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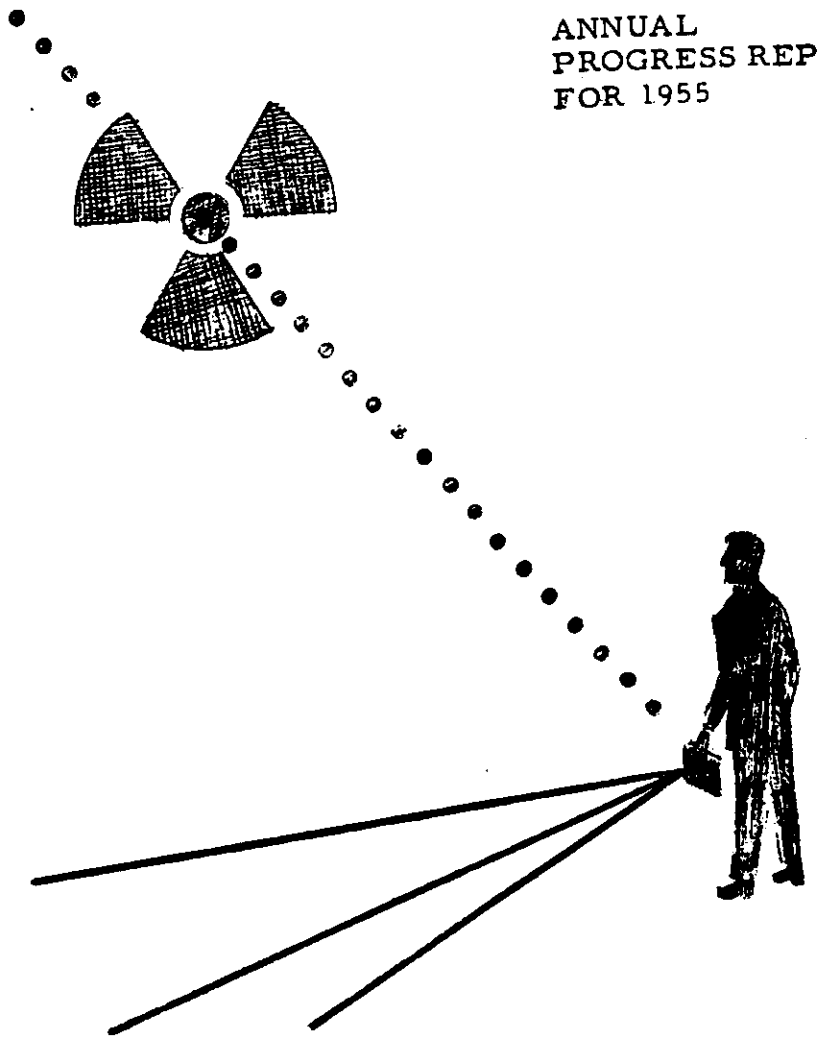
RADIOLOGICAL SAFETY AT USNRDL

ANNUAL
PROGRESS REPORT
FOR 1955



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RADIOLOGICAL SAFETY AT USNRDL — 1955

A. L. Baietti

Annual Progress Report
For Period 1 January to 31 December 1955

Health Physics Division

Captain A.R. Behnke, Jr., (MC) USN
Radiological Medical Director

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Commanding Officer and Director

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

31 March 1956

REVIEW OF RADIOLOGICAL SAFETY FOR THE YEAR

One of the outstanding services which the Health Physics Division provided to the Laboratory was its part in the move to Building 815 early in 1955. Material and equipment which had been near radioactive materials, their sites, and all vacated areas were monitored. Some former working areas required extensive decontamination. A long-range program of monitoring of the new building was begun to identify radiological safety situations and to follow their trends. Consultations with each of the scientific divisions produced possible measures for contamination control.

The Radiological Safety Branch continued its operational rad-safe liaison. Among the eight radiological accidents of the year, one required extensive decontamination. This involved 18 persons and had gone unnoticed until the completion of the experiment, by which time the contamination had been spread by tracking and air circulation. No radiological injury resulted from any of the year's accidents. Further indicating the continued high order of radiological safety, only one case of exposure exceeded the maximum permissible levels, when one film badge read at 9.5 rep beta.

In the routine rad-safe support, over 25 curies of radioactive material were handled. A semi-annual leak test of radiation sources was instituted. Thirteen barge loads of radioactive waste materials were sunk at sea.

Environmental monitoring was focused this year on designing a method for monitoring effluent air from the new building. Air samplers have been tentatively placed at some of the building's exhaust plenums. Also, plans were considered to sample the total liquid sewage from the building.

The Radiological Development Branch continued its diverse evaluation and consultation services to installations outside the Laboratory. Studied for the Laboratory were a new film badge which promised greater accuracy in dosimetry by its enabling better distinction between X and beta radiation, and the adaptation of radiac to the detection of contamination in drinking water.

The daily collection of aerosols revealed in November and December a concentration of radioactivity seven times as large as the normal background.

The evaluation of prototype radiac centered on a personnel alarm dosimeter. The main difficulty was the design of a weatherproof package.

The Branch's main effort in its training program was the completion of the preliminary edition of the manual Radiological and Contamination Control and further revision and enlargement to a final draft.

Again, preparation for and participation in field operations occupied a large part of the Division's effort for the year. While at first FO-12 was dominant, later on FO-15 required the greater attention.

RADIOLOGICAL SAFETY BRANCH

LABORATORY CONSULTATION AND MONITORING

Move to Building 815. During the first half of 1955, the Laboratory moved from various buildings throughout the Shipyard into the new laboratory building, number 815. During the transfer, each item to be moved from an area where radioactive materials had been stored or handled was monitored for contamination. Handling procedures were recommended when appropriate.

Each vacated building was monitored and final clearance conditions were realized before the buildings were released to San Francisco Naval Shipyard. Little or no decontamination effort was required to effect the final clearance of Buildings 313, 351, 351B, and 508. More extensive decontamination efforts were necessary to clear buildings 351A and 507. Very extensive decontamination was needed to clear Building 506; this was accomplished during the third quarter of the calendar year.

In the new building limited routine monitoring was done in the second half of the year to determine whether or not any trend could be noted regarding the general radiological situation of the Laboratory. Such a program was determined to be an essential part of the Health Physics Division's work for the Laboratory. Therefore, in accordance with the manpower available, the program will be expanded to a more comprehensive coverage. The results of the work completed have been documented in a Radiological Safety Branch memorandum.

Chemical Technology Division. Possible measures for contamination control in Building 815 were extensively studied and discussed with appropriate Chem-Tech Division personnel. A summary of the proposed recommendations will be made at the completion of the study.

Maintenance work involving radioactive material was controlled through the continued use of the special work permit. Fifty permits for maintenance, decontamination, waste removal, and shop work for the Chem-Tech Division were issued during the year.

In anticipation of the use of amounts of radioactive material larger than 1 curie in laboratory experiments, Building 364 was inspected. Recommendations for modifications of the building necessary to meet radiological safety requirements were being prepared. A memorandum to the Scientific Director cited the potential contamination control problem associated with the use of large quantities of radioactive material in unconfined form in Building 815. Also noted were recommendations to

relocate aerosol-producing experiments in Building 364. Additional information obtained during aerosol-producing work with 50-mc of Sr^{89} was forwarded to the Scientific Director to illustrate further the contamination problems.

Innumerable special monitoring surveys were made. These included spot checks of airborne, surface, [illegible] fluid contamination; radiological surveys of areas and spaces, labora[illegible] apparatus, field operation equipment, clothing, and waste materia[illegible] Some specific examples of special monitoring surveys and health physics evaluation are:

(1) Samples and equipment returned t[illegible] FO-12 and FO-16 were monitored and decontaminated as necessary. Appropriate instructions were issued for the safe handling and disposition of the material.

(2) Operational clearance of YAG's 39 and 40 was established upon their return from participation in FO-12.

(3) A shielded container was designed especially for shipping uranium foil that is to be irradiated at the Materials Test Reactor (MTR), Arco, Idaho.

(4) The Division requested that MTR and Oak Ridge National Laboratory (ORNL) provide special laboratory facilities for USNRDL personnel making spectral gamma measurements of bombarded uranium.

(5) Calculations and evaluations of shielding for a 1000-c of Co^{60} source were made.

Nucleonics Division. Monitoring of Building 816 after the Van de Graaff generator was modified from electron beam to positive ion beam operation revealed no significant radiation in areas normally occupied by personnel. Area monitoring by film badges indicated no significant gamma radiation in the work areas or outside the building during the operation of the generator.

A neutron monitoring survey, through the use of film, was conducted in Building 816 throughout the year. Except for the inside of the target room, there were no normal work areas where the neutron fluxes exceeded the established Maximum Permissible Exposure (MPE) levels.

Monitoring for gamma radiation inside and outside Building 816 when the 2-Mev Van de Graaff generator was converted to electrons showed that the gamma fluxes in normal work areas and on the exterior of the building were below the MPE levels.

Preliminary calculations were made of the expected radiation fluxes and shielding requirements for the proposed installation of either a General Electric or High Voltage Engineering 1-Mev X-ray generator. The findings indicated that neither machine could be operated, behind the proposed shielding, in a horizontal beam position without creating excessive dose-rates. Vertical beam operation would require that a lead yoke be placed in the target area to attenuate the scattered radiation to acceptable levels.

A monitoring survey was made in Room 480, Building 815, during irradiating experiments which utilized the 10-c Co^{60} source; film badges and monitoring instruments were used. The horizontal radiation beam was directed toward an outer wall of the building and no significant radiation levels were observed outside the controlled access work area.

Twenty-eight special monitoring surveys were made in Building 815 to delineate the radiation fields associated with various exposed gamma sources and the X-ray unit in Room 187, and to determine the effects of these sources on the general radiation background inside the building. No increase in the general background was detected.

Monitoring of 17 vehicles returned from the Nevada test area indicated that 11 of them required decontamination.

Three special work permits were issued to personnel of the Engineering Division for the decontamination of special equipment which was returned to the Laboratory from the Nevada Proving Grounds (NPG).

Biological and Medical Sciences Division. After the installation of two X-ray units in Rooms 595 and 597, monitoring surveys indicated the need for additional shielding to reduce the radiation to less than 7.5 mr/hr at various access points. Shielding of specific thicknesses was recommended; that for the doors was installed while that required on each wall of the two rooms remained to be installed.

During the last quarter of the year two experiments in connection with inhalation studies resulted in low-level contamination (500 c/m)in Room 538, an animal colony room which is used exclusively for contaminated animals. Suitable precautions have been taken to control the spread of this contamination.

Three special work permits for maintenance work in Bio-Med spaces were issued. Twenty-four isotope requests were evaluated and recommendations were made regarding equipment design, monitoring, and operational procedures for the proposed use of the isotopes.

RADIOLOGICAL ACCIDENTS

Chemical Technology Division. Two minor accidents occurred during the first half of the year in Room 19, Building 351A. The minor contamination of personnel and space was successfully decontaminated.

The radiation overexposure of an investigator occurred during a film calibration experiment which employed high-level Sr^{90} beta sources. In one hour's exposure the individual received 9.5 rep.

On 28 July personnel working in Room 1109, Building 815, on an experimental operation involving irradiated uranium foil were accidently contaminated. Since the contamination was not detected until completion of the experiment, it was necessary to expend much effort in decontaminating the room, the ventilation exhaust system, and other spaces in the building where individuals had inadvertently tracked the contamination. Overexposure to radiation was not observed in any one of the 18 persons involved in the accident. However, detectable quantities of radioactivity were present in the urine of 12 of these individuals. The maximum urine concentration observed was one third the Maximum Permissable Concentration (MPC). There were also minor amounts of personnel and clothing contamination noted.

On 8 November there was a small spill of a microcurie of Cs^{137} in a hallway of the sixth floor. No personnel contamination resulted and the corridor was decontaminated.

Nucleonics Division. No significant radiological accident involving division personnel occurred during the year. On one occasion it was suspected that one man's hand might have been overexposed to X rays. However, the investigation indicated that such was not the case and, further, that overexposure was not possible unless the hand were placed directly in the beam of the X ray.

Biological and Medical Sciences Division. As a result of the accident in Room 1109 on 28 July, it was discovered that Rooms 538 and 546 were contaminated to the amount of 2000 c/m; both spaces were successfully decontaminated.

An injection needle snapped while a technician was injecting Sr^{89} into a rat, with the result that the coat worn by the technician was spattered with the fluid. No contamination was observed on the individual or in the room; one spot on the coat had a reading of 6 mrep/hr.

Health Physics Division. One radiological accident occurred during the final quarter of the year. On 7 October a member of the Health Physics Division dropped a glass container with 17 mg of U^{233} in solution. The contamination was confined to Room 677, with personnel contamination found on the hands of one individual and on the shoes of four others. The room and the workers were successfully decontaminated.

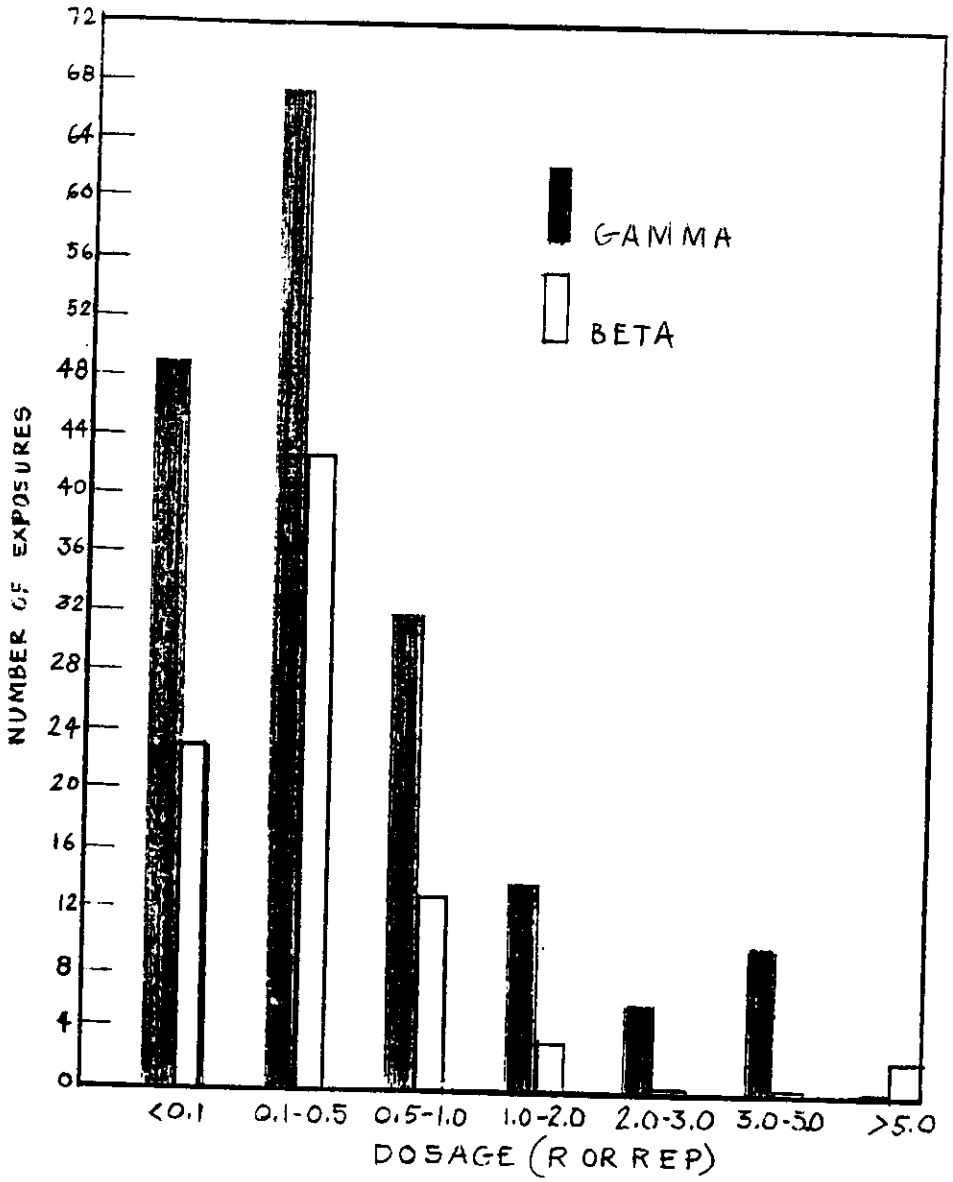
DOSIMETRY

Film was processed for NRDL and outside activities during 1955 as follows:*

NRDL	Film Processed
Laboratory personnel	7,800
Laboratory visitors	7,052
Calibrations	510
Environmental monitoring	276
Special (Mouse Irradiation)	68
TOTAL	15,706

Outside Activities	
Arco, Idaho (Submarine Thermal Reactor)	168
SFNS	1,735
Treasure Island	248
YAG's 39 and 40	70
Santa Barbara Research Center	46
U.S.S. Hancock	24
Naval Air Station, Moffett Field	19
Navy Dispensary, 50 Fell St., S.F.	89
Naval Ammunition Depot, Port Chicago	4
FO-12	9,800
TOTAL	12,203
GRAND TOTAL	27,909

* In addition, 74 neutron films were processed under contract for NRDL by Tracerlab, Inc.



Distribution of Film Badge Dosage Totals, NRDL, 1955

Of the Laboratory film badges processed, two were found to be exposed in excess of the MPE. One badge showed a beta exposure of 9.5 rep; investigation disclosed that the other badge had been mishandled. The distribution of film dosages are graphed in the accompanying illustration.

During the year, 898 pocket chambers were issued and read. Only two paired sets indicated positive readings greater than 60 mr; these were 100 and 80 mr.

A film perforator was obtained to facilitate the numbering of film. An improved record system, together with a saving in processing time, should be realized from the use of this device.

Progress by the Radiological Development Branch in developing a new film badge pointed to its early adoption for dosimetry. This badge employs filters of aluminum, cadmium, and lead, and enables more complete evaluations of X and beta radiation.

RADIOLOGICAL SAFETY SERVICES FOR LABORATORY OPERATIONS

Accountability. During the year 106 orders involving 4.985 curies of activity were processed. One hundred sixty-seven shipments involving 3.156 curies of activity were received from outside suppliers. Following is a summary of radioisotopes ordered and received.

Division	Processed	Received
Chemical Technology	41 orders - 302 mc*	52 shipments-409.3 mc
Biological and Medical Sciences	41 orders - 2568 mc	82 shipments - 618 mc**
Nucleonics	22 orders - 2109 mc	31 shipments - 2123 mc
Health Physics	2 orders - 6 mc	2 shipments - 6 mc

* Exclusive of order for 1,000-curie Co^{60} source.

** Exclusive of shipment of 26,000 rep/hr P^{32} plaques.

In addition to the above, one 10-curie quantity of tritium was received and delivered to Building 816 for the use of the Nucleonics Division. One irradiated sample involving approximately 3 curies of activity was ordered and received for the Chemical Technology Division. Five orders for seven individual solution standards were placed with the National Bureau of Standards; one shipment of three standards was received.

The following cyclotron- and pile-irradiated samples were processed and received. An indeterminate quantity of activity was produced in these irradiations.

Division	Orders Processed	Shipments Received
Chemical Technology	24	36
Biological and Medical Sciences	4	3
Nucleonics	3	2

Ten aliquots totaling 0.92 mc and three point sources (5 mc W^{185}, 3 mc Ce^{141}, 75 mc Hg^{203}) were prepared from radioisotope solutions in Building 529, and were delivered to Laboratory experimenters. Two wedges for testing five-fold hand and foot counters were prepared, using 189 mg of normal uranium foil.

Approximately 73 separate quantities of isotopes, totaling 3560 mc of activity, are being held in storage in Buildings 529 and 815, until needed by Laboratory personnel. Two hundred and fifty-two separate quantities of isotopes, excluding sealed sources, totaling 1595 mc of activity, were located in Laboratory spaces.

The results of the first semi-annual leak test of radiation sources in the Laboratory were documented and forwarded to the Isotopes Division, Atomic Energy Commission.

The following table summarizes the radioactive materials in the form of sources that were available in the Laboratory throughout the year:

Type	Number	Total Quantity
Co^{60}	11	46 curies (200 mc to 11 curies)
Ra	10	1129 mg (0.1 mg to 500 mg)
Cs^{137}	1	10 curies
Po^{210}	1	35 mc
Ra-Be	4	113 mg Ra
Pu-Be	1	2 g Pu
H^3-Zr	3	5 curies H^3

Two Sr^{90} sources, with a uniform distribution of activity over a 1-1/2-in. diameter surface, were prepared for the Nucleonics Division in connection with some contact dose-rate studies. The surface dose-rate of the two sources was 3 rep/hr.

A catalogue listing all radioisotopes in use and in storage at the Laboratory has been drafted and was to be issued early in 1956.

Radioactive Waste Disposal. During 1955 the Radiological Safety Branch coordinated the removal and disposal of radioactive wastes from this Laboratory as well as sea disposal of radioactive wastes from the University of California Radiation Laboratory, McClellan Air Force Base, and the San Francisco Naval Shipyard.

Thirteen waste disposal barge trips to sea were made to accomplish sea disposal of radioactive wastes from the Laboratory and the installations named above, and are summarized on the following page.

A summary of Laboratory waste disposal costs follows:

Engineering Division labor	(74 man-days)	$ 1455
Health Physics Division labor	(40 man-days)	700
Shipyard services		825
TOTAL	(114 man-days)	$ 2980

A total of 434 drums, 300 liquid and 134 solid, and 3 blocks of NRDL waste were removed during the year. The average cost per drum was approximately $6 and per concrete block approximately $200. The 1954 cost was approximately $11 per drum.

There was no spread of contamination during loading operations in 1955. Two minor incidents occurred during dumping operations: on the trip of 11 May, three wing tanks floated until sunk by rifle fire; on the 17 May trip, one hold containing 62 drums failed to discharge. The drums were returned, reloaded into another hold, and taken on the 16 June trip. All waste material was disposed of at the designated dumping area.

Since April 1955, dry active waste has been collected in 30-gallon fiber drums rather than 20-gallon steel drums.

Ocean Monitoring. Recommendations have been made by the Health Physics Division for a laboratory study of radioactive waste disposal in the ocean. Arrangements have been made with Scripps Institution of Oceanography to take ocean water and bottom core samples in and around the waste disposal dumping site to determine the rad-safe aspects of the present waste disposal packaging and ocean disposal procedures. Preliminary plans and experimental procedures for taking bottom core samples, water samples and carrying out drum rupture tests have been completed. The actual sampling was tentatively scheduled for some time in the last half of 1956.

Disposal of Radioactive Waste at Sea

Date	Source	Quantity
1/24/55	UCRL Livermore	80 drums, 4 blocks (800 cu ft)
	UCRL	50 drums, 1 steel tank
3/22/55	UCRL	180 drums, 6 blocks (1200 cu ft)
4/14/55	UCRL Livermore	121 drums, 6 blocks (1200 cu ft)
4/28/55	UCRL	122 drums, 1 bundle iron pipe, 1 piece sheet metal
5/5/55	UCRL	64 drums, 1 block (200 cu ft), 2 tanks
5/11/55	NRDL	124 drums, 2 blocks (300 cu ft)
	McCAFB	52 drums, 12 wing tanks
	UCRL	62 drums
5/17/55	NRDL	181 drums, 1 block (150 cu ft)
	McCAFB	1 tank
6/16/55	UCRL	113 drums
	UCRL Livermore	62 drums, 2 blocks (400 cu ft)
6/30/55	NRDL	48 drums
	SFNS	112 drums
7/25/55	NRDL	80 drums
	SFNS	72 drums
	McCAFB	80 oxygen tanks, 40 drums
10/7/55	McCAFB	1 concrete tank, 120 drums
	UCRL	60 drums, 1 block (200 cu ft)
	SFNS	60 drums
11/16/55	UCRL	120 drums, 1 block (200 cu ft), 3 tons scrap iron
	NRDL	1 drum
12/21/55	UCRL	94 drums, 3 blocks (600 cu ft), 2 flats scrap iron
	UCRL Livermore	30 drums, 1 block (200 cu ft)

Decontamination Laundry and Protective Equipment Issue. New stainless steel equipment for washing, extracting, and drying laundry have been installed in Building 815. This equipment is used for the laundering of contaminated clothing. All uncontaminated clothing is sent to Treasure Island for processing.

The decontamination laundry procedures were reviewed and a change in laundering techniques was recommended. A pre-rinse and the use of a commercial detergent, Turco, were tried and found to be successful.

During the year minor contamination was detected on 18 laboratory coats as a result of experimental operations in Building 815.

Decontamination laundry effluent was sampled but no activity concentration greater than 10^{-5} μc/cc was detected.

ENVIRONMENTAL SURVEY

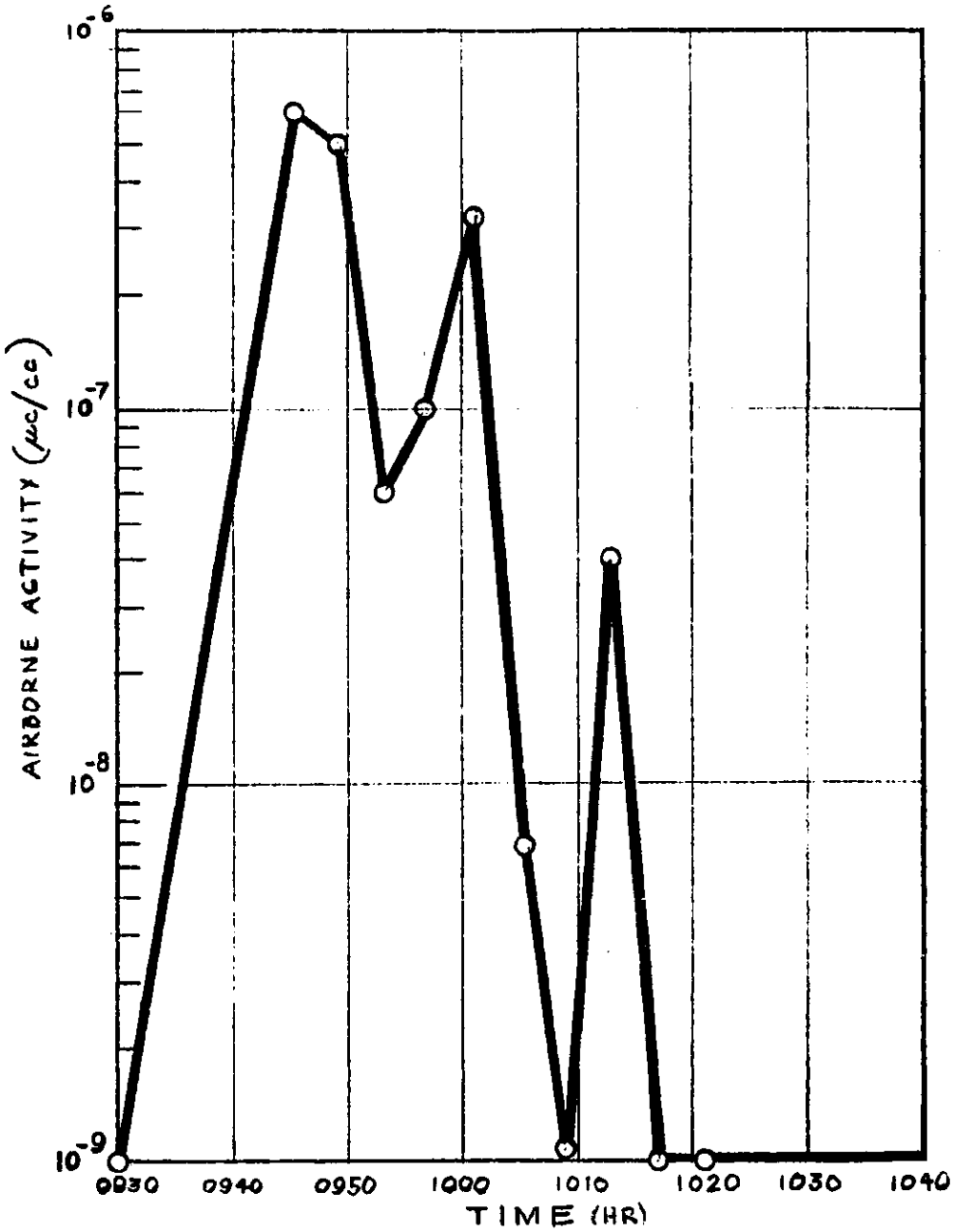
Air Sampling Operations. A continuous air monitoring device was operated in the area of Building 313 from 1 January until 15 May, at which time the move to Building 815 was virtually completed. No significant airborne concentrations above background were noted.

During the year an extensive study was made to determine the most feasible method for monitoring effluent air from Building 815. Tentative requirements for the air sampling program indicate the installation of five cyclic air samplers on the appropriate portions of the exhaust plenums that lead from the first, fifth, and sixth floors. Drawings and specifications have been submitted to the Management Engineer and Comptroller for further action.

A cyclic air sampler was operated on the roof of Building 815, during the third quarter of the year, to measure the radon-thoron concentration as a function of time. The tests established the fact that this sampler is capable of measuring concentrations of beta-emitting aerosols which are as low as 10^{-10} μc/cc.

On July 28, the day on which an accident occurred in Room 1109 of Building 815, the cyclic air sampler in operation recorded the data which is graphed in the following figure.

Liquid Sampling Operations. During the monitoring of Building 351A, prior to the release of the building to SFNS, beta contamination was observed in various portions of the drain piping.



Levels of Airborne Radioactivity During Accidental Release of Activity in Room 1109 on 28 July 1955

An evaluation was made as to the most feasible method of sampling the total liquid sewage effluent from Building 815 for the purpose of monitoring for radioactive contamination. Information from the City and County of San Francisco sewage disposal plants indicated that such a system might comprise the following features:

(1) Two 10,000-gal hold-up tanks which could receive the total effluent from Buildings 815 and 816.

(2) A dip sampler working in a two-stage weir box which removes a sample that is proportional to the total flow.

(3) A radiation monitoring system that will divert a slug of liquid contamination into one of the two tanks when the radiation level exceeds a predetermined value that would amount to a nominal concentration of 10^{-5} μc/cc in the hold-up tank.

Preliminary estimates indicate that this system can be installed at a cost of approximately $50,000. Further studies on this problem are being co-ordinated with the Engineering Division.

Radiation Intensity Monitoring. Measurement of radiation intensities in personnel spaces adjacent to particle accelerators was continued by the use of film through the first six months of the year.

Space monitoring in five locations in Building 816 disclosed no radiation levels in personnel spaces in excess of one mr/day.

Space monitoring in Room 140, Building 351B, in which were housed an X-ray unit and several cobalt-60 sources disclosed a radiation level of 30 mrep/day including 20 mr/day gamma radiation. Space monitoring in Rooms 240 and 242, Building 351B, directly over Room 140 disclosed a maximum level of 4 mr/day.

This program was inactive during the third quarter of the year because of the priority of other projects, but was again carried forth in the final quarter of the year.

RADIOLOGICAL DEVELOPMENT BRANCH

RADIOLOGICAL SAFETY EVALUATION AND CONSULTATION

San Francisco Naval Shipyard. A week's training in monitoring procedures and radio assay techniques was given to a chemist from the Industrial Laboratory. Monitoring of the Radium Dial Shop disclosed no significant contamination. Consultation with the Industrial Hygienist continued in the interpretation of Radiological Safety Regulations NavMed P-1325 (Proposed Revision), 13 October 1954, published by USNRDL. The SFNS Rad-Safe Committee was assisted in compiling the Shipyard Instructions for Radiological Safety.

A study was made of BuShips Instruction 5100.2 of 11 July 1955 regarding leak-testing and logging of sealed radioactive sources; recommendations were made to and accepted by the Radiological Safety Committee of SFNS on 24 August. Advice and assistance were given to the master of Shop 67 in repairing, decontaminating, and re-encapsulating a Co^{60} source for the AN/UDM-1 radiac calibrator set.

Mare Island Naval Shipyard. A radiac calibrator set, AN/UDM-1, with a broken source positioning cable was repaired. A new source capsule holder was designed and fabricated and a new cable installed. The Co^{60} source was loaded into the new capsule and reinstalled in the calibrator. Information was also made available on monitoring techniques for fast and slow neutrons.

Pearl Harbor Naval Shipyard. Information on setting up a decontamination facility including the equipment and procedures necessary for operation was supplied.

Stockton Naval Annex. Twelve small boats in storage at Stockton Naval Annex had been contaminated at previous field operations. The Division supplied assistance in the form of technical advice and monitoring services for the decontamination of these boats prior to their being rehabilitated or scrapped. All boats were successfully decontaminated to levels below that required for final clearance by fire hosing and scrubbing and by removing and disposing of contaminated gear aboard.

Marine Corps Supply Forwarding Annex, S.F. Information on the procurement, installation and use of an 8-curie Co^{60} source for calibration purposes was furnished. Specific details on Rad-Safe handling procedures were also discussed.

USS Hancock. A complete monitoring survey was made of the dental X-ray unit. Also a set of calibrated dental X-ray film was provided for visual estimation of the dosage recorded on film badges worn by personnel operating the X-ray unit.

Sandia Corporation. A Rad-Safe procedure for the operation of a 100-curie Co^{60} calibration source was discussed. Also information on the setting up of a photodosimetry unit was presented.

Los Angeles Flood Control District. Information on the establishment and operation of a photodosimetry unit was forwarded.

Aircraft Nuclear Propulsion Project. Information on hand-decontamination procedures used at NRDL was forwarded.

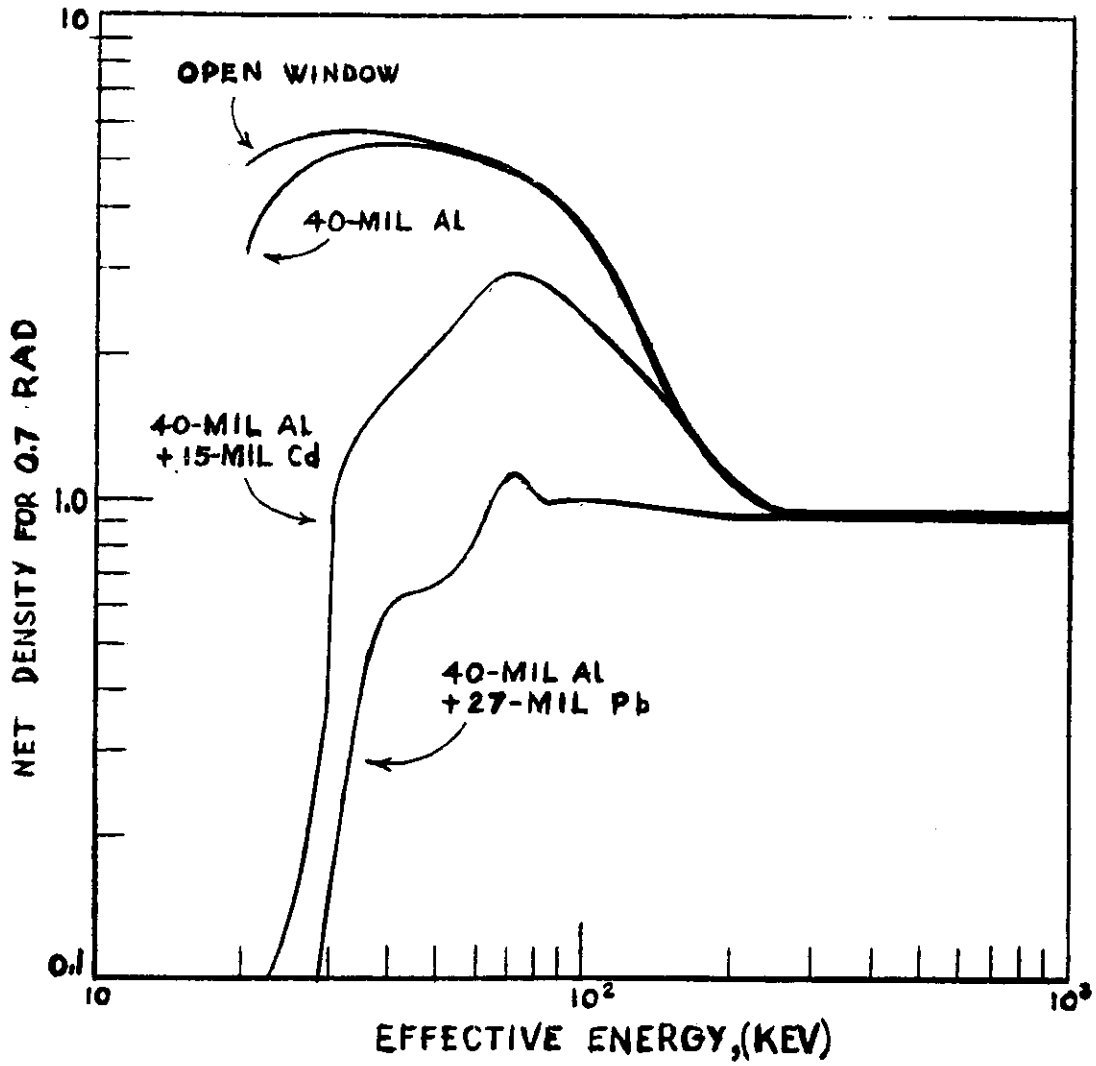
Oak Ridge Institute of Nuclear Studies. Information on the health physics training program formulated and used by NRDL was forwarded.

Kelly Air Force Base. Standard (NBS) solutions of Co^{60}, Sr^{90}, C^{14}, Na^{24} and Tl^{204} were used to prepare some low-level counting standards (approximately 1000 d/s) for use by KAFB in calibrating scaler counting equipment.

Special Source Preparation and Calibration. Work was begun on the fabrication of six Sr^{90} sources for the Nucleonics Division's Radiological Physics Program. These sources will have a uniform distribution of activity per unit area with intensities such that a single exposure to a film will establish the beta characteristics of that particular film.

Two curies of Sr^{90} were ordered for the fabrication of beta plaques, for the Thermal Injury Branch of Bio-Med Division, which was to be completed early in 1956. The development of equipment and experimental procedures for producing Sr^{90} beta plaques with a surface dose-rate of 1000 rad/min progressed satisfactorily. Tests were being made to determine the radiosensitivity of the plastic material to be used for holding the radioactivity. Two low-level sources, 1-1/2-in. diameter Sr^{90} plaques each with a uniform surface dose-rate of 1 rep/hr, have been fabricated. Additional low-level samples will be made using a new method of plaque preparation and if uniform distribution is obtained, the 1000 rad/min source will be made. Two P^{32} plaques also destined for the Thermal Injury Branch were calibrated. Additional calibration checks continued to determine the reproducibility of the calibration procedure.

Photodosimetry Development. As part of the new Laboratory identification badge, the Radiation Detection Company's "Universal Film Badge Holder" was to replace the badge holder still used in 1955.



Spectral Response Curve for duPont 555 Film (Emulsion No. 555-155-1) in the Badge Holder With 3 Shields

The new aluminum holder has an open window area and 3 shields: 0.040 in. Al; 0.040 in. Al plus 0.027 in. Pb; and 0.040 in. Al plus 0.015 in. Cd. The spectral response of duPont 555 film in this holder was studied and the results are presented in the illustration. The duPont 555 and 510 film types in a single packet continued to be used while the spectral response to X, gamma and beta radiation in the new aluminum badge was being studied. However, duPont film types 508 and 510 in a single packet were ordered for evaluation; this duPont 502 film packet was found not to have the required spectral response for the range of X and gamma radiation energies in use at NRDL.

Detection of Fission Product Contamination in Water With the AN/PDR-27 Series Radiac. The detection of fission product contamination in drinking water with the AN/PDR-27 Series Radiac was being investigated jointly with the Instruments Branch, Nucleonics Division. Studies are being made to determine the minimum detectable concentrations by monitoring water samples directly and by concentrating the contamination by precipitation and filtrations of specific volumes of contaminated water. The study should be completed early in 1956.

DAILY ENVIRONMENTAL AEROSOL COLLECTION AND ANALYSIS

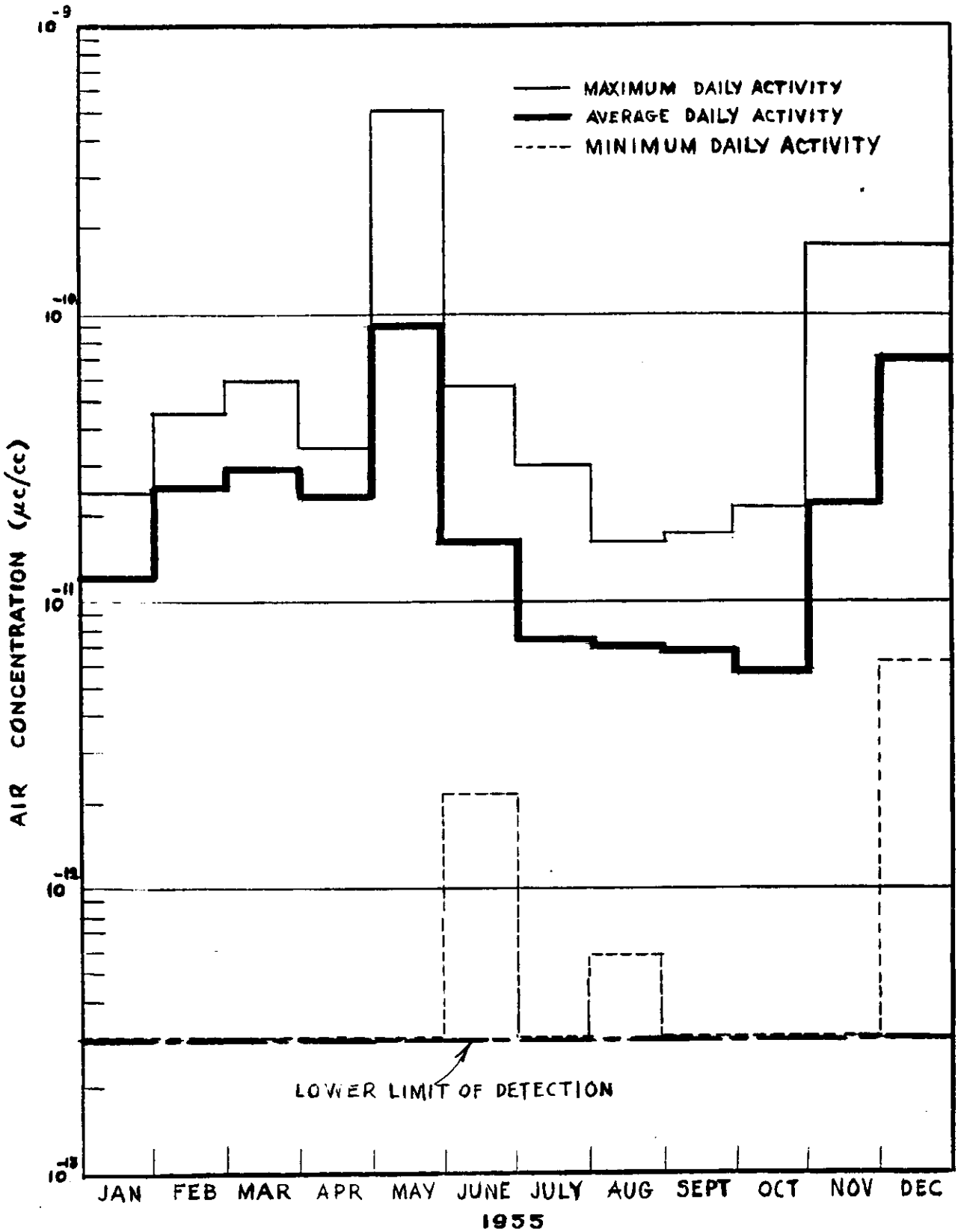
Under Operation DRILL, 24-hour air samples were taken daily and their half-life and activity concentrations were determined, documented and investigated. Activity levels of aerosol samples significantly greater than that of the natural thorium content were reported to Naval Research Laboratory. No aerosol concentrations above the MPCs were detected although concentrations above the normal background level were measured (see figure on following page).

Air sampling and analysis equipment have been installed on the 6th floor of Building 815 with the sampling lines extending through the roof of the building. Two 3-h.p. Leiman suction units were being converted to constant-flow collection units so that better determinations may be made of the radioactive aerosol concentrations.

A new rain gauge was installed to replace the original equipment that was damaged in the move to Building 815. The wind speed and direction recorder has been installed 20 ft higher because turbulent air currents over the roof of the building caused unsatisfactory readings.

RADIOLOGICAL SAFETY PROTOTYPE EQUIPMENT EVALUATION

"Final Clearance" Instrument. A prototype "final clearance radiac" was being fabricated and tested, a photomultiplier and NaI (Th) crystal being the radiation-sensitive element. Once the circuitry is developed, other phosphors will be tested for beta and alpha detection. It is planned to evaluate ZnS(Ag) for alpha detection and anthracene for beta detection.



Monthly Average Long-lived Beta Gamma Activity (ThB $T_{1/2}$ = 10.6 hr) of 24-hr Environ Aerosol

Since low levels of radiation and contamination are to be measured, radiation-sensitive crystals are being investigated to afford maximum detection efficiency (large signal-to-noise ratios) compatible with a portable radiac. The desired response of the device is that of two ranges, 10 and 100 mrad/hr, full scale.

Personnel Alarm Dosimeter. A prototype personnel alarm dosimeter was being developed. The prototype system as realized to date utilizes the principle of a dosimeter, but automatically recycles as the charge on the chamber is dissipated by the radiation field. A miniature register counts successive charging cycles. A reset control provides a manual charging mechanism. The number of mr per register unit can be varied between 25 mr and 100 mr by appropriate selection of chamber components. The circuit was still in the breadboard development stage with the design on the packaging progressing slowly. It is imperative that the packaging afford a weatherproof seal to allow the ion chamber to function properly under adverse weather conditions of high humidity and temperature. The packaging problem appears to be a major factor in the design of a satisfactory cyclic dosimeter.

RADIOLOGICAL SAFETY TRAINING PROGRAM

Training Course and Material Development for FO-12. The major effort of the Radiological Development Branch's training program for the year was bringing to the final stages the development of courses for the preparation of personnel to participate in Field Operation 12. Three different courses were ready in April:

Course I — A four-week course for the training of Shipyard personnel as radiological safety monitors. During the period of 14 March to 8 April, Course I was given at the Atomic Defense School, Treasure Island, to 45 personnel assigned to Project 0.17, Radiological Safety Support for FO-12, which was assigned to this Division. The first two weeks of instruction were given by the staff of the Atomic Defense School and the second two weeks by personnel of the Health Physics Division, assisted by personnel from the Health Physics units of ORNL and UCRL. Lectures, visual aids, demonstrations, laboratory exercises and field exercises were presented on all the pertinent aspects of radiological safety.

Course II — A three-day course for the indoctrination of scientific personnel in basic rad-safe principles. Since there was not a sufficient demand, this course was not presented.

Course III — A five-day course to indoctrinate Navy support group personnel in basic rad-safe principles. Due to limited time and for better security control, this course was condensed to two days.

On April 26 and 27, Course III was given to approximately 50 support personnel for FO-12 at San Diego by personnel from the Atomic Defense School at Treasure Island.

Class schedules and descriptive brochures were prepared for each of the above. The cooperation of the staff of the Naval Schools Command, Treasure Island, and the use of their facilities contributed greatly to the successful outcome of the training effort of Project 0.17.

FO-15 Training. Arrangements were complete for the presentation of a three-week Rad-Safe Monitoring Course to be given at the Naval Training Schools Command at Treasure Island to personnel selected either as project monitors for Program II or to be made available to Task Unit-7. The course brochure was completed and work continued on the lesson plans. The three-week course will be presented once in March and again in May 1956. The Naval Training School Command at Treasure Island has agreed to assist in the rad-safe training phase. A four-week training course is being formulated for the NRDL Rad-Safe Group. Three weeks of the course will be given at Treasure Island by the staff of the Atomic Defense School and health physicists from NRDL and AEC laboratories. The fourth week will be given at the Pacific Proving Grounds (PPG).

A one-week rad-safe training course was prepared for indoctrinating personnel from Task Groups 7.3 and 7.4. This course will be given primarily at the PPG by personnel from the staff of TG 7.3.

Radiation and Contamination Control Manual. A preliminary, 182-page edition of a training manual, Radiation and Contamination Control, which had been written for Course I was ready for use at the start of the FO-12 Training Course on 14 March. The various sections of this manual were written by members of the Health Physics Division. The preliminary draft was well received by those using it and requests for additional copies have been received from outside activities.

The preliminary draft of the manual was re-organized and rewritten to better satisfy the basic objective of supplying rad-safe information for industrial and field test type operations. Comments from TI, ORNL, BuShips, NRDL, etc., were incorporated where applicable.

Two hundred draft copies of the revised manual were forwarded to Fort McClellan, Alabama, for use in the Task Unit-7 Rad-Safe Training Program for FO-15 project monitors. Upon approval and allocation of printing funds by Joint Task Force-7 the manual was to go to press to be ready in the Spring 1956. This draft will be used for radiological safety training during FO-15. Additional effort is planned for 1956 to have the manual in final form for publication and extensive distribution.

NRDL Passive Defense Training Program. A two-hour lecture on "Rad-Safe in Atomic Defense" was prepared. Final editing of the text and the preparation of a few additional slides are necessary before the information will be ready for presentation. This should be accomplished early in 1956.

FIELD OPERATIONS

FO-11. The final draft of the NRDL Rad-Safe report for FO-11 was completed in February and given to the Director of Field Operations for final processing.

FO-12 Planning. Division personnel attended sea handling trials in preparation for FO-12 for one week in January. Details of the Operation were studied and plans were formulated to implement the Rad-Safe coverage.

Arrangements were made to establish an air sampling station at the Naval Repair Facility, San Diego, which would operate during the field phase of FO-12. Visits were made to the CVL-49, the ship being prepared at Long Beach Naval Shipyard to serve as the Main Rad-Safe Center (among other purposes), to arrange for facility and space requirements of the Rad-Safe Group. Several trips were made to AFSWP, ORNL, Scripps Institute of Oceanography which was to participate, and Brown Naval Air Station, San Diego, to clarify personnel requirements and details of the operation.

Equipment Requirements. All protective clothing and miscellaneous Rad-Safe equipment requirements were met by outright purchase, use of existing Laboratory stocks, or by extended loan from other agencies. Outright purchases totaled approximately $13,000.

Three transportainers were used for storage and transportation of this equipment. Where possible all clothing items were stenciled or marked with paint in order to distinguish them from like items in normal usage and to minimize losses.

Prior to embarkation, distribution was made to various ships in the Task Group in sufficient quantities considered to be necessary to best meet the expected Rad-Safe requirements. A central stock remained on the CVL-49 to meet further needs as they developed. A minimum of reshuffling of equipment was required to realize an adequate supply of gear at all points. Detailed equipment lists were prepared that proved to be very useful for planning purposes and in locating specific items during the operational and roll-up phases of the operation.

Dosimetry. For all dosimetry materials and equipment necessary for the operation, existing stocks were utilized where possible and new items totaling approximately $12,000 were purchased.

A complete photodosimetry center was established aboard the CVL-49. An operational film badge was issued to each member of the Task Group prior to the start of the operation and was collected at the end of the operation for processing. In addition, daily film badges were issued to members of the Task Group engaged in work involving possible radiation exposure.

All film badges used in the operation are in the process of being evaluated and the results will be incorporated in the Project 0.17 report. It is believed that no significant radiation exposure occurred to any of the personnel involved.

Instrumentation. In addition to existing stocks of instruments that were used, instruments costing a total of approximately $37,000 were purchased or fabricated. Also spare parts costing $3,000 and radiation sources costing approximately $4,000 were purchased.

Monitoring instruments were distributed to various operational centers prior to D-day, with a central stock pile being maintained in the Rad-Safe Center aboard CVL-49. Repair and maintenance facilities were also maintained aboard this ship and all inoperative monitoring instruments were returned to this point for repair and replacement.

Among the portable monitoring instruments available were side window GM's, including commercial models and specially-built logarithmic scale models, commercial "cutie pies" modified to have thin-walled plastic chambers and military AN/PBR-18's and T1B's. In addition to "spot" air samplers, continuous cyclic air samplers complete with counting and recording systems were made availabe as packaged, semi-portable units.

A trailer completely equipped for the counting of air, wipe and water samples was available aboard the CVL-49. Complete instrument calibration facilities including a 7-curie Cs^{137} source were also set up and operated aboard the CVL.

A draft of a report on the log-scale GM instruments that were developed for FO-12 was prepared and submitted to Tech-Info Division for editing prior to submission as a laboratory report to the Reports Review Board.

Synoptic outlines of a report on the development and fabrication of the cyclic air sampler and the modifications made to the "cutie pie" have been prepared. The reports should be ready for consideration by the Reports Review Board some time in 1956.

FO-12 Operations. The Division assumed the responsibility for the Rad-Safe phase of FO-12, with five members assuming key roles in the Project 0.17 organization. These personnel were actively engaged in the Operation on a full-time basis for 10 weeks.

Operational Manual for FO-12. A Rad-Safe operational manual was prepared to serve as a guide for personnel engaged in the field phases of FO-12. A detailed accounting of Rad-Safe procedures was presented as an aid to newly trained personnel engaging in rad-safe work for the first time and to provide a basis for a consistent application of rad-safe practices among the various personnel.

The manual contained sections on dosage control, contamination control, monitoring techniques, instruments, air and wipe sample assay, handling procedures for radioactive samples, and information in MPE's and MPC's. The manual contained over eighty pages, printed in a pocket-size edition for the convenience of personnel in the field.

FO-12 Report. A draft of the FO-12 Rad-Safe Report (Project 0.17) was completed and submitted to the Associate Scientific Director for review as requested. Minor revisions suggested by the Associate Scientific Director have been incorporated into the final draft which has been submitted to the Tech-Info Division for editing prior to formally transmitting the report to the Office of the Scientific Director of the Operation for publication, which is expected early in 1956.

FO-15. It is planned to handle all of NRDL's rad-safe requirements for FO-15 by a NRDL Rad-Safe Group set up under Project 2.10b. A study of all of the NRDL projects in FO-15 has been made to determine the manpower training and logistical support requirements, from the rad-safe viewpoint. Preliminary recommendations have been submitted and approved by the various NRDL project leaders. NRDL's Rad-Safe Group will supply technical advice and monitoring service while the main logistic support will be supplied by the TU-7 Rad-Safe Unit. No large scale testing or evaluation of rad-safe equipment and instrumentation is planned due to a lack of funds and manpower. Some minor evaluation of the cyclic air sampler will be made. In addition, a continuing study of the film badges used during FO-12 to determine a better method of beta-gamma dose interpretation will be made. This will include an attempt to correlate personnel dosage as determined by the film badge with calculated dosage estimates made on the basis of monitoring survey data. Initial contacts and some preliminary arrangements have been made with BuShips and Hanford Atomic Products Operation (HAPO) and ORNL to augment manpower requirements.

The manpower requirements for Project 2.10b and TU-7 were established and approved. The formal requests for personnel were made by BuShips to the 11 Naval Shipyards and the AEC. A list of nominees from each shipyard has been forwarded to the Laboratory and the selection of personnel from this list is in progress. A trip was made to HAPO and to

ORNL to make preliminary arrangements for senior health physicists to be supplied for Project 2.10b. An agenda for the planning conference for FO-15 for the health physicists from HAPO, ORNL and NRDL to be held at NRDL January 25, 26 and 27 has been prepared. Contacts and liaison with various NRDL project personnel have continued in order to establish the necessary rad-safe support measures for the field phase of FO-15.

In addition to the efforts involved in connection with Project 2.10b, the Head, Health Physics Division, has been assigned as a rad-safe consultant to the staff of TG 7.3. Two military personnel recently detached from the Naval Schools Command, Treasure Island, have also been assigned to the TG 7.3 staff to conduct appropriate rad-safe training programs at the PPG for the various components of TG 7.3.

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3-240	3-932
3-250	3-933
3-700	3-934
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