UNIVERSITY OF LOUISIANA Lafayette

RADIATION SAFETY & OPERATIONS MANUAL

Revised June 7, 2007

I. INTRODUCTION

The University of Louisiana at Lafayette (UL Lafayette) is authorized to utilize radioactive materials and operate various sources of radiation under Louisiana license LA-1794-LO1 and Registration LA-1794-ROO. The authorizations are issued and regulated by Louisiana Office of Air Quality and Radiation Protection, Radiation Protection Division (LAQRP-RP). The university's license is one of broad scope (Louisiana Radiation Regulations, Section 327 designed to provide the greatest possible flexibility in the exercise of the research mission of the university. Under the license, the university has the responsibility to establish administrative controls and provisions relating to procedures, record keeping and accounting and management review that are necessary to assure safe operation, including:

The appointment of a radiation safety officer;

The establishment of a radiation safety committee at UL Lafayette;

Control of movement and use of radioactive materials; and

Administrative procedures for:

The control of procurement and use of radioactive material;

Completion of safety evaluation concerning adequacy of facilities and equipment, training and experience of users, and of operating and handling procedures; and

Review approval and recording by the University Radiation Safety Committee (RS Committee) of all safety evaluation.

This Radiation Safety and Operations Manual has been prepared by the University Radiation Safety Committee so that all users of radioactive materials and radiation sources can be familiar with the rules and regulations under which they operate. If any inadvertent conflicts occur between the guidelines set forth here and the Louisiana Radiation Regulations, the latter will obviously prevail. By their nature the guidelines set forth in this manual seem to be restrictive. It is hoped rather that they will be enabling of a safe as well as flourishing, active program of research.

The University Radiation Safety Committee stands ready to assist and support faculty, staff and students; they but need to ask.

The University of Louisiana at Lafayette

ALARA PROGRAM

The following conditions describe the program followed by to ensure that occupational radiation exposures to employees at the University of Louisiana at Lafayette (UL Lafayette) engaged in the use of radioactive equipment are kept as low as reasonably achievable.

1. UL LAFAYETTE ADMINISTRATION COMMITMENT

UL LAFAYETTE IS COMMITTED TO MAKE EVERY REASONABLE EFFORT TO MINIMIZE RADIATION EXPOSURES TO EMPLOYEES, THROUGH THE FOLLOWING CONTROL MEASURES:

a. Personnel will be made aware of the UL Lafayette administration's commitment to maintain low exposure levels.

b. The UL Lafayette administration will periodically review operating procedures with radiation safety officer to determine steps taken to reduce exposures.

c. The UL Lafayette administration will ensure that the person, or persons, selected for Radiation Safety Officer responsibilities are fully qualified to administer all aspects of a radiation protection program.

d. The UL Lafayette administration will ensure that all employees engaged in the use of radioactive equipment are fully trained in the area of radiation safety. This will be reviewed at least once per year, and additional training will be scheduled as necessary.

e. The RSO has full authority to enforce safe operation, and to communicate as required with appropriate levels of management to halt an operation he deems unsafe.

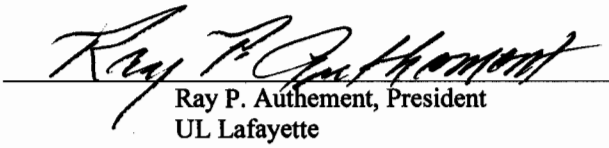
2. VIGILANCE BY THE RSO AND RADIATION SAFETY COMMITTEE

The UL Lafayette Radiation Safety Officer (RSO) has the responsibility to monitor the Radiation Safety Program to ensure that exposures are as low as reasonably achievable, and to search for new and better ways to perform jobs with less exposure. The following aspects apply to this responsibility:

a. The RSO shall know the origins of radiation exposure and be aware of trends in exposures.

b. Should unusual exposures occur, the RSO shall initiate an investigation of the circumstances to determine causes and prevent the likelihood of recurrence. Operating procedures should periodically be reviewed to identify situations in which exposures can be reduced.

c. The RSO shall be responsible for ensuring that the equipment used is maintained in good working order and used properly. Written procedures for use of the equipment are to be available and followed.

SIGNED: 

Ray P. Authement, President
UL Lafayette

II. ORGANIZATION

The University of Louisiana at Lafayette has established an administrative structure to provide for the smooth and efficient managements of research and leading programs, which utilize radioactive material or sources of radiation.

A. RADIATION SAFETY OFFICER AND UNIVERSITY RADIATION SAFETY COMMITTEE

The university Radiation Safety Officer, the members of the Radiation Safety Committee (RS Committee), and the Chair of the RS Committee are appointed by the Vice President for Research and Graduate Studies (VP Research). The RS Committee membership will consist of the UL Lafayette Environmental Health and Safety Director (ex-officio) and faculty members from various scientific departments on campus who possess the requisite expertise. All matters pertaining to radiation programs at the university shall be addressed to the RS Committee Chairman and the Radiation Safety Officer.

The RS Committee has the overall responsibility to see that the university programs are carried out in accord with the Louisiana Department of Environmental Quality, Environmental Regulatory Code Title 33, Part LV, Radiation Protection (LA DEQ XV).

The RS Committee will have the following functions:

1. To coordinate activities of various departments in the area of radiation research and teaching.

2. To provide necessary input for the periodic review of the program.

3. To provide consultation and service necessary to ensure the proper and safe use of radiation facilities in compliance with State and Federal regulations.

4. To review university policies on the use of radiation and make appropriate recommendations.

5. To set necessary rules and policies within he university for the proper and safe use of radioisotopes/ionizing radiation producing devices so as to ensure that the procedures followed are in compliance with the Louisiana Department of Environmental Quality, Environmental Regulatory Code Title 33, Part LV, Radiation Protection (LA DEQ XV).

6. To review and approve all proposals for the use of radioisotopes/ionizing radiation producing devices at the university.

7. To review and approve plans for all new laboratories and buildings and modification of existing structures where ionizing radiation are to be used and make recommendations.

8. To prescribe special conditions that will be required during a proposed use of by-product material, such as requirements for bioassays and physical examinations of users, minimum level of training and experience of users.

9. To prepare and disseminate information pertaining to radiation safety.

10. To formulate and review the institutional training programs for the safe use of radioisotopes.

11. To supervise the receipt of all radioactive materials/radiation producing devices coming to the university.

12. To administer a radioactive waste disposal program.

13. Consult and support Users/Principal Investigators in the conduct of the day-to-day radiation safety program, including appropriate surveys and maintenance of records.

14. To receive and review records and reports from Users/Principal Investigators.

15. To maintain all centralized records pertaining to the radiation safety program.

16. To review all instances of alleged infractions of the use of radioisotopes/ionizing radiation safety rules and to take the necessary steps to correct such infractions with the assistance and concurrence of the person(s) department chairperson/division director. The RS Committee may, by majority vote of a quorum attending, restrict or suspend the operations of a user. Such decisions are subject to the rules of due process.

17. To suspend any operation causing excessive radiation hazard or not in compliance with LA DEQ XV as rapidly and safely as possible. In carrying out this duty the Radiation Safety Officer will report directly to the VP Research.

B. PRINCIPAL INVESTIGATOR (USER) APPROVED BY THE UNIVERSITY RADIATION SAFETY COMMITTEE

The Principal Investigator (User) is ultimately responsible for the safety of his/her lab and all personnel assisting in the course of his/her research as well as all appropriate monitoring and record keeping as required herein. Specifically, the principal investigator shall be responsible for:

1. Adherence to the user regulations and the safe use of radioactive materials and ionizing radiations by himself/herself and those under his/her direction as well as making available a copy of this manual for laboratory personnel use.

2. Providing proper dosimetry for monitoring of laboratory personnel.

3. Providing for proper survey instruments and supplies for laboratories under his/her direction.

4. Proper procurement, storage, and disposal procedures of all radioactive materials and/or radiation producing devices under his/her direction.

5. Proper security of restricted areas of radioactive materials and/or radiation producing devices or equipment.

6. Proper control of employee and visitor exposure to the lowest practical level and always below the maximum permissible exposure.

7. Ensuring that minors (less than 18 years) are not put in a position to be exposed to radiation sources.

8. Proper training and supervision of all personnel working under his direction, in procedures and safety.

9. Proper marking and labeling of laboratories, radioactive materials and equipment.

10. Ensuring that pregnant women be counseled concerning the particular hazards of radiation for the developing fetus. Require that all women report pregnancy to their supervisor.

11. Ensuring a working knowledge of emergency and decontamination procedures by all personnel under his direction.

12. Immediate reporting to the RSO of spills, suspected overexposure, theft of radioactive materials, and other accidents involving restricted areas or radioactive materials or radiation producing devices or equipment.

13. Proper records of procurement, use, storage, and disposal of all radioactive materials or radiation producing devices or equipment in his possession as required herein.

14. Proper monitoring and surveying of applicable facilities, materials and equipment.

15. Proper record keeping and periodic reporting to RSO and RS Committee on laboratory and research

activities.

C. DEPARTMENT CHAIRPERSONS OF APPROVED PRINCIPAL INVESTIGATORS AND/OR APPROVED FACILITIES

Department Chairpersons shall be responsible for the following:

1. To have new staff members secure a copy of the Radiation Safety and Operations Manual from him/her if he/she is a prospective User.

2. To have any area where radioisotopes or radiation producing devices or equipment were previously used surveyed by the RSO or his/her representative before workmen do any remodeling or rearranging of the area.

3. To have plans for all new buildings and modifications of existing structures where radioactive materials or ionizing radiations are to be used to be submitted to his/her division to be reviewed by the University Radiation Safety Committee to be submitted with recommendations to the appropriate university division prior to construction or modification.

4. To have Principal Investigators (Users) who are leaving the university, return the Radiation Safety and Operations Manual to his Radiation Safety Coordinator and to inform the RSO or his representative of the final disposition of any radioactive wastes, unused radioactive materials, and/or radiation producing devices or equipment in his possession upon termination.

D. OTHER USERS, STUDENTS AND STAFF

1. All users of radioactive materials or radioactive sources are required to familiarize themselves with the regulations for safe practice in this manual. They should work closely with the principal user and/or their advisor. They should see the Radiation Safety Films, which can be checked out from the RSO.

2. Any hazardous situation should be reported to the Principal User and if necessary to the RSO.

3. Minors (less than 18 years of age) must report their age to the Principal User.

4. Pregnant women have the responsibility to report the pregnancy to the Principal User as soon as it is known.

III. NEW USERS GUIDE

New Principal Users of radioactive materials or sources of radiation at The University of Louisiana at Lafayette are required to meet with the RSO or other member of the RS Committee. The member of the committee will assist the new user to make application to the RS Committee for permission to establish a research program using such materials and/or sources. New faculty or staff can be directed to the RSO or a member of the RS Committee by their department heads or by the Office of Research and Sponsored Programs.

ALL PURCHASE REQUISITIONS FOR RADIOACTIVE MATERIALS OR EQUIPMENT REQUIRE APPROVAL BY THE RADIATION SAFETY OFFICER BEFORE THEY CAN BE ISSUED.

Any facility where radioactive material or sources of radiation are used must have the approval of the RS Committee. Various forms for applications are available from the Office of Research and Sponsored Programs, the RSO and on the website (http://orsp.louisiana.edu/Committees/URSC.shtml). Examples of these are contained in Chapter X of this manual.

IV. GENERAL REQUIREMENT FOR USE OF RADIATION SOURCES

A. LABORATORY DESIGN

Successful work with radioisotopes requires laboratories and equipment specifically designed for that purpose.

RSO must be consulted for assistance in developing such plans. In general, the following guidelines may be used:

1. Floors - smooth and continuous surfaces are recommended; tiles, and so forth are acceptable if cracks are filled.

2. Walls, ceiling, and woodwork - non-porous surfaces, should be washable.

3. Ventilation - labs with more than ten microcuries of isotopes may require hoods with face velocities of at least 100 feet per minute and individual exhaust air filters.

4. Equipment - suitable equipment for the activity, type and level, must be available; use of absorbent paper and strippable paint is recommended.

5. Benches - non-porous tops with no sharp corners.

6. Monitoring - appropriate to the radioisotope(s) used will be required as a routine procedure.

B. PERSONNEL

1. Individuals planning to use radioisotopes and/or ionizing radiation must submit an application to the RS Committee on the forms provided in this manual giving pertinent information about herself/himself, her/his training and experience, proposed project, laboratory and equipment. If the potential user cannot provide documented evidence of formal training or research experience, the application will be rejected until such training is acquired. The RSO can recommend proper training programs.

2. The authorized user is then responsible for assuring adequate training as outlined in the University Radiation Safety and Operations Manual to all his/her laboratory assistants, students, or personnel working under his supervision.

3. The authorized user is responsible for all records and reports required by the University Radiation Safety Committee.

C. FACILITY SECURITY

The authorized user is responsible for any facility utilizing radioactive materials/ionizing radiation producing devices shall be responsible for:

1. Securing the facility against unauthorized entrance.

2. Ensure that all personnel, laboratory workers, including securing and housekeeping associated with the facility receive proper instruction in accordance with the LADEQ XV. (See also Chapter V).

3. Posting all secured entrances of the facility with signs prohibiting unauthorized entrance, and names and phone numbers of the authorized user responsible for the laboratory and the RSO.

V. RADIOLOGICAL HEALTH PROCEDURES

A. RADIATION PROTECTION MEASURES

The following guidelines are designed to provide a safe working condition for all laboratory personnel, ensure public safety, and avoid contamination of equipment and facilities:

1. INSTRUCTION TO WORKERS
   a. LABORATORY DIRECTOR INSTRUCTIONS

In advance of any work involving radioisotopes/ionizing radiation, the laboratory director (Principal User) must:

(1) Discuss with the employees the work to be done and the necessary safety precautions in accordance with the LRR.
(2) Outline in writing the procedure for each job (make the amount of detail commensurate with the hazard).
(3) Stock the laboratory with plastic or rubber gloves, lab coats, warning tags and labels, wipes, appropriate survey/counting instruments, forms for necessary records, plastic bags and tape for waste disposal, absorbent paper, etc. The use of good procedures is greatly facilitated by having proper tools/supplies AT HAND.
(4) Have available and use when appropriate, remote handling devices, automatic pipettes or dispensers, tongs, etc., for the manipulation and transfer of radioactive preparations.
(5) All users must review the Radiation Safety Videos available from the RSO.

b. LABORATORY PERSONNEL RULES AND PROCEDURES

The rules and procedures listed below should be followed by all laboratory personnel.

(1) Designate and label a "hot sink" for radionuclide disposal and cleaning of contaminated glassware. Tag the sink drain to be surveyed before plumbing work is done.
(2) Designate label a storage area for radionuclides. Keep them there when not in immediate use.
(3) Measure and record the radiation levels (in mr/hr) in the work and storage area and adjacent non-controlled areas, with an appropriately calibrated detector A GM or scintillation probe is useful to detect "hot spots" even if not calibrated for that particular energy. Provide sufficient shielding to keep radiation exposures as low as practicable and always below established limits.
(4) Designate and label the radioactive work area(s). Consider the consequences of leakage or equipment failure. Choose non-porous bench tops. Cover work surfaces with absorbent paper that has plastic backing to protect furniture and facilitate cleanup. Use stainless steel or plastic trays to help confine liquids if spilled. Use disposable supplies whenever possible.
(5) When working with radioactive materials, wear a lab coat and plastic or rubber gloves for protection of clothes and skin. To avoid spread of contamination, remove gloves at work area and remove lab coat before leaving laboratory.
(6) Wear personnel radiation monitor (TLD, film, dosimeter, etc.) on body and hands while working. If applicable, Bioassay tests are the principle means for evaluating internal exposure to radioisotopes such as H-3 and C-14.
(7) Confine work with gaseous, volatile or dust-forming radioactive material to hoods or gloves boxes, if appropriate.
(8) Confine radioactive solutions in covered containers plainly identified and labeled with name of compound, radionuclide, date, activity and radiation level if applicable.
(9) Never pipette radioactive solutions by mouth. Mechanical devices shall be used.
(10) Prohibit eating, drinking, smoking or cosmetics application in radioisotope work areas. Failure to do so can lead to accidental ingestion of radioactive material.
(11) Never perform extensive radiochemical work with hazardous levels of materials until the procedure has been tested by a "dry run" to preclude unexpected complications. Aerosoling problems should be addressed if applicable.
(12) Supply containers for radioactive waste and contaminated glassware at the work location. Avoid transporting contaminated articles from the work area through clean lab areas. Shield the waste containers as required to prevent unnecessary exposure.
(13) Check hands, feet and clothing with a GM meter for contamination after handling radioactive materials. Check work area at least at the end of each working day.
(14) In case of spill or other accident, alert nearby personnel, confine spill, block off and mark area, decontaminate and monitor before moving temporary signs or barricade. If personnel contamination is involved, remove contaminated outer clothing, wash skin and monitor; seek medical advice if contamination persists and/or if injury has occurred. Report all accidents and injuries to the RSO and laboratory supervisor.
(15) The individual responsible for a spill is responsible for decontamination. Do not use custodial personnel unless specifically assigned the task by the RSO and laboratory supervisor/director.
(16) Keep "hot" vials and syringes in shielded containers. Syringe shields should be used for preparation and administration of radioactive material in millicurie quantities.

c. EXTERNAL AND INTERNAL HAZARDS

The principal radiations with which one may come in contact are X and gamma rays, slow and fast neutrons, and alpha and beta particles. Injury, as a result of being irradiated by such radiations, is caused mainly by ionizations within the tissues of the body. Neutrons, in addition, can easily induce radioactive nuclei in the body.

There are two main potential hazards connected with work with radioactivity: hazards from external radiation sources and hazards from internal radiation.

(1) External hazards arise from situations where the radiation source is external to the body and the body is penetrated by ionizing radiation emitted from the source. These radiations may be X-rays, gamma rays, neutrons, alpha particles or beta particles. Beta particles are usually not a serious external hazard since they have a relatively short range (example H-3, C-14, S-35). However, they may, if sufficiently intense or energetic (P-32, Sr-90), cause severe skin damage. Alpha particles, because of their larger mass, slower velocity and greater electrical charge, are capable of traveling only a few centimeters in air and rarely penetrate the outer layer of the skin.

However, because of their high specific ionization, alpha particles can cause severe damage when in direct contact with body tissues. Planned exposure to external radiations may be controlled by limiting the working TIME in the radiation field, by working at a DISTANCE from the source of radiation, and by inserting SHIELDING between the worker and the source.

(2) Internal hazards arise when radiation is emanating from internal deposits of radioactive material within the body. Although external hazards are caused primarily by X-rays, gamma rays, and neutrons, all forms of radiation, including alpha and beta particles, can cause internal hazards. Radioactive materials may gain access to the body by ingestion, by breathing air contaminated with radioactive substances, or by absorption of radioactive material through a cut or break in the skin. The primary danger of ingesting radioactive material is not necessarily a matter of ingesting large amounts at one time. Often a chronic hazard arises from small accumulations over a period of time.

It is known that many elements if taken into the body, will concentrate in certain body organs. For example, iodine will concentrate in the thyroid; strontium, calcium, radium and plutonium will concentrate in the bones. This latter group contains the most hazardous elements. Most of them have long half-lives and also remain deposited in the bones for long periods of time. The bone marrow contains blood-forming tissues, which are easily damaged by radiation. The amount of damage caused by deposits of radiation materials in the bones depends on the amount of radioactive material which has become "fixed", and the type or types of radiations which are emitted. If the deposit is substantial, sufficient damage may be caused to interfere with proper body function. Thus a disease such as leukemia or pernicious anemia can result. Safeguards must be used to insure, as much as possible, that such cases do not arise.

Protection of personnel against internal deposits of radioactive material is facilitated by the judicious use of protective clothing such as gloves, coveralls, impervious plastic suits, and respiratory equipment. In addition, adequately ventilated laboratories should be used and, where needed, equipped with high-velocity hoods. Good housekeeping procedures and adequate care in handling radioactive materials are imperative.

d. PRECAUTIONS WITH TRITIUM

Tritium emits a very weak beta whose maximum energy is only 0.01MeV. This is too weak to penetrate the outer layer of skin and thus is not an external hazard as would be P-32 or Co-60, for example. Because of its low energy, the beta will not penetrate any conventional monitoring instrument; therefore these instruments are useless for detecting tritium. When tritium enters the body, however, there is no outside layer of skin to act as a shield, so all the energy of these betas may now be absorbed in living tissue with consequent radiation exposure.

Tritium is commonly present as tritium gas (HT or T_2) or as tritium oxide (HTO or T_20). In most instances, a container of tritium gas will also have tritium oxide associated with it. In general, tritium gas in the elemental form does not present as great a hazard as does tritium oxide; this is because the body will absorb tritium oxide at a very high rate, while elemental tritium gas is asorbed considerably slower. Since tritium is an isotope of hydrogen it is readily incorporated into the molecular structure of most organic materials, including you. Thus there is a need to use safety measures even with tritium.

Personnel working with tritium oxide should be very cautious with procedures, which might lead to exposure to the vapor. This applies to skin exposures as well as to exposure by inhalation, since as much tritium oxide may pass through the total skin area of man per unit time as through the lungs. It has been found that people may absorb through the respiratory system as much as 98 to 99% of the activity inspired. Once tritium is absorbed into the body the isotope becomes uniformly distributed throughout the body fluids in about two hours. The biological half-life of tritium in the body is about 12 days; the radiological half-life is about 12.4 years.

The Maximum Permissible Body Burden of tritium is about one millicurie. This means that if sufficient tritium is continually taken into the body to maintain one millicurie in it throughout the year, then by the end of the year the body will have received a maximum permissible exposure of five rem. Also calculations have indicated that a single intake by inhalation of soluble material containing about 25 millicuries of tritium will deliver the Maximum Permissible Exposure of five rem in a year to the total body.

Particular hazards are encountered with tritium labeled nucleic acids, and to a certain extent, with all other labeled nucleic acids (thymidine being the most common. Insufficient information is available to accurately determine the hazard, but it has been estimated as being 1000 times that of tritiated water vapor. The increase of hazard for labeled nucleic acids occurs because deposition in the human body is not uniform, the biological elimination is quite different from that of tritium oxide and the areas of deposition are unusually radiosensitive. The problem is further complicated by the fact that it is difficult to monitor for tritium contamination, and air contamination can be detected only at relatively high levels. Virtually the entire safety of operations with this material must depend on sound technique of use.

For the above reasons, tritium should be handled and stored only in well-ventilated areas. Containers of tritium should be opened in a hood so that any vapor that has collected in the container can be dispersed to the atmosphere and not into the room. Because absorption through the skin occurs quite easily, rubber gloves should be worn. If the gloved hands are exposed to large amounts of tritium oxide for prolonged periods, the gloves should be changed every two hours or so because the oxide may penetrate the rubber in that period of time.

Vacuum pumps attached to a system containing tritium (or any other isotope) should be vented to a hood. Also, bear in mind that things like vacuum pump oil, stopcock grease and plastics readily become contaminated with tritium and should be carefully handled after coming in contact with tritium gas or tritiated water.

An estimate of the amount of tritium oxide contained in the body can be made by determining tritium concentration in the urine with a liquid scintillation counter. Therefore, personnel working with sufficient amounts of tritium may be required to furnish the University Radiation Safety Officer with urine sample test results. The RS COMMITTEE will normally make this request. However, if any person has reason to believe he/she has accidentally ingested material, he/she must notify the Radiation Safety Coordinator and the RSO at once. In the meantime, any urine samples should be saved for analysis.

NCRP Report No. 30 (NBS Handbook 92) suggests that regular urine analyses are desirable when handling solutions with tritium levels of about 100 mCi.

Airborne tritium monitors are commercially available. It should be pointed out that sensitivity, discrimination between other gases, and calibration of these devices present problems, which must be carefully evaluated by the user if the equipment is to be relied upon.

e. A DESCRIPTION OF SAFETY INSTRUCTIONS TO STUDENTS

(1) For the classroom use of radioactive material/radiation producing devices, the procedure followed is such that the radiation protection limits for the uncontrolled areas are not exceeded. These protection limits are set according to the LA DEQ XV.

(2) Under these conditions personnel monitoring is not necessary.

(3) If personnel monitoring is needed on a temporary basis, the Laboratory Director shall provide dosimeters or other suitable personnel devices.

(4) Since most of the teaching laboratories are part of a lecture class, students are given prior instructions in the class as to the effect of ionizing radiations, their hazards and instrumentation.

(5) Students are also made familiar with the safety regulations and procedures regarding safe handling and use of radioisotopes/ionizing radiation producing devices (See sections on instructions to workers).

(6) A copy of the summary of the Safety Regulations and Emergency Procedures is also to be posted in the laboratory.

B. EMERGENCY PROCEDURES

All cases of personal or work area contamination shall be immediately reported to the authorized user and the RSO or other member of the RS Committee. It reported to a member of the RS Committee other than the RSO, the member of the RS Committee will notify the RSO as soon as possible and provide a report as soon as practical. The person responsible for the radioactive material spill is responsible for initiation of the proper decontamination procedure and performing all or part of the procedure as directed by the authorized user and the RS Committee.

NOTIFY AREA PERSONNEL: notify persons in area that a spill has occurred.

PREVENT SPREAD: cover spill with absorbent paper.

CLEAN AREA: with caution (with protective disposable plastic gloves or decontamination tongs) fold absorbent paper or pad; insert into yellow plastic bag, twist top and wrap top three times, fold over twisted top and wrap three more times with radioactive warning tape thereby sealing the plastic bag; dispose sealed bag in solid radioactive waste material container; include all contaminated materials such as disposable plastic gloves.

SURVEY: with a Survey Meter, check area around spill, hands, feet and clothing for contamination.

REPORT: notify a member of the RS Committee of the incident, who will report to RSO.

C. DECONTAMINATION PROCEDURES

1. DECONTAMINATION OF PERSONNEL

The objective of personnel decontamination is to reduce radiation exposure promptly, minimize absorption of radionuclides into the body, and keep localized contamination from spreading. A survey instrument is absolutely necessary.

If a person is found to have radioactive contamination on their clothing or bodies, the following steps should be taken:

a. SKIN

(1) Remove any clothing found to be contaminated before determining levels of skin contamination. Generally, levels below 0.1 mrem/hr present a minimal hazard, but still should be removed if possible.

(2) Specific hot spots or areas on the skin should be located with a survey meter. These should be cleaned up so as to prevent the spread of contamination to clean areas of the body.

(3) Ordinarily, soap and lukewarm water (or detergent) will remove most of the contamination.

i. Wash for 1-2 minutes, rinse and dry the areas. Pay particular attention to the hands and fingernails. Monitor with a survey meter. Repeat if contamination still present.

ii. If contamination still present, wash again using plenty of soap and soft brush. Apply only light pressure to the brush. Rinse, dry and resurvey. Repeat if contamination still present.

iii. Take care to keep radioactivity from being washed into any skin break near the contaminated area. Covering the skin break with a sterile bandage will help.

iv. Even if contamination still persists, these efforts should be halted before the skin becomes reddened and irritated.

v. ALWAYS contact the RSO, for advice and final monitoring.

(4) If contamination is widespread over the body, shower with soap and water, dry and repeat survey. If contamination is still widespread, shower with scrubbing, dry and resurvey. If contamination still exists, select the most highly contaminated areas and proceed as in C.1.a.(3) i & ii. Never let the skin become irritated.

(5) DO NOT use organic solvents. These may only increase the probability of radioactive material penetrating the skin.

(6) When decontamination is completed, apply lanolin or hand cream to prevent chapping.

(7) Notify the RSO if any difficulty is encountered in removing the contamination or if assistance or monitoring is desired. The RSO should provide final monitoring.

b. HAIR

(8) If the hair is contaminated, try up to three washings with liquid soap and rinse water. Use towels to keep water from running onto the face and shoulders.

(9) Notify the RSO if any difficulty is encountered in removing the contamination or if assistance or monitoring is desired. The RSO should provide final monitoring.

c. CLOTHES

(10) Contaminated clothes (or shoes) should be removed from the body to prevent further spread of the contamination. Place these items in plastic bags or containers. Modesty is not a question in these circumstances.

(11) After necessary body decontamination has been accomplished, put on protective

gloves and lab coat (or surgical gown) and rinse the clothing in a Radioactive Waste Sink (providing the sink is less contaminated than clothing).

(12) If several washings still are not able to lower the contamination then either hold it for decay if the half-life is short or treat it as solid radioactive waste (See Section "Radioactive Waste Disposal").

(13) The RSO will provide final monitoring and advice.

2. DECONTAMINATION OF LABORATORIES

This job will be much easier if appropriate planning and precaution are made ahead of time.

a. The general procedure is to confine the radioactive material as much as possible and prevent spread to other areas.

b. Prepare yourself for this job by putting on protective gloves, lab coats or surgical gown, and shoe covers if the floor is contaminated.

c. A survey instrument is a must; otherwise you are only guessing where the contamination lies.

d. First remove the gross contamination caused by the spill; start at the edges of the contamination area and work inward.

e. After removing spilled liquids or other material, soap and water should usually be tried first to remove the remainder of the contamination.

f. All waste material should be placed in a plastic bag or other container to prevent recontaminating the area. The waste must eventually be sealed in plastic bags as described in section on "Radioactive Waste Disposal".

g. The individual involved in the spill is responsible for the clean up. DO NOT CALL JANITORS TO CLEAN UP RADIOACTIVE SPILLS.

h. The RSO will advise in the clean-up procedures and will provide final monitoring.

D. NOTIFICATION OF INCIDENTS

1. The following must be reported by telephone to the RSO. The RSO can then advise in the decontamination, if necessary, and provide final monitoring.

a. Any contamination or suspected contamination of personnel.

b. Any uncontained spill (example: radioisotopes spilled out onto the floor or onto areas of bench top not covered with disposable, absorbent material or confining tray).

2. The Radiation Protection Division, Department of Environmental Ouality, State of Louisiana requires immediate reporting each event involving a source of radiation possessed that may have caused or threatens to cause any of the following conditions. Therefore, each Principal Investigator or individual involved shall immediately notify the RSO by telephone of an incident and the RSO will directly communicate with the Radiation Protection Division of Department of Environmental Quality.

a. an individual to receive:

(1) a total effective dose equivalent of 0.25 Sv (25 rem) or more;

(2) an eye dose equivalent of 0.75 sv (75 rem) or more; or

(3) a shallow dose equivalent to the skin or Extremities or a total organ dose equivalent of 2.5 Gy (250 rad) or more; or

b. the release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the occupational ALI. This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.

3. Twenty-four Hour Notification. Each licensee or registrant shall, within 24 hours of discovery of the event, report to the division each event involving loss of control of a licensed or registered source of radiation possessed by the licensee or registrant that may have caused, or threatens to cause, any of the following conditions:

a. an individual to receive, in a period of 24 hours:

(1) a total effective dose equivalent exceeding 0.05 Sv (5 rem);

(2) an eye dose equivalent exceeding 0.15 Sv (15 rem); or

(3) a shallow dose equivalent to the skin or extremities or a total organ dose equivalent exceeding 0.5 Sv (50 rem); or

b. the release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational ALI. This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.

4. The RSO shall prepare each report filed with the division pursuant to this Section so that names of individuals who have received exposure to sources of radiation are stated in a separate and detachable portion of the report.

5. The RSO shall make the reports required by LAC 33:XV.486A-D by telegram, mailgram, or facsimile to the division.

6. The provisions of this Section do not apply to doses that result from planned special exposures, provided such doses are within the limits for planned special exposures and are reported pursuant to LAC 33:XV.488.

7. In addition to the notification required by LAC 33:XV.486, the RS0 shall submit a written report within 30 days after learning of any of the following occurrences:

a. incidents for which notification is required by LAC 33:XV.486;

b. doses in excess of any of the following:

(1) the occupational dose limits for adults in LAC 33:XV.410;

(2) the occupational dose limits for a minor in LAC 33:XV.416;

(3) the limits for an embryo/fetus of a declared pregnant woman in LAC 33:XV.417;

(4) the limits for an individual member of the public in LAC 33:XV.421; or

(5) any applicable limit in the license or registration;

c. levels of radiation or concentrations of radioactive material in:

(1) a restricted area in excess of applicable limits in the license or registration; or

(2) an unrestricted area in excess of 10 times the applicable limit set forth in this Chapter or in the license or registration, whether or not involving exposure of any individual in excess of the limits in LAC 33:XV.421; or

d. for licensees subject to the provisions of U.S. Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR Part 190, levels of radiation or releases of radioactive material in excess of those standards, or of license conditions related to those standards.

8. Contents of Reports

a. Each report required by LAC 33:XV.487.A shall describe the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

(1) estimates of each individual's dose;

(2) the levels of radiation and concentrations of radioactive material involved;

(3) the cause of the elevated exposures, dose rates, or concentrations; and

(4) corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, generally applicable environmental standards, and associated license or registration conditions.

b. Each report filed pursuant to LAC 33:XV.487.A shall include for each individual exposed: the name, Social Security account number, and date of birth. With respect to the limit for the embryo/fetus in LAC 33:XV.417, the identifiers should be those of the declared pregnant woman. The report shall be prepared so that this information is stated in a separate and detachable portion of the report.

E. RADIATION SURVEY PROGRAM

1. SURVEY PROCEDURES AND STANDARDS

a. SURVEY INSTRUMENTS

(1) Each authorized user of radioactive materials must provide his/her laboratory with a survey instrument or satisfy the RSO that he/she has immediate access to one. These instruments must be appropriate for the type and level of ionizing radiation being used. The one exception to the instrument requirement is tritium; no satisfactory survey instrument is presently commercially available for this isotope.

(2) Instruction of laboratory personnel in the use of survey instruments is the responsibility of the authorized user.

b. CLASSIFICATION OF LABORATORY AREAS

The purpose of classification is to determine how frequently the laboratory should be surveyed. The designations will be approved by the RS Committee.

(l) Laboratories or areas using <u>in vitro</u> only (I-125, I-131, H-3, C-14, etc.) would probably be classified as LOW level areas.

(2) Open labeling techniques (modifying factor of 0.1) using more than 100 mCi of I-131, for example, would change the classification to MEDIUM level.

(3) Areas where an individual could receive in any one hour a dose to the whole body in excess of l00 millirems would be classified as HIGH level area. Any entry into a

HIGH RADIATION area is prohibited unless the individual has a film badge, packet dosimeter, or appropriate personnel radiation monitor.

c. FREQUENCY OF SURVEY BY AUTHORIZED USER

(l) Low Level Area - Not less than once per month. Medium Level Area - Not less than once per week. High Level Area - Not less than once per normal working day.

(2) At a minimum, the RSO or a designated sub committee of the RS Committee will conduct surveys of the user facilities on a semi-annual basis.

d. METHOD OF SURVEY

Routine surveys should be carried out in two parts to determine both radiation levels and removable contamination levels.

e. RADIATION LEVELS

Monitoring area with a radiation survey meter sufficiently sensitive to detect 0.1 mr/hr. The results of this survey should be recorded on a standard form- See Chapter 10 which should show:

(1) Location date, and type of equipment used.

(2) Identification of person conducting the survey.

(3) Drawing of area surveyed, identifying relevant features such as active storage areas, active waste areas, etc.

(4) Measured exposure rates, keyed to location on drawing.

(5) Correction action taken in the case of excessive exposure rates, reduced exposure rates after corrective action, and any appropriate comments.

f. CONTAMINATION LEVELS

(1) A series of wipe tests should be taken in all areas where activity is handled in unsealed form. The location of wipe tests should be indicated on the above mentioned survey form and should be chosen for maximum probability of contamination, e.g. areas where individual doses are drawn up, incoming packages received, frequent pipetting carried out.

(2) Floors, particularly adjacent to doorways, lead shields, and door and drawer handles should also be wipe tested frequently. Care should be taken that cross contamination does not occur.

(3) An end-window GM or gas flow proportional counter normally may be used for assaying beta emitters at or above C-14 energies; low energy beta emitters will require liquid scintillation counting, (example: Tritium.)

(4) A gamma-scintillation counter (example: NaI well counter) should be used for pure gamma emitters. Make sure that the analyzer threshold is set below the lowest gamma energy used in the lab (usually I-125).

(5) Record a background count of 5-10 minutes using the same counting conditions used with the wipes.

(6) In the case if wipes contaminated with gamma emitters, the radionuclide can be identified from successive counts with different analyzer settings if the settings have

been calibrated with known energy standards.

g. ACCEPTABLE LIMITS

Exposure limits have been set for the protection of both laboratory personnel and the general public. It must be emphasized that the following limits are maximum permissible limits. DAY-TO-DAY EXPOSURE IS TO BE MAINTAINED AT THE LOWEST PRACTICAL LEVEL AT ALL TIMES.

(l) RADIATION LIMITS (Whole body only)

(a) Non-Controlled area:
Personnel must not receive greater than two millirem in any one hour, or greater than 100 millirem in seven consecutive days, or greater than 0.5 rem in any one year.

(b) Controlled area:
If an area is controlled for purposes of radiation protection, then exposure rate limits do not apply, but total exposure of any individual should not exceed l00 millirem at any one time.

An employee's total exposure rate must be <1.25/rem 13 week (there are certain conditions where up to three rem/13 weeks is allowed, but this exposure level cannot be continued routinely). On a basis of 40 hr/wk of exposure, the maximum exposure rate would have to be <2.5 mrem/hr.

(2) CONTAMINATION LIMITS

An individyal wipe test should routinely cover approximately 100-150 cm^2. Ideally, any contamination more than a few dpm above background should be cleaned up; however, a more usual level for B, at which cleanup is initiated is about 200 dpm. At approximately 1000 dpm a Contamination Zone should be established until the contamination is removed.

Contamination levels may also be estimated with a survey meter such as a thin-window GM counter, except for low energy beta emitters, e. g. H-3.

2. PERSONNEL MONITORING

Personnel monitoring devices may include film badges, pocket dosimeters and/or Thermoluminescence dosimeter (TLD) according to specific investigator needs.

a. TYPES AND USES OF PERSONNEL MONITORING DEVICES

(l) TLD BADGE

(2) RING BADGE

A type of film badge worn on the finger. Used to determine external beta-gamma exposure to the fingers and hands. The 0.2 MeV cutoff for beta radiation applies here also.

NOTE: Refer to the LA DEQ XV for additional information on acceptable limits (copy available from the RSO or through a link on the website http://orsp.louisiana.edu/Committees/URSC.shtml).

(3) POCKET DOSIMETER

An ion chamber the size of a fountain pen with direct-reading scale showing external exposure. Therefore, your exposure can be read immediately. There are two types; one is sensitive only to beta-gamma and neutron radiation. Pocket dosimeters are used: (1) whenever a radiation field is so high that working time is very limited. (2)

whenever a person is only temporarily exposed to radiation and needs to be monitored for a few days.

b. REQUEST FOR PERSONNEL MONITORING

It is the responsibility of the Principal Investigator and/or user to provide personnel monitoring for his laboratory personnel and himself. In obtaining monitoring devices the Radiation Safety Officer will assist in locating suitable monitoring device vendors.

c. EXPOSURE REPORT

(1) Quarterly exposure reports will be sent in accordance with the LA DEQ XV to each Department or area. The RSO encourages the posting of these reports for the information of those monitored.

(2) An individual who has a question about his exposure should contact the RSO.

3. RADIATION SAFETY OFFICER SURVEYS

The RSO or a sub committee of the RS Committee will conduct unannounced, non-periodic spot surveys of areas where radiation or radionuclides is in use. Records of the PI will be inspected at that time. Violations will be recorded by the RSO and the user notified by letter. Repeated violations may result the RS Committee making a recommendation to the Vice President for Research and Graduate Studies for action against the user.

4. METHODS FOR CALIBRATION OF SURVEY METERS, INCLUDING PROCEDURES, STANDARDS AND FREQUENCY

a. Calibration of survey meters should be performed with radionuclide source such that:

(l) The sources are approximate point sources.

(2) The source activities are traceable within 5% accuracy to the United States National Bureau of Standards (NBS) calibrations.

(3) The frequency should be at least annually.

(4) Two reading points should be taken on each scale, (approximately 1/3 and 2/3 of full scale, respectively).

(5) The instrument is ascertained to read within +10% of true value; read appropriate section of the instrument manual to determine how to make necessary adjustments to bring instrument into calibration.

b. A reference check source of long half-life, e.g. Cs-137 or Ra-226 shall be also read at the time of the above calibration. The reading shall be taken with the check source placed in specific geometry relative to the detector. A reading of this reference check source should be taken.

(l) Before each use.

(2) After each maintenance and/or battery change.

(3) At least quarterly.

If any reading is not within +10% of this check source at calibrated reference, Step A shall be initiated.

c. The instrument must be calibrated at lower energies if its response is energy dependent and it is to be used to measure in the I-125, Xe-133, or Tc-99m energy range.

This calibration may be done either:

(l) As in a above with calibrated standards of radionuclides at or near the desired energies, or

(2) As a relative intercomparison with an energy independent instrument and uncalibrated radionuclides.

d. Records of the above calibrations must be maintained.

e. For those instruments where calibration sources are not available, the instruments will be returned to the manufacturer for calibration or the services of a consultant will be used.

f. Sample Calculation:

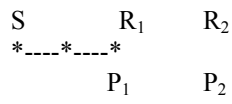
Use of Inverse Square Law and Radioactive Decay Law

(1) A calibrated source will have a calibration Certificate giving its output at a given distance measured on a specified date by the manufacturer or NBS.

(a) The Inverse Square law may be used with any point source to calculate the exposure rate at other distance.

(b) The Radioactive Decay law may be used to calculate the output at other times after the specified date.

(2) Inverse Square Law:



Exposure Rate at P_2:

$R_2 =$

where
(a) S is the point source
(b) R1 and R2 are in the same units (mr/h or r/h)
(c) P1 and P2 are in the same units (cm, meter feet, etc.)

(3) Radioactive Decay Law

where
(a) R_o and R_t are same
(b) R_o is exposure rate measured specified calibration date.
(c) R_t is exposure rate t units of time later.
(d) $T_{1/2}$ and t are in the same units (years, months, days, etc.)
(e) $T_{1/2}$ is radionuclide half-life
(f) t is number of units of time elapsed between calibration and present time.

(4) *Example: Source output is given by calibration certificate as 100 mr/h at one foot on 10 March 1985. Radionuclide half-life is 5.27 years.

Question: What is the output at three feet on 10 March 1987 (2.0 years later)?

(a) Output at one foot, 2.0 years after calibration date:

$R = 100 \text{ mr/h} \times e^{\frac{-0.693}{5.3}} \times 2.0 = 100\ 0.77 = 77 \text{ mr/h}$

at one foot on 10 March 1987.

(b) Output at three feet, 2.0 years after calibration date:

$R_3 \text{ feet} = \frac{(1 \text{ foot})^2}{(3 \text{ feet})^2} \times 77 \text{ mr/h} = 1/9 \times 77 - 8.6 \text{ mr/h}$

at three feet, 2.0 years after calibration

5. SEALED SOURCES AND LEAK TESTS

a. Radiation sources will be given an initial leak test by the RSO or his designate when they arrive at the university designated storage area according to the procedures set forth in LAC 33:XV.426. (Also see leak test procedure in section 5.d.)

b. Subsequent leak tests at intervals not to exceed six months, or in accordance with leak-test condition on the license of the sealed sources are responsibility of the authorized user/investigator. See section 5.d. The RSO will assist in conducting the leak tests.

(1) EXCEPTIONS for Leak tests:

In accordance with LAC 33:XV.426.B.3.B. sealed sources containing 3.7 MBq (100μCi) or less of beta or photon-emitting material or 370 kBq (10μCi) or less of alpha-emitting material are exempt from any requirement for periodic leak tests.

c. Wipe tests of all areas where radioactive materials are handled in an unsealed liquid form will be performed at least once every semester according to the procedure in 5.d. A record of the results of these wipe tests will be maintained by the RSO.

(1) Records of leak tests must be maintained by the user and a copy sent to the RSO.

(2) Report immediately to the RSO all lost or deteriorating sealed sources.

(3) Sealed sources containing licensed material must not be opened, or the contents removed.

d. Procedures for leak testing of sources or areas:

i. Sources:

(a) All leak tests will be performed according LAC 33:XV.426 using the following procedures: Remove the sealed source from the lead container with proper handling tongs/pliers, that the hands will not come close to or in contact with source.

(b) Wipe the source with the vendor-supplied filter paper and then place the paper in the container supplied or recommended by the vendor.

(c) Ship the test wipe to the vendor using the procedures recommended by the vendor.

ii. Areas:

(a) Wipe the area with the vendor-supplied filter paper and then place the paper in the container supplied or recommended but the vendor.

(b) Ship the test wipe to the vendor using the procedures recommended by the vendor.

VI. IN VIVO USE OF RADIOACTIVE MATERIALS AND IONIZING RADIATION

Authorized users wishing to use radioactive materials or ionizing radiations on living animals, plants or microbes (HUMAN USE NOT PERMITTED) should do so only in secured areas, and shall satisfy the following:

A. ANIMALS

1. All radioactive excreta, bedding, food, insect., are to be disposed of by the user, using the procedures outlined in the section on 'Biological Radioactive Waste', in the chapter on "Radioactive Waste Disposal".

2. Feeding and watering of animals given radioisotopes are under the supervision of the user.

3. All animal care equipment used with animals given radioisotopes must be washed, and monitored under the supervision of the user before being returned to storage.

4. Radioactivity of equipment must be non-detectable with any ordinary beta-gamma survey meter before being returned to storage. For beta energies less than 0.3 MeV a thin window GM tube of 2 mg/cm^2 must be used.

5. Animals that have been administered ^{14}C or ^{3}H labeled metabolites or other radioisotopes that are exhaled in significant amounts must be provided proper ventilation.

6. The user is responsible for monitoring the following areas at least once each week: (Refer to section V.E)

    a. Floor of the room housing the animals.

    b. Sink at which equipment is washed.

    c. The monitoring of animal groups as in lOc of this section.

7. Areas occupied by animals and equipment must be surveyed at the termination of the experiment.

8. Radiation at the cage surface must in no case exceed 5 mr/hr unless adequate shielding is provided by the investigator.

9. There must be posted by the investigator (user) at the area in which the animals are housed appropriate radiation signs.

10. There must also be posted the following minimal information.

    a. Type and form of isotope administered to the animals.

    b. Maximal amount given per group of animals and date of administration.

    c. Radiation emitted in mr/hr at one meter per group of animals.

    d. User name and telephone number.

11. Sacrificed radioactive animals must be carefully monitored. Dissection or Viva section or biopsy of radioactive animals must be carried out in an appropriate glove box, approved hood, or proper ventilated and prepared facility.

12. Irradiated animals are not to be held in position for radiation exposure by humans.

13. Records of all monitoring and surveying must be kept by the investigator (user).

14. The user is responsible for submitting appropriate application to and obtaining approval from the

Institutional Animal Care and Use Committee (IACUC) prior to beginning research involving animals.

B. PLANTS

1. All plants to which radioactive isotopes are to be administered should have been placed in container(s) singly or in groups so that watering or adding nutrients or exogenous application of substances under the supervision of the user with or without radioactive labels or isotopes should in no manner result in contamination of the immediate environment with radioactive materials.

2. Caution should be used in the administration of certain radioisotopes in as much as they may be metabolized and released in gaseous form in significant amounts in which case proper ventilation shall be provided.

3. In as much as the soil or hydroponic solution may become contaminated, monitoring is necessary before disposal. Radioactive soils or hydroponic solution shall be disposed of according to the sections on 'Liquid Radioactive Waste' or 'Solid Radioactive Waste' in the chapter on "Radioactive Waste Disposal".

4. All equipment utilized with plants to which radioactive isotopes have been administered should conform to items No. 3 and No. 4 under the section on animals of this chapter.

5. The user is responsible for monitoring the following areas at least once a week: (Refer to section V.E.)

   a. Type and form of isotope administered to the plants.

   b. Maximal amount given per group of plants and date of administration.

   c. Radiation emitted in mr/hr at one meter per group of plants.

   d. User name and telephone number.

6. The area occupied by the plants and equipment must be surveyed at the termination of the experiment.

7. There must be appropriate radiation signs posted by the user at that area in which plants are kept.

8. Exposure of plants to radioactive gas(es) should be done under conditions which prohibit the accidental release of gas(es) into the atmosphere.

9. Excised plant materials must be carefully monitored and dissection or maceration carried out in proper equipment and facilities to minimized dose of radiation as well as possible release of radioactive or contamination of equipment or area.

10. Disposal of radioactive plant material must be carried out according to the section 'Biological Radioactive Waste' in the chapter on "Radioactive Waste Disposal".

11. Records of all monitoring and surveying must be kept by the user.

C. MICROBES

1. All microbes to which radioactive materials are to be added should be handled with wet radio-biochemistry technique with radioactive substances with the same precautions for liquid cultures and those techniques that are applicable to gel cultures.

2. Caution should be used in the administration of certain radioactive materials which may be metabolized and release radioactive gas in significant amounts which will require proper ventilation and storage for incubation.

3. The radioactive microbe material is disposed of as instructed in the section on 'Biological Radioactive

Waste' and the culture media treated as indicated in that section and the sections on 'Solid Radioactive Waste' or 'Liquid Radioactive Waste', whichever is appropriate, in the chapter on "Radioactive Waste Disposal".

4. All equipment utilized with microbes to which radioactive materials have been administered should conform to items No. 3 and No. 4 under the section on animals of this chapter.

5. There must be posted by the user at the area in which the microbial material is kept the following information:

   a. Type and form of the isotope administered to the microbes.

   b. Maximal amount given per group of microbial cultures, name of the organism in the culture, and date of administration.

   c. Radiation emitted in mr/hr at one meter per group of cultures of that organism.

   d. User name and telephone number.

6. The area occupied by the microbial cultures and equipment must be surveyed at the termination of the experiment.

7. Appropriate radiation signs must be posted by the user at the area where microbial cultures are kept.

8. Microbial cultures exposed to radioactive gas should be done so under conditions approved by the RSO or his designate.

9. The user is responsible for monitoring the following areas at least once each week. (Refer to section V.E.)

   a. Floor of the rooms of preparation and incubation of the microbial cultures.

   b. Sink at which equipment is washed.

   c. Monitoring of microbial groups as in 5c of this section.

10. Records of all monitoring and surveying must be kept by the user.

11. Any special precautions and procedures used and drawings of in vivo facilities where radioactive materials are to be used and/or in vivo organisms housed shall be provided to the RSO prior to in vivo application of Radioactive materials or ionizing radiation.

The necessary forms are given in Chapter X: Record Keeping, Reports and Forms.

VII. ACQUISITION, RECEIVING AND STORAGE OF RADIOACTIVE MATERIALS

A. PROCEDURES FOR ACQUISITION OF RADIOACTIVE MATERIALS

1. ***ONLY USERS AUTHORIZED BY THE RSO MAY ORDER RADIOISOTOPE MATERIALS.*** A list of authorized users will be maintained by the RSO. Each department will submit a list of department-approved users to the RSO. The RSO will authorize each user by insuring that each user has (i) completed required radiation safety training, (ii) has access to an RSO-approved laboratory space with adequate accommodations for storage and use of radioactive materials, and (iii) has an RSO-approved statement of procedures for use, record keeping and disposal of radioactive materials in the user laboratory. See Chapter IV.B.1 for general requirements pertaining to authorized users of radioisotopes.

2. ***ALL REQUISITIONS FOR RADIOISOTOPES/IONIZING RADIATION PRODUCING DEVICES MUST BE APPROVED BY THE RSO BEFORE PROCESSING BY THE PURCHASING DEPARTMENT.***

   THE RSO WILL:

   a. insure that the amount of radioisotopes in use at any one time shall not exceed the total possession limits as specified in the Radioactive Materials License of the university,

   b. insure that the user has indicated on the requisition form a primary and secondary contact person who can accept delivery of materials in the department. (Room numbers and telephone numbers are required for both primary and secondary contacts.)

   c. determine if the material requested is allowable by the University of Louisiana at Lafayette Radioactive Materials License and

      i. If approved, sign and date the purchase requisition and send it to the next administrative level for signature

      ii. If disapproved, the RSO will notify the primary user so that the user may resubmit the requisition consistent with requirements of the University of Louisiana at Lafayette Radioactive Materials License.

B. PROCEDURES FOR RECEIVING PACKAGES

1. All radioactive materials shipments approved by RSO will be received at the UL Lafayette Louisiana Accelerator Center (LAC) unless otherwise authorized by the RSO.

   a. No package will be accepted by LAC if the package is damaged.

   b. LAC will immediately notify the RSO if the package is found to be damaged or leaking after delivery has been completed.

   c. After receipt LAC the package will be locked in the LAC source room until transferred to the user. LAC will notify the primary user that the material has been received. The secondary contact will be notified if the primary contact cannot be located.

   d. The user shall pick up package at LAC.

   e. LAC will transmit a copy of the user-signed receiving report to the RSO within one working day after material has been transferred to a user.

   f. ***ANY MATERIALS NOT APPROVED BY THE RSO FOR RECEIPT BY LAC WILL NOT BE ACCEPTED BY LAC AND WILL BE RETURNED TO THE VENDOR.***

   g. The RSO shall insure that the appropriate LAC personnel will be instructed as to the disposition, handling and security of all radioactive materials received.

   h. The RSO shall provide a calibrated survey meter to LAC personnel for routine survey of all packages placed in storage.

2. The RSO shall be notified by LAC if any shipment remains in storage for a period exceeding two working days.

3. Packages containing radioisotopes in excess of Type A (as defined by LAC 33:XV.1503 and Appendix A of LAC 33:XV.Chapter 15) shall be received ***only by the RSO*** according to procedures set forth by LAC 33:XV.455.

4. Upon receipt of a package of radioactive material in excess of Type A, the external surfaces of the package will be monitored for radioactive contamination caused by leakage of the radioactive contents. The monitoring shall be performed as soon as practicable after receipt, but no later than three (3) hours after the package is received by the RSO at the LAC facility if received during the licensee's normal working hours, or eighteen (18) hours if received after working hours.

5. If removable radioactive contamination in excess of 0.01 microcurie (22,000 disintegrations per minute) per 100 square centimeters of package surface is found on the external surfaces of the package, the user shall immediately notify, the RSO who have the responsibility to notify the receiving station, the final delivering carrier and the LAQRP-RP.

6. If radiation levels in excess of 200 millirem per hour are found on the external surface of a package, or in excess of ten (10) millirem per hour at three (3) feet from the external surface of the package, the RSO shall immediately notify, by telephone or telegraph, the final delivering carrier and the LAQRP-RP.

7. Such monitoring need not be performed if:

   a. materials conform to the allowable limits set forth by LAC 33:XV.455, LAC 33:XV.1503 and Appendix A of LAC 33:XV.Chapter 15,

   b. packages contain less than 1 millicurie (37MBq) of beta or gamma emitting radioactive material or 10 microcuries (370 kBq) of alpha emitting radioactive material,

   c. packages contain no more than ten (10) millicuries of radioactive material consisting solely of tritium, carbon-14, sulfur-35 or iodine-12

   d. packages contain only radioactive material as gases or in special form, or

   e. packages contain only radionuclides with half-lives of less than thirty (30) days and a total quantity of no more than one hundred (100) millicuries.

C. PROCEDURES FOR INSPECTION OF PACKAGES

1. Packages should be treated as contaminated until proven otherwise, especially if damaged. Place package on surface with absorbent material during survey. Complete a copy of IC-3 in Chapter 10 and submit to the RSO.

2. Arrange to open and inspect packages as soon as possible after receipt.

3. Plastic or other protective gloves and lab coats should be worn for opening packages for the protection of the surveyor.

4. If the manufacturer's directions for opening or unpacking radioactive material are provided, follow these directions in addition to those below.

5. Packages containing radioactive materials with associated high exposure levels may require some or all of the following steps to be performed behind a radiation shield and/or using other appropriate safety measures. The RSO should be present for such an opening.

6. Procedure for Package Inspection

   a. Receive in prepared, protected place.
   b. Observe for mechanical damage -- record condition.
   c. Observe outer package for leakage stains -- record condition
   d. If stains are present -- wipe 100 cm^2 area with dry wipe and assay Record. An end window GM or gas flow proportional counter (with window thickness less than or equal to 1.5mg/cm^2

normally may be used for assaying beta emitters at or above C^{14} energies; low energy beta emitters will require liquid scintillation counting. A gamma-scintillation counter should be used for pure gamma emitters.

D. STORAGE OF RADIOACTIVE MATERIALS

1. Radioactive materials must be secured against unauthorized removal from the place of storage as well as be provided with reasonable protection against loss, leakage, or dispersion by fire or water.

2. Storage sites for large amounts of radioactive materials should be in as remote areas as practical away from occupied areas.

3. Storage areas must be well marked with "Caution Radioactive Materials" signs conspicuously displayed and the area secured against unauthorized personnel. If the aggregate of stored radioactive materials stored in an area accessible to personnel in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirems, or in any five consecutive days a dose in excess of 100 millirems, then such area shall have displayed "Caution Radiation Area" signs in conspicuous places. If the aggregate of stored radioactive materials in an area accessible by personnel in which there exists or could exist radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 mrem, then such area shall be posted with "Danger High Radiation Area". High Radiation Areas for storage shall be limited to special facilities as recommended by the RSO and approved by the RS COMMITTEE.

4. Containers of radioactive materials should be a maximum of 200 mrem of the containers' surface or 10 mrem/hr one meter from the center of the container. Containers of radioactive materials in storage areas shall be shielded so as to not exceed a dose of 2 mrem/hr at its surface.

5. Storage areas should be shielded so that background radiation in unrestricted areas for an individual dose shall note be in excess of two mrem/hr or 100 mrems per seven (7) consecutive days.

6. Storage areas containing radioactive solutions that emit radioactive gases should be labeled and kept in approved hoods which are provided with proper filters and adequate ventilation. Only the amounts of material necessary for immediate experimentation should be stored in approved hoods in the laboratory.

7. Gases should be stored in approved hoods in the laboratory.

8. All radioactive materials in storage shall be clearly labeled giving isotope, chemical form, activity, date of the activity, and the name of the responsible user.

9. All appropriate records pertaining to the storage of radioactive materials shall be maintained.

VIII. RADIOACTIVE WASTE

Disposal of radioactive waste materials is an important part of any safety program and therefore the following procedures shall be followed by all authorized users of radioisotopes.

A. TYPES OF RADIOACTIVE WASTE

Basically radioactive waste can be divided into four categories for disposal:

Biological Radioactive Waste

Solid Radioactive Waste

Liquid Radioactive Waste

Gaseous Radioactive Waste

1. BIOLOGICAL RADIOACTIVE WASTE

a. All biological radioactive waste shall include any plant, animal, or microbial material which exhibits radioactivity above background as a result of any operational activity in the intentional or unintentional application of radioactive materials or ionizing radiation. Therefore these biological radioactive waste shall be properly bagged and sealed in such a manner as to ensure that no liquid may leak out or contaminant may be rubbed off a sealed yellow plastic bag (4 mil). The material in the bag, if necessary, must be wrapped or packed with some materials such as gauze or vermiculite to prevent rupture of the bag, and some preservatives such as salt, formalin, or phenol should be added to specimen to retard spoilage, and possible release of radioactive gas from the gradual putrification of the contents. The bag is then twisted at the top and three turns of radioactive warning tape applied. The twisted portion is folded over and three more turns of radioactive warning tape applied to ensure complete sealing of the bag.

b. The RS Committee will keep authorized users informed as to the waste disposal area(s) for biological radioactive waste with suitable containers into which the sealed wastes are to be placed. Large quantities of materials will require special notification by the authorized user to the RS Committee so that any additional arrangements can be made prior to their utilization.

c. Other biologically radioactive wastes such as excreta, bedding, food, etc. are to be handled as above.

d. Radioactive soil wastes should be handled as solid radioactive waste.

e. Solid radioactive culture media should be handled as above whether contaminated with microbes or not.

f. Liquid radioactive culture media should be handled as a liquid after treatment to stop microbial active before disposal whether contaminated with microbes or not (Preservative material should be carefully selected for solubility and/or solvent abilities with the unbreakable containers.).

g. All biological radioactive waste are to be labeled and recorded as per instructions. (Note RS Form #6).

2. SOLID RADIOACTIVE WASTE

a. Solid radioactive wastes cans with "Caution Radioactive Solid Wastes" signs will have a yellow plastic bag liner (4 mil) into which solid radioactive wastes are placed. Should the bag be fitted or achieve a dose rate 2 mrem/hr or greater at one meter from the can, then seal the bag as per instructions on the twisting of the top etc. in the section on biological radioactive waste above and dispose of bag in solid waste disposal containers and area. Should a solid waste container be filled then notify the division RSO so that he may arrange to fill the interstices with vermilculite and seal the container for shipping.

b. All solid radioactive wastes are to be labeled and recorded as per instructions in the section on waste disposal (Note RS Form #6).

3. LIQUID RADIOACTIVE WASTE

a. Some sanitary sewage disposal systems may be suitable for utilization in disposal of some particularly weak and/or short half-life radiation emitters. In this event, soluble materials, diluted to the minimum activity as given in Appendix B. Table II or III of LAC 33:XV, the radioactive substance(s) are soluble in water, some may be disposed into a sink designated as a "Radioactive Waste Sink" by the RSO. DO NOT USE A SINK FOR RADIOACTIVE WASTE UNLESS IT IS MARKED FOR SUCH! After utilizing a radioactive waste sink, rinse thoroughly for ten minutes with running water being careful not to splash and survey for two mrem/hr maximum. Any quantity of radioactive liquids with an activity over 20 microcuries may present a voluminous dilution problem and thus the radioactive liquid may be placed in sealed containers and disposed of. When in doubt consult the RSO.

b. Special caution should be used in disposal of significant quantities of long half-life high energy gamma emitters in as much as it is usually advisable to dispose of these materials in an appropriate, properly labeled plastic or unbreakable containers.

c. CAUTION should be used in disposal of any radioactive liquid forms in radioactive waste sinks or in sealed plastic or unbreakable containers so as to not mix any substances which may react to release gases or heat. Therefore, separate sealed plastic or unbreakable containers should be used for each different radioactive liquid form.

d. In case of any questions as to the disposal of radioactive liquid waste, contain waste in a suitable sealed container and inform the RS Committee that such waste needs immediate attention.

e. All liquid radioactive waste shall be appropriately labeled and records kept according to the section on wastes (Note RS COMMITTEE Form #6).

4. GAS RADIOACTIVE WASTE

a. Some tritiated compounds release the tritium label readily under certain conditions and as a result must be handled with additional precautions (note section "Special Precautions with Tritium"). Other classes of substances may under the certain conditions chemically react to produce a radioactive gas, for example, carbonate salts containing carbon-14 react with acids to produce $^{14}CO_2$. Some Radioactive materials utilized in gaseous form should be handled with an approved radioisotope hood in which final gaseous emission from the final exhaust of the hood shall not exceed the activity in air as set forth in Table I, Appendix B of LAC 33: XV.

b. All record keeping and reports shall be in accordance with the instructions in the section on waste (Note RS Form #6).

5. LIQUID SCINTILLATION VIALS

The following procedures are to be used with regard to the disposal of liquid scintillation vials.

a. Scintillation vials to be discarded with liquid included shall have the vials sealed with radioactive labeling tape and placed in polyethylene bag with a ratio of vermiculite to liquid in the vials of 2 to 1, and the polyethylene bag top twisted and sealed with radioactive warning tape according to the section of Radioactive Waste Disposal. The sealed bag with the vials are to be placed in a special radioactive container.

b. Radioactive scintillation liquids to be discarded without vials shall be placed in unbreakable plastic containers and sealed with radioactive warning tape and the RS Committee notified for appropriate disposal.

c. The vial itself can be <u>flushed</u> and discarded into the regular waste bin, if not radioactive. Otherwise, the radioactive vials to be discarded empty of liquids should be treated as a solid

radioactive waste.

d. Water soluble flora may be disposed of as specified under “Liquid Radioactive Waste” above.

B. WASTE DISPOSAL REPORTS

Radiation Safety Coordinators shall file a copy of all records and reports pertaining to radioactive waste packages from their area with the RS0.

C. FINAL DISPOSAL REPORTS

Stored radioactive waste will ultimately be disposed through commercial waste management contracts. The university storage capacity will be used until it fills.

IX. RECORD KEEPING, REPORTS AND FORMS

A. RECORD KEEPING AND REPORTS

The procedures of these chapters are to be followed in compliance with LAQRP-RP regulations for record keeping and reports.

1. All applicants, to be authorized users, shall provide the RS Committee with the copy of all previous records of exposure on RS Form #7.
2. All records showing radiation exposure history of authorized users shall be maintained by the RS Committee.
3. The dose exposure shall be for periods of time not exceeding one calendar quarter (for those requiring monitoring refer to Chapter V.)
4. Each authorized user shall provide on a quarterly basis to the RS COMMITTEE, the results of surveys and monitoring required by Chapter V, the disposal of radioactive waste under Chapter IX, and radioactive inventory as provided in Chapter VIII.
5. Survey instruments should be calibrated according to Chapter V, and records maintained by the authorized user and shall be available for inspection by the LAQRP-RP.

B. FORMS

The appropriate RS COMMITTEE forms are to be used in applications and submission of reports.

1. LIST OF TITLES:

a.	1-A	APPLICATION FOR USE OF RADIOISOTOPES
b.	1-B	STATEMENT OF TRAINING AND EXPERIENCE
c.	1-C	RADIATION EQUIPMENT
d.	2	REQUEST FOR USE OF RADIOISOTOPES IN ANIMAL QUARTERS
e.	3	RADIOACTIVE MATERIAL SHIPMENT RECEIPT REPORT
f.	4-A	RECORDS OF SURVEY AND REPORTS
g.	4-B	RECORDS OF SURVEY AND REPORTS
h.	5	QUARTERLY RADIOISOTOPE REPORT
i.	6	RADIOACTIVE WASTE DISPOSAL FORM
j.	7	EXPOSURE HISTORY RELEASE FORM
k.	8	LABORATORY REGISTRATION FORM

APPENDIX A: GLOSSARY OF TERMS

Accelerator produced material means any material made radioactive by a particle accelerator.

Agreement State means that any state with which the U.S. Nuclear Regulatory Commission or Atomic Energy Commission has entered into an effective agreement under subsection 274b of the Atomic Energy Act of 1954, as amended (73 Stat. 689).

Airborne radioactive material means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors or gases.

Airborne radioactivity area means (i) any room, enclosure or operating area in which airborne radioactive materials exists in concentrations in excess of the amounts specified in Appendix A, Table I, Column I of Part D or (ii) any room, enclosure or operating area in which airborne radioactive material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25% of the amounts specified in Appendix A, Table I, Column I of Part D.

Becquerel means the SI unit of measurement of radioactivity and is equal one transformation per second. One "Curie" is equal to 3.7×10^{10} Becquerels.

By-product material means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.

Calendar Quarter means any period consisting of not less than twelve consecutive weeks nor more than fourteen consecutive weeks. Calendar quarters shall be so arranged that no day in any year is omitted from inclusion within a calendar year. No licensee or registrant shall change the method observed by him for determining calendar quarters for purposes of these regulations more than once in a calendar year. All days in the calendar quarter of the former system to the effective date of the change must be assigned to the first calendar quarter in the new system for the purposes of these regulations.

CFR means Code of Federal Regulations.

Curie is a unit of measurement of radioactivity. One Curie (Ci) is that quantity of radioactive material which decays at the rate of 3.7×10^{10} disintegrations per second (dps). Commonly used submultiples of the Curie are the millicurie and the microcurie. One millicurie (mCi) = 0.001 Curie = 3.7×10^{7} dps. One microcurie

(Ci) = 0.000001 Curie = 3.7×10^{4} dps. One Curie is equal to 3.7×10^{10} Becquerels.

Depleted uranium means the source material uranium in which the isotope uraniumn -235 is less than 0.711 weight percent of the total uranium present. Depleted uranium does not include special nuclear material.

LAQRP-RP means Louisiana Office of Air Quality and Radiation Protection, Radiation Protection Division

Dose as used in these regulations shall mean absorbed dose or dose equivalent, as appropriate.

Absorbed dose is the energy imparted to matter by ionizing radiation per unit mass of irradiated material to the place of interest. The special unit of absorbed dose is the rad. (See **RAD**.) The SI unit of absorbed dose is the Gray (Gy) which is equal to one Joule per kilogram. One rad is equal to 0.01 Gray (See **Gray).**

Dose equivalent is a quantity that expresses, on a common scale for all radiation, a measure of the postulated effect on a given organ. It is defined as the product of the absorbed dose in rads and certain appropriate modifying factors. The unit of dose equivalent is the Rem. (See **Rem**). The SI unit of dose equivalent is the Sievert (Sv) which is equal to one Joule per kilogram. One Rem is equal to 0.01 Sievert (See **Sievert**).

Dose Commitment means the total radiation dose to a part of the body that will result from retention in the body of radioactive material. For purposes of estimating the dose commitment, it is assumed that from the time of intake the period of exposure to retained material will not exceed 50 years.

Emergency means any condition existing outside of the bounds of nuclear operating sites owned or licensed by a federal agency, and further any condition existing within or outside of the jurisdictional confines of a facility licensed or registered by the Office and arising from the presence of by-product material, source material, special nuclear material, or any other radioactive material or source of radiation, which is endangering or could reasonably be expected to endanger the health and safety of the public or to contaminate the environment (R.S. 30:1103).

Exposure means the quotient of dQ (dQ/dm), where "dQ" is the absolute value of the total charge of ions of one sign produced in air when all the electrons (negatrons and positrons) liberated by photons in a volume element of air having mass "dm" are completely stopped in air. The special unit of exposure is the Roentgen (R) (See **Roentgen**). The Si unit of exposure is the Coulomb per kilogram (C/kg). One Roentgen is equal to 2.58×10^{-4} Coulomb per kilogram.

Exposure rate means the exposure per unit of time, such as R/min, mR/h, etc.

Gray means the SI unit of absorbed dose and is equal to one joule per kilogram. One rad is equal to 0.01 Gray (Gy).

Healing arts means the professional disciplines authorized by the laws of this state to use radiation or radioactive material in the diagnosis or treatment of human or animal disease.

High level waste means unprocessed spent fuel rods or that waste resulting from the reprocessing of spent fuel rods.

High radiation area means any area, accessible to individuals, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirems.

Human use means the internal or external administration of radiation or radioactive materials to human beings.

Individual means any human being.

Inspection means an official examination or observation including, but not limited to, tests, surveys, and monitoring to determine compliance with rules, regulations, orders, requirements and conditions of the Division and/or Commission.

Ionizing radiation means any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter. It includes any or all of the following: alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but not sound or radiowaves, or visible, infrared or ultraviolet light.

Licensee means any person who is licensed by the Commission or Assistant Secretary in accordance with the Act and regulations promulgated by the Commission. (R.S. 30:1103)

Licenses means general licenses and specific licenses.

a. **General license** means a license effective pursuant to regulations promulgated by the Commission without the filing of an application to transfer, acquire, own, possess, or use quantities of, or devices or equipment utilizing by-products, source, or special nuclear materials, technologically enhanced natural radioactive material, or other radioactive material occurring naturally or produced artificially.

b. **Specific license** means a license, issued after application to the Office, to use, manufacture, produce, transfer, receive, acquire, own, or possess quantities of, or devices or equipment utilizing by-product, source, or special nuclear materials, technologically enhanced natural radioactive materials or other radioactive material occurring naturally or produced artificially. (R. S. 30:1103)

Natural radioactivity means radioactivity of naturally-occurring radioactive materials (NORM).

Naturally-occurring or accelerator-produced radioactive material (NARM) means any nuclide which is radioactive in its natural physical state (i.e., not man-made) or which has been made radioactive by exposure to an accelerator beam, but does not include source, by-product or special nuclear material.

Occupational dose means from exposure of an individual to radiation (i) in a restricted area or (ii) in the course of employment in which the individual's duties involve exposure to radiation; provided that occupational dose shall not be deemed to include any dose caused by exposure of an individual to radiation for the purpose of diagnosis or therapy of such individual.

Particle accelerator means any machine capable of accelerating electrons, protons, deuterons or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 million electron volts.

Personnel monitoring equipment means devices (e.g.,film badges, pocket dosimeters, thermoluminescent dosimeters) designed to be worn or carried by an individual for the purpose of estimating the dose received by the individual.

Physician means an individual who possesses a certificate to practice medicine issued under the provisions of R.S. 37:1261 et seq.

Rad is the special unit of absorbed dose. One rad equals one hundredth (0.01) of a Joule per kilogram of material: For example, if tissue is the material of interest, then 1 rad equals 100 ergs per gram of tissue.

Radiation means any electromagnetic or ionizing radiation including gamma rays and X-rays, alpha and beta particles, high-

speed electrons, neutrons, protons, and other nuclear particles; but not sound waves. (R.S. 30:1103) Unless specifically stated otherwise, these regulations apply only to ionizing radiation.

Radiation area means any area, accessible to individuals, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirems, or in any 5 consecutive days, a dose in excess of 100 millirems.

Radiation machine means any device capable of producing radiation except those which produce radiation only from radioactive material.

Radiation safety officer (RSO) means one who has the knowledge and responsibility to apply appropriate radiation protection principles and regulations.

Radioactive material means any material, whether solid, liquid or gas, which emits radiation spontaneously. (R.S. 30:1103)

Radioactivity means the disintegration of unstable atomic number usually accompanied by the emission of radiation.

Rem means a measure to the dose of any radiation to body tissue in terms of its estimated biological effect relative to a dose received from an exposure to one Roentgen (R) of X-rays. One millirem (mRem) = 0.001Rem. For the purpose of these regulations, any of the following is considered to be equivalent to a dose of one Rem:

(i) An exposure of 1 R of X or gamma radiation;

(ii) A dose of 1 rad due to X, gamma or beta radiation;

(iii) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye; or

(iv) A dose of 0.1 rad due to neutron or high energy protons.[2]

Restricted area (controlled area) means any area to which access is controlled by the licensee or registrant for purposes of protection of individuals from exposure to radiation and radioactive material. A Restricted area shall not include any areas used for residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area.

Roentgen (R) is the special unit of exposure. One Roentgen equals 2.58×10^4 Coulomb/kilogram of air. (See **Exposure**)

Sealed source means radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling.

SI means the International System of Units.

Sievert (Sv) means the SI unit of dose equivalent and is equal to one Joule per kilogram. One Rem is equal to 0.01 Sievert.

Source material means: (i) uranium or thorium, or any combination thereof, in any physical or chemical form or (ii) ores which contain by weight one-twentieth of one percent (0.05%) or more of (a) uranium, (b) thorium or (c) any combination thereof. Source material does not include special nuclear material as hereinafter defined (R.S. 30:1103).

Source of radiation means any radioactive material or any device or equipment emitting or capable of producing radiation (R.S. 30:1103).

Special form means any of the following physical forms of licensed material of any transport group:

(i) The material is in solid form having on dimension less than 0.5 millimeter or at least one dimension greater than five millimeters; does not melt, sublime, or ignite in air at a temperature of l,000°F; will not shatter or crumble if subjected to the percussion test described in Appendix B of this part; and is not dissolved or converted into dispersible form to the extent of more than 0.005 percent by weight by immersion for 1 week in water at 68° or in air at 86°F or

(ii) The material is securely contained in a capsule having no dimension less that 0.5 millimeter or at least on dimension greater than five millimeters, which will retain its contents if subjected to the tests prescribed in Appendix B of this part; and which is constructed of materials which do not melt, sublime or ignite in air at 1,475°F, and which do not dissolve or convert into dispersible form to the extent of more than 0.005 percent by weight by immersion for 1 week in water at 68°F or in air at 86°F.

Special nuclear material means:

(a) plutonium, uranium-233, uranium enriched in the isotope U-233 or in the isotope U-235, and any other material which the U.S. Nuclear Regulatory Commission, pursuant to the provisions of Section 51 of the Atomic Energy Act of 1954, as

amended, determines to be special nuclear material, but does not include source material; or

(b) any material artificially enriched by any of the foregoing, but does not include source material (R.S. 30:1103).

Special nuclear material in quantities not sufficient to form a critical mass means uranium enriched in the isotope U-235 in quantities not exceeding 350 grams of contained U-235; uranium-233 in quantities not exceeding 200 grams; plutonium in quantities not exceeding 200 grams; or any combination of them in accordance with the following formula: for each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all of the kinds of special nuclear material in combination shall not exceed "1" (i.e., unity). For example, the following quantities in combination would not exceed the established limit:

$$\frac{175 \text{ grams U-235}}{350} + \frac{50 \text{ grams U-233}}{200} + \frac{50 \text{ grams Pu}}{200} = 1$$

Survey means an evaluation of the production, use, release, disposal, and/or presence of sources of radiation under a specific set of conditions to determine actual or potential radiation hazards. When appropriate, such evaluations include, but is not limited to, tests, physical examination and measurements of levels of radiation or concentrations of radioactive materials present.

Technologically enhanced natural radioactive material (hereafter referred to as TENR) means natural sources of radiation which would not normally appear without some technological activity not expressly designed to produce radiation (R.S. 30:1103).

Temporary job site means any location where sources of radiation are used other than the location(s) listed in the license or registration certificate for non-licensed sources of radiation.

Test means a procedure for determining the characteristics or condition of sources of radiation or components thereof.

These regulations mean all parts of the Louisiana Radiation Regulations.

U.S. Department of Energy means the Department of Energy established by Public Law 95-91, August 4, 1977, 91 Stat. 565, 42 U.S.C. 7101 et seq., to the extent that the Department exercises functions formerly vested in the U.S. Atomic Energy Commission, its Chairman, members, officers and components and transferred to the U.S. Energy Research and Development Administration and to the Administrator thereof pursuant to sections 104(b), (c) and (d) of the Energy Reorganization Act of 1974 (Public Law 93-438, October 11, 1974, 88 Stat. 1233 at 1237, effective January 19, 1975) and transferred to the Secretary of Energy pursuant to section 301(a) of the Department of Energy Organization Act (Public Law 95-91, August 4, 1977, 91 Stat. 565 at 577-578, 42 U.S.C. 7151, effective October 1, 1977.)

Unrefined and unprocessed ore means in its natural form prior to any processing, such as grinding, roasting, beneficiating or refining.

Unrestricted area (uncontrolled area) means any + which access is not controlled by the licensee or registrant for purposes of protection of individuals from exposure to radiation and radioactive material and any area used for residential quarters.

Waste handling licensees mean persons licensed to receive and store radioactive wastes prior to disposal and/or persons licensed to dispose of radioactive waste.

Worker means any individual engaged in work under a license or registration issued by the Assistant Secretary and controlled by a licensee or registrant but does not include the licensee or registrant.

Working level (WL) means any combination of short-lived radon-222 daughters, polonium-218, lead-214, bismuth-214 and polonium-214, in one liter of air, without regard to the degree of equilibrium that will result in the ultimate emission of 1.3x105 MeV of alpha particle energy.

Working level month (ELM) means the occupational exposure incurred in one working month of 170 hours by individuals in an atmosphere containing radon daughter products; e.g., one working month in a mine atmosphere containing one Working level of radon daughter products equals one WSM.

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[2]If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron absorbed dose in rads, one Rem of neutron radiation may, for purposes of these regulations, be assumed to be equivalent to 14 million (1.4x10) neutrons per square centimeter incident upon the body; or, if there exists sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to one Rem

may be estimated from the table in Appendix D.