Gate)	< 1	1	< 1	1
(North of Gate)	< 1	3	< 1	1
Shoreline				
(North)	2	52	15	14
(East)	< 1	24	5	13
(Southeast)	< 1	4	< 1	2
(South)	46	107	140	56
Shack				
(Inside berm)	2	41	14	46
NEUTRON FILM				
Bldg. 364				
(Door - inside)	< 1	< 1	10	11
(Fence - front)	< 1	< 1	10	1
(Fence - rear)	< 1	< 1	< 1	< 1
Bldg. 365				
(North wall)	< 1	< 1	< 1	< 1
Room 4128				
(South wall)	3			
(West wall)		< 1		

Average Daily Dose (mr/day) (continued)

Location	1st Q	2nd Q	3rd Q	4th Q
Room 4101 (East wall)	4	<1	<1	<1
Room 4117 (Outside door)		<1	<3	<1
Room 4121-4129 (South)			2	<1
(Wall)			<1	<1

Project 1.50 RAD-SAFE INSTRUMENTATION

Twenty IM 113A/PDR radiacs (side window GM's) were obtained from the Army surplus list. Five were serviced for use by the Health Physics Division. Fifty IM9/PD dosimeters (0-200 mr self-reading) were received. A 2 π-γ scintillation counting system was assembled from existing Laboratory equipment by the Central Instruments Branch for rad-safe use at Camp Parks.

Two major rad-safe monitoring units were obtained for the Hydra II operation:

1. A tritium air monitor, Baird-Atomics TSM 91A, used to monitor Xe-133;

2. A Franklin Systems, Inc., underwater β-γ scintillation detector with gamma energy window to detect specific energy levels. The unit, which can provide readout information for a ratemeter, scaler or recorder, is portable, operating from re-chargeable batteries.

Fabrication of an aerosol alarm monitoring system under Chem Tech sponsorship was completed. Test samples were made and the simulated response of the monitor to an aerosol in a radiation background was observed. An operating manual for the unit was prepared. The unit was to be used in cold weather tests conducted by the Army some time in early 1962.

The Eberline AM-3 air monitor was evaluated with particular attention to its usefulness to measure aerosol concentrations when located in a radiation field. It was determined that the unit could be used to alarm at 10^{-8} μc/cc in radiation fields up to 10 mr/hr., 10^{-7} μc/cc in radiation

fields up to 40 mr/hr and 5 x 10^{-7} μc/cc for fields up to 100 mr/hr. The possible error could be quite large and modifications would be required before such a unit could be used for some of the Camp Parks air monitoring problems.

The possibility of using the Laboratory vacuum system as an air sampler was investigated. Such a method could greatly simplify air sampling problems within Bldg. 815 by providing continuous collection and greatly reducing the sampler-noise level. Preliminary checks indicate that the following flow rates are obtained with a 1½ inch sampling head:

Paper	Flow-Rate (cfm)
Glasswool	2.03
CWS #5	1.56
Millipore	1.09

An air sampling head type A-51 filter holder was purchased for continuing evaluation of the vacuum system. Additional studies were scheduled for 1962.

Funds were requested from BuShips for construction of a continuous monitoring system for the tanks used to hold up the liquid effluent from Bldg. 815.

Program 2.0 RAD-SAFE EVALUATIONS

This program is chiefly concerned with the evaluation of special radiological problems within the Laboratory and from outside activities. During the year about 8% of the total available effort was devoted to these evaluations. The program is divided into two sub-groups.

Project 2.1 RADIOLOGICAL EVALUATION AND PROCEDURAL DEVELOPMENT

Chief of Naval Operations - A representative of Code 730 was designated as the "official Navy observer" in connection with the Stationary Low Power Reactor (SL-1) incident of 3 Jan 1961 at the NRTS, Idaho Falls. Nine days were spent at the NRTS collecting information. A summary report was prepared and forwarded to CNO.

BuShips, Code 362 - The radiological significance of five magnetic wrist compasses with Pm^{147} markings was determined. Three compasses were of a prototype design with numerals on the course ring cover and two compasses had the numeral markings within the compass bowl. Both designs

appeared to contain the radioactivity and neither produced significant dose rates at the compass surface (≈5 mr/hr at contact). One spot of contamination was noted on one unit after the course ring cover was removed. The source of the contamination was not apparent. A letter report presenting the results of the test was forwarded. It was recommended that all units be marked as to their radioactivity content.

U. S. Naval Station, San Diego - A procedure for evaluating wipe tests made on sealed radioactive sources was forwarded to the Industrial Manager of the USNS, San Diego. References relating to commercial services for leak testing were also included.

Photodosimetry Calibration - Fading studies of the insensitive film component of the NRDL film dosimeter indicated that, in a 30-day period, a 50% error in dose interpretation could occur. The manufacturer's representative was requested to have the manufacturer investigate this problem. A new film emulsion has been ordered and additional fading studies will be made.

Calibration curves for two separate emulsions of film type 555 and 510 were made using Co-60 (γ) and U-238 (β) radiations.

Additional calibration curves were made using U-238 (β) and Lu^{177} and Xe^{133} (γ)

Radiological Trainer - Calculations were provided to the GETR concerning the irradiation of K Br for use in evaluation tests of Device X11F3 at Camp Parks. A lead shipping container was obtained from NAVSCOLCOM, T.I., and modified to hold the K Br capsule. A scintillation counting system was provided by the Engineering Division. The system shows only a 2% variation in a 1-hour background count and will reproduce a sample count with 95% confidence level (1 hour counting time). The unit is supplied with a print-out system and automatic timers.

Eight tests, using 75 mc to 1.4 c of Br-82 per test were conducted. Test areas varying from 1,200 to 1,900 sq ft were contaminated. Gamma dose rates of about 100 mr/hr at 3 ft above the surface were obtained. The gamma dose to personnel doing the spreading averaged about 70 mr for each spreading operation. The average dose to the eight persons conducting the tests was 0.395 r (γ). The maximum total dose was 0.880 r (γ). No personnel contamination was observed during the test series. All urine samples that were counted for radioactivity and analyzed chemically for bromine were negative. Aerosol samples taken during the test series did not exceed 1×10^{-10} μc/cc at the time of collection. (The 168-hr MPC for Br-82 is 4×10^{-7} μc/cc.)

The use of wood glue to hold the contaminant to a surface was abandoned since the tests indicated it did not retard the removal of the radioactivity. Spraying a silver nitrate solution on the area prior to spreading the bromine solution makes the radioactivity difficult to remove. Laboratory tests verify this effect and also indicate that silver nitrate retards the release of Br-82 as a gas from the contaminated surface.

The addition of sugar to the contaminant was also abandoned since it did not aid in making the radioactivity adhere to the shoe covers of test personnel. (In addition, it did attract various pests, such as ants into the test area.) Laboratory efforts will continue in an attempt to find some substance that will increase the tracking capability of the contaminant.

The device requires several additional design modifications. The structural strength of some of the parts is questionable. The cutting knife will only cut one capsule and then must be replaced. These deficiencies (and others) will be corrected in the planned redesign of the unit.

Preliminary analysis of the data from the test series indicated that no significant radiological or technical problems exist in the operation and use of the device. An evaluation report (ER-12) was completed and published.

Acceptance tests indicate that the depleted uranium shipping container is satisfactory for use. Modification of six AN/PDR-18A radiacs is still in progress. The modification is such that the radiac will indicate rad per hour dose rates in millirads per hour radiation fields.

Additional evaluation tests of the device are planned for NAVSCOLCOM, Treasure Island, and aboard ship. Funds have been requested for this purpose from BuPers.

Information on the cost, use, and capabilities of the device was supplied to the Office of Special Weapons Development, Fort Bliss, Texas.

BuSanda and NSC Oakland - Discrepancies in reported alpha contamination levels on stock items and their packing materials when similar items were monitored at NSC Oakland, CSO, Mechanicsburg, and the Naval Air Material Center Laboratory were investigated. It was determined that the NSC Oakland monitoring results appeared to be correct and the others in error. The error originated from the instructions to the activities which states that all readings be taken at 1 inch from the source. This distance is greater than the range in air for the alpha particles being measured.

Alpha Monitoring Facility - Favorable endorsements on the NRDL proposal were provided by BuShips and BuPers. CNO indicated that the proposal has been included in the FY63 program and the priority assigned is such that its chances of being funded are good.

Optical Coating Laboratory, Santa Monica - Rad-safe information on the problems associated with the use of thorium fluoride were provided in response to a letter-request.

NSC Oakland - Consultation was provided on the contamination control procedures required to convert a storage area for radium-containing items into a work area to be continuously occupied by personnel.

U. S. Army, Presidio - Information was provided on the effects of medium energy X rays on photographic film. The shielding problems associated with the use of the unit were also reviewed.

NAD Hawthorne, Nevada - A rad-safe inspection and report was made on the temporary and permanent facilities used for housing a 1 Mev X ray unit. The temporary installation, although useable, did not have sufficient shielding in areas other than the control panel. It was necessary to restrict access to a considerable area in order to provide adequate radiation control. The design of the permanent facility is such that only the transmitted beam (beam parallel to the long axis of the tube) may be used. The machine must be beamed at the outside wall of the shielded space.

U. S. Department of Agriculture - Information on the decontamination of clothing was provided. Five references to additional detailed studies were given.

Project 2.2 RAD-SAFE TRAINING

A 1-hour lecture on the use of Navy radiac instruments was presented to NRDL enlisted personnel as part of their training program.

A set of 12 complete lesson plans were prepared in connection with a training course to teach the fundamentals of radiation and contamination control. A preliminary evaluation of the course material was made in connection with the SFNS adult education program. The course was entitled "Introduction to Radioactivity and Its Control." The material was organized as follows:

GENERAL UNDERSTANDING OF RADIOACTIVITY AND RADIATION
- Nuclear Structure
- Radioactivity
- Types of Radiation

BIOLOGICAL EFFECTS OF RADIATION
- Biological Effects of Radiation

HOW TO MEASURE RADIOACTIVITY AND RADIATION
- Principles of Radiation Detection Instruments
- Operation of Radiation Detection Instruments

HOW TO CONTROL RADIATION EXPOSURE
- Methods of Dosage Control
- Typical Dose Control Problems

HOW TO CONTROL CONTAMINATION
- Contamination - Decontamination
- Contamination Monitoring and Delineation
- Protective Equipment and Waste Disposal

REGULATION AND GUIDES
- Regulation and Guides

Volume I of PORACC was used as a text. The major portion of the material for the lesson plans was obtained from Volume II of PORACC.

A 5-day rad-safe training program was conducted at San Clemente Island. The course was presented to six Navy enlisted personnel who were to assist the health physicist assigned to Hydra IIA.

A lecture demonstration on dosimetry and radiacs was presented to NRDL enlisted personnel.

Program 3.0 SPECIAL OPERATIONS

About 12% of the total available effort was expended on program 3.0 assignments.

Project 3.1 RAD-SAFE SUPPORT FOR NOTS, PROJECT 173

The report on two test operations conducted at NOTS was completed and forwarded to NOTS. There were no radiological problems.

Rad-safe support was also supplied in connection with the clean-up of the SNORT II area following a contaminating event. The rad-safe

aspects of this incident were documented in a letter report to files.

Since no additional effort was requested, the project has been cancelled.

Project 3.2 HYDRA IIA

Rad-safe coverage was provided to project personnel during the evaluation and calibration of various detection instruments to be used. Rad-safe monitoring gear was also calibrated, using the same radiation source (Lu-177.)

Rad-safe support was provided for the field phase of HYDRA IIA. Three shots, using 500 c of Lu-177 per shot and a fourth shot, using 500 c of Xe-133, were completed during the fall. The lutetium was used to trace the particulate products of the explosion (10,000 lb of TNT) and the xenon to trace the gaseous products.

Support for the project included:

a. Preparation of Annex E "Radiological Safety" for the HYDRA IIA Operation Plan.

b. Participation in briefings conducted for the various state agencies, press, commercial, and sport fishing industries. The briefings reassured all parties that there need be no concern as to the impact of these tests on the marine environment. The briefings provided good contacts for future interaction, should this be necessary. Arrangements were made to establish a 2-mile restricted area around the shot point and to patrol the area as necessary to maintain entry control.

c. Development of equipment and procedures to collect and analyze Xe-133 samples. The samples were collected by arranging empty cans of water as the cloud passed over the collecting station. The sample analysis was done by freezing out the Xe-133 onto activated charcoal and counting the charcoal in a 3-inch deep-well scintillation counter. The system can detect concentrations of 4×10^{-9} μc/cc from a 1-gallon sample can.

d. Setting up an air monitoring station at Camp Mathews near San Diego. This station is in the general downwind direction from San Clemente Island.

e. Procurement of the necessary rad-safe gear for support of the field phase of Hydra IIA.

Monitoring results showed the following:

a. No measurable radiation exposure (<40 mr) was observed.

b. Maximum air contamination observed was in the 10^{-8} µc/cc range. The aerosol concentrations at the edge of the controlled area were in the 10^{-11} µc/cc range. (The 40-hour MPC for Lu-177 is 5×10^{-7} µc/cc. The MPC for uncontrolled release is 2×10^{-8} µc/cc.)

c. The maximum water contamination observed was in the 10^{-4} µc/cc range. The water was continuously monitored and kept under surveillance until levels of 10^{-7} µc/cc were observed. (The 40-hour MPC for Lu-177 is 3×10^{-3} µc/cc. The MPC for uncontrolled release is 1×10^{-4} µc/cc.)

d. Very little contamination was detected. The maximum radiation level observed following the shots was 2 mr/hr. (Measured with an unshielded GM tube.)

At the end of the year, work was under way on field sample analysis, data organization, and preparation of the rad-safe report for the project.

Post-operational environmental samples were collected and analyzed. The levels observed indicated that no restrictions from the radiation and contamination control viewpoint were required on San Clemente Island.

Project 3.3 OPTEVFOR

This project involved the preparation for and participation in a classified project under the direction of COMOPTEVFOR.

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26	Oak Ridge Gaseous Diffusion Plant (Henry)
27	Oak Ridge National Laboratory (Morgan)
28	Phillips Petroleum Company (McCaslin)
29	Public Health Service, Washington (Terrill)
30	Public Health Service, San Francisco (Kinsman)
31	Reynolds Electrical and Engineering Company, Las Vegas (Wilcox)
32	Robert A. Taft Sanitary Engineering Center, Cincinnati
33	San Francisco Operations Office (Smith)
34	Union Carbide Nuclear Company (West)
35	University of California Radiation Lab., Berkeley (Thaxter)
36	Westinghouse Atomic Power Laboratory (Barnes)
37	Westinghouse Electric Corporation. Idaho Falls (Farkas)
38	Aerojet General, San Ramon (Simmons)
39-90	USNRDL, Technical Information Division

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