UNIVERSITY OF LOUISIANA
Lafayette

RADIATION SAFETY
&
OPERATIONS MANUAL

Revised: April 15, 2021

I. Contents

II. INTRODUCTION

The State of Louisiana is an Agreement State, under the Atomic Energy Act of 1954. This provision allows the state to assume regulatory authority for radiation protections, as long as the state regulations are in concordance with the minimum standards of the federal regulations. Therefore many of the policies set by the University will refer only to the state regulations (LAC 33 Environmental Quality, Part XV Radiation Protection (LAC 33:XV) or current equivalent).

The University of Louisiana at Lafayette (UL Lafayette) is authorized to utilize radioactive materials and operate sources of radiation under a broad scope license (Title 33:XV.327), LA-1794-L01 (renewed every 4 years). The authorizations are issued and regulated by Louisiana Department of Environmental Quality (DEQ), Division of Radiological Services. The University's license is 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, accounting, and management review that are necessary to assure safe operation, including:

- Appointment of a Radiation Safety Officer (RSO);
- Establishment of a Radiation Safety Committee (RSC);
- Control of movement and use of radioactive materials; and
- Development of administrative procedures for:
  - Controlling the procurement and use of radioactive material;
  - Evaluating safety of facilities and equipment, training, and experience of users.
- Evaluation of operating and handling procedures.
- Review, approval, and recording by the RSC of all safety evaluations.

The Radiation Safety and Operations Manual prepared by the RSC will allow all users of radioactive materials and radiation sources to be familiar with the rules and regulations under which they operate. In case of any conflicts between the guidelines set forth in this manual and the Louisiana Radiation Regulations, the latter shall prevail. This manual intends to enable all users to work in a safe environment while participating in an active research program. The RSC stands ready to assist faculty, staff and students. Please contact the RSO with any concerns. Electronic resources can be found at vpresearch.louisiana.edu/research-compliance/radiation-safety-committee.

Regulation of Radiation Exposure at the University of Louisiana at Lafayette

UL Lafayette is committed to keeping occupational radiation exposures to employees and students at the University of Louisiana at Lafayette (UL Lafayette) As Low As Reasonably Achievable (ALARA) through the following control measures.

ADMINISTRATIVE COMMITMENTS:

- Appointment of a Radiation Safety Officer (RSO) who is fully qualified to administer all aspects of a radiation protection program.
- Providing the RSO full authority to enforce safe operation and communicate, as required, to halt an operation determined to be unsafe
- Making those engaged in the use of radioactive materials and/or radiation producing equipment aware of the UL Lafayette administration's commitment to achieve minimal exposure.
- Providing training to those engaged in the use of radioactive materials and/or radiation producing equipment
- Ensuring training will be refreshed at least once every three years, and additional training will be scheduled as necessary
- Ensuring periodic review of operating procedures with the RSO to reduce exposures

VIGILANCE BY THE RSO AND RADIATION SAFETY COMMITTEE

The 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:

- The RSO shall know the origins of radiation exposure and be aware of trends in exposures.
- In the event an unusual exposure occurs, the RSO shall initiate an investigation of the circumstances, determine the causes, and work with the Authorized User to implement techniques that will prevent re-occurrences.
- Operating procedures should be periodically reviewed for situations in which exposures can be reduced.
- The RSO shall be responsible for ensuring that the radiation producing equipment is used and maintained in good working order.

SIGNED: Signature on File
Dr. E. Joseph Savoie, President
UL Lafayette

III. ORGANIZATION

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

A. RADIATION SAFETY OFFICER AND RADIATION SAFETY COMMITTEE

The Radiation Safety Officer (RSO), the members of the Radiation Safety Committee (RSC), and the Chair of the RSC are appointed by the Vice President for Research (VP Research). The RSO may also serve as committee chair. The RSC will consist of:

- The UL Lafayette Associate Director of Public Safety and Risk Manager (ex-officio),
- A member of the Office of the Vice President for Research, and
- Faculty and staff members from scientific departments on campus who possess the requisite expertise.

All matters pertaining to radiation safety programs at the University shall be addressed to the RSC, Chair, and the RSO. The RSC has the responsibility to see that the University radiation safety programs are carried out in accord with the Louisiana Department of Environmental Quality, Environmental Regulatory Code Title 33, Part XV, Radiation Protection (LAC 33:XV) or current version.

The Radiation Safety Officer will:

- Supervise the receipt of all radioactive materials and radiation producing devices for the University.
- Provide for annual inspection of laboratories utilizing radioactive materials and /or radiation producing devices.
- Receive and review records and reports from Authorized Users.
- Maintain a centralized location for records pertaining to the radiation safety program.
- Suspend laboratory activities with excessive radiation hazard or non-compliance with LAC 33:XV, or current version, as rapidly and safely as possible. In carrying out this duty, the RSO will report directly to the VP for Research.

The Radiation Safety Committee will:

1. Ensure the University complies with State (LAC 33:XV) and Federal (10 CFR parts 40 and 150) regulations governing the use of radiation.
2. Set the rules and policies for the safe use of radioactive materials and /or radiation producing devices. (LAC 33:XV.406.A).

3. Review and revise the radiation safety program, to ensure compliance with regulations, at intervals not to exceed 12 months (LAC 33:XV.406.C)
4. Complete safety evaluations of proposed uses of radioactive material taking into consideration – adequacy of facilities and equipment, training and experience of the user, and operating or handling procedures (LAC 33:XV.327.B.3.c.ii).
5. Review, approve and record the safety evaluations of proposed uses procedures (LAC 33:XV.327.B.3.c.iii).
6. Coordinate radiation area activities and teaching
7. Formulate and review the institutional radiation safety training information and programs
8. Prescribe special conditions required during a proposed use of by-product material, such as requirements for bioassays and physical examinations of users, and/or minimum level of training and experience of users.
9. Administer a radioactive waste disposal program.
10. Review, make recommendations, and approve plans for all new laboratories and buildings, and modification of existing structures where ionizing radiation is to be used.
11. Review instances of alleged infractions of safety rules or policies, and provide a mechanism to correct proven infractions with the assistance and concurrence of the departmental chairperson or supervisor of the involved person. The RSC may, by simple majority vote, restrict or suspend the operations of a user.

B. AUTHORIZED USER APPROVED BY THE RSC

The Authorized User is ultimately responsible for safety in 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 by this manual and the federal and state regulations. Specifically, the Authorized User shall be responsible for:

1. Submitting a completed Radiation Use Application Form for review and approval of each proposed radiation use project.
2. Re-submitting a Radiation Use Application Form for projects lasting more than 3 years to the RSC for re-review.
3. Adherence to the regulations, the safe use of radioactive materials and radiation producing devices by all laboratory personnel under his/her direction, and providing laboratory personnel access to this manual.
4. Participation in the training provided by the RSC every three years.

5. Training and supervision of all personnel working under his/her direction, in procedures and safety, especially emergency and decontamination procedures.
6. Consulting the RSO to obtain proper dosimetry to monitor radiation exposure of laboratory personnel.
7. Providing appropriate survey instruments and supplies for laboratories under his/her direction.
8. Marking and labeling of laboratories, radioactive materials and equipment.
9. Requiring all women who will be working with radioactive materials and radiation producing equipment to report pregnancy, as soon as possible.
10. Minimizing exposure to employees and visitors, especially minors (zero exposure) and declared pregnant women.
11. Procurement, storage, and disposal procedures of all radioactive materials and/or radiation producing devices under his/her direction.
12. Maintaining records of procurement, use, storage, and disposal of all radioactive materials or radiation producing devices or equipment in his possession.
13. Security of radioactive materials and/or radiation producing devices or equipment.
14. Immediate reporting of uncontained spills, suspected overexposure, theft of radioactive materials, and other accidents involving restricted areas, radioactive materials, or radiation producing devices or equipment to the RSO.
15. Monitoring and surveying of applicable facilities, materials, and equipment.
16. Requesting the RSO to survey any area previously containing radioisotopes or radiation producing devices prior to workman (maintenance, custodial, etc) accessing the area.

C. DIRECTORS AND DEPARTMENT HEADS

Directors and department heads shall be responsible for:

1. Directing new prospective users to contact the RSO or an RSC member for an application to use radiation.
2. Requiring new prospective users to obtain and review the Radiation Safety and Operations Manual.
3. Notifying the RSO of plans for new buildings or modifications of existing structures designed to house radioactive material or radiation producing equipment prior to construction or modification such that the RSC can review such plans.

4. Requiring users who terminated the use of radioactive material or radiation producing equipment or who leave the university to inform the RSO of the final disposition of any radioactive waste, unused radioactive material, and/or radiation producing devices in their possession.

IV. USER GUIDE

A. PURCHASING

Purchase of radioactive materials or radiation-producing equipment must be approved by the RSO. All radioactive materials or radiation producing equipment must be described in the Radiation Use Application Form, which is reviewed and approved by the RSC. The RSO will approve with signature, all paperwork associated with the purchase of radioactive material or radiation producing equipment.

B. GENERAL REQUIREMENTS FOR USE OF RADIATION SOURCES

1. LABORATORY DESIGN

Successful, safe work with radioisotopes requires laboratories and equipment specifically designed for that purpose. The RSO should be consulted in developing such plans. In general, the following guidelines shall be used:

- **Floors** – smooth, continuous, and sealed surfaces are recommended; tiles are acceptable if cracks are filled.
- **Walls, ceiling, and woodwork** - non-porous surfaces, should be washable.
- **Ventilation** - Labs that handle high activity unsealed radioactive compounds that may generate aerosols or may become volatilized require hoods with an average face velocity of at least 100 feet per minute and individual exhaust air filters
- **Equipment** - suitable equipment for the activity, type and level, must be available; use of absorbent paper and strippable paint is recommended.
- **Benches** - non-porous tops with no sharp corners
- **Monitoring** - appropriate to the radioisotope(s) used will be required as a routine procedure.

2. PERSONNEL

Potential Authorized Users planning to use radioactive materials or radiation producing equipment must submit a Radiation Use Application Form to the RSC for each project that will use radioactive

materials or radiation producing equipment. The form can be obtained from vpresearch.louisiana.edu/research-compliance/radiation-safety-committee.

Authorized Users are responsible for:

- Completing the RSC approved training once every 3 years
- Ensuring all personnel working with radiation or radioactive materials complete the RSC approved training once every 3 years
- Providing hands-on training of procedures and methods to all personnel working with radiation or radioactive materials
- Providing all records and reports required by the RSC
- Providing a prior exposure history on the Exposure History Form for each person with prior work related radiation exposure

3. FACILITY SECURITY

The Authorized User of radioactive materials and/or radiation producing devices shall be responsible for:

- Securing the facility against unauthorized entrance.
- Securing radioactive materials against unauthorized use.
- Securing radiation producing machines against unauthorized use or removal
- Prohibiting housekeeping or custodial staff from entering the facilities,
- Posting signs in accordance with the LAC 33:XV.450 and 451.

V. RADIOLOGICAL HEALTH PROCEDURES

A. RADIATION PROTECTION MEASURES

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

1. AUTHORIZED USER INSTRUCTIONS

In advance of any work involving radioisotopes or ionizing radiation, the Authorized User must:

a. Provide access to the Radiation Safety and Operations Manual for use in the laboratory.
b. Discuss the work to be done and the necessary safety precautions with laboratory personnel in accordance with the LAC 33:XV.
c. Provide specific written procedures for the use of radiation or radiation producing devices in the laboratory.
d. Obtain required personnel dosimetry devices from the RSO.

e. 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.
f. Provide and direct the use of remote handling devices, automatic pipettes or dispensers, tongs, etc., for the manipulation and transfer of radioactive preparations.
g. Require all users to participate in RSC approved Radiation Safety Training and read the Radiation Safety and Operations Manual.
h. Require all laboratory personnel must follow these work practices:
    i. Designate and label the radioactive work area(s) with signs containing the standard radiation symbol and words in compliance with LAC 33:XV.451.E and 102:
        - "Caution, Radioactive Materials" for 1 mCi of 14C or 10 mCi of ^{3}H (LAC 33:XV.451.E)
        - "Caution Radiation Area" for areas with a potential dose between 5 mrem and 100 mrem in 1 hr at 30 cm from the source (LAC 33:XV.451.A).
        - "Caution High Radiation Area" for areas with a potential dose greater than 100 mrem in 1 hr at 30 cm from the source (LAC 33:XV.451.B and 102).
    ii. Exceptions from posting:
        - X-ray machines for veterinary use (LAC 33:XV.452. C).
        - Sealed sources with less than 5 mrem per hour at 30 cm from the surface (LAC 33:XV.452.D).
    iii. Designate and label a "hot sink" for cleaning contaminated glassware. Tag the sink drain to be surveyed before plumbing work is done.
    iv. Designate and label a storage area for radionuclides not in immediate use
    v. Ensure labels on solutions containing radioisotope note the:
        - radioisotope,
        - activity and
        - date of activity
        - user name, when lab is used by multiple people
    vi. Ensure labels for sources exceeding Appendix C in LAC 33:XV.499 (i.e. >100 micro Ci of ^{14}C or >1000 micro Ci of ^{3}H) contain (in accordance with LAC 33:XV.453 and 454):
        - Radiation symbol
        - "Caution Radioactive Material, Notify Civil Authorities" or "Caution Radioactive Material, Notify University of Louisiana at Lafayette"
        - Identity of radionuclide

- Estimated quantity of radionuclide and date when at that quantity
- Radiation levels
- Kinds of materials

vii. Cover work surfaces, even non-porous bench tops, with plastic-backed absorbent paper to facilitate cleanup. Use stainless steel or plastic trays to help confine liquids, if spilled. Use disposable supplies whenever possible.

viii. Use a Geiger meter or scintillation probe calibrated within the last 12 months.

ix. Measure and record the radiation levels with a Geiger meter or scintillation probe (in mR/hr) in the
- work areas
- storage areas
- adjacent non-controlled areas

x. Provide sufficient shielding to keep radiation exposures ALARA

xi. Wear a lab coat and plastic or rubber gloves for protection of clothes and skin. Avoid spreading contamination by removing gloves at work area and removing lab coat before leaving laboratory.

xii. Wear eye protection.

xiii. Wear personal radiation monitor (TLD, film, dosimeter, etc.) on body and/or hands when applicable. Bioassay tests can be used to evaluate internal exposure to radioisotopes such as ^{3}H and ^{14}C.

xiv. Confine work with gaseous, volatile or dust forming radioactive material to hoods or glove boxes, as appropriate.

xv. Never pipette radioactive solutions by mouth. Mechanical devices must be used.

xvi. Prohibit eating, drinking, or cosmetics application in radioisotope work areas. Failure to do so can lead to accidental ingestion of radioactive material.

xvii. Use a “dry run” to preclude unexpected complications prior to working with highly radioactive materials. Address aerosolizing problems, if applicable.

xviii. Use labeled containers for radioactive waste and contaminated glassware. Avoid transporting contaminated articles from the work area through clean lab areas. Shield the waste containers as required to prevent unnecessary exposure.

xix. Check hands, feet and clothing with a Geiger meter for contamination after handling radioactive materials. Check work area at least at the end of each working day.

xx. When a spill is larger than the absorbent paper, or other accident occurs, alert nearby personnel, confine spill, block off and mark the area. Follow instructions in IV.D. Decontamination Procedures.

xxi. Keep "hot" containers and laboratory equipment in shielded containers. Shields should be used whenever possible.

2. SAFETY INSTRUCTIONS FOR CLASSROOM USE OF RADIOACTIVITY

Authorized Users are required to determine if any students are minors or pregnant prior to conducting classroom activities involving radiation. Consult the RSO if minors or pregnant women are in the class. Dosimeters or other suitable personal monitoring devices can be obtained from the RSO for temporary use. Pregnant women and minors have a dose limit of 0.5 rem annually (LAC 33:XV.416 and 417); using a badge to monitor dose is not required if the dose received is less than 10 percent of the annual dose (LAC 33:XV.431.A).

For classroom use of radioactive material/radiation producing devices, the protection limits set in LAC 33:XV. 410 must be followed – no one shall receive more than 5 rem total effective dose annually or the sum of a deep dose equivalent and a committed dose equivalent to any organ or tissue, other than the eye, of 50 rem. Under these conditions, personal monitoring is not necessary (LAC 33:XV.431.A.1), unless pregnant or a minor.

Prior to using radiation, students will be given instructions regarding the effect of ionizing radiations, their hazards and the instrumentation to be used. They will also be made familiar with the safety regulations and procedures regarding safe handling and use of radioisotopes or ionizing radiation producing devices (See AUTHORIZED USER INSTRUCTIONS)

B. EMERGENCY PROCEDURES

All cases of personnel or work area contamination shall be immediately reported to the Authorized User and the RSO. Spills requiring medical attention or exceeding the planned physical containment should immediately be reported to the University Police in addition to the RSO. 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 RSO.

- **NOTIFY AREA PERSONNEL**: notify persons in area that a spill has occurred.
- **PREVENT SPREAD**: cover liquid spills with absorbent paper. Block off area.
- **NOTIFY EMERGENCY PERSONNEL**: When the spill exceeds the planned containment, have someone notify university police and the RSO immediately after evacuating personnel and preventing the spread of radiation.
- **CLEAN AREA**: with caution (use protective disposable plastic gloves or decontamination tongs) fold absorbent paper or pad; insert into yellow plastic bag. Clean contaminated, unprotected areas with soap, water and paper towels; place these and contaminated PPE in the yellow plastic bag. When cleaning is complete, twist the top of the bag and wrap three times with radioactive warning tape, fold over the twisted top and wrap three more times with radioactive warning tape thereby sealing the plastic bag; dispose of sealed bag in solid radioactive waste material container. For more detail see Decontamination Procedures below.
- **SURVEY**: with a Survey Meter, check the area around the spill, hands, feet and clothing for contamination. If contamination is still present, repeat the cleaning procedure.
- **REPORT**: notify the RSO that clean-up is complete.

C. DECONTAMINATION PROCEDURES

Always notify adjacent personnel and block off area to prevent the spread of contamination, before beginning decontamination. Decontamination of people should occur as soon as the spread of contamination is stopped. Decontamination of the laboratory should occur after radiation is removed from personnel.

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. CLOTHING

- **Remove contaminated clothing** (or shoes) and place these items in plastic bags or containers for disposal.

- Check for skin contamination.
- After necessary body decontamination has been accomplished, put on protective gloves and an uncontaminated lab coat (or surgical gown).
- The RSO will provide final monitoring and advice.

b. SKIN

i. Determine level of skin contamination. A reading 2x above background is contaminated.

ii. Cover broken skin with a water proof bandage before washing.

iii. Type of washing depends on the degree of contamination:
- Widespread over body – shower up to 2 times, then focus on localized hotspots
- Localized on hands, arms or face – wash in sink to prevent contamination of other body parts

iv. Method of washing:
- Never use organic solvents or hair conditioner
- Use soap and lukewarm water to wash each area 1-2 minutes, rinse
- Dry and re-survey (towels should be discarded to radiation waste with each use
- If needed, repeat wash, dry and re-survey
- If still contaminated, repeat wash with light scrubbing – never let skin become irritated, dry and re-survey)
- Even if contamination still persists, washing should be halted before the skin becomes reddened and irritated.

v. When decontamination is completed, apply lanolin or hand cream to prevent chapping

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

c. HAIR

- Wash with liquid soap and rinse water up to 3x (no conditioner).
- Use towels, plastic backed paper or disposable gown to keep water from running onto the face and shoulders. Towels, paper and gowns are disposed of in radioactive waste.
- Notify the RSO if any difficulty is encountered in removing the contamination or if assistance is desired. The RSO should provide final monitoring.

2. DECONTAMINATION OF LABORATORIES

a. Confine radioactive material as much as possible to prevent spread to other areas

b. Wear appropriate PPE: protective gloves, lab coats or surgical gown, and shoe covers, if the floor is contaminated.
c. Use a survey instrument or wipe tests and a scintillation counter to locate contamination.
d. Remove the gross contamination caused by the spill, working from the edges inward
e. After removing spilled liquids and contaminated materials, soap and water should be used to remove remaining contamination.
f. All waste material should be placed in a yellow plastic bag or other container to prevent re-contaminating the area. The waste must be sealed in plastic bags as described in the section on Radioactive Waste.
g. The individual involved in the spill is responsible for the clean-up. CUSTODIAL STAFF CANNOT BE USED TO CLEAN UP RADIOACTIVE SPILLS.
h. The RSO can advise in the clean-up procedures and provide final monitoring for high activity spills.

D. NOTIFICATION OF INCIDENTS AND REPORTABLE EVENTS

1. Notification of incidents

Due to the reporting requirements of LAC 33:XV.486, the following must be reported by telephone to the RSO immediately.

- Any contamination or suspected contamination of personnel that could result in:
  - a total effective dose equivalent of 25 rem or more;
  - an eye dose equivalent of 75 rem or more; or
  - a shallow dose equivalent to the skin or extremities or a total organ dose equivalent of 2.5 Gy (250 rad) or more;
- 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) that could cause an individual to receive an intake 5x the occupational annual limit on intake. (This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.)

2. Reportable Events

To assist the RSO with the requirements of LAC 33:XV.487, Authorized Users are required to report any of the following occurrences within 48 hours of discovery:

- incidents as described above;
- sources that are lost or stolen

- doses in excess of any of the following:
  - the occupational dose limits for adults in LAC 33:XV.410
  - the occupational dose limits for a minor in LAC 33:XV.416
  - the limits for an embryo/fetus of a declared pregnant woman in LAC 33:XV.417
  - the limits for an individual member of the public in LAC 33:XV.421
  - any applicable limit in the license or registration
- levels of radiation or concentrations of radioactive material in:
  - a restricted area in excess of applicable limits in the license or registration
  - an unrestricted area in excess of:
    - 1 rem per year for total effective dose equivalent
    - 0.02 rem per hour
    - 5 rem of infrequent exposure from radiation machines

3. Contents of Reports

In accordance with LAC 33:XV.487.A, the following items are required for reports of incidents or reportable events:

- **Description** of the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:
  - estimates of each individual's dose
  - levels of radiation and concentrations of radioactive material involved
- **Cause of the elevated exposures**, dose rates, or concentrations
- **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
- **Identification** of overexposed individuals (on a separate sheet):
  - name,
  - driver's license or state identification number and the issuing state, and
  - date of birth.

E. RADIATION SURVEY PROGRAM

1. SURVEY PROCEDURES AND STANDARDS

a. SURVEY INSTRUMENTS

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 (^{3}H), since no satisfactory survey instrument is presently available for this isotope. Instruction of laboratory personnel in the use of survey instruments is the responsibility of the Authorized User.

b. FREQUENCY OF SURVEY

When unsealed radioactive materials are in use, Authorized Users are expected to:

- Survey every day that unsealed sources are used
- Wipe test weekly during the time period that radioisotopes are used.

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At a minimum, the RSO or a designated member of the RSC:

- Will conduct surveys of the user facilities on an annual basis
- Can conduct unannounced, spot surveys of areas where radiation or radionuclides are in use
- Will inspect the Records of the Authorized User during inspection
- Will record violations and notify the Authorized User by letter. Repeated violations may result in the RSC making a recommendation to the Vice President for Research for action against the user.

c. METHOD OF SURVEY

i. Geiger Meter

- Must be calibrated within the last 12 months
- Able to detect the radioactivity at 0.1 mR/hr or
- Appropriate for the energy being detected
- An end window GM or gas flow proportional counter with window thickness less than or equal to 1.5 mg/cm^2 normally may be used for assaying beta emitters at or above ^{14}C energies
- Hold probe about ½ inch away from the surface or wipe
- Authorized User will provide hands on training with the available detector

ii. Wipe Test

- Low energy beta emitters require liquid scintillation counting
- Filter paper is used to wipe areas that may be contaminated

- Areas wiped in laboratory must be indicated on a drawing of the laboratory space on the RS Form 4 Radiation Survey Form
- Counting may be accomplished by immersing the filter papers in scintillation fluid and using a scintillation counter
- A gamma-scintillation counter should be used for pure gamma emitters. The analyzer threshold should be set below the lowest gamma energy used in the lab (usually ^{125}I). The radionuclide can be identified from successive counts with different analyzer settings, if the settings have been calibrated with known energy standards.

iii. Package Wipe Test

These requirements come from LAC33:XV.1516.A.9, which references 49CFR 173.443)

- One filter paper
- For non-leaking packages, wipe a 7x7 cm square on all six sides. Enter the counts into formula:
  - (dpm/300cm^2)/0.1 wiping efficiency
  - For beta, gamma and low energy alpha emitters (see Appendix B)
    - < 240 dpm/cm^2 = no contamination
    - > 240 dpm/cm^2 = contamination NOTIFY RSO
  - For all other alpha emitters (see Appendix B)
    - < 24 dpm/cm^2 = no contamination
    - > 24 dpm/cm^2 = contamination NOTIFY RSO
- For non-leaking packages, wipe a 10x10 cm square from the edge toward the center of the leak
  Calculate radiation contamination as above.

d. RECORDING RADIATION LEVELS

The Radiation Survey Form (RS Form 4) should be used to record the results of the survey.

- Please print. Full names only; initials are NOT allowed.
- For multiple uses in the same area, draw a diagram, label and make multiple copies for completion as needed.
- Choose surfaces to wipe or survey for maximum probability of contamination detection.
- Enter N/A for items that do not apply.
- Levels 2x above background require decontamination and re-survey.
- If necessary, complete 2 sheets per day and record the time of the surveys next to the date.

- An end-window GM counter normally may be used for assaying beta emitters at or above ^{14}C energies; however, low energy beta emitters will require liquid scintillation counting, (example: Tritium).
- When using a liquid scintillation counter, a standard must be run with each set of vials.

2. *PERSONAL MONITORING*

Personal monitoring devices may include film badges, thermoluminescent dosimeters (TLD), optically stimulated luminescence (OSL) dosimeters or pocket dosimeters, according to specific investigator needs. Personal dosimetry devices must not be taken home or left in the laboratory areas where they may be exposed to radiation from radioactive material. The TLD badge is sensitive to heat and humidity and false positive readings may result when badges are left in hot cars, near hot windows, or other sources of heat.

a. TYPES AND USES OF PERSONNEL MONITORING DEVICES

i. FILM BADGES

This non-self reading dosimeter is capable of identifying and quantifying several types of radiation: x-rays, gamma, beta, and neutron. It is the least accurate for very low exposure and is sensitive to temperature and humidity. They can be worn either on the body or the finger. It must be sent to a company to have the radiation exposure determined.

ii. THERMOLUMINESCENT DOSIMETERS (TLD)

This non-self reading dosimeter is capable of identifying and quantifying several types of radiation: x-rays, gamma, beta, and neutron. It is more accurate than a film badge and is sensitive to temperature and humidity. They can be worn either on the body or the finger. It must be sent to a company to have the radiation exposure determined.

TLDs are used to monitor personnel for exposure of the body to penetrating ionizing radiation such as gamma and x-rays, and exposure of the skin to less penetrating radiation such as high energy beta particles. Results of the TLD badge readings are also used as estimates for the exposure of the lens of the eye. TLD badges cannot detect beta emissions from 3H, 14C or 35S, which are too weak to penetrate skin or travel more than 1 foot in air.

iii. Optically Stimulated Luminescence (OSL)

This non-self reading dosimeter is capable of identifying and quantifying the type of radiation: x-rays, gamma, and beta. Landauer offers the option to add a neutron detection chip to their badge. It is more sensitive than both film and TLD badges, can be worn longer, and it can be re-analyzed to confirm an exposure (an advantage over TLDs). They provide accurate readings even when exposed to temperature and humidity. They can be worn either on the body or the finger. It must be sent to a company to have the radiation exposure determined.

iv. RING BADGE

A type of film, TLD or OSL badge worn on the finger, used to determine external beta-gamma exposure to the fingers and hands when high doses or high activity radiation is used. It must be sent to a company to have the radiation exposure determined.

v. POCKET DOSIMETER

This direct-reading dosimeter is sensitive to gamma and X-ray. It is an ion chamber the size of a fountain pen with a direct-reading scale showing external exposure on the end. An advantage of using a pocket dosimeter is your exposure can be read immediately. A disadvantage is that dropping or tapping the dosimeter on the table can change the reading. The W138 dosimeters, available in the Accelerator Center and Geosciences, detect gamma and X-ray radiation from 16keV to 6MeV, 0-200mR. Pocket dosimeters are not efficient at detecting beta radiation and should not be used when this is the only type of radiation from the source. Pocket dosimeters are used:

(1) when a radiation field is so high that working time is very limited, and

(2) when a person is only temporarily exposed to radiation and needs to be monitored for a few days.

A TLD or OSL badge is more appropriate for longer periods radiation exposures.

b. REQUEST FOR PERSONAL MONITORING

Once the Radiation Use Application Form is approved, the Authorized User should contact the RSO to obtain personal monitoring devices for everyone in his/her laboratory who will be using radiation, including graduate students and technicians. If using Film, TLD, OSL or ring badges, each person must have their own assigned badge appropriate for the radiation.

c. EXPOSURE REPORT

When film, TLD, or OSL are used, annual exposure reports will be sent in accordance with the LAC 33:XV.1013.B to each individual. In the event that an exposure limit has been reached or is close to being reached, a report will be sent prior to the annual exposure report. An individual who has a question about his/her exposure should contact the RSO.

VI. IN VIVO USE OF RADIOACTIVE MATERIALS AND IONIZING RADIATION

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

A. Application

Special precautions and procedures used, and drawings of in vivo facilities where radioactive materials are to be used and/or organisms housed shall be provided to the RSC in the Radiation Use Application Form. The form is found at http:\\vpresearch.louisiana.edu/node/1393.

B. Posting

1. Appropriate radiation signs must be posted where organisms treated radioactivity are housed.
2. Additional minimal information must be posted:
   - The type and form of isotope administered to the animals.
   - The maximal amount given per group of animals and the date of administration.
   - The radiation emitted in mR/hr at one meter per group of animals.
   - The name and telephone number of the individual responsible for the project

C. Monitoring

1. The user is responsible for monitoring the following areas at least once each week: (Refer to Chapter IV. E. Radiation Survey Program)
   - Floor of the room housing the organisms.
   - Sink at which equipment is washed.
   - Radiation within an arm's distance of the organism(s), must in no case exceed 5 mr/hr unless adequate shielding is provided by the authorized user
2. Used and cleaned equipment must be washed, and monitored under the supervision of the user before being returned to storage.

3. 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/cm2 must be used.
4. Areas occupied by organisms treated with radioactivity must be surveyed at the termination of the experiment.
5. Records of all monitoring and surveying must be kept by the authorized user

D. ANIMALS

1. Feeding and watering of animals given radioisotopes should be supervised by the authorized user.
2. 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.
3. All radioactive excreta, bedding, food etc. 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.
   Sacrificed radioactive animals must be carefully monitored. Dissection, vivisection or biopsy of radioactive animals must be carried out in an appropriate glove box, approved hood, or properly ventilated and prepared facility.
4. Animals to be irradiated are not to be held in position for radiation exposure by humans.
5. The user is responsible for submitting an application to and obtaining approval from the Institutional Animal Care and Use Committee (IACUC) prior to beginning research involving animals.

E. PLANTS

1. All plants to which radioactive isotopes are to be administered need to be placed in container(s) so that application of substances with or without radioactive labels or isotopes do not result in contamination of the environment with radioactive materials.
   Caution should be used in the administration of radioisotopes such that any release in gaseous form, occurs with proper ventilation.
2. Exposure of plants to radioactive gas should be done under conditions which prohibit the accidental release of gas into the atmosphere
3. Monitoring soil or hydroponic solution is necessary before disposal. Radioactive disposal is to be performed as outlined in the chapter on "Radioactive Waste"

Excised plant materials must be carefully monitored. Dissection or maceration should be carried out with proper equipment to minimize radiation dose, release, and equipment or area contamination.

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

F. MICROBES

1. All microbes, grown in liquid or on gel, to which radioactive materials are added, should be handled with wet radio-biochemistry technique.
2. Radioactive materials, which may be metabolized to a gas, are to be used and incubated in a properly vented hood.
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 the sections on 'Solid Radioactive Waste' or 'Liquid Radioactive Waste', as appropriate, in the chapter on "Radioactive Waste".
4. Exposure of microbial cultures to radioactive gas should be done under conditions approved by the RSC via approval of the Radiation Use Application Form.

VII. ACQUISITION, RECEIVING AND STORAGE OF RADIOACTIVE MATERIALS

A. PROCEDURES FOR ACQUISITION OF RADIOACTIVE MATERIALS

1. ONLY AUTHORIZED USERS MAY ORDER RADIOISOTOPE MATERIALS. An authorized user must submit for approval a Radiation Use Application Form for each project and the RSC must approve the use prior to any acquisition of radioisotope. The RSC will review the proposed use, safety measures in place, required radiation safety training, record keeping and disposal of radioactive materials for the user laboratory. When satisfied that radiation can be used safely, the RSC will grant approval for the project. See Chapter III. Section B for general requirements pertaining to authorized users of radioisotopes.

2. ALL requisitions or purchases via credit card of radioisotopes or radiation producing devices must be approved by the RSO before processing by the purchasing department or vendor.

THE RSO WILL:

- Ensure the radioisotopes or devices to be purchased correspond with the approved Radiation Use Application Form;
- Ensure 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;

- If approved, sign and date the purchase requisition or email request for credit card purchases and send it to the next administrative level for signature. LAC will be notified to expect a package of radiation materials.
- If not approved, notify the primary user, so the user may either submit a modified Radiation Use Application Form or modify the purchase request to reflect the items approved by the RSC in accord with the University of Louisiana at Lafayette Radioactive Materials License.
- Ensure that the user has indicated a primary and secondary contact person who can receive materials (room numbers and telephone numbers are required for both primary and secondary contacts);

B. PROCEDURES FOR RECEIVING PACKAGES

All radioactive materials shipments approved by the RSO will be received at the UL Lafayette Louisiana Accelerator Center (LAC) unless otherwise authorized by the RSO. Items that will not be received include:

- Any purchases not approved by the RSO
- Damaged packages

Items that are not accepted will be returned to the vendor.

The RSO shall:

- Ensure that the appropriate LAC personnel will be instructed as to the disposition, handling and security of all radioactive materials received.
- Provide a calibrated survey meter to LAC personnel for routine survey of all packages prior to acceptance.

General Receipt Procedures.

1. Packages should be treated as contaminated until proven otherwise.
2. Place the package on a surface with absorbent material and survey.
3. If package is undamaged, not leaking and shows external radiation below 200 mrem/h (LAC 33:XV.455 & 1513.A), sign for package and complete numbers 1 - 4 of RS Form 3.
4. Place the package and RS Form 3 in the source room at an appropriate temperature and notify the RSO.
5. If a package is accepted without surveying, the survey must be completed within 3 business hours of the receipt. (LAC 33:XV.455. C)
6. If an accepted package is found to be damaged or leaking after delivery has been completed, notify RSO immediately. Damaged packages will be monitored for external contamination via wipe test.

7. Wipe the leak area (approximately 10x10 cm, starting wide and moving in). See Package Wipe Test for details
8. If the general wipe test assessment of 300 cm^2 finds radiation on the outside of the package exceeding 7200 dpm, the RSO will notify the carrier and DEQ (225-765-0160) (LAC 33:XV.455.D.1 and 1516.A.9 which references 49CFR173.443). See Package Wipe Test for details
9. RSO will notify the primary user that the material has been received. The secondary contact will be notified, if the primary contact cannot be located
10. The RSO shall deliver the package to the authorized user.

C. PROCEDURES FOR AUTHORIZED USER OPENING PACKAGES

1. Arrange to open and inspect packages as soon as possible after receipt.
2. Plastic or other protective gloves and a lab coat should be worn while opening packages for the protection of the surveyor.
3. If the manufacturer's directions for opening or unpacking radioactive material are provided, follow these directions in addition to those below.
4. Packages containing radioactive materials with associated high exposure levels may need to be opened behind a radiation shield and/or using other appropriate safety measures.
5. Procedure for Package Inspection
    - Receive in a prepared, protected place.
    - Observe outer package for mechanical damage or leakage stains and record the condition.
    - If stains are present - wipe 100 cm^2 area with dry wipe or filter paper. Assay for radioactivity (see Method of Survey). If evidence of radiation leakage is discovered contact the RSO immediately.
    - If no stains are present, follow the wipe tests methods for non-leaking packages in Package Wipe Test.
    - Complete items 5-9 on RS form 3. For items that do not apply to the shipment, enter N/A in the blank.

D. STORAGE OF RADIOACTIVE MATERIALS

1. Radioactive materials must be secured against unauthorized removal, as well as, be protected against loss, leakage, or dispersion by fire or water.
2. Storage sites for large amounts of radioactive materials should be as remote as practical, away from occupied areas.
3. Storage areas must be conspicuously marked with "Caution Radioactive Materials" signs and the area secured against unauthorized personnel, if the aggregate of radioactive materials stored in any area exceeds 10 times the quantity specified in LAC 33:XV.499.Appendix C.

4. Containers of solutions that emit radioactive gases should be labeled and sealed air tight. If an air tight seal is not possible, it should be placed in a hood or in an area with proper ventilation. Only the amounts of material necessary for immediate experimentation should be purchased.
5. All radioactive materials, exceeding the concentration shown in LAC33:XV.499.Appendix B and the amount shown in LAC33:XV.499.Appendix C shall be clearly labeled with the following:
    - radionuclide present,
    - chemical form,
    - estimate of the quantity of activity,
    - date of the activity, and
    - name of the user.
6. All appropriate records pertaining to the storage of radioactive materials shall be maintained.
7. All radioactive materials shall be inventoried annually on RS Form 5, which will be provided to the RSO.

VIII. RADIOACTIVE WASTE

Radioactive waste is defined as any material (solid, liquid, and/or gas) containing one or more radioactive nuclides, in which the material is no longer useful to the University for its intended purpose. Disposal of radioactive waste materials is an important part of any safety program. All authorized users, whether employee or student, must deposit radioactive waste from laboratories in the designated location for waste as determined by the RSO. Should the waste container in the staging area be filled to capacity, the RSO should be notified so that the container can be sealed for shipping and an additional empty drum can be provided. Procedures set forth for each type or radioactive waste shall be followed as appropriate.

Note: Radioactive waste containing **hazardous materials** must also abide by the hazardous waste requirements in the Environmental Health and Safety Policy, Section 11. Briefly,

- Must be disposed of within 270 days of generation
- Labels on the waste bags must include:
    - The words "Hazardous Waste" (2 inch high letters)
    - Name of the hazardous material contained therein
    - Isotope contained therein
    - Activity
    - Authorized user name
    - Date it became waste.

A. TYPES OF RADIOACTIVE WASTE

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. Includes any plant, animal, or microbial material which exhibits radioactivity above background
   b. Will be bagged and sealed in yellow plastic bag (4 mil) so no liquid may leak out or contaminant rub off.
   c. Must be wrapped or packed to prevent rupture of the bag
      - gauze
      - paper towels
      - vermiculite
   d. Use preservatives to retard specimen spoilage and possible release of radioactive gas from decomposition of the contents
      - such as salt,
      - formalin, or
      - phenol
   e. **Sealing the bag** - The top of the bag is twisted 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.
   f. The RSC will keep authorized users informed as to the waste disposal area(s) for biological radioactive waste with suitable containers into which the sealed waste bags are to be placed. Large quantities of materials require prior notification by the Authorized User to the RSC so that proper arrangements can be made
   g. Other biologically radioactive wastes such as excreta, bedding, food, etc. are to be handled as above.
   h. Radioactive soil waste should be handled as Solid Radioactive Waste.
   i. Solid radioactive culture media should be handled as above whether contaminated with microbes or not
   j. Liquid radioactive culture media should be handled as a Liquid, after treatment to stop microbial activity before disposal, whether contaminated with microbes or not (Preservative material should be carefully selected for solubility and/or solvent compatibility with unbreakable containers.)
   k. Complete RS Form 6

l. Labeled and sealed bags are transferred to the waste staging area and placed in the disposal drum.
m. Complete the log on the top of the drum

2. SOLID RADIOACTIVE WASTE

a. Containers temporarily storing waste in a laboratory
   i. Will be marked with "Caution Radioactive Solid Wastes" signs
   ii. Must have a yellow plastic bag liner (4 mil
   iii. When full or dose rate is 2 mrem/hr or greater at one meter from the container, the bag is sealed as above in Biological Radioactive Waste
d. Full bags will be transported to the waste staging area, as determined by the RSO.
e. Complete RS Form 6
f. Labeled and sealed bags are transferred to the waste staging area
g. Complete the log on the top of the drum

3. LIQUID RADIOACTIVE WASTE

Residual radioactive liquid in glassware may be put in the sanitary sewer during washing in a properly labeled sink. Sinks used to wash radioactive glassware and the drains below them must be identified with radioactive tape.

a. All non-scintillation, liquid waste is put in a labeled container
   - date waste is deposited
   - approximate activity
   - radioisotope
b. Do not mix solvents or chemicals that may react to form a gas or heat
c. One radionuclide per container
d. For long half-life, high energy gamma emitters, use an unbreakable container
e. Questions about the container suitability can be addressed to the RSC

.

f. All liquid radioactive waste shall be appropriately labeled and records kept on RS Form 6.
g. All hazardous waste shall be disposed within 270 days of generation.

4. GASEOUS RADIOACTIVE WASTE

a. Authorized users will not be allowed to perform work that exceeds, LAC 33: XV.499.Appendix B, Table I. All radioactive work under these limits involving radioactive gases will be performed under a hood that has been inspected by the EHS office.
b. Caution should be used with radioactive carbonates, because react with acids to produce $^{14}CO_2$.
c. 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 TITLE 33: XV.
d. All record keeping and reports shall be performed on RS Form 6).

5. LIQUID SCINTILLATION VIALS

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

a. One isotope per yellow waste bag (4mil) for scintillation vials
b. Waste bag must be appropriately labeled see hazardous materials
c. Discard intact vials with liquid secured inside
d. Broken vials should be discarded in a solid container that prevents leakage
e. Waste bags of scintillation vials must be removed within 270 days of the first deposit.
f. Secure the bag as above
g. Complete RS Form 6
h. Labeled and sealed bags are transferred to the waste staging area and placed in the disposal drum.
i. Complete the log on the top of the drum

B. LABELING OF WASTE

All containers of radioactive waste shall be marked with:

- Initial date waste is transferred into the container
- Radionuclide present
- Chemical form
- Estimate of the of activity
- Date of the activity
- Name of the user

In addition, a log of all waste contained in each container shall be maintained and updated as waste is added using RS Form 6.

IX. I Use of Radioactive Material in Research at the New Iberia Research Center

A. *OBJECTIVE*

To present basic requirements for the safe and effective use of radioisotopes in research at the New Iberia Research Center (NIRC). The intent of this chapter is to present a personnel specific guide to individuals directly involved in the conduct of experiments with radioactive materials at NIRC.

B. *PERSONNEL*

1. *General Information*

a. All personnel who will be directly involved with the use of radioactive material must be listed on the Radiation Use Application Form (Chapter III.B.).
b. Only Authorized Users with an approved Radiation Use Application Form may order radioisotopes or use radioisotopes.

2. *Study Director (Authorized User)*

a. The Study Director is responsible for the safety of all personnel involved in his or her research project and compliance requirements of the RSC.
b. The Study Director must obtain and complete the Radiation Use Application Form and obtain approval from the RSC prior to use of radioactivity for a project.

3. *Laboratory Personnel*

All laboratory personnel involved in the use of radioisotopes must follow the rules and procedures listed in Chapter IV.A.

C. *ORDERING AND RECEIPT OF RADIOISOTOPES*

1. The same principles apply as described in the User Guide
2. All radioisotope shipments must be received at the UL Lafayette, Louisiana Accelerator Center, unless otherwise authorized by the RSO.
3. Isotopes received at NIRC are subject to the package inspection procedures set forth in Chapter VI. B and C.
   a. Wear personal protective equipment (PPE) as required. A lab coat and protective gloves must be worn at all times. With gloved hands, place the package on a protective mat within an approved chemical or biological hood in a designated laboratory.
   b. Open the outer package.
   c. Remove items and verify the contents with the order requisition. Report any discrepancies to the Study Director.
   d. Check to confirm there is no evidence of leakage of material.

e. If contamination is suspected, take appropriate precautions, inform the Study Director and contact the RSO immediately for guidance.
f. If the inner containers are intact and there is no evidence of leakage, secure the materials in storage as indicated by the supplier, or prepare for use.
g. Monitor packing materials and empty shipping containers as specified by the Safety Manuel to insure there is no radioactive contamination.
h. Remove or deface all warning labels before discarding contamination-free shipping materials in regular trash containers.
i. Discard any contaminated materials into appropriate radioactive waste container.

4. The authorized user must complete the Radioactive Material Shipment Receipt Report (RS Form 3) and submit a PDF to the RSO.

D. HANDLING OF RADIOISOTOPES

1. Safety

a. Follow all rules and procedures listed in the Radiation Safety and Operations manual
b. Wear PPE appropriate for the radioisotope in use. Minimum PPE requirements for work with radioactive materials at NIRC consist of:
   - A closed lab coat
   - N95 respirator
   - Double gloved hands
   - Disposable face shield, Bionic Shield and/or goggles.
c. Work only in a designated area in a properly labeled work area.
d. Use absorbent paper in the radioactive material work areas to contain spills and splatter.
e. Ensure that all materials, reagents and equipment are available before starting a procedure.
f. Be mindful that certain lab equipment (centrifuge, shaker, vortex mixer) is capable of producing radioactive aerosol from liquid samples. Use this equipment in an appropriate manner.
g. Clean work area after handling radioactive materials and dispose of all contaminated material, including the absorbent paper and PPE, in a radioactive waste container.

2. Storage and inventory control of radioactive materials (see Chapter VI. D.)

a. Radioisotope stock vials are to be stored in accordance with the recommendations of the supplier in a designated, appropriately

labeled, and secure location within laboratory space authorized by the RSO.

b. Prepare a vial use log for each stock vial in storage, listing the date of receipt, radioisotope name, supplier, exact location, physical or chemical form, amount of activity upon receipt (mCi or Ci), amount used and date of use, amount remaining, and a space for affirmation by an authorized user.
c. Place the vial use log near the isotope storage site.
d. Complete the appropriate entries in the vial use log at the time of use.
e. Close each vial use log when a stock vial is placed into radioactive waste. Transfer the original to the project study records and forward a copy to the Study Director for subsequent incorporation into the Radioisotope Inventory Report (RS Form 5) for submission to the RSO.

3. Decontamination and Emergency Procedures

The protocols specified in Chapter IV.B for appropriate emergency procedures, and Chapter IV.C for decontamination of personnel and laboratories will be followed. Note: All cases of personnel or work area contamination must be immediately reported to the Study Director and the RSO.

4. Shipping Specimens from in vitro Studies to the Research Sponsor

a. Consult with the prospective carrier (e.g., Federal Express) for specific requirements prior to any planned shipment. Have specific information regarding the radioisotope available when contacting the carrier.

b. Follow requirements of the carrier with regard to packaging and labeling.

5. Disposal of Radioactive Waste (see, Chapter VII.)

a. Establish which of the four categories of radioactive waste will be generated by the study procedures.

b. Submit an expedited requisition for the appropriate radioactive waste container(s).

c. Maintain records of all biological, solid, liquid, and/or gaseous radioactive waste discarded on the Radioactive Waste Disposal Form (RS Form 6).

E. RADIATION SURVEY PROCEDURES (See Chapter IV. Section E.)

- Wipe Test to be performed as designated in approved RUAF.

a. Draw a diagram of the laboratory and/or list areas to be tested. These should be included as an Appendix to the study protocol.

b. Obtain an appropriate number of Wipe Test kits by contacting the Louisiana Accelerator Center.

c. Complete the record sheet supplied with the test kit for each wipe test.

d. Follow instructions provided by the reference laboratory and survey each of the designated work areas listed in the protocol. Label the test kit by area surveyed.

e. An individual wipe test should cover an approximate area of 100 cm^2.

f. A wipe test of all designated areas is to be conducted prior to use of radioactive material and at the completion of the study, and not less than once per month for long half-life radioisotopes should the use of radioactive material continue for more than one month.

g. Return the used test kit with accompanying survey form to the Louisiana Accelerator Center.

h. Original results of the survey are kept by the RSO with certified true copies to be included in the original study records.

X. Radiation-Producing Machines

A radiation-producing machine (RPM) has two definitions: 1) Any piece of equipment primarily intended to produce radiation, or 2) Any electrical equipment which is not primarily intended to produce radiation but produces sufficient radiation that might pose a threat upon exposure.

RPMs that fall into the definition 1 may include:

- X-ray diffraction or X-ray fluorescence units,
- Electron microscopes (**exempt from registration, see LAC 33: XV. 203. C.**)
- Medical X-ray equipment,
- X-ray radiography units,
- Cabinet X-ray systems, or
- Particle accelerators,

RPMs that fall into definition 2 may include:

- High voltage rectifiers,
- Transmitting tubes (such as found in commercial and amateur radio transmitters),
- High-power amplifying tubes (e.g., klystrons and magnetrons) used to produce microwaves, or
- Discharge tubes where the gas pressure can be varied.

Any electronic tube operating at a potential above 10 kV should be considered as a possible source of X-rays even though it may not have been designed for that purpose. Consult the RSO if there are questions concerning the radiation-producing potential of any equipment. The possession and use of radiation-producing machines is regulated by the LAC Title 33 Environmental Quality, Part XV Radiation Protection.

A. ACQUIRING RADIATION-PRODUCING MACHINES

1. Purchasing Machines

Any proposed purchase and installation of a radiation-producing machine must be reviewed and approved by the Radiation Safety Committee. Complete a Radiation Use Application Form and submit to the RSO. The RSO through the University's chain of command will register the new machine with the Louisiana Department of Environmental Quality.

2. Loans or Other Transfers of Machines

The RSO must be notified in advance when any radiation-producing machine is planned to be acquired as a loan, transfer or a gift from another institution or from any individual or department at the University. The RSO will inspect to ensure a safe location has been chosen and through the University's chain of command register or update previously registered machines with the Louisiana Department of Environmental Quality.

B. EXPOSURE MONITORING

Depending on the specific type of radiation-producing machine, it may be necessary to monitor radiation exposure of workers in the vicinity of the equipment. The RSO administers the radiation exposure monitoring program for all persons using RPMs at the University.

C. RADIATION SURVEYS

The Authorized User is required to make periodic surveys to check for radiation leaks during operation. This can be accomplished by placing a dosimeter near the machine during operation and recording the reading following operation. The RSO will also perform radiation surveys on any existing RPM and any newly installed, relocated, or modified equipment, and following any service that could affect the equipment's radiological safety. As necessary, the RSO will conduct spot exposure checks for all RPMs to insure compliance.

D. TRAINING

All Authorized Users are required to follow Chapter III above. Workers who use RPMs must receive basic radiation safety training provided by the RSO before starting work. Specific training may be available, depending on the type of radiation. The RSO will determine which if any additional training is required. Machine-specific training will be provided by individual faculty members, PIs, or the RSO, as necessary. All persons who are occupationally exposed to radiation while using a RPM will receive basic radiation safety training.

XI. RECORD KEEPING, REPORTS AND FORMS

A. RECORD KEEPING AND REPORTS

The procedures of these chapters are to be followed in compliance with LAC 33: XV regulations.

- All authorized users shall provide the RSC with a copy of all previous records of exposure or complete RS Form 2, so that the records may be obtained.
- All records showing radiation exposure history of authorized users shall be maintained by the RSC.
- For authorized users requiring radiation dose monitoring, the reporting of exposure dose shall be for periods of time not exceeding one calendar year (refer to Chapter IV.E.2.)
- Records of survey instruments calibrated annually will be maintained by the RSC and shall be available for inspection in accordance with the LAC33:XV. Contact the RSO for assistance with survey instrument calibration.
- Radioisotope Inventory shall be recorded and returned to the RSO at the end of each semester
- Sealed source inventory shall be recorded annually and returned to the RSO
- Radioactive waste deposited in the waste area will be recorded on the waste log on top of the drum.

B. FORMS

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

RADIATION USE APPLICATION FORM – available online

EXPOSURE HISTORY RELEASE – This form is used to list all locations where work or research related exposures have occurred and to give them permission to release this information to the University of Louisiana at Lafayette RSO permission to request and receive them.

RADIOACTIVE MATERIAL SHIPMENT RECEIPT REPORT – This form will be used by the RSO or his designee and the authorized user to document the condition of radiation containing packages upon receipt from the shipper.

RADIATION SURVEY RECORD – Use this form to record survey results after use of unsealed radioactive sources, either via Geiger meter or wipe test and scintillation counting. These should be kept in a binder near the area surveyed for inspection by RSO and DEQ.

RADIOISOTOPE INVENTORY REPORT – Use this form to report your inventory of radiation producing sources at the end of each semester.

RADIOACTIVE WASTE DISPOSAL – Use this form to catalog radioactive waste.

XII. APPENDIX A: GLOSSARY OF TERMS

Absorbed dose - 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).

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

Agreement State - 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).

Authorized User – any person who has completed the radiation safety training approved by the RSC and is listed on a Radiation Use Application Form. This person is authorized by the RSC to use radiation as described in the Radiation Use Application Form.

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

By-product material - 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.

CFR - Code of Federal Regulations.

Curie - a unit of measure 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 (μCi) = 0.000001 Curie = 3.7×10^{4} dps. One Curie = 3.7×10^{10} Becquerel.

DEQ - Department of Environmental Quality

Dose equivalent - 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 rad 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).

Emergency - any condition existing within or outside of the jurisdictional confines of a facility licensed or registered by the DEQ 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

Exposure - being exposed to ionizing radiation or to radioactive material.

Gray - the SI unit of absorbed dose, equal to one joule per kilogram. One rad = 0.01 Gray (Gy).

GM – Geiger-Müller counter

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

Inspection - 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 - 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 radio waves, or visible, infrared or ultraviolet light.

Licensee - the University of Louisiana at Lafayette, which holds a broad scope license from the state of Louisiana for the use of radioactive material.

Licenses - general licenses and specific licenses.

General license - 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.

Specific license - 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.

mR/hr - millirem per hour

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

Naturally-occurring or accelerator-produced radioactive material (NARM) - 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 - 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 - 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.

rad - the special unit of absorbed dose equal to 0.01 Gy. 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 - 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. Unless specifically stated otherwise, these regulations apply only to ionizing radiation.

Radiation area - 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 millirem, or in any 5 consecutive days, a dose in excess of 100 millirem.

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

Radiation Safety Committee – group of individuals appointed by the Vice President for Research. In accordance with LA regulations, it minimally consists of the RSO, a representative from management, and persons trained and experienced in the safe use of radioactive material LAC 33: XV Title 33, Part XV, Section 327,B,3,b.

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

Radioactive material - any material, whether solid, liquid or gas, which emits radiation spontaneously.

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

rem – (Röentgen equivalent in man) a measure of 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. If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron absorbed dose in rad, one rem of neutron radiation may, for purposes of these regulations, be assumed to be equivalent to 14 million (1.4×107) 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 LAC33:XV.199Appendix A.

Restricted area (controlled area) - 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) - the special unit of exposure. One Roentgen equals 2.58×10^4 Coulomb/kilogram of air. (See Exposure)

Sealed source - 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 - the International System of Units.

Sievert (Sv) - the SI unit of dose equivalent, equal to 1 Joule per kilogram. 1 rem = 0.01 Sievert.

Source of radiation - any radioactive material or any device emitting or capable of producing radiation.

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

(i) The material is in solid form having no 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; 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 tests; 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.

Survey - 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 are 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) - natural sources of radiation which would not normally appear without some technological activity not expressly designed to produce radiation. (R.S. 30:1103)

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

U.S. Department of Energy - 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.)

Unrestricted area (uncontrolled area) - any space where 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.

XIII. APPENDIX B: LISTING OF RADIONUCLIDES

ISOTOPE Name	(half-life t1/2) Energy, eV	Annual Limits on Intake (µCi)	Derived Air Concentration * (µCi/mL)	Critical Body Organs
^{3}H, Tritium	t1/2: 12.30 years ß: 18 keV	oral: 80,000 inhaled: 80,000	2×10^{-5} > 1000 µCi requires labeling	whole body tissue
^{14}C, Carbon-14	t1/2: 5730 years; ß: 156 keV	oral: 2,000 inhaled: 2,000	>1000 µCi requires labeling	fat, body tissue
^{22}Na, Sodium-22	t1/2: 2.6 years; ß: 1.82 MeV γ: 2 MeV	oral: 400 inhaled: 600	3×10^{-7} >10 µCi requires labeling	ß: whole body tissue γ: eyes
^{32}P, Phosphorus -32	t1/2: 14.3 days ß: 1.7 MeV	oral: 600 inhaled: 900	4×10^{-7} >10 µCi requires labeling	bone, lungs
^{35}S, Sulphur-35	t1/2: 87.2 days ß: 0.3 MeV	oral: 10,000 inhaled: 20,000	7×10^{-6} >100 µCi requires labeling	gonads, lungs
		Ten-fold lower values apply for: sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, Mo and sulfates of Ca, Sr, Ba, Ra, As, Sb and Bi		
^{36}Cl, Clorine-36	$t_{1/2}$: 301,000 years ß: 0.7 MeV	oral: 2,000 inhaled: 2,000	1×10^{-7}, >10 µCi requires labeling	whole body, lungs
^{45}Ca, Calcium-45	$t_{1/2}$: 164 days ß: 0.257 MeV	oral: 2,000 inhaled: 800	>100 µCi requires labeling	
^{59}Fe, Iron-59	$t_{1/2}$: 44.5 days ß: 1.56 MeV	oral: 800 inhaled: 300	1×10^{-7} >10 µCi requires labeling	spleen, lungs
^{131}I, Iodine-131	$t_{1/2}$: 8 days ß: 0.807 MeV	oral: 30 inhaled: 50	2×10^{-8}	thyroid,

XV. APPENDIX C: Instructions for using lasers

1. Preamble

Lasers are ubiquitous in modern tools and instruments. The word "laser" is an acronym for *Light Amplification by Stimulated Emission of Radiation.* A laser is a device that produces intense visible or invisible light – both of which have the potential to cause damage under specific conditions. Several entities have created classification systems that are used to instruct the user about needed protections.

The Federal Food, Drug and Cosmetic Act (FFDCA), Chapter V, Subchapter C - Electronic Product Radiation Control, controls the design and manufacture of laser products. Regulations concerning safe laser use have been developed and vary by state. At the time of writing, the State of Louisiana only has regulations that forbid directing a laser beam at a police officer, or aircraft. However, the Federal Occupational Safety and Health Administration (OSHA) does have specific standards that address laser safety. Moreover, the American National Standards Institute (ANSI) as well as the International Electrotechnical Commission (IEC) are two international organizations that write rules and guidelines for laser safety. The IEC rules are the more useful for risk management and there is a movement to adopt these as, or in lieu, of the Federal standard. The Food and Drug Administration (FDA) has stated that they plan to adopt a "least burdensome approach" and have no objection to conformance to IEC 60825-1 and 60601-2-22 with regards to laser classification. (FDA Laser notice No. 50, June 24, 2007)

The goals of these instructions are to ensure laser devices containing Class 3 or Class 4 lasers are operated at UL Lafayette in a safe manner and have the appropriate safety controls to minimize the risks of exposure to laser beams for University employees, students, and the public.

2. Classification of lasers and laser devices/products

In IEC 60825-1, lasers are classified into one of four classes according to their potential for causing damage to the eyes and skin of humans. Class 1 presents the lowest hazard and class 4 the highest. Class 1 and 2 have a sub-classes Class 1M and Class 2M that denote they present an eye hazard if they are viewed with an optical instrument such as a magnifying glass or eye loupe within 10 cm or about 4 inches. Class 3 has sub-classes R and B that denote a low risk from short (0.25 s) accidental exposure or there is a major risk of eye damage and/or skin burns.

Normally, the laser class is marked with a label on the laser/laser device, which commonly states if the laser is continuous or pulsed, the power and the wavelength(s) of the light.

International Electrotechnical Commission Classification

Laser Class	Characteristic	Subclass characteristic
Class 1	Regarded as not able to give eye damage during operation	M – indicates there is a risk of eye damage if light collecting optics(1) are used to view the beam.
Class 2	Visible light beam and the aversion reflex normally prevents eye damage	M – indicates there is a risk of eye damage if light collecting optics(1) are used to view the beam.
Class 3	Viewing direct and specular (Mirror-like) reflections can be hazardous but not diffuse reflections. Does not pose a fire hazard.	R – hazardous for direct viewing and reflected beam into the eye. B- avoid exposure to the beam. More hazardous than 3R.
Class 4	The direct beam is hazardous to the eye and skin. May produce a hazardous diffuse reflection or fire hazard.	No subclass.

(1) Light collecting optics include telescope, binoculars, magnifying lens or eye loupe.

2.1 Class 1 / Class 1 M laser devices.

It should be noted that a "Class 1" or "Class 1 M" laser device refers to an instrument or tool where the beam is completely enclosed by screens. In this case, the instrument or tool may be classified as a laser Class 1 or Class 1M device, even though it contains a Class 3 or even Class 4 laser, because the beam is completely inaccessible and shielded from the operator. An example of a Class 1 laser device is a CD/DVD recorder/player which typically contains a laser of Class 2 where the beam is completely enclosed inside the device.

2.2 Hazard assessment

Normally, the manufacturer's signage on the laser/laser device and in the instruction manual will provide a reliable and appropriate indication of the laser/laser device class. The hazard level, and hence class, is assigned based on the emitted wavelength(s), if the beam is continuous or pulsed, the beam diameter and divergence. These are compared with the Maximum Permissible Exposure (MPE) and the extent of the Nominal Hazard Zone (NHZ). This will be determined by the manufacturer and is posted on the information on the laser hazard label/sign.

It is recognized that UL Lafayette is a research environment and instruments may need to be modified or used for a purpose other than originally intended. In this situation, a new laser/laser device class must be assigned in consultation with the Radiation Safety Officer.

3 Laser safety, control and mitigation

3.1 Administrative

Only Class 3 and Class 4 lasers are required to be registered with the RSO at UL Lafayette at the time of procurement. Contractual requirements may require that instruments classified as Class 1/1M laser devices are registered if they contain Class 3 or Class 4 lasers. Class 1/1M laser devices to be registered do NOT include those intended to be used in a domestic environment (as is the case for CD/DVD players and laser printers etc.).

Laser pointers of the type normally used in lecture rooms and labs do not need to be registered. However, high-power laser pointers that are used in the teaching of astronomy (field demonstrations) and in measuring the speed of light or similar lab experiments should be registered. Laser scanners such as used at checkouts are also exempt.

Consultations will be carried out by a member of the Radiation Safety Committee, who will ensure that signs are appropriate, beam shielding is in place and interlocks are appropriate and functioning.

3.2 Training

In the case of registered Class 1/1M laser devices containing a higher class laser, and Class 2/2M lasers, the responsible user, will confirm that normal users have read the safety instructions pertaining to lasers in the instrument/tool manual.

3.2.1 Training for Class 3 lasers

When class 3 lasers and beams are not fully encased in an instrument to prevent exposure and reduce to a Class 1 laser device rating, the responsible user should at least have received instruction relating to laser safety pertaining to the specific device. The form and manner of the instruction is at the discretion of the RSO. If the laser generating equipment has training and instruction from its manufacturer, this will be considered favorably. Additionally, prior experience and/or certifications in the use of lasers will also be considered. A responsible user should have completed laser safety

training. Normal users will be instructed by the responsible user in laser safety with the laser instrument.

3.2.2 Training for Class 4 lasers

The responsible user must complete laser safety training. The users must be given laser safety training either by completing a laser safety training course or detailed instruction on the specific instrument by the responsible user.

3.3 Engineering controls

Engineering controls are physical devices or constructions that minimize exposure of people to laser beams. In class 1/1M laser devices the beam is totally enclosed for example.

When a complete instrument is procured, the manufacturer will normally build in appropriate laser safety functions that prevent the user from being exposed to the laser beam, making it a Class 1 device.

3.3.1 Class 1M, 2, 2M, 3R laser engineering controls

These depend on the specific set-up. Controls ensure that lasers are never directed at people, even accidentally:

- Personnel should never look directly at the beam, especially with magnifiers, such as magnifying lenses and telescopes
- Laser beam should be terminated by a non-reflective surface
- Laser beam height is adjusted to be above or below normal eye height
- Prevent unintentional reflections

3.3.2 Class 3B laser engineering controls

Again, this depends on the particular instrument or situation. When open laser beams are used, safety measures must include all controls for lower classes and:

- Personnel access by means of locked door
- Laser warning signs posted at the entrances to the area
- Remote interlock connected to room or door circuits – prevents laser energizing or reduces laser energy when door is open
- Key required to activate the beam – remove when not in use
- Laser emission indicator
- Prevent unintentional reflections
- Laser beam should be terminated by a non-reflective surface

- View diffuse reflections through a screen at a minimum distance of 13 cm and no more than 10 s without goggles.
- Eye protection is required for direct or specular reflected beam viewing or diffuse viewing not meeting the above requirements – ensure eye protection optical density is appropriate for the laser beam in use
- Protective clothing may be needed in some instances
- Completely opaque (for the wavelength in question) window curtains or blinds to prevent laser light from escaping outside from the room or area where its used

3.3.3 Class 4 laser engineering controls

This class requires the strictest controls. Use all the controls for 3B lasers and the additional ones listed here:

- Beam paths should be enclosed whenever practicable
- Use of non-flammable laser-resistant materials for curtains and clothing
- Operate via remote control, when possible
- Good Illumination of the room
- Appropriate beam stop, such as cooled metal or graphite, designed to spread the laser power over a wide area
- Beam and target area should be surrounded by opaque material for the emission wavelength in question.