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NAVAL RADIOLOGICAL DEFENSE LABORATORY

SAN FRANCISCO NAVAL SHIPYARD
SAN FRANCISCO 24, CALIF.

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NS087-003

Final Report
April 1949

RULES AND PROCEDURES FOR RADIOLOGICAL SAFETY

Radiological Safety Committee

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13 September 1949

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INTRODUCTORY STATEMENT

This manual is divided into two parts. Section I consists of general rules and procedures concerning radiological hazards; Section II contains a glossary of terms, and specific information on various procedures pertaining to handling radioactive materials.

This manual was outlined and compiled by an interim Radiological Safety Committee under the chairmanship of D. F. Mastick and later of N. L. Petrakis. The final editing was done by J. A. Kinney and the members of the Committee: N. E. Ballou, V. P. Bond, R. A. Conard, C. P. Carlson, M. C. Fishler, W. W. Hawes, F. R. Holden, G. W. Morrison, R. H. Pullen, W. B. Taylor and E. C. Vicars.

The members of the permanent Radiological Safety Committee will be the chiefs of the branches of NRDL, the Radiological Safety Officer and the Laboratory Fire Marshal.

The Committee is charged with the formulation of rules and procedures to minimize injuries resulting from direct or indirect exposure to radioactive materials through handling them or being exposed to their radiation. More specifically the Committee will act:

(1) To prepare and amend rules and regulations pertaining to the radiological hazards encountered by laboratory personnel.

(2) To aid in educating personnel regarding safe practices and protection from hazards by acting in an advisory capacity to the Health Physics Branch.

(3) To serve as a reviewing committee for accidents involving injuries resulting from radioactive materials.

(4) To act as a reviewing board for making recommendations to the BuMed Project Officer concerning the disposal of contaminated materials, and the safety procedures necessary in handling the same.

(5) To review any instances in which existing safety rules prevent operations considered essential by the section concerned. The enforcement of rules and procedures established is not the responsibility of the Committee. It is the responsibility of each individual and/or his direct supervisor.

SECTION I-A

THE NATURE OF RADIOLOGICAL HAZARDS

The harmful effects of wave and corpuscular radiations are considered to be due to their ionizing effect on living tissues, resulting in cell injury or death. Although it is beyond the scope of this manual to provide an extensive discussion of the biological effects of radiation, a few of the fundamental principles are briefly presented for the purpose of clarifying these safety regulations.

All types of tissues are susceptible to this ionization effect, blood-forming tissues being the most sensitive. Regardless of the type of radiation involved, the result in the cell is apparently the same. The degree of injury probably depends upon the quantity of radiation absorbed by the cells of the body. In addition to the immediate effects, there may be marked cumulative effects and late changes.

In the field of radiological safety, two types of hazards are recognized: external radiation and internal radiation. The source of external radiation may be an X-ray machine, or any material which emits gamma-rays or neutrons. Beta-radiating substances may be considered external radiation hazards at very short range where they affect the superficial layers of the skin.

Even though it may seldom occur that the whole body be subjected uniformly to external radiation, it is nevertheless necessary, in the interest of safety, to assume that this always takes place and to regard such exposure to external radiation as "total body irradiation", rather than "limited body irradiation".

Internal radiation is the type of hazard that exists when radioactive materials enter the body by ingestion, inhalation, or through the skin (as by way of an open wound). Materials which emit gamma-rays, beta-rays, and/or alpha particles---such as radium, plutonium and other heavy, unstable elements---may be absorbed and deposited throughout the body. Various fission products, particularly those with long half-lives and those emitting beta particles, also present radiation hazards when they enter the body. These radioactive substances act as poisons to injure the blood-forming organs or other tissues. Clinical findings of injury may be produced in a few days or weeks in severe cases, or may not appear for years if smaller amounts of radioactive material have been absorbed. In laboratory operations it is possible for an individual to be exposed to both external and internal hazards.

SECTION I-B

MAXIMUM PERMISSIBLE DOSE (TOLERANCE LEVELS)

The term "maximum permissible dose" is considered more satisfactory than "tolerance dose", because tissues actually do not tolerate any type of ionizing radiation. The values given as maximum doses do not allow complete disregard of exposure up to the maximum dose. The aim should be to avoid radiation to the greatest possible extent. The following maximum permissible doses apply for work with radioactive objects and materials or in all radiation areas.

1. EXTERNAL RADIATION

The maximum permissible dose for total or limited body exposure is 0.3 rem (roentgen-equivalent-man) in any seven day period. The 0.3 rem represents the total additive exposure from the independent components of all ionizing radiations involved, including X-rays, gamma-rays, beta-rays, and neutrons. No individual shall knowingly expose himself or cause others to be exposed to greater than 60 mrem in any twenty-four hour period, assuming a five-day work week.

2. INTERNAL RADIATION

The ingestion of any amount of plutonium, radium or a similar alpha-emitting element is never permissible. A total of one microgram of plutonium or similar element deposited in the bones is probably a lethal dose. For practical purposes in the protection of the individual, no person should be allowed to accumulate more than 0.1 micrograms of plutonium or other alpha-emitter.

a. Air contamination.

The maximum permissible level for the most hazardous and common beta-gamma radioisotopes (such as iodine, barium or strontium) is considered to be 10^{-9} microcuries per cc of air. The maximum permissible level for alpha-emitting heavy elements in the atmosphere is 8×10^{-11} micrograms per cc of air (or 5×10^{-12} microcuries per cc of air) for an 8-hour working day, six days per week for a period of one year.

b. Water contamination.

The maximum permissible level in water for alpha or beta-gamma isotopes is considered to be 10^{-7} microcuries per cc of water.

c. Maximum permissible exposure to radiation.

Type of radiation	mr/day	mrem/day*	mrep/day*
X-ray	60	60	60
Gamma	60	60	60
Beta	—	60	60
Fast neutron	—	60	12
Thermal neutron	—	60	10 to 60
Alpha**	—	60	60

* See Section II-A for definitions of terms.
** Considered from the standpoint of internal effects only. Consult Section II-B for specific maximum levels for various surfaces, shipment containers, and hoods.

SECTION I-C

MONITORING

1. FACTORS IN THE SELECTION OF MONITORING INSTRUMENTS.

Monitoring is defined as determining with suitable instruments the amount of radiation coming from a given object or present in a certain area. The portable survey instrument for monitoring an area suspected of radioactive contamination must be chosen from several types of instruments that are limited in application.

Four factors influence the selection of an instrument: 1) the type of radiation (alpha, beta, gamma, neutron), 2) the energy levels of the radiations, 3) the intensity of activity in the area to be monitored and 4) the size of the instrument.

If the type of radiation is not known, a complete survey at all practical energy levels should be made. Both ion-chamber and GM-tube instruments should be used, because a high intensity of low-energy gamma-radiation could exist in a field that gave no reading on a GM-tube instrument. If the type of radiation is known but the contaminating elements are not identified, a survey of the complete range of energy levels of the particular emanation should be conducted.

In the laboratory an estimate of the energy levels of the radiation suspected is usually obtained from knowledge of the radio-elements present as contaminants. Low-energy beta-radiations and neutrons present special problems. No attempt should be made to measure these radiations with existing survey meters: the monitoring problem should be referred to the Health Physics Branch.

Finally, the intensity of activity must be measured with an instrument sufficiently sensitive to ensure that a lack of radiac indication is evidence that no radiation hazard exists. Fortunately, most survey instruments are comparatively portable and are serviceable for surface monitoring problems. When small instruments are needed, it may be advisable to employ a dosimeter or an allied instrument.

2. OUTLINE OF SUGGESTED INSTRUMENTS

Portable survey instruments are available in the Health Physics Branch. Information and instructions for their operation can be obtained there also. The forms for reporting monitoring data are found in Section II-F.

Alpha Monitoring. . . . . AN/PDR-10 "Poppy"

Beta Monitoring

a. Energies below 0.15 Mev . . . . *- - - -

b. Energies above 0.15 Mev . . . . MX-5 (Beckman)
AN/PDR-8 (Hoffman)
AN/PDR-5 (Victoreen 263)
AN/PDR-7 (IDL 2610)

Gamma Monitoring

a. Energies below 0.25 Mev . . . . Ion chamber

b. Energies above 0.25 Mev

1. Intensities below 2000mr/h . . . .IM-3/PD (Victoreen 247A)
MX-6 (Beckman)
2. Intensities above 2000mr/h AN/PDR-12

Neutron Monitoring . . . . *- - - -

* Should not be attempted with existing survey meters.

3. TYPES, FREQUENCY AND METHODS OF SURVEYS

a. Personnel Surveys

In addition to establishing the information obtained by the Dosimetry Group- - -total body beta-gamma radiation, neutron exposure and special measurements such as finger or wrist exposure- - -it is necessary to measure, record and correct radioactive contamination of the body or clothing.

When procedures have been established, a memorandum will be published for inclusion in this manual.

b. Area Surveys

All laboratories will be monitored every day to measure radiation levels and to detect and measure any contamination of floors, tables and other services.

Beta-gamma monitoring will be done using the Beckman MX-5 or its equivalent. All areas where radiation exceeds 8 mr/h will be roped off with warning signs posted or, if the hazard is permanent, barricades will be installed, permanent signs erected and existing doors locked. Where hazards are very high, a guard should be posted to prevent accidental over-exposure.

Alpha monitoring will be done using a portable, alpha proportional wire counter or its equivalent.

If the radioactive contamination exceeds the limits listed in Section II-B, "Maximum Permissible Levels of Radioactive Contamination", the area will be outlined in red by the monitor. Notice of the levels of activity with recommended decontamination procedures will be given to the operating group assigned to the room or area involved.

Immediate notification of the Health Physics Branch is required if spills of radio-chemicals occur. The spills will be cleaned as soon as possible by the group making the spill. Health Physics may be consulted on the procedures to be used and will furnish monitoring aid.

SECTION I-D

DOSIMETRY

Dosimetry is the measurement of the accumulated exposure of laboratory personnel to external radiation. There are three dose-measuring devices in use at this laboratory: 1) the film badge, 2) the ionization chamber and 3) the direct-reading personnel-protection meter.

1. THE FILM BADGE

Photographic films are sensitive to radiations other than light and have been adopted for detection and radiation dosimetry. Indeed, Roentgen initially became aware of the presence of X-rays through the accidental exposure of a photographic plate in his laboratory. By selecting suitable films and by standardizing developing techniques, the film badge has been developed into the routine method of radiation detection and measurement. The amount of blackening of the film is roughly proportional to the amount of radiation received.

Film badges are worn by all persons working with radioactive material, and by all who enter an area where there is potential exposure to radiation. The film badges have been incorporated into the AEC identification badge which is issued in exchange for the laboratory identification card at the beginning of the working period. The badges must be returned and exchanged for the identification card upon completion of the working day. The badges should be securely attached to an outer garment.

a. Records of films issued.

Eastman Type K film is used in personnel film badges. Type K films are very sensitive to small amounts of radiation and are used for the range of 0.03 to 2.00 r.

These films are numbered in series from 1 to 2,000. They are issued to all personnel working with radioactive materials. A record is kept showing the name and rank, rate or shop number of the person to whom the film is issued and the number of the film.

Films are returned to the Dosimetry Group at the end of each week with the following information: 1) film number, 2) name of wearer, 3) rank, rate or shop number of wearer, 4) place film was worn, 5) number of days film was worn and 6) time film was worn in hours and minutes.

In the record system that is used an individual file card is kept for each person who wears a film badge. The card shows the time, date, and place the film badge was worn and the dosage of radiation in roentgens. At the end of each month each card is totaled and a report is made to the Bureau of Medicine and Surgery of the total time and total exposure of all persons wearing film badges.

b. Developing the films.

With each batch of films processed, an unexposed film, and 12 films exposed to known amounts of radiation are developed. By reading the densities of the 12 calibration films a characteristic curve representing film density versus roentgens is made.

c. Reading the films.

The films are read on a densitometer; the net density of the exposed film is determined by subtracting the density of an unexposed film from the density of the film worn by each individual. The radiation dosage is then read directly from the calibration curve.

2. IONIZATION CHAMBERS

The Victoreen Minometer (Model 287) is a string electrometer and ionization chamber. It provides a daily check of the amount of radiation to which personnel are exposed. Each person in actual contact with radioactive substances carries two ionization chambers which are charged, issued and read daily. The readings of these chambers are recorded daily and at the end of the week the daily readings are totaled. These minometers cannot be read directly, but must be read by a special instrument in the dosimetry office.

3. QUARTZ-FIBER PERSONNEL-PROTECTION METER

The quartz-fiber meter can be read directly by the wearer and it is used to measure the rate at which radiation is received at the time of exposure. These meters are issued by the Dosimetry Group of the Medical Services Branch and should be used when the investigator suspects the possibility of an overexposure to radiation.

SECTION I-E

PROTECTIVE CLOTHING AND PROTECTIVE DEVICES

Radioactivity should always be confined to its source, and laboratory personnel should check the effectiveness of their techniques from time to time. Good techniques will prevent the contamination of work surfaces, and the individual's body and clothing.

1. PROTECTIVE CLOTHING

Protective clothing is either discardable or washable and it is removed before leaving a work area. Protective clothing must be worn in all areas where radioactive materials are handled. Wearing this clothing where food or drink might be served is prohibited.

The amount of protective clothing to be worn may vary from the laboratory coat and rubber gloves worn in the low level laboratories to the complete outfit of socks, shoes, booties, underwear, shirt, pants, jacket, hard hat and gloves worn on radioactive ships. The section chief shall specify the amount and type of protective clothing to be worn in areas under his cognizance, but common sense and caution should guide the individual at all times.

The following clothing is available:

Aprons Rubber gloves	Medical Supply Office, Bldg. 351
Belts Booties Goggles Hard hats Jackets Laboratory coats Pants Rubber boots Sandals Shirts Shoes Shorts Socks Wilson or MSA masks (respirators)	Decontamination Center, Bldg. 507

All laboratory coats, towels, and other launderable materials shall be collected periodically by a designated person from each division and taken to the Decontamination Center through the Clean Entrance of Building 507. These items will be laundered separately from other laundry and will be returned the following day.

Individuals should not launder laboratory coats used in radioactive areas because of the danger of radioactive contamination.

All laboratory personnel are encouraged to make suggestions for additional types of protective clothing or modifications of available clothing for better protection of health. Make all suggestions in writing to the Chief, Health Physics Branch.

2. PROTECTIVE DEVICES

a. Hoods

Hoods, which confine radioactive materials, should have air entering the working opening at a rate of at least 100 feet per minute and preferably not over 200 feet per minute. The lower limit is required to prevent the withdrawal of contaminated air into the room by the movements of the worker's hands. If the upper limit is exceeded, small light articles may be upset by the moving air.

The exhaust air from hoods should be thoroughly filtered to prevent contamination of the duct system and surrounding vicinities. Filters should be installed as near to the hood exit as possible. Filter papers are more efficient than electrostatic precipitators and are less subject to possible breakdown.

The interior surfaces of the hood should be decontaminable; that is, of a nature that will allow cleaning with acid and/or base solutions. The surfaces should be nonporous and resistant to attack by solutions containing radioactivity. In general, stainless steel and plastics are satisfactory for this purpose. An attempt should be made to keep these surfaces flush and as seamless as possible to simplify cleaning them.

b. Dry Boxes

For operations requiring shielding from gamma-emitting substances or amounts of radioactivity that would be hazardous even in the hood described above, closed glove hoods that contain the tools and equipment, exterior controls, shielding and a filtered exhaust sufficient to maintain the dry box at a negative pressure are used. It is always better to confine the radioactive materials to avoid having to decontaminate sizable areas.

Prior to conducting work in dry boxes, laboratory personnel should contact the Health Physics Branch for operating instructions.

SECTION I-F

EATING AND SMOKING RULES

Eating, storing, or preparing food in Building 506 or in other areas where radioactive materials are handled is prohibited.

No food container or utensil of any kind shall be used for storing or handling radiochemicals.

Protective clothing or devices used in connection with radioactive work shall not be taken into any area where food is stored, prepared, dispensed, or eaten.

Smoking shall be controlled by local rules and is prohibited in radioactive areas.

SECTION I-G

RULES FOR RECEIVING, HANDLING AND SHIPPING RADIOACTIVE MATERIAL

The procedures of receiving, handling, and shipping radioactive material involve potentially serious health hazards and are subject to regulation so that no person will be exposed to radiation in excess of 60 mrem per 24 hours. In addition, appropriate measures must be taken to prevent internal radiation hazards resulting from inhalation, ingestion, or absorption of radioactive material as through open lesions.

1. RECEIVING AND HANDLING RADIOISOTOPES

a. Information required by the Health Physics Branch

The following information is required by the Health Physics Branch in order to insure the safe handling and storing of radioisotopes:

(1) Notification of arrival of shipments. The Chemistry Branch will notify Health Physics immediately after a shipment arrives. Health Physics will monitor the shipment externally before approving interim storage. An estimated date of transferral should be submitted by Chemistry as soon as possible after the shipment arrives.

(2) Shipping invoice data. After external monitoring, the shipment invoice shall be removed from the box. Either a copy of the invoice or the following information taken therefrom shall be given to Health Physics:
(a) Identification of isotope, amount present and physical state.
(b) External radiation level.
(c) Unshielded radiation level.

(3) Operation plan. Prior to undertaking any experiments with high-level radioactivity, the user must give adequate assurance to the Health Physics Branch that no health hazard will exist in the use of the radioactivity.

A plan of operation shall be submitted to Health Physics prior to approval of the transferral. The plan should give the following information:
(a) Location of the operation, i.e., laboratory and hood to be used.

(b) Anticipated methods to be used in effecting the transfer.
(c) Anticipated storage containers and space.
(d) Date of operation.

Access to stored radiochemicals will be granted only after satisfactory preparations have been completed. Dry runs will be required in some instances.

b. Services provided by the Health Physics Branch

The following services will be provided by Health Physics:

(1) Monitoring. Shipments will be monitored on arrival. A watch will be maintained during transferral, and the empty containers will be checked for contamination after the isotope is removed. Upon completion of the operation, the laboratory space involved will be thoroughly monitored.

(2) Personnel safety. Hand or finger film badges, respirators, shields, gloves, etc. will be furnished as required.

(3) Determination of expected health hazards. Calculation of the levels of radiation expected, time limits of personnel exposure and minimum distances, will be made on the basis of the shipping invoice data furnished by Chemistry. This information will be given to Chemistry and will be used in determining the adequacy of the "operation plan" from the standpoint of health protection.

(4) Reports. A complete report of each operation will be routed to the Director, the Scientific Director and the Chief of the Chemistry Branch.

2. SHIPPING RADIOISOTOPES

The provisions of Docket No. 3666---Interstate Commerce Commission "In the Matter of Regulations for Transportation of Explosives and Other Dangerous Articles" in amendment of Section 233 of the Criminal Code (Transportation of Explosives Act), and Part II of the Interstate Commerce Act, shall apply for shipping all radioactive materials.

SECTION I-H

DISPOSAL OF RADIOACTIVE WASTE WITHIN THE LABORATORY

The quantities of radioactive isotopes now being used in the laboratory necessitate a uniform procedure for handling and disposing of such materials when they have served the purposes of individuals employing them. This includes all substances with which there is associated significant activity, either in directly usable form or mixed with other materials. It also includes such laboratory residues as may be presumed to be contaminated by contact with radioactive materials in their use, e.g., wipes, wash solutions and discarded precipitates. The procedures are intended 1) to guard against contamination of laboratory spaces and outside shipyard services, 2) to facilitate recovery and utilization of radioisotopes and 3) to dispose of ultimate waste safely.

All laboratories using radioactive materials are furnished special receptacles for discarded material. All radioactive waste must be placed in these receptacles immediately and with minimum movement in the laboratory. A sufficient number of receptacles shall be provided by the Health Physics Branch that they are convenient to each location and individual requiring them. Receptacles are distinctively painted blue and violet and are furnished with a waxed cardboard carton insert for dry material or with a glass bottle for liquids. Separate containers shall be used for dry wastes, for aqueous liquid wastes and for organic liquid wastes. If any material to be discarded is incompatible with these containers special receptacles must be requested. All decomposable or objectionably odoriferous materials, such as animal matter, shall be sealed into pliofilm bags before they are put in the receptacles.

Individual laboratory personnel shall not handle or transfer the material after it has been deposited in the receptacles provided. The receptacles will be collected and replaced by Health Physics monitors who will make transfers outside and away from the laboratories. For the time being collection will be daily.

All contaminated materials and all which may be presumed to be contaminated should be handled as set forth. On the other hand, caution must be observed to minimize the quantity of waste, consistent with ease and efficiency of operation.

All usable radioactive materials will be collected in their normal storage containers when they are no longer required for experimental purposes. Notification should be given to the Chief of the Chemistry Branch.

SECTION I-J

RADIOLOGICAL SAFETY IN CASE OF FIRE

Radioactive substances in the laboratory constitute an added risk to firemen, and the purpose of these rules on fire fighting is to minimize that risk.

1. PERSONNEL PROTECTION

The two principal hazards to persons during fire-fighting are inhalation of radioactive material and exposure to penetrating radiations.

a. Inhalation hazard.

It is not practicable to delay fire-fighting operations until the atmosphere at any given point can be assayed for the presence of radioactive dust. Therefore, during fire-fighting operations each person entering a building in which there are radioactive substances shall wear an RBA type of self-contained oxygen mask, unless otherwise directed by the Health Physics Branch. The RBA mask affords protection against the inhalation of radioactive dust even in heavy concentrations.

The Bullard hose type of mask may also be used at the discretion of the Fire Chief. Both types of gas masks are included as part of the equipment of the Shipyard fire trucks.

b. Radiation hazard.

All persons assisting in fire-fighting in buildings in which there are radioactive materials will wear film badges.

An adequate supply of film badges will be kept in a removable box which will be located adjacent to the bulletin board containing the building plan with colored pins showing the location of radioactive material in the building. These film badges will be kept in frames attached to clasps that may be secured quickly to outer clothing. The film will be checked and replaced periodically by the Dosimetry Group.

The Shipyard Fire Chief will insure compliance with this rule by all personnel working under his direction. After the fire, each film badge will be turned in for evaluation by the Dosimetry Group. The person assigned by the Fire Chief to collect the badges will record the name of each person issued a film badge and this record and the badges will be turned over promptly to the Health Physics Branch.

2. LOCATION OF RADIOACTIVE MATERIAL

In each building in which radioactive materials are maintained, a plan of the building will be posted on a bulletin board just inside the main entrance. This plan will be kept current by the chief of the Health Physics Branch, and by means of colored pins will indicate the location of radioactive material in amounts deemed dangerous by the Health Physics Branch.

The Laboratory Fire Marshal will keep the Shipyard Fire Chief advised of the buildings in which radioactive materials are present. Containers holding radioactive materials will be identified by the regular blue and violet stickers and tags, and in addition, rooms in which relatively high levels of activity are being stored or used will be identified by large cards placed in the windows and on the door. These cards show a blue spot on a white background and will aid firemen in locating areas of high activity quickly.

3. MONITORING

a. During working hours the Chief of the Health Physics Branch will send a representative to the scene of fire in buildings in which there are radioactive materials. This representative will measure radiation intensities and furnish necessary advice to the Shipyard Fire Chief or Officer in Charge at the scene of the fire. Under extreme emergency conditions the maximum permissible dose to individuals will be raised to a total dose of 5 roentgens to be acquired at intensities not exceeding 20 roentgens per hour. This dose will produce no demonstrable effects on personnel.

b. During non-working hours radioactive materials, except in unusual cases, will be secured and the Shipyard Fire Chief or Officer in Charge at the scene of the fire will proceed to fight the fire taking the precautions noted above. The Laboratory Duty Officer will request the Chief of the Health Physics Branch to furnish a representative when the possibility of exposure warrants such action.

c. Immediately after a fire in a building in which there is radioactive material, firemen and other personnel who were in a contaminated area during fire-fighting operations shall report to the Personnel Decontamination Center, where a representative of the Health Physics Branch will receive their film badges, monitor their clothes, and direct personnel decontamination measures if required. Thereafter all gear used in fire-fighting will be monitored and cleared.

d. During other than regular working hours, the Personnel Decontamination Center will be secured. For such cases, firemen and other personnel who were in a contaminated area will shower at the firehouse and effect a complete change of clothing including footgear. The duties of the Health Physics Branch in (c) above will be provided by the Laboratory Duty Officer.

4. FIRST AID

Personnel injured during fire-fighting operations in buildings in which there are radioactive materials will be sent immediately to the Medical Services Branch examination room during working hours, and to the Shipyard Dispensary at other times.

5. SECURITY

When fires occur during non-working hours within the area of NRDL that is protected by the security fence, the Executive Duty Officer will furnish men from the stand-by duty section to act as guards. These men will prevent unauthorized personnel from entering the area until the laboratory guard can secure each gate or opening. Breaks in the fence will be guarded until temporary repairs can be made.

6. FINAL REPORT OF FIRES

The Health Physics Branch will submit a report to the Director of NRDL within one week after a fire.

SECTION I-K

SUMMARY OF RESPONSIBILITIES FOR ENFORCING THE SAFETY RULES AT NRDL

The serious nature of radiological hazards calls for the most scrupulous observance of the safety rules in detail. It is important that every individual in the laboratory realize that his cooperation is absolutely essential to the success of our health physics program.

1. THE INDIVIDUAL

a. Each employee shall prepare a written plan in advance for all operations which, in the opinion of the Branch Chief, may involve a health hazard. The branch chief or designated group leader shall check the plan with the Health Physics Branch prior to its inauguration.

b. All work shall be planned to avoid exposing any personnel to more than 60 mrem per 24 hours. Anticipated exposure above 60 mrem per 24 hours will be permitted only on specific written authorization from the Director or the Scientific Director.

c. All employees shall wear prescribed dosimetric devices, such as film badges.

d. Each employee shall wear special protective devices, such as gloves or respirators, when a need is indicated.

e. It shall be the responsibility of the individual to notify the Health Physics Branch at once, whenever a spill of radioactive materials occurs. Spills shall be cleaned up by the personnel responsible for the contamination. The Health Physics Branch will provide advice on decontamination, and will monitor the area.

2. THE GROUP LEADER

a. The group leader shall insure that the members of his group be instructed in the responsibilities given above.

b. It shall be the responsibility of the group leader to inform all visitors to his area of any special requirements for the protection of health and to enforce them.

3. THE BRANCH CHIEF

It is the responsibility of the Branch Chief to enforce the radiological safety regulations among his personnel.

4. THE HEALTH PHYSICIST

a. All laboratories will be monitored on a periodic basis. The frequency and type of monitoring will be determined by the Chief of the Health Physics Branch, based on a discussion of operations with the congnizant Branch Chief. Monitoring reports will be routed daily to the Director and the Scientific Director. Copies of reports will be sent to the Branch Chiefs involved.

b. The health physicist will report bad practices or dangerous situations found in any laboratory to the Chief of the Branch involved. If agreement on correction of the condition cannot be reached, the problem will be resolved by consultation with the Chief of the Health Physics Branch. A written report will be submitted in all cases to the Scientific Director, describing the condition, the recommended corrective measures, and the end results.

c. The health physicist will be available for consultation on radiation problems at any time. It is necessary, however, that advance notice be given on problems when it is possible to do so.

5. THE SECURITY GUARD

The security guard shall restrict admittance to Building 506 to personnel wearing film badges. Pencil dosimeters will also be worn by individuals who expect to enter an area where there is danger of radiation exposure.

SECTION I-L

ACCIDENTS

1. ALL ACCIDENTS SHALL BE REPORTED TO THE SHIPYARD DISPENSARY AT ONCE.

This rule covers (a) accidental overexposure to external radiation, (b) ingestion or inhalation of radioactive material and (c) wounds. All wounds, no matter how minor, must be reported immediately to the dispensary.

First aid procedures and treatment are detailed in Section II-G.

2. RESPONSIBILITY OF PHYSICIANS AT NRDL.

a. The Radiological Health Officer's position is one of prevention, not treatment.

b. Other physicians are assigned to NRDL in research capacities, and are not authroized to treat personnel beyond emergency first-aid measures. They are not authroized to minister acute or chronic treatment to laboratory personnel and must not treat non-occupational diseases.

c. The responsibility for treating all shipyard personnel involved in accidents within the yard lies with the Shipyard Medical Officer and the Dispensary. The Dispensary maintains full facilities for medical treatment, whereas NRDL has none. The records kept by the Dispensary are necessary for safeguarding employees rights in medical-legal situations involving compensation. Follow-up records in all cases of radiation damage will be maintained by the Dispensary; no facilities for the maintenance of such records are established at NRDL.

3. ASSISTANCE GIVEN THE DISPENSARY BY NRDL.

a. The physicians assigned to NRDL are at all times available to the Dispensary in a consultant capacity in problems involving overexposure to external or internal radiation. The RHO will normally act as consultant on such problems, but he may call upon any or all the physicians at NRDL for this purpose.

b. The facilities of the Medical Services Branch for analysis of body tissues, fluids and excretions for active material will at all times be available to the Dispensary by previous arrangement with the RHO.

4. RESPONSIBILITY OF THE RHO IN ACCIDENT CASES.

a. If radiation is not involved, the RHO has no responsibility.

b. If radiation is involved in any fashion, the RHO will initiate an investigation and prepare a complete case report for the Laboratory Director, including the following:

1) Readings of dosimetry devices worn by or placed near the person at the time he was injured.

2) The report of the Health Physics Branch prepared at the request of the RHO. This report will establish the cause of inadvertent exposure and will indicate evidence of carelessness, defective shielding, or defective technique.

3) A complete medical report from the Dispensary.

c. The RHO may call a meeting of the Radiological Safety Committee, and, in specific cases, may ask that additional members sit on the board. The Committee will review the case and may recommend that the Laboratory Director:

1) Take no action other than corrective measures to assure that the accident is not repeated.

2) Change the individual's job within the laboratory.

3) Authorize him to take an extended leave from the laboratory.

4) Release the individual from the laboratory.

SECTION II-A

DEFINITIONS OF UNITS

CURIE. The curie (c) represents the amount of radon (radium emanation) in radioactive equilibrium with one gram of radium. It equals 6.51×10^{-6} grams and occupies 0.66 cubic millimeters at S.T.P. A substance has an activity of one curie when 3.7×10^{10} atoms disintegrate each second. (Some authorities prefer to reserve the curie for radium and its disintegration products.)

1 c $= 10^3$ millicuries $= 10^6$ microcuries $= 10^{12}$ micro-microcuries

M.A.C. Maximum allowable concentrations (M.A.C.), frequently called tolerances, represent the maxiumum concentrations of radioactive substances permissible in air, water or food. They are subject to revision upward or downward as more knowledge is gained.

NEUTRON UNIT. One neutron (n) is the quantity of fast neutrons that produces ionization in the Victoreen 100 r thimble chamber equal to 1 esu/cc of dry air at S.T.P. Neutrons give their energy to recoil protons which ionize heavily over a short path, whereas X- and gamma photons produce less effective recoil electrons.

1 n $=$ 2.5 rep = 200 ergs/gram of tissue.

ROENTGEN. The roentgen (r) is a unit of photon energy dissipation in an arbitrary material air. It is defined as "that quantity of X- or gamma radiation such that the associated corpuscular emission per 0.001293 gram of air at S.T.P. produces, in air, ions carrying 1 esu of quantity of electricity of either sign". This unit applies only for X- or gamma radiation in air. Note that the r is a cumulative unit; it does not define a rate.

1 r $=$ 83.8 ergs/gram of air at S.T.P.
$=$ 1 esu/cc of air at S.T.P.
$= 2.083 \times 10^9$ ion pairs/cc of air at S.T.P.
$= 1.61 \times 10^{12}$ ion pairs/gram of air at S.T.P.
$= 6.77 \times 10^4$ Mev/cc of air at S.T.P.

ROENTGEN EQUIVALENT MAN. The roentgen-equivalent-man (rem) is the estimated amount of energy dissipated in tissue, which is biologically equivalent in man to one roentgen of X- or gamma radiation.
1 rem $=$ (83/RBE)(ergs/gm tissue) where RBE is the relative biological effectiveness. The secondary ionization produced by fast neutrons is much more effective than the same amount of energy absorbed from the secondary elections produced by gamma rays. So that:

1 rem $\approx$ 0.2 rep (for fast neutrons)
$\approx$ 0.1 n (for fast neutrons)

ROENTGEN EQUIVALENT PHYSICAL. The roentgen equivalent physical (rep) is that quantity of corpuscular radiation which produces ionization per gram of tissue equivalent to the ionization produced by one roentgen of X- or gamma radiation in air. The rep is applicable to beta particles, protons, deuterons, alpha particles and neutrons. The rep is equal to the r only for dry air at S.T.P.

1 rep = 83.8 ergs/gram of tissue

ROENTGEN PER HOUR AT ONE METER. The roentgen per hour at one meter (rhm) is the quantity of any radioactive substance which emits X- or gamma radiation such that the ionization produced in air by the radiation at a distance of one meter from the source is one roentgen per hour. This unit fixes the "amount" of any radioactive substance which emits gamma or X-radiation whether or not the disintegration scheme is known.

RUTHERFORD. The rutherford (rd) has been proposed as a unit of the amount of any active substance except members of the radium series (for which the curie applies). One rutherford equals 10^6 disintegrations per second.

1 rd $= (10^6/3.7 \times 10^{10})$ curie $= 2.7 \times 10^{-5}$ curie of Ra, Rn, etc.

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SECTION II-B

MAXIMUM PERMISSABLE LEVELS OF RADIOACTIVE CONTAMINATION

MEASUREMENT	INSTRUMENT USED*	MAXIMUM LEVELS
Table tops, floors, etc., exposed to handling	Poppy	2000 disintegrations per minute of alpha from an area of 150 cm^2.
	Beckman MX-5	300 counts per minute with counter in contact approx. 0.1 mr/h at counter.
Table tops, floors, etc., protected from handling	Poppy	10,000 disintegrations per minute of alpha from an area of 150 cm^2.
Inside intermittently used hood	Poppy	30,000 disintegrations per minute of alpha from an area of 150 cm^2. A hood containing greater than 1 microgram of plutonium or isotopes of similar hazard should be marked "High Level Hood".
Smear tests on table tops, floors, apparatus	2 sq. in. filter paper smeared over approx. 12 sq. in. and counted with beta-gamma and alpha counters	0 disintegrations per minute of alpha. 200 counts per minute of beta and gamma.
Boxes for shipment by air or rail	Smear tests	0 disintegrations per minute of alpha. 200 counts per minute of beta and gamma.
	Electroscope	Less than 15 mr/h at the surface of package for air shipments and less than 50 mr/h for rail shipments. Less than 10 mr/h at 1 meter from package surface of all shipments.

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MEASUREMENT	INSTRUMENT USED	MAXIMUM LEVELS
Truck shipments	Electroscope	Requirements same as for rail shipment and in addition less than 30 mr/h at rear wheels of truck and less than 60 mr/day in cab for trip.
All laboratory and operation areas	Electroscope, CP meters, etc.	All areas with radiation greater than 8 mr/h shall be roped off and have signs posted.

* Instructions for operating these instruments can be obtained from the monitors in the Health Physics Section.

SECTION II-C

FORMS FOR REPORTING MONITORING DATA

On succeeding pages the forms are shown for reporting:

1) Monitoring of Surfaces
2) Monitoring of Air Samples

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NAVAL RADIATION LABORATORY

NR-HP-1
6 April 1948

MONITORING REPORT

Date: ____________________

Object To Be Monitored: ______________________________
(Identify Completely)

____

Where Object May Be Monitored: ______________________________

Desired Completion Date: ______________________________

Request Made By: ______________________________

Report to Be Sent to: ______________________________

Signed: ____________________

FOR LABORATORY USE ONLY

Report No: __________ Final: __________ Preliminary: __________ Date: __________

Serial No. and Type of Beta Gamma Instrument: ______________________________

Beta Count: __________ Gamma Count: __________ Distance From Surface: __________

____

Beta Gamma Count: __________ Distances From Surface: __________

Serial No. and Type of Alpha Instrument: ______________________________

Alpha Count: __________ Distance From Surface: __________

Decontamination Procedure: ______________________________

____

____

Final Beta Count: __________ Final Gamma Count: __________

Distance From Surface: ______________________________

Final Beta Gamma Count: __________ Distance From Surface: __________

Final Alpha Count: __________ Distance From Surface: __________

Remarks: ______________________________

____

Monitor: ____________________

Approved: ____________________

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NR-HP-2
8 April 1948

AIR ANALYSIS FOR RADIOACTIVITY

Sample No.: ______________ Date: ______________

Sample Location: ______________
(Identify Completely)

____

Operations: ______________
(Present or Recent)

____

Exact Analysis Desired: ______________

Analysis Requested By: ______________ Report to be Sent to: ______________

Ser. No. and Type of Sampling Instrument: ______________

Sampling Rate: ______________ Start: ______________ Finish: ______________

Weather: ______________

Signed: ______________

FOR LABORATORY USE ONLY

Date Received: ______________ Date Completed: ______________

Serial No. and Type of Alpha Instrument: ______________ SAN BRUNO FRC

Serial No. and Type of Beta Gamma Instrument: ______________

Component	Immediate T =	~Six Hours T =	~24 Hours T =
Alpha			
Beta-Gamma			

Radon Components: (μC/cc of air): ______ α: ______ β-γ

Thoron Components (μC/cc of air): ______ α: ______ β-γ

Long Live Components (μC/cc of air): ______ α: ______ β-γ

Remarks: ______________

____

Approved: ______________ Analyst: ______________

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SECTION II-D

PROCEDURES FOR WASHING CONTAMINATED HANDS

1. GENERAL PROCEDURES

a. Wash thoroughly for two to three minutes by the clock with a teaspoonful of a lanolin and corn meal hand cleaner, using a sufficient amount of tepid (not hot) water to maintain a thin paste, and rub the paste over the entire surface of the hands and fingers.

b. Rinse off completely with water and repeat the process at least three times.

c. If the above procedure is not enough to remove all the dirt and contamination, the hands should then be scrubbed for a period of at least eight (8) minutes by the clock with a liquid or cake soap, a hand brush, and tepid water, being sure to brush the entire surface of the hands, especially around the nails and between the fingers. Light pressure should be exerted on the brush---do not press so hard that the bristles are bent out of shape.

d. Eight minutes is usually sufficient time to allow three complete changes of tepid water and soap.

e. Each one of these three washings should be so thorough that the brush will cover all areas a minimum of four strokes. A convenient routine is to start by scrubbing one thumb, being sure to brush all surfaces, proceed to the space between the thumb and index finger and similarly to each finger and the webs between the fingers.

f. Attention should be given to cleaning the palm and back of the hand and finally to scrubbing the nails and cuticles again before proceeding in the same manner with the other hand.

g. Lanolin or lanolin-containing hand creams may be used after washing to soften the hands and prevent chapping.

2. REMOVING FISSION PRODUCTS OR PLUTONIUM

a. Rinse the hands thoroughly in 24% sodium citrate or sodium tartrate solution.

b. Rub a saturated solution of potassium permanganate thoroughly but briefly over the hands, rinse in water, and remove the residual stain with a freshly prepared 5% solution of sodium acid sulphite ($NaHSO_3$).

c. Acid washes are recommended only as a last resort, and should be used under the supervision of the Medical Service Branch.

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SECTION II-E

PROCEDURES FOR DECONTAMINATING WORKING AREAS AND EQUIPMENT

1. DECONTAMINATION OF SURFACES

Painting surfaces, especially porous materials, is essential for quick and easy decontamination of hot areas. The workers must have ample protection from dust, active materials, acids, etc., and precautions must be taken to prevent spreading the activity beyond the hot area.

The workers need heavy rubber gloves, safety glasses, dust masks, hats, special shoes, booties and coveralls. This special clothing must always be removed when leaving the hot area. For small areas with small amounts of activity the amount of protection that the workers need is decided by the person in charge.

Waste disposal cans must be on hand before starting the "cleanup". The cleaning is generally done with heavy rags, or wads of cheese cloth; they should not be so wet as to slosh and splash the cleaning solutions. Large dusty areas must be vacuumed first.

It may be necessary to try three or four different cleaning solutions, depending on the material spilled and the surface contaminated. On painted surfaces carbon tetrachloride should be the first cleaner tried; if ineffective, a solution of 10% hydrochloric acid is usually strong enough to remove the activities; strong trisodium-phosphate soap solution is occasionally effective because it removes the top surface of paint. Adequate ventilation is required when organic solvents are used. Three operations are needed, first washing the area with rags wet with the cleaning solution, then removing the solution with a clean dry cloth, finally rinsing with water.

Plutonium contamination can often be removed with sulfuric-acid-dichromate cleaning solution, but this should be handled only by an experienced chemist.

Metal surfaces can usually be treated just as painted surfaces are cleaned; stainless steel can even be treated with 6N hydrochloric acid if necessary, but special ventilation will be needed.

Linoleum and pastics can be cleaned using either carbon tetrachloride or kerosene, followed by washing with strong soap solution.

Porous surfaces, like unpainted wood, concrete and transite are difficult to clean. Repeated washing with a mixture of hydrochloric acid and citric acid is sometimes effective; if not, the material must be dug away; wood can be planed or scraped if not highly contaminated. These surfaces must then be painted and covered with linoleum before the areas are used again.

2. DECONTAMINATION OF EQUIPMENT

Equipment that is subject to contamination should be small and fabricated of glass or stainless steel. When simple pieces of equipment are grossly contaminated, it is sometimes cheaper to discard them than to decontaminate them.

a. Decontaminating solutions.

(1) For glass:

(a) A solution containing 3.5% hydrochloric acid and 10% citric acid.
(b) Chemical Cleaning Solution (Saturated potassium dichromate in concentrated sulfuric acid). Avoid spattering this solution because the chromic acid formed is extremely corrosive.

(2) For stainless steel:

(a) A solution of citric acid, 10% of weight.
(b) A solution of 8N nitric acid.

b. Procedure for glass equipment.

The following stepwise procedures are applicable to small pieces of glass equipment, that is, up to approximately three liter capacity. For larger equipment use the techniques described in the section on surfaces.

(1) Survey all equipment to be decontaminated and divide according to levels of contamination.

(2) Place the lowest level of contaminated equipment in a vessel large enough to cover the equipment with the citric-acid-hydrochloric-acid mixture. Do not mix grossly contaminated equipment with relatively clean material.

(3) Allow equipment to stand for one hour.

(4) Transfer to a similar container filled with water; rinse equipment thoroughly.

(5) Dip equipment in the chromic acid solution and allow 15 minutes contact.

(6) Rinse with tap water and distilled water, dry and monitor.

(7) If monitoring indicates the equipment is still contaminated, recirculate the solutions. For equipment that is to be resubjected to contamination, choose an appropriate working level for your decontamination work that is well within the health levels.

(8) After each set of hot equipment has been cleaned, assay the decontaminating solution for radioactivity and discard if it is radioactive enough to be a health hazard or a serious source of contamination in subsequent cleanings. See Section I-H for the method of disposing of the solution.

c. Procedure for stainless steel.

(1) Monitor the equipment.

(2) Divide equipment according to levels of activity.

(3) Place stainless steel equipment of lowest activity in a citric acid bath and allow to soak one hour.

(4) Transfer to a container filled with water; rinse equipment thoroughly.

(5) Place equipment in 8N nitric acid and let soak for two hours.

(6) Wash with tap water and distilled water.

(7) Dry equipment and survey.

(8) Repeat procedure as necessary.

(9) After each set of hot equipment has been cleaned, assay the decontaminating solution for radioactivity and discard if it is radioactive enough to be a health hazard or a serious source of contamination in subsequent cleanings. See Section I-H for the method of disposing of contaminated solutions.

SECTION II-F

SURGICAL TECHNIQUE IN THE USE OF RUBBER GLOVES

Surgical rubber gloves, used during procedures in which hand contamination is probable, should be prepared in advance by powdering the inside and by folding out the wrist portion of the gloves to form a cuff of about two inches.

To put on the gloves, the following procedure is advised:

1. Powder the hands well with talc.

2. Grasp the first glove at the folded cuff without touching the exterior of the glove, and pull it onto the fingers and hand, leaving the cuff in the folded position.

3. Lift the second glove by inserting the fingers of the gloved hand beneath the cuff, and pull it onto the bare fingers and hand.

4. Then turn the cuffs of both gloves back over the wrists, without touching the bare skin.

5. Finally, work the loose fitting glove fingers into position as you would cloth gloves.

To remove the gloves, reverse the procedure.

1. With the fingers of one gloved hand grasp the beaded rim of the glove on the other hand without touching the skin or the inside of the glove. As you pull the glove off, it turns inside out.

2. Now insert the index finger of the bared hand beneath the rim of the other glove and, without contacting the exterior surface of the glove, invert it and pull it off the hand.

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SECTION II-G

FIRST AID AND TREATMENT FOLLOWING ACCIDENTS

(This section will be issued at a later date.)

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SECTION II-H

MEDICAL SERVICE BRANCH

1. RADIOLOGICAL HEALTH OFFICER IN CHARGE

The Medical Service Branch is supervised by a Naval Medical Officer who is designated as the Radiological Health Officer. He is responsible for the health of all civilian and military personnel at the Naval Radiological Defense Laboratory from the radiological standpoint. He formulates and executes such health protective measures as he may deem necessary to prevent overexposure from ionizing radiations. He initiates and performs such physical examinations and clinical laboratory procedures as may be necessary to adequately detect and observe possible radiation damage which may occur in personnel employed in this laboratory. He at all times works in close liaison with the Health Physics Group and informs the Director of the laboratory regarding unusual radiological hazards and overexposure of laboratory personnel. The Radiological Health Officer maintains supervision of the Clinical Radiochemistry and Dosimetry laboratories. He is chairman of the Radiological Safety Committee, and has specific responsibility for the complete investigation of any overexposure of personnel to ionizing rays. (See Section I-L for details.)

2. FACILITIES MAINTAINED

a. Physical examinations.

Suitable quarters will be maintained to conduct complete physical examinations.

b. Routing laboratory procedures.

A clinical laboratory will be equipped and maintained to perform laboratory examinations on blood and urine.

c. Radioactivity analysis.

A clinical radiochemistry laboratory will be equipped and maintained to perform radio-chemical analysis on urine, feces, and other excretions as well as on tissue samples.

3. REASONS FOR INITIAL AND PERIODIC EXAMINATIONS

The purpose of conducting special radiological physical examinations is to provide greater protection for the employees of the Naval Radiological Defense Laboratory. Futhermore, these examinations may prove to be of inestimable value to both the individual and the Laboratory should medico-legal actions be warranted. The follow-up examinations will be of mutual benefit to the individual and to the medical profession.

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4. EXAMINATIONS

a. Initial physical examination.

An initial physical examination will be conducted on all personnel prior to employment by the laboratory. This examination will serve a two-fold purpose. First, it will disqualify those individuals from employment in the Naval Radiological Defense Laboratory who are physically and psychologically unfit for the tasks for which they are to be hired. Second, these examinations will serve as a "Base-line" for the evaluation of any changes which may be noted on subsequent examinations. The examination will include a complete physical, complete blood count, a sedimentation rate, urinalysis, and chest X-ray. The X-ray of the chest may be made by any available technique including 35mm micro-film; however, whenever an individual has a history of relatively prolonged and/or high intensity of exposure to ionizing radiations, X-ray examination of the chest will be made with 14 in. by 17 in. film. A record of finger prints of all fingers will be made. Criteria for qualifications and special methods of recording will be in accordance with succeeding paragraphs.

b. Physical requirements.

Because of the diversified types of employment at the Naval Radiological Defense Laboratory, no detailed blanket qualifications can be established. It will be necessary that the Radiological Health Officer will determine whether an individual is physically qualified for his particular job. In general, those who are qualified under civil service requirements for their particular job classification will be qualified to work at the Naval Radiological Defense Laboratory. A morbid fear of radiation is sufficient to disqualify. The following findings may be considered disqualifying for work entailing possible exposure to ionizing radiation:

(1) Skin and integument.

All open wounds, whether cuts, abrasions, ulcerations, or inflammations, until healed. All conditions in which there are open or raw surfaces or external roughened areas in which foreign bodies may be deposited or which the examiner believes may be aggravated by irradiation. Excess longitudinal corrugation and brittleness of the nails. Atropic skin conditions. Severe chronic blepharitis.

(2) Eyes, ears, nose, and throat.

Any severe infection, acute or chronic, of the eyes, ears, nose, or throat. Markedly enlarged tonsils. Allergic conditions of the nose or nasal sinuses, if active under working conditions.

(3) Mouth.

Pyorrhea, or extensive pocketing of gums. Severe dental caries. Severe gingivitis or stomatitis. Any open lesions. Precancerous lesions, including leucoplakia.

(4) Respiratory system.

Any acute or chronic infection. Acute exacerbations of respiratory allergies.

(5) Cardiovascular and blood systems.

Total white count below 4,000 or above 12,000. (In cases where abnormal white cell count may be due to transient diseases or other conditions, re-examination should be made upon recovery.) Persistently abnormal differential count. Total red blood count below 3.5 million or above 6.4 million. Sedimentation rate persistently above 15mm/hr. (Cutler or Wintrobe).

(6) Genito-urinary system.

Any acute or chronic urinary tract disease. Any persistently abnormal urinalysis.

(7) General.

Any pre-cancerous disease. Changes in finger prints, indicative of atrophy.

(8) X-ray findings.

Evidence of active infectious process or of bronchiectasis. Evidence of changes secondary to respiratory allergies. Evidence of intra-thoracic neoplasms.

c. Routine periodic examinations.

All personnel working at the Naval Radiological Defense Laboratory will have a complete physical examination yearly. This will be similar to the initial examination and will be recorded in the same manner. Personnel working in radioactive areas will be required to have more frequent examinations; and, if an internal hazard is present, periodic radiochemical analysis of the urine (and feces, if indicated) must be done. The frequency of any or all of these examinations will be determined by the Radiological Health Officer and will be dependent on the type and degree of exposure of the individual. A chart of the nature and minimum frequency of examinations is given below.

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FREQUENCY OF RADIOLOGICAL PHYSICAL AND CLINICAL EXAMINATIONS

	Physical examination	Blood work	Radiochemical Urinalysis (fecal if indicated)
I. No radiation hazard.	Yearly	Yearly	Not required
II. Work with external radiation hazard only.			
(a) No overexposures recorded	Yearly	6 month intervals	Not required unless possible indirect exposure to internal hazard - then once yearly.
(b) Overexposure	6 month intervals (minimum) More frequent at discretion of the Medical Officer	3 month intervals for 6 months if all counts normal. More often if excessive exposure or abnormal counts.	Not required unless possible indirect exposure to internal hazard - then once yearly.
III. Internal hazard. (if overexposure to external hazard following will be modified by Medical Officer)			
(a) Microcurie level isotope activity	6 month intervals (minimum)	3 month intervals more often if abnormal counts or abnormal radiochemical urinalysis	3 month intervals
(b) Millicurie level isotope activity or any work with plutonium	6 month intervals (minimum)	1 month intervals more often if abnormal counts or abnormal radiochemical urinalysis	1 month intervals
(c) Greater than millicurie level isotope activity	6 month intervals (minimum)	1 month intervals (minimum) More frequent at the discretion of Medical Officer	Bi-weekly (minimum) More frequent at discretion of Medical Officer

Note: Any sudden overexposures of personnel accidentally or otherwise (as due to a spill of radioactive materials) will require immediate physical and clinical checks with follow-up examinations as indicated.

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5. RECORDS AND REPORTS

a. Medical service office.

(1) Recording of examination.

The results of the physical laboratory examinations will be recorded as follows: the physical examination and laboratory date on the Standard Forms 88 and 89, the chest X-ray report and fingerprints record on NavMed Form 57. Each fingerprint will be labelled. All forms will be prepared in duplicate. A statement will be entered under "remarks" on each Standard Form 89, giving the known total previous exposure to radiation and the type of work being performed. The original copies of all papers for each person examined will be firmly fastened together and will be forwarded to the Atomic Defense Division, Code 74, Bureau of Medicine and Surgery. The X-ray film will be retained at the Shipyard Dispensary and kept in a permanent file. The duplicate of each examination will likewise be securely fastened and filed at the Office of the Medical Service Branch of this laboratory. For Army personnel attached to the activity one additional copy of the completed examination will be prepared and forwarded to the Atomic Defense Division, Code 74. Civilian personnel records and Navy personnel records will be handled in the same manner. In the case of military service personnel, a statement that a special radiation examination was given shall be entered in the corresponding person's health record, with the date of the examination. An abstract of the examination will be entered in the special Radiation Abstract of the Health Record. These abstracts are to remain in each Health Record for the duration of service of all personnel involved.

(2) Daily log.

A daily log will be kept of all examinations performed, giving name of individual examined and the purpose of examination.

(3) Individual file card.

An individual file card will be kept on each employee giving dates of initial and follow-up examinations. These cards, when arranged in proper order, will facilitate the scheduling of the routine recheck examinations.

b. Dosimetry office.

(1) Log book.

A log book will be kept numerically of the film badges issued, to whom issued, the densitometer readings and interpretations of each. These interpretations of dosages received will be cross filed alphabetically according to names of personnel. These cards will be a permanent record of the accumulated radiation each employee receives.

(2) Monthly report.

A monthly report of the accumulated film badge exposures of employees will be prepared and forwarded to Atomic Defense Division, Code 74, Bureau of Medicine and Surgery.

(3) Weekly report.

A weekly report of the pocket ionization chamber readings will be prepared and sent to the BuMed Projects Officer. This report will include the number of chambers read, the number of chambers which read in excess of 60 mr, the number of pairs of chambers in excess of 60 mr, and the number of pairs of chambers in excess of 60 mr,substantiated by film badge reading above 60 mr.

(4) Other reports.

Adequate records will be kept of the progress of miscellaneous functions such as the shipment of films to other activities; development and interpretation of films from other activities, preparation of pre-exposed films to known sources of radiation and training film ladders.

c. Clinical radiochemistry.

A work book will be maintained in which all specimen data is recorded. An individual card will be kept on each employee working with radioactive material for the purpose of recording results of radiochemical analyses of urine and feces. Any abnormal sample will be reported by a special memorandum to the Radiological Health Officer and to the Chief of the Health Physics Branch.

d. Monthly radiological safety reports to the Bureau of Medicine and Surgery.

(1) Monthly report of Medical Service functions.

(a) Radiological Safety

Number of initial, recheck, and termination physical examinations completed during the month, and report of inspections of all radiological facilities where radioactive contamination might be present, conducted from the standpoint of radiation hazards and sanitary conditions.

(b) Dosimetry

Number of film badges processed, number of pocket ionization chambers read and recharged, number of films exposed for emulsion calibration, and number of film shipments and number of films shipped to other naval activities.

(c) Clinical radiochemistry

Number of radiochemical analyses of urine and feces done during the month and the findings from those examinations.

(2) Monthly photodosimetry report.

This report shall give the name, rate or rank, total number of days and hours exposed, and the total amounts of radiation received.