

NDSU

NORTH DAKOTA STATE UNIVERSITY

RADIATION SAFETY HANDBOOK



RADIATION SAFETY

University Police & Safety Office

1523 – 12th Avenue North

Fargo, ND 58102

Telephone: 701-231-7759 Fax: 701-231-6739

Dear Faculty, Staff, and Students of North Dakota State University:

In the use of radiological substances, all investigators at North Dakota State University must follow procedures to assure the radiological safety of employees and students. These procedures apply to all education and research activities conducted by faculty, students, staff, or other representatives of the University.

In order to comply with state and federal regulations relevant to the safe use of radiological substances and radiation producing devices, North Dakota State University has established an institutional committee competent to oversee the implementation and enforcement of the NDSU Radiation Safety Handbook. This committee has been designated as the University Radiation Safety Committee.

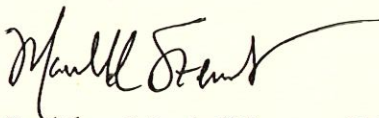
The primary functions of the University Radiation Safety Committee are:

1. To maintain and revise the NDSU Radiation Safety Handbook as appropriate to ensure compliance with regulatory changes.
2. To advise the University Administration on changes to ensure regulatory conformity.
3. To assist and support the Radiation Safety Officer in maintaining adherence to the management plan and other regulatory requirements.

The committee membership will include a representative of the University's Administration.

All educational and research activities involving the use of radiological substances or radiation producing devices shall be conducted under the conditions of the NDSU Radiation Safety Handbook. All members of the university community are expected to comply with both the spirit and the letter of this plan.

Sincerely,



President Marshall Stewart, Ed.D.

OFFICE OF THE PRESIDENT

102 Old Main | NDSU Dept 1000 | PO Box 6050 | Fargo ND 58108-6050
701.231.7211 | Fax 701.231.8722 | www.ndsu.edu

2026 Radiation Safety Committee:

Mike Borr: Radiation Safety Officer; Director, University Police & Safety Office

Fred Haring: Administration Representative

Wenhao Dai: Professor, AES Plant Sciences

Scott Hoselton: Core Laboratory Facility Director, AES Microbiological Sciences

Bernhardt Saini-Eidukat: Professor, Chemistry and Biochemistry

Beth Tacke: Chemist, AES Veterinary Diagnostic Services Department

Angel Ugrinov: Director Material Characterization Lab, Chemistry and Biochemistry

Brandon Gustafson: Associate Director UPSO, Environmental Health and Safety

Ver. 052026

I.	Introduction	1
A.	Purpose of the Handbook	1
B.	Scope of the Handbook.....	1
II.	Administration of the Radiation Safety Program.....	1
A.	Radiation Safety Committee	2
1.	Organization and Membership of the Committee.....	2
2.	Duties and Responsibilities of the Radiation Safety Committee	3
3.	Schedule of Meetings.....	4
4.	Appeal of Committee Actions	4
B.	Radiation Safety Officer	4
1.	Duties of the Radiation Safety Officer	4
C.	Radiation Safety Staff.....	5
D.	As Low As Reasonably Achievable (ALARA)	5
III.	University Requirements Governing the Use of Radioactive Materials	6
A.	Procurement of Radioactive Material.....	6
B.	Transfer of Radioactive Materials.....	6
1.	On Campus Transfers	6
2.	Off Campus Transfers.....	7
C.	Authorization to use Radioactive Materials	7
1.	Summary of the Process	7
2.	Personnel Authorization	8
3.	Project Authorization	10
4.	Facility Approval.....	11
5.	Sealed Sources or Radiation Producing Devices	12
6.	Radioactive Materials or Radiation Producing Devices as Teaching Aids.....	14
D.	Exposure Control.....	16
1.	Permissible Levels of Radiation Exposure.....	16
2.	Pregnant Employee Policy	16
3.	Dose to Members of the General Public.....	17
4.	Dose to Minors.....	17

5.	Planned Special Exposure	17
E.	Personnel Monitoring	19
1.	External Monitoring	19
2.	Internal Monitoring.....	21
F.	Principal Investigator Responsibilities	22
1.	Duties	22
2.	Records Maintenance	23
3.	Monitoring Requirements.....	23
4.	Terminating or Transferring Employees and Students	24
G.	Responsibilities of Authorized Users	24
H.	Procedures for Laboratory Use of Radioactive Material	25
1.	Preventing Personal Contamination	25
2.	Security of Radioactive Materials	27
3.	Protective Rules for Controlling Contamination of Laboratory Facilities and Equipment.....	27
4.	Use of Caution Signs and Labels	28
5.	Small Animal Experiments.	29
I.	Procedures Related to Sealed Radioactive Sources.....	29
1.	Handling Precaution.....	30
2.	Leak Testing and Inventory Requirements.	30
3.	Signs and Labels.	31
4.	Shipping and Repair.	31
5.	Special Source Type: Moisture Gauges (Neutron Source)	31
6.	Special Source Type: Gas Chromatograph Detectors	34
J.	Disposal of Radioactive Waste.....	34
1.	General Considerations.....	35
2.	Documentation.	35
3.	Segregation of Waste.....	35
4.	LSC Vial Disposal.....	38
5.	Waste Pick-up.	38
6.	Radioactive Waste Disposal Flow Chart.....	39
IV.	Appendices.....	40
A.	Radiation Emergency Procedures	40

1. Minor Spills (involving no radiation hazard to personnel).....	40
2. Major Spills (involving radiation hazards to personnel)	41
3. Accidents Involving Radioactive Dusts, Mist, Fumes, Organic Vapors, And Gases.....	41
4. Injuries to Personnel Involving Radioactive Materials.....	42
5. Overexposure, Ingestion or Inhalation	42
6. Fires Involving Radioactive Material	42
B. Waste Disposal Chart for Laboratory Personnel.....	43
C. Waste Handling Chart for Radiation Safety Staff.....	44

I. Introduction

A. Purpose of the Handbook

The purpose of this handbook is to provide information to the users of radiation emitters so that they may comply with University, State and Federal regulations concerning the safe use of radioactive materials and radiation producing devices. It is also the purpose of this handbook to guide the user through the procedures which are required to obtain University authorization for projects, personnel, and facilities.

This manual is intended to supplement, summarize, and clarify existing State and Federal regulations and should not be construed to be at variance from these laws. Adherence to these procedures will ensure that researchers, teachers and students may continue to use radiation sources under the University license with the assurance that they will not be exposed to excessive hazards. Failure to comply with State and Federal regulations can jeopardize the University license and thereby the research resources of the University.

The North Dakota Radiological Health Regulations are hereby made a part of this manual.

B. Scope of the Handbook

The NDSU Radiation Safety Handbook governs the use of radioactive materials and radiation producing devices at the main campus at Fargo, all satellite campuses, research farms, experiment stations and other areas under the administrative control of NDSU. All research workers, faculty, staff, and students employed by or attending NDSU are subject to these regulations.

II. Administration of the Radiation Safety Program

Ultimately, the President of the University is responsible for the University Radioactive Materials License. The NDSU Radiation Safety Committee (RSC) is the licensing and regulatory agency on the campus, and, as such, is responsible only to the President. The Radiation Safety Officer (RSO) is responsible only to the RSC and through them to the President. The duty of the RSO is to institute/execute the decisions of the committee and enforce the regulations of the NDSU Radioactive Materials License. The isotope users are responsible to the RSO, the RSC, and through them to the President.

It is the policy and intent of the University that all levels of Radiation Safety Program Administration strive to keep radiation exposures to levels which are as low as reasonably achievable (ALARA), with economic and social factors being taken into account.

A. Radiation Safety Committee

Due to the increased utilization of ionizing radiation on the campus, it was deemed appropriate and necessary that a committee be appointed to formulate policies, consistent with existing laws that assure radiological safety for all personnel. Such a committee, the Campus Isotope Committee, now called the NDSU Radiation Safety Committee (RSC), was established by a letter from the office of the President on June 1, 1961.

1. Organization and Membership of the Committee

The Radiation Safety Committee (RSC) includes the Radiation Safety Officer and members who shall be appointed by the Provost of the University. A representative of the University's Administration will serve on the Committee.

The activities of the committee are directed by the chairperson who is appointed by the Provost of the University upon recommendation by the committee.

Membership should consist of faculty and professional staff experienced in handling radionuclides, the use of radiation producing or emanating devices, the practice of radiation protection, or those who have a desire to institute practices of safety with regard to radiation.

The business of the Committee is administered through the University Police and Safety Office (UP&SO). The Radiation Safety Officer (RSO) is a full-time professional staff member of the UP&SO and is appointed to this position based on experience, education and qualifications in the area of Radiation Safety with the ultimate approval of the State Licensing Authority, the North Dakota Department of Environmental Quality. The RSO is a voting member and serves on the committee to provide technical advice and to serve as a liaison between the committee and authorized users.

A quorum of the Committee to conduct business shall consist of the RSC Chair (or his/her alternate), the RSO, one representative of management (or his/her alternate), and at least one technical member from each topical area to be discussed.

The RSC delegates the RSC Chairperson and the RSO, acting as a team, the authority to review, grant or deny temporary permission for use of radioactive materials during the interim between Radiation Safety Committee meetings. Such decisions are subject to final approval or denial after review at the next scheduled Committee meeting.

2. **Duties and Responsibilities of the Radiation Safety Committee**

In accordance with letter from the President, the committee was charged with the responsibility of performing the following duties:

- a) Review and grant or deny permission for the use of radioactive isotopes within the institution from the standpoint of safety.
- b) Prescribe special conditions and requirements as may be necessary (such as physical examinations, additional training, designation of limited areas or locations of use, disposal methods, etc.).
- c) Prepare and disseminate information on radiation safety for the use and guidance of staff and students.
- d) The RSC is authorized to evaluate and approve or disapprove the adequacy of safety measures and health protection for safeguarding University employees and students.
- e) The RSC and its chairman or the RSO shall keep a record of the actions taken in approving the use of radioisotopes and other transactions, communications and reports involved in the work of this committee.
- f) The chairman of the RSC and the RSO are authorized to act for the committee between meetings, reporting his or her actions to the committee for review at appropriate intervals.
- g) Provide policy direction to the RSO, based upon State and Federal regulations and licenses, for the use of ionizing and non-ionizing radiation at NDSU.
- h) Review and approve or disapprove all applications from prospective users of radioactive materials and from prospective operators of sources of ionizing and non-ionizing radiation.
- i) Approve or disapprove all applications for facilities in which radioactive materials are to be used or in which sources of ionizing or non-ionizing radiation are to be operated.
- j) Review plans for all new buildings or modifications to existing buildings in which the use of radioactive materials or other sources of ionizing radiation is involved.

k) Authority to suspend any operation that, in the opinion of the RSC, represents a serious radiation hazard or violates applicable regulations. Act as the final authority in reviewing any operation suspended by the RSO.

3. Schedule of Meetings

The RSC shall meet at least once a quarter with additional meetings as often as necessary to conduct the business of the Committee. The Chairman of the Committee shall advise the members of the time and place of the meeting and shall arrange for a different time of the meeting if the original time is not convenient for the majority of the members.

4. Appeal of Committee Actions

Appeals to the actions taken by the Radiation Safety Committee should be directed to the Chairperson of the Radiation Safety Committee.

B. Radiation Safety Officer

A position of Radiation Safety Officer was established by letter from the President of the University on January 11, 1962, in which the duties of this position were outlined.

1. Duties of the Radiation Safety Officer

The duties of the RSO have been defined to include, but are not limited to, the following items:

- a) The day-to-day administration and development of the Radiation Safety Program.
- b) Disseminate information on Radiation Safety and Health Physics.
- c) Review all proposals for radiation usage and recommend to the RSC approval or disapproval of all applications from prospective users of radioactive materials and from prospective operators of sources of ionizing and non-ionizing radiation.
- d) Inspect facilities and equipment on behalf of the RSC.
- e) Review plans of all new radioisotope and radiation facilities.
- f) Obtain all necessary licenses and registrations pertaining to radioactive materials and sources of ionizing and non-ionizing radiation for the University.
- g) Develop procedures for the purchase and transfer of radioactive materials.
- h) Develop procedures for the disposal of solid and liquid radioactive wastes.
- i) Maintain required records including the following:

- (1) personnel dosimetry
 - (2) radioactive waste disposal
 - (3) radioisotope inventory
 - (4) instrument calibration
 - (5) leak tests of sealed sources
- j) Provide radiation surveys and monitoring of all radioisotope and radiation facilities.
- k) Offer brief courses on radiation safety for users and prospective users of radioactive materials and ionizing and non-ionizing radiation.
- l) Suspend any operation which, in his or her opinion, represents a serious hazard or violates applicable regulations. The operation suspended will be reviewed by the RSC.
- m) Conduct an Annual Self Audit of the licensed activities.

C. Radiation Safety Staff

The Radiation Safety Staff consists of any Health Physics technicians operating under the supervision of the RSO and performing such tasks as waste pick-up, and other duties as assigned.

D. As Low As Reasonably Achievable (ALARA)

As stated earlier in this section, it is the policy and intent of the University that all levels of the Radiation Safety Program Administration strive to keep radiation exposures to levels which are as low as reasonably achievable, with economic and social factors being taken into account.

The Radiation Safety Committee, through the RSO and the radiation safety staff, incorporates the ALARA Policy into safety activities described elsewhere in this Manual. Tasks directly related to ALARA include:

- Review of Project applications and amendment requests to ensure that procedures are conducted and facilities are used in a way to minimize exposures.
- Conduct contamination checks of all incoming shipments of radioactive materials.
- Ensure that radioactive material users have been adequately trained in exposure guidelines and exposure minimization techniques.
- Inspect on at least an annual basis the facilities and projects involving the use of radioactive materials. The investigation will include a review of the PI's radionuclide inventory, authorization, RAM processes, training records, and contamination

survey records. Any problems encountered during the audit are discussed with laboratory staff or the laboratory supervisor and, when necessary, with the PI. Authorized personnel are responsible for correcting any problems identified through these audits. Written corrective action plans may be required. Notice of uncorrected or repeated deficiencies will be forwarded by the RSO to the Radiation Safety Committee for their action which may include suspension of radioactive materials usage privileges.

- Conduct an investigation whenever:
 - There is a radioactive material incident such as a spill, or when a wipe survey indicates contamination of equipment or facility;
 - A personal dosimeter report identifies an exposure in excess of 40 millirems, or if the same individual receives an exposure in excess of 10 millirems in two consecutive reporting periods;
 - A thyroid scan indicates an elevated level of radioiodine.
- Such investigation will be conducted by the RSO and shall include a discussion of the incident, ways to prevent a recurrence, operating procedures, equipment/facility review, and ways that exposures can be reduced. The investigation will be documented.

III. University Requirements Governing the Use of Radioactive Materials

A. Procurement of Radioactive Material

All radioactive materials intended for use at North Dakota State University shall be procured through the University Police and Safety Office's Radiation Safety Office. The Radiation Safety Office will approve the purchase, process the order request and place the order. Only persons authorized by the Radiation Safety Committee may place a request to purchase radioactive material.

B. Transfer of Radioactive Materials

1. On Campus Transfers

- a) Transfer, exchange, or other disposition of radioactive materials and/or radiation emanating equipment to other laboratories or individuals shall not be made without prior approval of the RSC, since approval for use of such materials is given only for the original working area.

b) All transfers between laboratories, or from storage areas to working areas, must be done in a manner as to minimize the probability of spillage or breakage. Double containers should be used, including suitable shielding, for such transfers.

c) Responsibility for obtaining approval lies with the original owner of the radioactive material. Approval may be obtained by contacting the Radiation Safety Office.

2. Off Campus Transfers

a) Radioactive material shall not be shipped or transferred to or from the University without the approval of the Radiation Safety Officer. Approved shipments must be packaged and labeled in accordance with the Department of Transportation Regulations, North Dakota Radiological Health Regulations, the Nuclear Regulatory Commission Regulations, or the U.S. Postal Regulations, whichever is applicable.

C. Authorization to use Radioactive Materials

1. Summary of the Process

All use of radioactive materials at NDSU must have approval of the Radiation Safety Committee.

Approval or denial of an application to use radionuclides in research and development by the Radiation Safety Committee is based on:

- Training in and experience with radionuclide usage of the applicant
- Proposed use of the radionuclides in the project and the precautions that are in place for the safe use of the radionuclides
- Type of radionuclide and amount to be used
- Adequacy of the facility and equipment for the projected use and compatibility of the project to other uses of the laboratory
- Training and experience of others working on the project

Application forms can be obtained from the University Police & Safety Office and must be submitted to the Radiation Safety Officer who will evaluate and present the application to the Radiation Safety Committee. Applicants are advised that this process may take several weeks and are, therefore, urged to submit their application sufficiently in advance of the proposed start date. If the proposed activity lies outside the scope of our existing license, acquisition of an amendment from the North Dakota Department of Environmental Quality Radiation Control Program is required and the process may take significantly

longer.

The application should be submitted on a Radiation Project Summary form available on the University Police & Safety Office website. Applicants are reminded that it is important to completely answer all applicable questions prior to submitting the application. Much time is lost if the application is returned with a request for more information.

If the proposed project will use a facility which has not been approved as a radionuclide laboratory, a Facility Approval Request for Radioisotope Usage form should accompany the Radiation Project Summary form. See section III.C.4 for more information.

2. Personnel Authorization

The qualifications of each applicant will be evaluated by the RSO and the RSC. Authorization to use radioactive materials or radiation producing devices will be granted to applicants who, in the opinion of the Committee, demonstrate the ability to use radioactive materials in a safe manner.

Personnel should apply for authorization using the form titled "Radiation Statement of Training and Experience" which includes the Statement of Agreement.

The amount and level of training will be evaluated based on the type of work expected of the individual requesting authorization. Required training to use isotopes or radiation producing instruments is expected as follows:

- a) A principal investigator must have accredited or certified course-work in radioactive materials use which meets the requirements of the Radiation Safety Committee. (Minimum of the NDSU Radiation Safety Short Course)
- b) Post-doctoral and research staff must attend the NDSU Radiation Safety Short Course and should have experience with the radionuclides requested or experience with the equivalent radionuclides or demonstrated competency to conduct specific radionuclide techniques. At the discretion of the Principal Investigator, these individuals may be trained in the laboratory in order to gain this experience.
- c) Graduate Students intending to use isotopes in their research must have completed the NDSU Radiation Safety Short Course.
- d) Graduate Students intending to use radiation producing equipment (x-ray, neutron gauges, etc.) must complete training with their supervisor and attend a Radiation Safety Short Course for the instrument they will use.

e) Technicians must attend the Radiation Safety Short Course and complete training with their supervisors or as required by the RSC.

f) Undergraduates or other types of employees will be required to meet the training set for them by the RSC as determined by their level of use of radioactive materials and their experience and education.

NOTE: All of the above categories of personnel, regardless of experience or training or the type of work planned or type of isotope used, MUST apply to the RSC for authorization to use radioactive materials or radiation producing instruments under the license of NDSU. There are no exemptions and no exempt materials.

Continued authorization requires the completion of a radiation safety refresher course conducted by the RSO at least every five years.

The authorization to use radioactive materials or radiation producing devices under the auspices of the license of NDSU requires that the authorized individual will strictly follow the regulations within that license. These regulations are set forth in this handbook and in the North Dakota Radiological Health Rules, a copy of which is on file in the RSO's office. It is also the responsibility of any person using radioactive materials or radiation producing devices to minimize their exposure and the exposure of students or individuals in the surrounding area. Exposure to ionizing and non-ionizing radiation must be kept as low as reasonably achievable, and in any event, within the limitations imposed by this document and any requirements set by the RSC.

Regular Authorization will be granted to an applicant if:

- a. The applicant has had sufficient training and/or experience with radioisotopes to carry out the proposed work in a safe manner.
- b. The work to be performed as set forth in the Project Summary is commensurate with the applicant's knowledge and ability relative to the hazards involved.
- c. The applicant agrees in writing to follow all University, State and Federal regulations governing the use of radioactive materials and agrees to assume all risk of and responsibility for personal injury resulting from failure to comply with such regulations.
- d. The applicant submits, upon the request of the RSC, a record of a recent complete blood count, a history of past occupational and medical exposures, and shall meet any special medical requirement of the RSC.

Temporary Authorization: If the applicant has not, in the opinion of the committee, had adequate training or experience, he or she may be granted temporary authorization provided:

- a. Supervised on-the-job training is available such that the applicant works under the direct personal supervision of, and in the presence of, an individual who has received regular authorization; or, the applicant is in the process of taking formal course work or training
- b. The work involves low levels of activity as specified by the Radiation Safety Officer.
- c. The authorization shall expire after six months at which time the applicant may apply for regular authorization.
- d. The requirements of paragraph c and d above under Regular Authorization are met.

3. **Project Authorization**

The project for which radionuclides are requested shall be reviewed by the Radiation Safety Officer and the Radiation Safety Committee for feasibility based on the applicant's experience with the radionuclides requested for the project and other information given on the Radiation Project Summary application form. Project authorizations are good for a period of up to five years and are reviewed on an annual basis during scheduled visits by the Radiation Safety Officer. At his or her discretion projects with extended periods of inactivity may be discontinued.

- a) Authorization will be granted for the project if:
 - (1) Personnel listed on the project meet the requirements set forth above for personnel authorization
 - (2) Adequate facilities exist for the safe handling and use of the requested radioactive material
 - (3) The requested radioactive material is within the allowed limits of the radioactive materials license
 - (4) All other RSC concerns have been addressed

b) Amendments to Projects

Any change in the use of radioactive materials or sources of ionizing radiation from that described in the application shall be discussed with the RSO.

Significant changes, such as an increase in isotope needed, use of an open source as opposed to a sealed source, use of dry powders instead of a less hazardous form, etc., require an amendment to the project. The amendment

may be temporarily approved by the RSO and the Chairperson of the Radiation Safety Committee if only minor changes are involved. The full Committee's approval is necessary if significant changes are involved.

c) Temporary Authorization

The RSO and the Chairperson of the Radiation Safety Committee working collaboratively have been authorized by the RSC to issue a temporary approval at their discretion. Temporary approval must be specifically requested and for justifiable reasons. Temporary approval is valid for up to 90 days.

d) Project Renewal

Projects are subject for review (and subsequent renewal) at the discretion of the RSO. Renewals of projects will be valid for an additional period of five years. Submit the Radiation Project Renewal form to the University Police & Safety Office at least 30 days prior to the expiration date of your project to guarantee that the authorization stays in effect pending the renewal.

Projects which entail the use of radioactive materials in teaching laboratories must be renewed prior to each use. See section III.C.6 for more information.

e) Revocation of Authorization

The Radiation Safety Committee has the right to revoke any authorization granted if, in its opinion, sufficient justification exists.

4. Facility Approval

Radioactive Materials are to be used only in those facilities which have been approved by the RSO and the RSC.

a) Requests for Facility Approval.

Principal Investigators desiring to use radioactive materials in an area which has not been approved by the RSC must submit a Facility Approval Request, either prior to or at the same time as the proposal application is submitted. The RSO and/or representatives of the RSC will examine such facilities and either approve or make recommendations for improvement prior to approval.

b) Release of Radioisotope Laboratories for Unrestricted Use.

In the event that a greenhouse, radioisotope laboratory, or other facility approved for the use of radioactive materials is to be abandoned or released for unrestricted use, the principal investigator will notify the RSO/ARSO so that a thorough radiation survey can be made just prior to such abandonment or release. If appropriate, decontamination must be done. All radiation warning signs, tags, and labels shall be removed. After the survey has been accepted, the laboratory will be released for unrestricted use. If, in the future, it is desired to

use the facility for radioactive materials, application for reactivation using the Facility Approval Request will be required.

c) Monitoring Instruments.

Unless specifically exempted by the RSC or the RSO, each laboratory in which radioactive materials are used shall have on hand and in operating condition, a properly calibrated survey meter or monitoring instrument appropriate to the type and level of ionizing radiation used.

d) Other Radiation Safety Equipment.

The RSC may require the use of other special equipment or devices necessary to assure the safe use of radionuclides or radiation producing devices in a given situation. This includes special shielding, handling tools or tongs, alarms and warning devices, air sampling equipment, and other such apparatus. Radioactive waste containers are required as specified in Section III.J.

5. Sealed Sources or Radiation Producing Devices

a) Moisture or Density Gauges (Neutron Source)

(1) Training and Experience Requirements.

(a) The prospective user must attend an NDSU Neutron Gauge Short Course or equivalent course at another institution.

(b) Application must be made to the Radiation Safety Committee for permission to operate the instrument.

(c) The authorized user shall have knowledge of the radiation hazards associated with the gauge.

(d) The user must be familiar with the emergency procedures to follow in the event of an accident with the source.

(e) The user shall have knowledge of the requirements of this handbook.

(f) The user shall have at least 8 hours of field use of the gauge under the direct personal supervision of an approved user or the manufacturer's technical representative, or equivalent training and experience as determined by the RSC.

(2) Authorization for the Use of Gauges.

(a) Any student or employee wishing to use a neutron gauge must have a Principal Investigator who is authorized to use a radioactive sealed source of that type.

(b) The forms to be completed and turned in to the RSO are:

(i) Statement of Training and Experience for each individual who is to be using the probe.

(ii) Statement of Agreement for each individual using the probe.

(iii) Request for Film Badge Service.

(c) Sealed sources of radioactive material are required to be leak tested every six months. The RSO will assign a leak test schedule to the probe as convenient as possible for the user.

(3) Temporary Authorization.

In instances of summer personnel being hired after the Radiation Short Course has been held, temporary authorization is possible for that individual in the following sequence:

(a) Obtain packet of study materials on fundamentals of gauge use.

(b) Study the materials.

(c) An oral quiz will be administered by the Principal Investigator. If the oral quiz is passed then the forms in III.C.5.a)(2)(b) shall be submitted to the RSO.

(d) Training in field use shall comply with III.C.5.a)(1)(f).

(4) Exposure Monitoring Requirements.

Any person operating or supervising someone operating a neutron source moisture or density gauge must wear a film badge or TLD monitoring badge. See section III.E.1 for more information.

b) X-Ray Producing Devices

(1) Training and Experience Requirements.

No person may operate an x-ray producing instrument or device

without safety instructions pertinent to the instrument. The Radiation Safety Training covered in Veterinary Science 255, The Radiation Safety Program and sign-off sheet employed in Chemistry's X-Ray Diffraction Lab or the X-Ray Safety Training program from the University Police & Safety Office are all acceptable. All prospective users of such instruments or devices must be trained to operate them under the direct supervision of a Principal Investigator, who may be assigned by the RSC.

(2) Registration of the X-Ray device.

It is required that all x-ray producing devices, whether for diagnostic, teaching or research purposes, must be registered with the North Dakota Department of Environmental Quality. Registrations are conducted and kept current by the RSO.

(3) Exposure Monitoring Requirements.

The personnel who operate an x-ray producing device are required to wear a monitoring badge. In addition, some instruments require area monitors to be placed near them in areas where leakage of the x-ray beams is the most likely to occur. These area monitors can be substituted for personnel badging in the event of a class using the device where there will likely be minimal or no exposure to the individuals. See section III.E.1 for more information.

c) Irradiation Sources

Contact the Radiation Safety Office for information related to other types of sealed radioactive source instruments.

6. Radioactive Materials or Radiation Producing Devices as Teaching Aids

The use of radioactive materials and radiation producing machines as teaching aids requires special precautions. This is because these individuals are considered to be members of the "general population" as opposed to "radiation workers" and as such, the allowable limits of radiation exposure are quite low.

a) Requests for Approval of the Experiments.

(1) Define the Experiment.

The experiment planned must be submitted to the RSC on the Project Summary and Evaluation form along with the laboratory handout (or a draft copy). Indicate how many students will be directly involved, what level of radioactive material or exposure they will be near, what materials they might be handling and

what radiation safety instruction they will receive before the experiment.

(2) Identify the Class or Lab Members.

Every semester the class is given a class list must be submitted along with the application for approval. This list is kept on file in the RSO office to record what exposure the class received and in what context.

(3) Identify the Facilities.

If the laboratory has not previously been approved for the use of radioisotopes, a Facility Approval form must be submitted along with the above material.

b) Duration of the Approval.

Approval is given only for the class session(s) for which approval is sought. The new class list must accompany each request for approval. ***Each Time an Experiment Is Done Using Radioactive Materials as a Teaching Aid it must Be Submitted to the Radiation Safety Committee for Approval.*** For laboratory experiments that are identical to previously approved experiments, a memo may be used in lieu of the Project Summary and Evaluation.

c) Termination of the Experiment.

Upon completion of the experiment, the principal investigator will notify the RSO who will:

(1) Pick up any radioactive waste produced.

(2) Pick up for storage and/or disposal all radioactive material used for the experiment.

(3) Swipe test and release the laboratory for unrestricted use if uncontaminated.

d) Radiological Safety Considerations.

Principal investigators are reminded that the students most likely have not had previous experience with radioactive materials. Also, as previously mentioned, the precautions necessary to insure the safety of individuals from the “general population” are necessarily quite strict.

- (1) If the students will be handling radioactive materials or using radiation producing machines, or in any way exposed to ionizing radiation, then they shall be given a preliminary discussion concerning the precautions necessary for the safe use of the radioactive materials or radiation producing machines.
- (2) The principal investigator will be in the laboratory at all times.
- (3) Any additional safety requirements of the RSC shall be met.

D. Exposure Control

The following levels of exposure and details of special circumstances related to ionizing radiation are set in the North Dakota Radiological Health Rules and as such are adopted by the State of North Dakota. They are based on recommendations by the National Council on Radiation Protection.

1. Permissible Levels of Radiation Exposure.

- a) Occupational dose limits for adults: The licensee or registrant shall control the occupational dose to individual adults as follows:
 - (1) An annual limit, which is the more limiting of:
 - (a) the total effective dose equivalent being equal to five-hundredths sievert [5 rem]; or
 - (b) the sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to five-tenths sievert [50 rem].
 - (2) The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities, which are:
 - (a) a lens dose equivalent of fifteen-hundredths sievert [15 rem]; and
 - (b) a shallow dose equivalent of five-tenths sievert [50 rem] to the skin of the whole body or to the skin of any extremity.

2. Pregnant Employee Policy

Any woman employee who declares her pregnancy, in writing, to the Radiation Safety Officer will be further protected by the following radiation dose limiting guidelines. Such guidelines will be followed, regardless of when the woman

declares the pregnancy.

- a) The declaration of pregnancy must be in writing, and shall indicate an estimated date of conception.
- b) The woman does not have to supply proof of the pregnancy.
- c) The woman may withdraw her declaration at any time if she decides that she no longer wants the lower dose limit to apply to her.
- d) If the woman works in a room containing radioactive material or an x-ray machine and is not being monitored, monitoring will be initiated at the time of declared pregnancy.
- e) If the woman works in a room containing radioactive material or an x-ray machine and is being monitored, the following limits apply:
 - (1) Her dose shall not exceed 500 millirem over the course of the entire pregnancy.
 - (2) Example: If she has received more than 450 millirem by the time of declared pregnancy, she is only allowed an additional 50 millirem.
 - (3) Work assignments will be adjusted to encourage a consistent, rather than variable monthly dose. (i.e., 50 mRem, 50 mRem rather than 10 mRem, 90 mRem in successive months).
- f) The woman's job assignment may be adjusted during the pregnancy to limit her dose. If there is adjustment in the job assignment, the woman's rate of pay or hours will not be reduced.

3. Dose to Members of the General Public

Surveys of exposure rates will be conducted around all sources of higher energy beta and gamma emitters. If a member of the general public could be exposed to a dose of 100 millirems or more, then access will be restricted or additional shielding added. Documentation of surveys will be maintained on file in the University Police & Safety Office.

4. Dose to Minors

Occupational Dose Limits for minors (under 18 years of age) are 10% of the limits specified for adults.

5. Planned Special Exposure

A Planned Special Exposure (PSE) is a situation that necessitates that an

employee receive a higher-than-normally-allowable exposure to respond to an urgent and/or severe situation.

Planned Special Exposures will only be used under exceptional circumstances (such as a source disconnection), and will not be used as a routine method of increasing dose limits. An employee who is a minor or a pregnant woman will never receive a PSE.

The following conditions must be met:

- a) **Prior Written Authority:**
The Radiation Safety Officer shall authorize the PSE in writing prior to conducting the activity that will result in the PSE.
- b) **Individual Informed and Instructed:**
The Radiation Safety Officer shall inform the employee(s) involved in the PSE of:
 - (1) Purpose of the Planned Operation.
 - (2) Expected radiation levels, estimated dose, and associated risks, and
 - (3) Measures to be taken to keep the dose as low as reasonably achievable.
- c) **Determine Prior Dose:**
All previous PSE's and all doses in excess of routine occupational limits must be subtracted from the limits for the PSE prior to authorization.
- d) **PSE's and Exposure Limits:**
Individuals receiving PSEs can receive a maximum dose in 1 year of any or all of the following:
 - (1) 10 rems total effective dose equivalent (5 rems from routine operations and 5 rems from PSEs); or 100 rems to any individual organ or tissue, including any deep-dose equivalent plus the committed dose equivalent for the organ or tissue (50 rems from routine operations and 50 rems from PSEs); and
 - (2) 30 rems dose equivalent to the eye (15 rems from routine operations and 15 rems from PSEs) and
 - (3) 100 rems to the skin or to any extremity (50 rems from routine operations and 50 rems from PSEs).

Individuals can receive a lifetime dose from PSEs of any or all of the following:

- (1) 25 rems total effective dose equivalent; or 250 rems to any individual organ or tissue; and
 - (4) 75 rems to the eye; and
 - (5) 250 rems to the skin or to any extremity.
- e) Documentation:
The PSE will be documented by the RSO and this documentation will be kept on file at the Safety Office. A copy of the documentation will be sent to the North Dakota State Department of Environmental Quality within 30 days of the PSE.
- f) Informing the Worker:
A copy of the completed PSE documentation will be supplied to the affected employee(s) within 30 days of the PSE to inform them of the dose received.

E. Personnel Monitoring

1. External Monitoring

a) Issuance of Monitoring Devices

In order to ascertain that the above exposure levels are not being exceeded, certain experiments or isotope users are required to be badged with whole body TLD's (thermo-luminescent dosimeter) or film badges. In addition, finger badges will be required if the proposed use involves high exposure to hands from a high energy beta or gamma emitter. The RSO will determine the need for TLD's and finger badges. General guidelines for issuance of the monitoring devices are as follows:

- (1) When working with beta emitters with a maximum beta energy exceeding 0.250 MeV
- (2) When working with X-Ray or gamma emitters of any energy (exception: I-125 in amounts less than 100 uCi)
- (3) When working with neutron sources of any type
- (4) When working with X-Ray producing devices

The RSC, in approving a project or person, may further recommend area or personnel monitoring. Badges and exposure records are to be maintained by

the University Police & Safety Office. Badges are to be worn at all times that exposure to OCCUPATIONAL radiation is possible. (This excludes any medical or environmental radiation exposure.)

By regulation, any person occupationally exposed to radiation must be issued and shall use an individual monitoring device such as a film badge if he or she is likely to receive a dose in excess of 10% of the allowable limits noted above in section III.D. In general, any use of gamma, neutron, or high energy beta radiation will require a badge. Exposure records are maintained in the office of the RSO and are available upon request.

b) Exemptions from External Personnel Monitoring

The use of personnel dosimeters may not be required in cases where it has been definitely established by the University Police & Safety Office that exposure to external sources of radiation will not exceed 10% of the occupational dose limits listed in section III.D. Exceptions will depend on an evaluation of the intensity and energy of the radiation and working conditions involved.

c) Dosimeter Information

The University Police & Safety Office issues personnel dosimeters who work with radiation as described in III.E.1.a). Individuals must fill out a Badge Service request available on the University Police & Safety Office website.

If an individual is issued a personnel dosimeter, it must be worn at all times when the individual is occupationally exposed. Whole body dosimeters shall be worn on the part of the body most susceptible to damage from deep dose exposure, i.e. anywhere from the collar to the waist. Extremity dosimeters such as ring badges shall be worn on the part of the extremity which receives the highest exposure.

Dosimeters are cycled on a monthly basis. Exposed badges are returned to the University Police & Safety Office for processing upon receipt of new badges.

The badge shall not be worn when an individual is undergoing diagnostic or therapeutic radiation exposure.

When not in use, the badge shall be stored in a location away from sources of radiation other than normal background, excessive heat or moisture.

d) Records and Reports

Permanent records of the radiation dose to workers are maintained by the University Police & Safety Office.

In cases where an individual receives a monthly exposure equal to 40 mrem

Deep Dose Equivalent, the Radiation Safety Officer will contact the individual as part of the University's ALARA policy. Together with a radiation safety staff member the individual will evaluate exposure potentials to determine whether future similar exposures can be avoided or reduced.

The University Police & Safety Office will provide an individual on an annual basis or upon written request, a copy of his or her external occupational exposure at the University.

Individuals who indicate on the Badge Service request form that they have had previous occupational exposure which was recorded by a personal dosimeter at other institutions shall authorize release of such exposure information from each of these prior institutions to the NDSU Police & Safety Office.

2. Internal Monitoring

a) Thyroid Monitoring

All individuals authorized to handle and use in an experiment I-125 or I-131 shall be monitored for possible thyroid uptake of radioiodine by the University Police & Safety Office depending on the chemical or physical form and amount of radioiodine used per experiment (e.g. > 100 uCi non-bound form; 1 mCi bound form). Initial measurements shall be taken prior to initial use of the radionuclide and between 6 and 72 hours after use.

Each authorized individual subject to thyroid monitoring shall have a measurement taken at least once per calendar quarter. Individuals subject to this routine monitoring should have an uptake measurement within one week after last possible use of radioiodine and prior to total termination of usage.

Should results of thyroid monitoring exceed 0.06 uCi of I-125 or 0.02 uCi of I-131, the University Police & Safety Office shall take appropriate measures to investigate operations, determine possible causes for uptake, and take other corrective actions to eliminate or lower the potential for future exposures. Refer to Nuclear Regulatory Commission Regulatory Guide 8.20 for more information.

b) Other Bioassay

Individuals who are known or suspected to have accidentally swallowed, inhaled, absorbed or otherwise ingested radioactive materials shall be required to submit urine or other biological assay samples (e.g. fecal, nose wipes, breath, blood) through the NDSU Occupational Health provider or the employee's designated medical provider. Additional samples and actions up to and including hospitalization will be based on the providers evaluation of the

submitted samples and other employee symptoms.

Other specimens for bioassay may be required at the discretion of the Radiation Safety Officer.

c) **Records and Reports**

Permanent records of exposure determinations from these internal monitoring results on individuals subject to the regulations of this section are on file in the University Police & Safety Office.

Upon written request, the University Police & Safety Office will provide an individual a copy of his/her exposure from internal monitoring results.

F. Principal Investigator Responsibilities

1. Duties

a) Ensure that the codes in this manual are observed by all personnel in the laboratory.

b) Ensure proper training of new personnel and authorization before allowing them to work in an installation using ionizing radiation.

c) Prepare a concise list of radiation safety procedures to be used in the individual's particular lab.

d) See that spill control and cleanup materials are available and that everyone is aware of emergency procedures.

e) See that surveys are made of suspected contamination and keep records of inventory, waste, etc. as required by the RSC and this manual.

f) Make sure that proper posting and labeling of radioactive sources and material are done. (Consult the RSO).

g) Prepare radioactive waste for disposal and complete Radioactive Waste Forms.

h) Secure radionuclides utilized under their authorization from unauthorized access.

i) Report immediately to the Radiation Safety Officer any theft or loss of radionuclides and accidents involving radionuclides.

j) Decontaminate spills to a level specified by the Radiation Safety Officer.

- k) Communicate to the Radiation Safety Officer all pertinent information regarding changes in their authorizations (e.g., change in facility, deletion or addition of personnel, changes in project, etc.)
- l) Cooperate with the Radiation Safety Committee and Radiation Safety Officer on all matters related to radiation safety and sources of ionizing radiation.
- m) Answer communications from the Radiation Safety Committee and Radiation Safety Officer in a timely manner regarding deficiencies or violations of regulations indicating corrective actions taken.
- n) Clearly label radionuclide use areas in their laboratories.

2. Records Maintenance

- a) Dispensation of radioactive materials. Each user must have records of the use of radioactive materials. Research records as to how much was used for each purpose is adequate.
- b) Disposal Records. Each user shall maintain records of the disposal of radioactive material by deduction from inventory when the Radiation Safety Office picks it up or in special cases where the RSC has given approval for laboratory disposal.
- c) Inventory Records. Each user shall maintain an inventory of the radioactive materials under his or her control. A copy of this inventory shall be sent to the RSO upon request.
- d) Contamination Survey Records: Each user shall maintain documentation related to required contamination surveys. These surveys are typically required on each day the material is used.
- e) Any other records that may be required by the RSC as necessary to the project.

3. Monitoring Requirements

If the isotope or source used can give a significant level of exposure, authorized users are expected to routinely monitor with a G-M counter and record in their research notebooks the radiation level at significant steps in their use of radioactive materials. Such times might be a dilution, distillation, volume reduction, crystallization, and so forth. If the possibility of contamination exists, it would also be expected that users will perform swipe tests of areas they suspect or contact the RSO for testing and record the results of such tests.

4. **Terminating or Transferring Employees and Students**

The termination or transfer of personnel that have been using radioactive materials must include the following:

- a) One month's notice must be given to the RSO to cancel badge service.
- b) Radioactive materials and waste must be collected and turned in to the RSO with all documentation of inventories.
- c) If materials are to be transferred either within campus or off campus, see Section III.B of this manual.
- d) Contaminated equipment must be identified and either transferred, decontaminated, or turned in to the RSO as waste.
- e) It is the Principal Investigator's responsibility to see that no student or employee leaves without identifying, transferring, or turning in all radioactive materials.
- f) Material or equipment that is out of use temporarily, or can be reused, may be transferred to the RSO for storage. This could be in the event of a sabbatical leave or a long term lapse in a project.

G. **Responsibilities of Authorized Users**

Each person who is authorized to use radionuclides has the responsibility to comply with the University policies and procedures contained in this manual and also to:

- a) Not smoke, eat, drink, prepare food, apply cosmetics, store food or food containers in any laboratory where radionuclides are used or stored.
- b) Survey hands, shoes, body and clothing for radioactivity and remove contamination prior to leaving the laboratory.
- c) Check work areas, periodically, for contamination and keep a written record of results. Periodically means at least daily when radionuclides are used.
- d) Conduct decontamination procedures when necessary.
- e) Report immediately to the Principal Investigator and/or laboratory supervisor as well as the Radiation Safety Officer the details of spills or other accidents, loss or theft of radioactive materials.
- f) Wear personnel dosimeters, as required, and comply with the rules concerning these dosimeters.

- g) Use all recommended or required protective measures, such as, protective clothing, respiratory protection, automatic pipetting devices, ventilated and shielded glove boxes and hoods.
- h) Limit the use of radionuclides to procedures approved by the Radiation Safety Committee.
- i) Keep accurate records of all radioactive material received, in use, storage, transferred to another permit, or transferred for disposal.
- j) Keep his or her personal exposure to radiation as low as reasonably achievable.
- k) Follow the protective rules for preventing personal contamination.
- l) Submit urine or blood samples, as required; be monitored for thyroid uptake of iodine, as required.
- m) Dispose of radioactive wastes in proper containers and document the amounts of these disposals.
- n) Maintain security of radionuclides in use and in storage.
- o) Maintain good housekeeping practices, label equipment contaminated with radionuclides to avoid cross contamination of the laboratory.

H. Procedures for Laboratory Use of Radioactive Material

1. Preventing Personal Contamination.

Extreme personal cleanliness and careful techniques are the primary means of preventing contamination and protecting against the ingestion of radioactive materials. In order to minimize the possibility of external or internal contamination, the following rules **MUST BE OBSERVED BY ALL RADIOISOTOPE LABORATORIES** where unsealed sources are used:

- a) Eating, drinking, food preparation, food storage, and smoking will not be permitted in laboratories where unsealed radioactive materials are stored or used.
- b) The use of milk bottles or other food containers for handling or storing radioactive materials is forbidden.
- c) The pipetting of radioactive solutions by mouth is not permitted. Remote pipetting devices are available and mandatory for such applications.

- d) Glass blowing in laboratories containing radioactive materials is discouraged.
- e) No radioactive experiment shall be done until trials, complete in every detail, are made with non-radioactive materials. Such trials should be made until the procedure is reproducible and improvements incorporated as needed.
- f) Any work with materials susceptible to atmospheric distribution (that is, from vaporization, spillage, dusting, effervescence of solutions, or other releases of radioactive gas) should be done in a suitable hood or glove box. Specifically, a glove box is REQUIRED for work with tritium in excess of 100 mCi and for most alpha emitters.
- g) Personnel are not permitted to work with radioactive materials if there are open cuts or abrasions on the body. Extreme precautions must be taken to avoid cuts or puncture wounds, especially when working with materials of high radio-toxicity and/or of high activity.
- h) Care must be exercised when using organic solvents to avoid skin contact with radioactive materials. Solvents may make the skin more permeable.
- i) Thorough monitoring of hands, feet, and clothing is advised whenever leaving a radioisotope laboratory where work with radioactive materials is in progress. Each individual radioisotope user is personally responsible to check themselves for contamination every time they leave the radioisotope area.
- j) Protective clothing and/or devices shall be used for all manipulations with unsealed sources where the possibility of contamination exists. In particular, suitable gloves shall be worn whenever hand contamination is possible. Surgical glove techniques should be used for putting on and removing gloves in order to avoid contaminating the inside surfaces. Protective apparel includes laboratory coats or coveralls, rubber or plastic gloves, shoe covers, safety glasses, and, in emergency work, disposable uniforms and respirators. In most cases, however, the laboratory coat and gloves will provide adequate protection. The laboratory coats intended for use while working with radioactive materials are to be used with the following conditions:
- (1) They shall be buttoned up when worn.
 - (2) They should not be worn out of the laboratory area, as contaminated coats may contaminate other areas.

- (3) They should not be stored with street clothes. The danger of cross contamination is too great.
- (4) They should be monitored periodically and always prior to release to a commercial laundry.
- (5) They should be decontaminated or disposed of if the contamination exceeds background. If the lab coat is contaminated, it can be disposed of as radioactive waste.

2. Security of Radioactive Materials

Radioactive materials shall be secured from access by unauthorized persons. Such security shall be maintained by:

- a) Storing the radioactive material in a locked refrigerator, freezer, cabinet, or other container, and keeping onsite personal surveillance by authorized personnel when not in the locked storage area, or
- b) Storing and using the radioactive material in a laboratory or room which is locked when unattended.

3. Protective Rules for Controlling Contamination of Laboratory Facilities and Equipment.

- a) Auxiliary containers, blotters, and covers should always be used where danger of spills and contamination of personnel or equipment is possible.
- b) Contaminated equipment, or equipment that has been used and is suspected of contamination should be isolated in designated areas in the laboratory or in suitable storage spaces.
- c) Handling tools, equipment, and apparatus, when used, should be placed in nonporous metal or plastic trays or pans which are lined with absorbent disposable paper. This paper should be monitored and changed frequently.
- d) Care should be taken that equipment not immediately necessary to the operations being performed is not brought into the active area.
- e) Equipment and tools should be routinely monitored following their use. No equipment shall be released to stock unless it is known to be completely free of contamination inside and out.

f) Removable contamination should not be allowed to remain on floors. This is particularly important in the low level isotope laboratories where shoe covers are not routinely required. Where floors are known or suspected of being contaminated, the area involved shall be immediately restricted to further traffic and designated as a shoe cover area until such time as it is known to be free of removable contamination.

g) Surveys of the work areas are required daily when material is in use, and other occasions when contamination is suspected. Such surveys shall be conducted by the isotope user of the work surfaces, floor, and equipment, and shall be documented on the Laboratory Contamination Survey Form (or equivalent Form).

h) All laboratories are swipe tested on a monthly or bi-monthly basis by the RSO or trained staff under the direction of the RSO. Any contamination found in excess of twice the background level is reported to the Principal Investigator. A date is set for the area to be reswiped after cleanup. If the area is not decontaminated within the time agreed upon, the RSO or staff will clean the area and bill the department.

4. Use of Caution Signs and Labels

Posting of laboratories, areas, and containers containing radioactive materials must be in accordance with the North Dakota Radiological Health Rules.

In general, the RSO or radiation safety staff will assume the responsibility of providing appropriate signs for posting laboratories and other areas where radioactivity is in use. Laboratory personnel are responsible for the labeling of containers and equipment in which radioactive materials are used in the laboratory.

All caution signs and labels used by the University must comply with the requirements of the North Dakota Radiological Health Rules. The radiation symbol prescribed is the conventional three-bladed design. Colors shall be magenta or purple on yellow. Where such containers are used for storage, the labels must also state the quantity and kind of radioactive material and the date of measurement of the quantity. Labels may also contain any additional information which may be appropriate in aiding individuals to minimize exposure.

Labeling Guidelines:

- a) CAUTION: RADIATION AREA is used where there is a level of radiation that might deliver a dose of 5 millirems in one hour at 30 cm from the radiation source to anyone in that area.
- b) CAUTION: HIGH RADIATION AREA is used where there is a level of radiation that might deliver a dose of 100 mRem in one hour at 30 cm from the radiation source to anyone in that area. Visible or audible alarms must also be in place.
- c) CAUTION: AIRBORNE RADIOACTIVITY AREA must be posted where there is the danger of any radioactive material in the air.
- d) CAUTION : RADIOACTIVE MATERIAL must be posted on any room where radioactive material is used or stored.
- e) CAUTION: RADIOACTIVE MATERIAL must be posted on each container as a clear, durable label. Racks of assay tubes or groups of containers may be combined and the rack or outer container may be labeled with the total activity within the smaller tubes or containers. It is important for safety and clarity to mark everything that contains radioactive material in the lab. There are some special circumstances allowing an exception to this rule. Contact the Radiation Safety Office for more information.

5. **Small Animal Experiments.**

Small animals treated with radioactive materials shall be handled with glove-protected hands and shall remain in their cages or experimental chambers until their excreta contain only background amounts of radioactive material or until they are sacrificed. The radioactive animals or their cages should be marked with labels indicating the kind and amount of radioisotope used, the date of administration and name of the user. Cages should be properly decontaminated by scrubbing with detergent or decontamination solution before reuse. Adequate ventilation must be provided in instances where animals are kept after an injection with radioactive materials that may become volatilized and dispersed into the room at significant levels. Animal handlers must be instructed by the principal investigator as to the dose levels, time limitations in the area, and the handling requirements of the animals and excreta.

I. **Procedures Related to Sealed Radioactive Sources**

A sealed source is one in which radioactive materials are permanently encapsulated (in stainless steel, plastic, glass, lacquer, or other material) to prevent leakage, and in which the intent is to utilize the radiation emitted rather than the material itself.

1. Handling Precaution.

- a) Sealed sources should not be handled directly by the hands. The use of remote handling tools for sources of high activity is essential to minimize both whole body and hand exposure.
- b) Under no circumstances should a user attempt to repair a ruptured or leaking source.
- c) In the case of devices containing sealed sources, the device should be used only as recommended by the manufacturer. Sources may not be removed from such devices except in those cases where the devices are specifically designed for external usage of the source.
- d) Repair of devices containing radioactive sources is normally not permitted when such repair involves those parts of the device containing the source. The RSO should be consulted before corrections may be authorized.

2. Leak Testing and Inventory Requirements.

Unless otherwise exempted by North Dakota Radiological Health Rules because of low activity, periodic leak tests are required on all sources.

- a) Such tests will be carried out at intervals not to exceed 6 months, unless the source is in storage wherein the interval between tests shall not exceed 3 years. If the source has been in storage and hasn't been leak tested in the previous six months, a leak test must be conducted prior to removal from storage.
- b) All required leak tests will be performed either by the RSO or an authorized representative. Leak tests of all sealed sources on the main campus will be conducted by the RSO. Leak tests of sealed sources at Experiment Stations throughout the state can be conducted either by the RSO at the main campus or by an authorized representative at the Experiment Station. Such a representative will be trained by the RSO, will conduct the swipe test, and will send the swipe to the RSO for evaluation.
- c) Whenever leak tests reveal the presence of 0.005 micro curies (10,000 dpm) or more of removable contamination on a sealed source, the source must be immediately removed from further use and steps must be taken to prevent and control the spread of contamination.
- d) Leaking sources must either be disposed of as radioactive waste (See Section III.J) or returned to the manufacturer for repair (see Section III.I.4).

3. Signs and Labels.

- a) Except as provided in III.I.3.b) below, any sealed source containing radioactive material and which is used outside of its shielded container shall be labeled with a permanently attached metal tag not less than one square inch in size bearing the radiation symbol and the words, CAUTION (or DANGER), RADIOACTIVE MATERIAL -- DO NOT HANDLE -- NOTIFY CIVIL AUTHORITIES IF FOUND. In addition, the nuclide, activity, and date of assay shall be included. Colors shall be magenta on yellow.
- b) Sealed sources permanently mounted in devices or shields are not required to be tagged as defined in this section above, provided the container or device is labeled as set forth in Section III.H.4.
- c) Rooms or areas in which sealed sources are stored or used should be posted with caution signs as specified in Section III.H.4.
- d) Replacement of tags on sealed sources is not permitted without the specific authorization of the RSO.
- e) Sealed sources used for medical purposes including veterinary medicine (such as implants) are exempt from the tagging requirements of this section.

4. Shipping and Repair.

In the event a gauge needs to be returned to the manufacturer or to a service center for repair or calibration, the instrument must be shipped by the RSO. To assure that all DOT requirements are met and the instrument is shipped properly, take it to the RSO with instructions and the RSO or radiation safety staff will leak test the source, package, label and arrange for a carrier. You may specify the type of service for the shipment (air, ground, overnight, etc.) which you prefer.

5. Special Source Type: Moisture Gauges (Neutron Source)

- a) **Transportation During Routine Usage.**
Department of Transportation (DOT) regulations must be complied with in transporting gauges containing radioactive material. An individual who will transport a gauge shall first be trained in driving safety in accordance with NDSU's training requirements on Neutron Producing Devices.

The following documentation must be maintained. Items 1-3 are located within the gauge case:

- (1) Emergency Procedures.
- (2) Owner's Certificate. This form shows who is the owner of this sealed source (NDSU).
- (3) Most recent Leak Test Certificate.
- (4) Shipping Paper.

The shipping paper, including Emergency Response Information, must be next to the driver within hand's reach of the driver in the vehicle. In the event of an accident, authorities are then alerted that hazardous material was contained in the vehicle.

- (5) Emergency phone numbers sticker:
This sticker is placed on the outside container, (i.e., gauge case). It has a list of numbers to call in the event of an accident or emergency involving the gauge. If the sticker is soiled or lost, have the RSO replace it.

b) Radiological Safety Requirements.

- (1) Each person participating in the use of a gauge shall wear a radiation monitoring badge at his waist.
- (2) The operator shall use the gauge as expediently as possible pursuant to instructions without compromising radiological safety.
- (3) When transporting a gauge to a field site, it shall be in its carrying case, placed as far as possible from the occupants of the vehicle, and secured to prevent shifting during transport. A minimum of two independent physical controls that form tangible barriers to secure the portable gauge(s) from unauthorized removal shall be used.
- (4) Hands shall not be placed on the gauge when the gauge is in an unshielded position.
- (5) The source shall not be placed in an unshielded position when the gauge is not being used for its intended purpose.
- (6) The source or shield shall not be tampered with.
- (7) The source shall be returned to a shielded position when not in use.

(8) If the gauge has been damaged to the extent where the source or shielding has been severely damaged, notify the principal investigator who shall notify the RSO. Do not touch or move the gauge. Keep all personnel away from the gauge for a distance of at least 10 feet. See section III.I.5.c).

(9) The gauge shall be stored in a locked room where the radiation level at the closest approach shall not exceed 0.05 milliroentgen per hour. The door to the room shall be posted with a standard sign reading CAUTION: RADIOACTIVE MATERIAL. This sign will be supplied by the RSO. Each portable gauge authorized user shall use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal, whenever portable gauges are not under the control and constant surveillance of the licensee's authorized user.

(10) If the gauge has been lost or stolen, immediately notify the principal investigator who shall notify the RSO for guidance.

(11) The gauge, if located on the main campus, shall be made available to the RSO upon notification that the source is due for a periodic leak check.

(12) When authorized users have a thorough knowledge of a nuclear gauge, its operating principles, purpose and method of operation, and comply with the safety requirements specified in this handbook, the RSC considers the gauge almost harmless and the purchase of a costly instrument for monitoring gamma rays or neutrons as optional. This is further justified by reviews of many exposure reports that have indicated only minimal exposures to personnel using a gauge properly. Should a reversal of this become apparent, however, the Committee will require principal investigators to purchase and use an appropriate instrument.

c) Emergencies and Accidents.

NDSU's license permits use of soil measurement gauges throughout the state of North Dakota. (If a gauge is to be taken over state lines, permission must be received in writing from the other state through the RSO). Since gauges are out in the field, the likely accident/incident site is one remote from campus. Gauge users MUST be familiar with the Emergency Procedures that accompany the gauge. Do not hesitate to block traffic or do whatever is necessary to contain the possible spill until an emergency person with monitoring instruments can come to

the scene. Cleanup of contaminated accident/incident sites with spread of contamination is very time consuming and expensive. The hazard of contaminating people must be a primary concern as well.

6. Special Source Type: Gas Chromatograph Detectors

Some GC's are equipped with electron capture detectors that contain radioactive sources (foils) of H-3, Sr-90, Ni-63, or Ra-226. Procedures for procuring and using such sources are similar to those for standard sealed sources. However, the following additional radiological safety requirements shall be met.

- a) The part of the GC containing the detector shall be vented directly to the atmosphere or to an operating hood to prevent radioactive off-gases from entering the laboratory.
- b) The GC shall not be operated above the recommended temperature for the electron capture detector. Normally this is about 225°C for Hydrogen-3, and 350°C for Nickel-63. (The Operator's Handbook should be consulted for individual units).
- c) Prior committee approval shall be obtained if the principal investigator desires to replace or clean the corroded foil themselves. In such cases, the request to the RSO shall contain:
 - (1) Replacement and cleaning procedures, including handling and radiation safety procedures to be followed.
 - (2) Experience of the principal investigator in replacing or cleaning foils.
 - (3) Method of disposal of the replaced foil or contaminated cleaning materials.

J. Disposal of Radioactive Waste

There are strict requirements on the manner and methods used for the disposal of radioactive wastes which apply to the University as a radioactive material licensee. In order to comply with these requirements, the following procedures are established and shall be followed.

1. General Considerations.

- a) Except as specifically authorized by the RSC, no radioactive materials shall be disposed of directly into the sanitary sewage system, into the atmosphere, or into trash baskets not designated for radioactive waste. All radioactive wastes must be collected by the user in suitable labeled containers, as described below, for processing and disposal by the RSO.
- b) All experimental residues and first rinses shall be placed in waste containers.
- c) Any accidental releases of activity into the environment must be reported immediately to the RSO.
- d) When unusual problems of disposal arise, the RSO must be consulted to establish a satisfactory procedure.
- e) Radioactive waste containers shall not be used for non-radioactive waste.

2. Documentation.

An NDSU Radioactive Waste Form must be completed and attached to each container of radioactive waste. The information required on each form includes:

- a) Principal Investigator's Name and Department, Building, room number & telephone.
- b) Waste Classification.
- c) Isotope(s) contained in each container.
- d) The chemical form (of the purchased material).
- e) The activity of each isotope-chemical name combination.
- f) Any information on the biological/chemical hazards associated with the waste.
- g) Signature and date.

3. Segregation of Waste.

Radioactive waste must be segregated according to the scheme detailed in this section and diagramed in the appendix, section IV.B.

- a) Segregation by Isotope:
Separate waste containers shall be used for collection of each isotope.

The only exception to this shall be for waste generated in multiple labeling experiments. Once collected, each material will be disposed of by the RSO or radiation safety staff.

b) Putrescible Waste:

Putrescible waste is any material which, under normal conditions, would be expected to undergo decomposition by micro-organisms, producing foul smelling matter.

(1) Solid Putrescible Waste includes radioactively contaminated animal carcasses, fecal matter, soiled animal bedding, plant by-products and any other solid material which is expected to rot.

(2) Liquid Putrescible Waste includes radioactively contaminated media, blood, urine and any other liquid material which is expected to rot.

Containers: Putrescible Waste should be stored in plastic containers which can be frozen without breaking. Ordinarily, inexpensive plastic containers should be used as the container may not be returned in all cases. GLASS CONTAINERS ARE NOT ACCEPTABLE.

c) Non-Putrescible Waste:

Non-putrescible waste is any radioactively contaminated waste which, under ordinary circumstances, will not undergo decomposition by micro-organisms, yielding foul smelling matter.

(1) Solid non-putrescible waste must be further separated as indicated in each subsection below.

Containers: Normally metal waste cans with a step-pedal operated lid and plastic bag liner will be purchased by the user. For 32-P Plexiglas containers should be used with a bag liner. All solid waste containers must be conspicuously labeled with a "Caution Radioactive Material" sign; such labels can be obtained from the RSO. THE SOLID WASTE MUST BE PACKAGED SO AS TO ENSURE THAT PIPETS, HYPODERMIC NEEDLES AND OTHER SHARP OBJECTS WILL NOT PENETRATE THROUGH THE PLASTIC BAG. FOR THESE ITEMS, A "SHARPS" PUNCTURE-PROOF CONTAINER SHALL BE USED.

(a) Scintillation vials. These are used in Liquid Scintillation counting procedures. Glass vials should be separated from plastic vials.

(b) Other solids. This includes all other contaminated solids including clothing, paper, gloves, leather, glassware, metal, pottery, plastics, ceramics, etc.

(c) Carbon-14 and Hydrogen-3 solids. Any solid, including clothing, paper, gloves, etc. contaminated with C-14 or H-3 in the Liquid Scintillation Counting process is considered "Liquid Scintillation Counting Media". These wastes shall be segregated from non-liquid scintillation solid wastes.

(2) Liquid Non-Putrescible Waste.

Unless special arrangements are made with the RSO, the user is required to neutralize or otherwise dilute strongly acidic or basic waste solutions to the point where they can be reasonably mixed with solidifying or absorbing agents without causing violent chemical reactions or releasing strong fumes and vapors. In the case of organic solvents, especially those which may be highly volatile or otherwise reactive, appropriate precautions must be noted on the Radioactive Waste Form.

Types of Liquid Non-Putrescible Waste Includes:

(a) Aqueous waste, which is any liquid such as acidic or basic extracts from plant, animal or insect matter, aqueous solutions of inorganic or organic salt or any other liquid in which water is the primary solvent. Organic solvents (alcohol, acetone, toluene, etc.) will be tolerated in aqueous waste containers, only to the degree that they are inseparable from the primary solvent and all must be clearly labeled on the waste container. *Note: Investigators are encouraged to use aqueous based (or "biodegradable") liquid scintillation fluids.*

Containers: Aqueous waste will be contained in plastic containers provided by the University Police & Safety Office. If possible, these containers will be returned for reuse once disposal of their contents has been completed. GLASS CONTAINERS ARE NOT ACCEPTABLE.

(b) Non-aqueous waste (or organic waste) is any liquid in which water is not the primary solvent. If the non-aqueous waste is organic in nature, or immiscible with water, then water will be tolerated as a contaminant only to the degree that it is inseparable from the primary solvent.

Containers: Non-aqueous liquid waste may be contained in metal solvent cans or plastic containers which have been conspicuously labeled with a CAUTION: RADIOACTIVE MATERIAL sign; such labels can be obtained from the RSO. Metal cans are acceptable only if the waste will not cause corrosion of the metal. Plastic containers are acceptable if the organic solvents will not dissolve the container. GLASS CONTAINERS ARE NOT ACCEPTABLE.

4. LSC Vial Disposal.

a) Vials:

All vials must be emptied of liquid. The liquid should be collected and turned in as liquid waste. The emptied vials should then be allowed to air dry in the hood if cocktail was contained in them, then bagged and turned in as solid waste. It is not possible to dispose of vials with the cocktail in them.

b) To Reuse Vials:

Vials should be rinsed with a solvent suitable to dissolve the material in the vials. The first rinse should be collected in the radioactive waste container. The vials should then be soaked in a decontamination solution 24 hrs. A 5 ml sample of the wash water should be counted, and, if below twice background, may be released to the sewer. If the wash water is above twice background, it too should be turned in as waste. The vials may then be discarded in the normal trash, or reused. If a high level of activity was contained in the vials, it is expected that a sampling of empty cleaned vials will be counted with cold cocktail in them to verify that the radioactivity has been removed by the above cleaning procedure.

5. Waste Pick-up.

The RSO should be notified when waste containers are ready for removal from a laboratory. Any radioactive waste which is not segregated, packaged and for which a Radioactive Waste Form has not been completed in accordance with the procedures outlined in section III.J.2 of the Handbook will not be removed from the investigator's laboratory. Since it is often impossible during waste

collection to determine how well materials are segregated, any waste which has been collected and is later found to be in violation of these procedures will be returned to the investigator for repackaging.

6. Radioactive Waste Disposal Flow Chart.

The Radiation Safety Office will dispose of all radioactive wastes in accordance with current waste disposal regulations. The waste disposal activities conducted by Safety Office personnel are outlined on a Flow Chart (see Section IV.C).

IV. Appendices

A. Radiation Emergency Procedures

Emergencies resulting from accidents in isotope laboratories may range from minor spills of radioactive material, involving relatively no personal hazard, to major radiation incidents and spills involving extreme hazards or injury. Because of the numerous complicating factors which may arise, and because of the wide range and variety of hazards, set procedures cannot be made to cover all possible situations. In any emergency, however, the primary concern must always be the protection of personnel, either from radiation hazards or from injury. The secondary concern is the confinement of contamination.

The following general guidelines are required at NDSU by the Radiation Safety Committee. Please note that notification of the RSO is required on all incidents. Documentation must be kept on all accidents as part of the NDSU license requirements.

1. Minor Spills (involving no radiation hazard to personnel)

- a) Notify all other persons in the room at once.
- b) Permit only the minimum number of people necessary to deal with the spill into the area.
- c) Confine the spill immediately
 - (1) Liquid Spills:
 - (a) Don protective gloves.
 - (b) With hands gloved, right the container.
 - (c) Drop absorbent paper on the spill.
 - (d) Carefully fold the absorbent paper with the clean side out and place in a plastic bag for transfer to a radioactive waste container. Put contaminated gloves and any other contaminated disposable material in the bag.
 - (2) Dry Spills:
 - (a) Don protective gloves.
 - (b) Dampen the spill thoroughly, taking care not to spread the contamination. Water may be used except when a chemical reaction with it would generate an air contaminant.

- d) Survey the area with an appropriate low-range radiation detector survey meter or other appropriate technique. Check the area around the spill for contamination. Also check hands, clothing and shoes for contamination.
- e) Notify the RSO as soon as possible.
- f) Permit no one to resume work in the area until approval of the RSO is secured.

2. Major Spills (involving radiation hazards to personnel)

- a) Notify all other persons in the room at once of the hazard.
- b) Request all persons not involved in the spill to vacate the room at once.
- c) Make no immediate attempt to clean up the spill. If the spill is liquid and your hands are gloved, right the container.
- d) If the spill is on the skin, flush thoroughly with water. If the spill is on clothing, discard outer clothing at once.
- e) Switch off all fans.
- f) Vacate the room and prohibit entrance to the contaminated area.
- g) Notify the RSO as soon as possible, giving all details of the spill.
- h) Permit no person to work in the area until the approval of the RSO is secured.
- i) Under no circumstance should an untrained person attempt to examine or clean up the radioactive material.

3. Accidents Involving Radioactive Dusts, Mist, Fumes, Organic Vapors, And Gases.

- a) Notify all other persons to vacate the room immediately.
- b) Hold breath and close all windows, escape valves, air conditioners, etc. as time permits.
- c) Vacate the room.
- d) Notify the RSO.
- e) Ascertain that all doors to the room are closed and locked. If necessary, post guards to prevent accidental opening of the doors.

- f) Do not reenter the room until approval of the RSO is secured.

4. Injuries to Personnel Involving Radioactive Materials.

- a) If injury is significant, call 911 immediately.
- b) Remember that first aid to the victim comes first and decontamination efforts second.
- c) Wash minor wounds immediately (within 15 seconds if possible). Spread the edges of the gash under running water, flushing it thoroughly. (Note: light tourniquet action to stop venous return, but not to restrict arterial flow, may be desirable to stimulate the bleeding).
- d) Report all radiation accidents/incidents (wounds, over-exposure, ingestion, inhalation) to the RSO as soon as possible.
- e) Submit an incident report with the Workers Compensation Claims Specialist in the University Police & Safety Office.
- f) Permit no person involved in a radiation injury to return to work without the approval of the RSO and the attending physician.

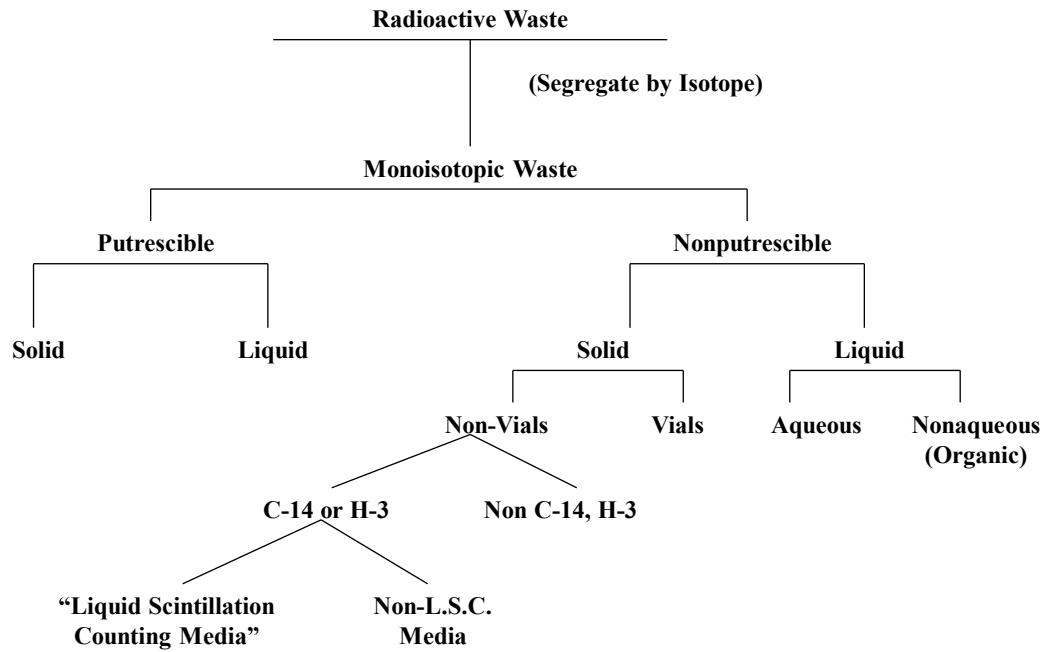
5. Overexposure, Ingestion or Inhalation

- a) Any person who suspects overexposure to radiation from any source must report immediately, by phone or in person, to the RSO.
- b) Any person who swallows, inhales, absorbs, or otherwise ingests radioactive materials must report to the RSO immediately.

6. Fires Involving Radioactive Material

- a) Notify all persons in the room and building at once.
- b) Attempt to put out the fire if possible, only if a radiation exposure hazard is not immediately present.
- c) Notify the fire department by pulling the fire-alarm or by dialing 911.
- d) Notify the RSO.

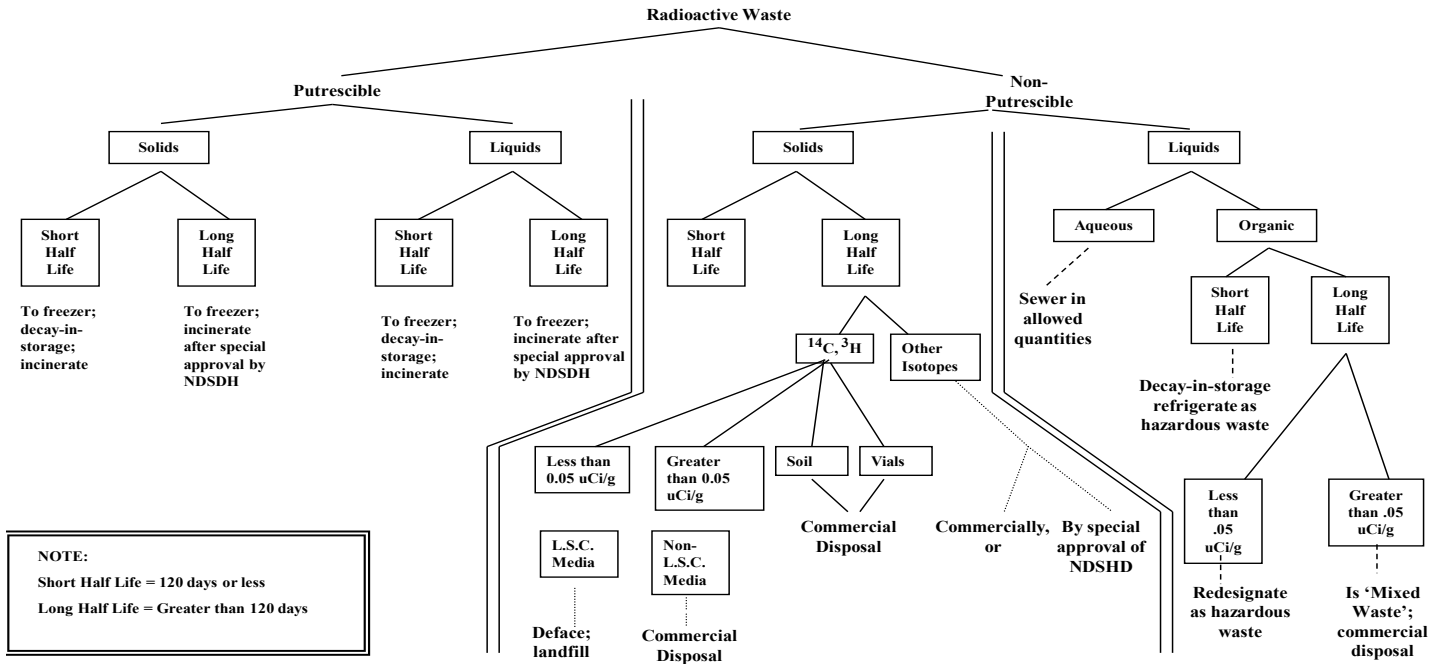
B. Waste Disposal Chart for Laboratory Personnel



[For Use By Laboratory Personnel in Segregating Radioactive Wastes]

C. Waste Handling Chart for Radiation Safety Staff

Radioactive Waste Disposal Flow Chart



05/15/03 RadWasteDisposalChart