ILLINOIS STATE UNIVERSITY
Illinois' first public university.

Radiation Safety Manual

September 2016

TABLE OF CONTENTS

SECTION 1: INTRODUCTION

This manual of procedures and regulations concerning the use of radioactive isotopes and radiation producing machines has been adopted by Illinois State University in conformance with Title 10, Code of Federal Regulations (10-CFR) in its entirety with emphasis upon sections 10-CFR-20, 10-CFR-30, and 10-CFR-33; and with the regulations of the Illinois Department of Nuclear Safety.

This manual describes the regulatory body on radiation safety at Illinois State University which is the Radiation Safety Committee. This manual attempts to provide basic policies for uniform practices throughout the University wherever radioactive materials or radiation producing devices are involved. The Radiation Safety Committee, as overseers of the radiation protection program, with the aid of this manual are to ensure that radioactive materials are being procured, used, safeguarded, and disposed of in such a manner that they do not endanger the health and safety of University personnel, students, visitors, or residents of the community.

SECTION 2: RESPONSIBILITIES AND DUTIES OF DEPARTMENTS AND INDIVIDUALS

The University uses radioactive material under an Illinois Department of Nuclear Safety License, and is committed to follow the laws and regulations (Radiation Protection Act of the State of Illinois) stipulated by this Agency under an Agreement State Pact with the Nuclear Regulatory Commission.

Overall responsibility for compliance with the above regulations is vested in the Radiation Safety Committee. In turn the Radiation Safety Committee delegates operation of the safety program to Environmental Health and Safety and the Radiation Safety Officer.

Day to day operation of the radiation safety program is of necessity vested in the departmental supervisory staffs. Departmental supervisory staffs are the chairperson, and the Principal Investigators (hereafter referred to as "PI"s) who have been granted authorization to use radioactive materials on campus. Each individual involved in activities utilizing radiation on this campus must adhere to the guidelines in this manual where responsibilities and duties are clearly defined. If ambiguities arise, the individual concerned must check with the Radiation Safety Committee for clarification. Failure to abide by the manual, the committee, or the state regulations can result in forfeiture of all privileges to use any radiation material on campus.

2.1: Radiation Safety Committee

The Radiation Safety Committee, as appointed by the President, will consist of at least one representative from the Department of Biological Sciences, the Department of Chemistry, Student Health Services, and Environmental Health and Safety. Other departments may be asked to participate if a need arises. The Director of Environmental

Health and Safety will serve as chairman. Responsibilities and duties of the Radiation Safety Committee are:

2.1.1 Establish policies for the safe procurement, use and disposal of radioactive materials and radiation producing machines.

2.1.2 In cooperation with the Radiation Safety Officer and the PIs establish procedures necessary to implement the safe use of all types of ionizing radiation.

2.1.3 Review and approve or disapprove requests for user's permits according to the criteria set forth in this manual.

2.1.4 Review all research protocol for research or teaching to determine that all safety measures have been established.

2.1.5 Review all requisitions for radioactive isotopes.

2.1.6 Review unusually hazardous uses of radioactive material and radiation producing machines.

2.1.7 Review investigations and violations of radiation regulations, and ensure all problems are corrected.

2.1.8 Appoint a qualified person to the position of Radiation Safety Officer.

2.1.9 Enforce the provisions of the University's Radiation Safety Program as set forth in this manual, and formulate new provisions if situations or regulations warrant.

2.1.10 Set forth and carries out disciplinary action against personnel who violate the rules and regulations of the state or federal government or the policies and procedures of this manual. The disciplinary action can include probation, suspension and revocation of the privilege to work with radioactive materials.

2.1.11 Conduct at least one Radiation Safety Committee meeting per quarter to discuss radiation issues. Written minutes of these meetings are to be maintained.

2.2: Environmental Health and Safety

Environmental Health and Safety assumes the responsibility for the following services:

2.2.1 General surveillance of all health physics activities, including both personnel and environmental monitoring.

2.2.2 Furnish consulting services to personnel at all levels of responsibility on all aspects of radiation protection.

2.2.3 Supervise receipt, delivery and shipments of all radioactive materials coming to or leaving Illinois State University.

2.2.4 Maintain all records relating to licensing and registration of radioactive materials and radiation producing devices.

2.2.5 Maintain copies of personnel exposure records, notify individuals and their supervisors of exposures approaching the maximum permissible levels and recommend appropriate remedial action.

2.2.6 Supervise and coordinate the waste disposal program including the storage of the waste and the maintenance of disposal records.

2.2.7 Supervise decontamination when accidents or spills involving radioisotopes occur.

2.2.8 Maintain a continuous program of environmental radiation hazard evaluation and hazard elimination.

2.2.9 Ensure all radiation producing devices are inspected periodically by a qualified inspector.

2.2.10 Provide educational classes to ancillary personnel who may work in areas designated as radiation areas. Classes should be given annually and for each new employee working in those areas as required.

2.2.11 Act as liaison between the University and the Illinois Department of Nuclear Safety, and/or other federal or state agencies.

2.2.12 Assist the Radiation Safety Officer in filing appropriate and timely reports required by federal or state regulations.

2.2.13 Maintain all records, reports, and correspondence as required. This is to include annual updates on PIs, RMA-1 forms or their equivalent, investigations, etc.

2.2.14 Environmental Health and Safety has the authority to stop operations covered in this manual which may in any way seriously endanger the health and safety of University personnel or the welfare of the University. Such operation shall be resumed only upon written authorization from the Radiation Safety Officer and with the approval of the Radiation Safety Committee.

2.3: Radiation Safety Officer

The Radiation Safety Officer is responsible to the Radiation Safety Committee for the following:

2.3.1 Provide expertise to Environmental Health and Safety and to the PIs as needed.

2.3.2 Review requests from PIs for radioisotopes to ensure the types and amounts are allowed by the University's license.

2.3.3 Inspect all deliveries of radioisotopes for leakage or other problems.

2.3.4 Monitor all radiation producing devices and certify that the output of stray radiation from these devices is within safe limits.

2.3.5 Insure proper maintenance and calibration of all instruments used for radiological safety purposes.

2.3.6 Perform leak tests on all sealed sources.

2.3.7 Perform and maintain periodic inventory of all radioactive materials at Illinois State University.

2.3.8 Perform monthly wipe tests of all laboratories to determine whether there is contamination present.

2.3.9 Inspect and determine if a laboratory is clean of all contamination should the laboratory no longer be used for radioisotopes and before anyone else occupies it.

2.3.10 Assist Environmental Health and Safety in investigating incidents involving radiation exposure.

2.3.11 Supervise decontamination when accidents involving radioisotopes occur.

2.3.12 Maintain a continuous program of environmental radiation hazard evaluation and hazard elimination.

2.3.13 The Radiation Safety Officer has the authority to stop operations covered in this manual which may in any way endanger the health and safety of University personnel or the welfare of the University. Such operation shall be resumed only upon written authorization from the Radiation Safety Officer and with the approval of the Radiation Safety Committee.

2.4: Supervisors of Personnel Using Radioisotopes

Supervisors are defined as the Principal Investigators that have been granted the privilege to work with radiation material by the Radiation Safety Committee.

They are responsible for insuring that individuals using radioisotopes within their departments or areas discharge their responsibilities as listed in Section 2.5. Supervisors are directly responsible for the following:

2.4.1 Principal Investigators are to have direct supervision over all the work and personnel working for them. This responsibility cannot be delegated to anyone not granted authorization to use radiation material by the Radiation Safety Committee.

2.4.2 Before an experiment is performed the supervisor should determine the types and amounts of radiation or radioactive materials to be used. The procedure must be well outlined. In any situation where there is appreciable radiation hazard, the Radiation Safety Officer should be consulted before proceeding.

2.4.3 Provide radiation safety training for all employees and students involved with the use of radioactive materials and/or radiation producing machines. This training should include the hazards of the materials, the use of safe techniques, the application of approved radiation safety practices, disposal practices, specific procedures, and any other information required providing a safe working environment. For techniques, safety practices, etc. that are not outlined in this manual the supervisor should have written procedures immediately available in the laboratory. All training must be documented and maintained on file. A copy may be sent to Environmental Health and Safety, but is not required.

2.4.4 Provide Environmental Health and Safety with information concerning monitored individuals and activities in their areas.

2.4.5 Notify Environmental Health and Safety and the Radiation Safety Officer in writing whenever major changes in operational procedures, new techniques, alterations in physical layout, or new operations which might lead to personnel exposure are anticipated.

2.4.6 Comply with all regulations governing the use of radioactive materials as established by the Illinois Department of Nuclear Safety, and the Illinois State University Radiation Safety Committee, with special emphasis on the following items:

2.4.6.1 Use the correct procedure for the procurement of radioactive materials by purchase or transfer (See sections 3.3 and 3.4).

2.4.6.2 Account for the disposition of radioactive materials stored under PI's supervision.

2.4.6.3 Assure that all radioactive waste materials are disposed of in accordance with the procedures in this manual (See section 8).

2.4.6.4 Prevent the transfer of radioactive materials to unauthorized individuals.

2.4.7 Supervisors who leave the University for any extended period of time (in excess of two weeks) but still have personnel working with radioisotopes shall accomplish the following:

2.4.7.1 Ensure all personnel working with the radioisotopes are properly trained in the use of the material, safety procedures, emergency procedures, and know whom to contact in case of an emergency.

2.4.7.2 Arrange for another supervisor, who has been accepted by the Radiation Safety Committee for isotope usage, to assume responsibility for the safety and proper conduct of that research. A graduate student is not a proper supervisor.

2.4.7.3 A letter should be sent to the Radiation Safety Officer and the Chairman of the Radiation Safety Committee. This letter should indicate that items 2.4.6.1 and 2.4.6.2 have been completed and should identify the person that is assuming responsibility for the work.

2.4.7.4 If no one will assume the responsibility then the work will need to be terminated or suspended until the return of the PI.

2.4.7.5 Failure to comply with the above items will constitute grounds for the Radiation Safety Committee to terminate the research work that involves the use of radioactive materials.

2.4.8 Ensure that all personnel working with radioactive materials have the proper protection necessary for the material they are working with. This protection must be present before any radioactive material work begins. This protection may include film badges. Personnel required to wear film badges may not work with radioactive material until they have their badge.

2.4.9 Comply with all information requests submitted by Environmental Health and Safety, the Radiation Safety Officer, the ISU Radiation Safety Committee, the University Administration, and the Illinois Department of Nuclear Safety.

2.5: Responsibilities of Individuals in Radioisotope Areas

Every individual at Illinois State University who has any contact with radioactive materials is responsible as indicated below:

2.5.1 Exposure to radiation should be kept as low as reasonably achievable and specifically below the maximum permissible exposure as listed in section 6.1.5.

2.5.2 Prescribed monitoring equipment, such as film badges, ring badges, etc. are to be worn in radiation areas when working with beta emitters having an energy greater than 0.2 Mev and for any gamma or X-ray emitter. Personnel who work only with pure beta emitters having a maximum energy level of less than 0.2 MeV (tritium, carbon-14, and sulfur-35) are not required to wear film badges, but may do so if desired.

2.5.3 Personnel wearing film badges must follow the regulations listed below:

2.5.3.1 Badges must be worn on waist or chest at ALL times while on duty.

2.5.3.2 The face of the badge must always face toward the front and away from the body.

2.5.3.3 Leave the film badge in a secure place when not in use and never leave the badge in an area where it may be exposed to radiation when it is not being worn.

2.5.3.4 Never wear a film badge issued to another person.

2.5.3.5 Take care not to send a film badge to the laundry with a uniform.

2.5.3.6 The film badge issued to you is your responsibility. You are required to turn it in to your supervisor on a monthly basis for another badge of the same number.

2.5.3.7 Do not interfere with the film badge by tampering with the film.

2.5.3.8 Report a lost film badge immediately to the Radiation Safety Officer and your supervisor.

2.5.3.9 Report all accidental exposures when not wearing a film badge to the Radiation Safety Officer and your supervisor.

2.5.3.10 If required to wear a film badge, then no work can be done until the badge is obtained and is worn.

2.5.4 Remove all loose contamination and thoroughly wash hands before leaving the laboratory.

2.5.5 Use all appropriate protective measures such as protective clothing whenever contamination is possible. Gloves, lab coats and goggles are required at all times when using radioactive materials. Do not wear such clothing outside of the laboratory area.

2.5.6 Wear respiratory protection when necessary; use protective barriers and other shields whenever possible; use mechanical devices whenever their aid will assist in reducing exposure, such as pipette filling devices. NEVER PIPETTE RADIOACTIVE SOLUTIONS BY MOUTH.

2.5.7 Work performed with Gamma emitters or large quantities of hard Beta emitters greater than 1 mCi should be in the confines of an approved hood or glove box with appropriate shielding. Hard Beta emitters at less than 1mCi may be used outside the hood but should have appropriate shielding. The Radiation Safety Officer should check procedural variations.

2.5.8 SMOKING OR EATING in approved radiation laboratories is prohibited.

2.5.9 Refrigerators may not be used jointly for foods and radioactive materials.

2.5.10 Maintain good personal hygiene:

2.5.10.1 Keep fingernails short and clean.

2.5.10.2 Do not work with radioactive materials if there is a break in the skin that cannot be protected from contamination.

2.5.10.3 Wash hands and arms thoroughly before handling objects that go to the mouth, nose, or eyes.

2.5.11 Check the immediate area (i.e. hoods, benches, etc.) where radioactive materials are being used at least once daily for contamination. On a weekly basis each User is required to conduct Wipe Tests in all areas of his responsibility to determine if there is any contamination. Follow procedures outlined in Appendix 2-A.

2.5.12 Keep the laboratory neat and clean. The work area should be free from equipment and materials not required for the immediate procedure. Work surfaces should be covered with absorbent material, preferably in a tray or a pan, to limit and collect spillage in case of accident.

2.5.13 Keep and/or transport materials in such a manner as to prevent breakage or spillage. A double container with proper shielding should be used when transporting radioactive materials within hallways.

2.5.14 Label and isolate radioactive waste equipment, such as glassware used in laboratories or radioactive materials. Once used for radioactive substances, equipment should not be used for other work or sent from the area to cleaning facilities, repair shops, or to surplus until demonstrated to be free of contamination.

2.5.15 Request radiation safety supervision of any emergency repair of contaminated equipment in the laboratory by shop personnel or by commercial service contractors. At no time shall servicing personnel be permitted to work on equipment in radiation areas without the presence of a member of the laboratory staff to provide specific information.

2.5.16 Report accidental inhalation, ingestion, or injury involving radioactive material to the supervisor and the Radiation Safety Officer, or Environmental Health and Safety and then carry out their recommended corrective measures. The individual shall cooperate in any and all attempts to evaluate exposure levels. (See Emergency Procedures included in Appendix 2-B).

2.5.17 Institute decontamination procedures when necessary and take all required steps to prevent the spread of contamination to other areas (See Decontamination Procedures in Appendix 2-C).

2.6: Responsibilities of Department

Department chairpersons by virtue of their position are responsible for insuring that PIs are adhering to the rules, regulations, and the University procedures. Among the items the Department chairperson are responsible for are:

2.6.1 Assist the Radiation Safety Committee in maintaining the health and safety of personnel at the University by insuring that departmental PIs adhere to all radiation safety measures.

2.6.2 If unsafe or unauthorized procedures are identified, the chairperson is required to stop the procedure, caution the Users of the problem, and notify the Radiation Safety Officer or Environmental Health and Safety.

2.6.3 Department chairpersons have the right to move personnel and reassign laboratories. However, before moving personnel in or out of a laboratory that has been used for radioisotope research they must have the laboratory inspected and proven to be clean of any radioactive contamination. The Radiation Safety Officer will conduct this inspection and monitoring.

2.6.4 Professors leaving the University must check out with the Department. During this checkout the Department will ensure that the professor has contacted the Radiation Safety Officer for final disposition of all radioactive material, inspection of laboratory for contamination, and any final paperwork that is required.

2.6.5 The Department will assist Environmental Health and Safety, the Radiation Safety Officer, and the Radiation Safety Committee in ensuring that the regulations and safety procedures set forth for the University are adhered to.

2.6.6 The Department is encouraged to set up their own internal safety committee to assist in overseeing radiation safety. Any problems or comments of the program may be addressed to the Radiation Safety Committee direct or through the department's representative to the Committee.

APPENDIX 2-A

Required Periodic Procedures in Work Areas

At least once daily or more often if contamination is suspected, all work areas should be checked to determine if any contamination is present. A proper survey meter should be used at a distance of one inch above the surface of table tops and equipment that has been used during the day. If any substantial reading above background is present, then the absorbent material on the table tops needs to be removed and the area cleaned with the proper cleaning agent. The area or equipment needs to be cleaned again and again until the contamination is no longer present.

Weekly wipe tests are to be conducted by the Users to assist in determining contamination levels for those isotopes that can not be detected by the survey meter.

These daily and periodic surveys shall not replace the monthly survey performed by the Radiation Safety Officer.

APPENDIX 2-B

Emergency Procedures for Radiation Accidents and Spills

The procedures outlined below may vary with a particular emergency and are intended as general guidelines to avoid further contamination and injury to personnel.

A. Minor accidents and spills without a radiation hazard to personnel.

1. Confine the spill immediately. Post the spill area.

    a. Liquid spills

        1. Wear protective gloves.

        2. Drop absorbent paper on the spill.

    b. Dry spills

        1. Wear protective gloves.

        2. Damp wipe with proper solvent, taking care not to spread contamination. (Water may generally be used except where chemical reaction with the water would generate an air contaminant).

2. Notify the following as soon as possible.

    a. Radiation Safety Officer – Adam McCrary

        Home phone: 309-808-1175

    b. Environmental Health and Safety

        Office phone: 438-8325

        After hours: 438-8631

    c. Principal Investigator

3. Decontaminate, using procedures outlined in Appendix 2-C of this manual.

4. Monitor all persons involved in the spill and clean up operations.

5. Permit no person to resume work in the area until a survey by the Radiation Safety Officer has been completed.

6. A copy of the written report of this spill shall be sent to the Safety Office.

B. Major accidents and spills involving a radiation hazard to personnel

1. Notify all persons not involved in the spill to evacuate the room at once. Personnel not involved shall:

   a. Give first aid to any injured person first of all.

   b. Evacuate the room.

   c. Monitor themselves and decontaminate if necessary.

   d. Notify the Radiation Safety Officer.

   e. Stand by to assist and limit all access to the affected room

2. Notify the following as soon as possible:

   a. Radiation Safety Officer

      Home phone: 309-808-1175

   b. Environmental Health and Safety

      Office phone: 438-8325

      After hours: 438-8631

   c. Principal Investigator

   d. Health Service (if needed) Office phone: 438-8655

3. THE RADIATION SAFETY OFFICER WILL BE IN COMPLETE CHARGE UPON NOTIFICATION OF THE ACCIDENT OR SPILL.

4. If the spill is liquid and the hands are protected, right the container.

5. If the spill is on the skin, flush thoroughly.

6. If the spill is on the clothing, discard outer or protective clothing at once.

7. Vacate the room, evacuate possibly exposed and/or injured personnel from the accident area, give them urgent first aid, and seal off the area. Remain in the general area so that the contamination is not spread to other areas.

8. Take immediate steps to decontaminate personnel involved, as necessary.

9. Plan the decontamination procedure and obtain the necessary equipment. Do not start the decontamination program until plans have been carefully worked out, the required equipment has been obtained, and the Radiation Safety Officer has authorized the cleanup.

10. Decontaminate the entire area. Personnel involved in decontamination must be adequately protected. If air contamination is suspected, an ultrafiltration respirator must be worn.

11. Monitor all persons involved in the spill or accident and all cleaning operations to determine the adequacy of the decontamination.

12. Permit no person to resume work in the area until a survey by the Radiation Safety Officer has been completed.

13. Prepare a complete written history of the accident and subsequent action; as soon as possible evaluate:

    a. Personnel exposure.

    b. Amount of activity released outside the laboratory.

14. Health Service personnel involved in treating exposed patients should, with the aid of the Radiation Safety Officer, do the following:

    a. Confine and survey all contaminated people. Then give first aid for traumatic injury and burns.

    b. Evaluate situation in regard to contamination by radionuclides and level of radiation exposure.

    c. If contamination is present, perform simple decontamination and resurvey patient.

    d. Put the patient to bed. The Health Service's Staff Physician should conduct a brief physical examination.

    e. Save all samples of clothes, jewelry, blood, urine, stool, vomitus. Label with name, time, and date.

f. Obtain careful history of accident.

g. If the exposure is over 100rem or more or if the staff physician so dictates, the patient should be sent to the hospital emergency room for additional treatment or diagnosis.

C. Accidents involving radioactive dusts, mists, fumes, organic vapors and gases.

1. Hold breath & do whatever is possible to confine the activity as time permits.

2. Notify all other persons to vacate the room immediately.

3. Vacate the room. Close the door and remain at the doorway. Remove protective clothing and monitor or be monitored thoroughly for contamination. If skin or hair is significantly contaminated, proceed to adjacent radioisotope laboratory and begin decontamination. The Radiation Safety Officer will take nasal smears and saliva samples.

4. Notify the following as soon as possible:

   a. Radiation Safety Officer

      Home phone: 309-808-1175

   b. Environmental Health and Safety

      Office phone: 438-8325

      After hours: 438-8631

   c. Heating Plant: 438-5656. Inform them that there is a radiation problem and they need to shut down the general ventilation system in that building.

5. Ascertain that all doors giving access to the room are closed and post conspicuous warnings or guards to prevent accidental opening of doors.

6. Radiation Safety Officer shall collect smears and saliva samples from all personnel involved. Keep all personnel in one area until all are monitored.

7. Wear protective clothing and respiratory protection to evaluate contamination. Determine the cause of contamination and rectify the condition if contamination is escaping from a primary source.

8. Plan the decontamination procedure and assemble equipment. Do not decontaminate until plans have been worked out, the required equipment has been obtained and the Radiation Safety Officer has authorized the cleanup.

9. Decontaminate the area working from "clean" to "warm" to "hot" areas.

10. Monitor all persons suspected of contamination.

11. Prepare a complete written history of the accident and subsequent events. Evaluate as soon as possible:

    a. Personnel exposure.

    b. Amounts of activity released outside the laboratory.

D. Other Emergency Procedures

1. PIs that have more specific details for emergencies or have special procedures for accidents should have them written out and posted in their laboratories. A copy should be sent to the Radiation Safety Officer and Environmental Health and Safety.

2. The Radiation Safety Committee for comment or revision shall review these specific or special procedures.

APPENDIX 2-C

Decontamination Procedures:

A. Equipment

1. If equipment is contaminated it should be washed with a suitable cleaning solution as determined by the contaminant and rinsed as a routine procedure. The use of acid on metal tools may unnecessarily corrode them causing greater difficulty in future decontamination procedures. If it is necessary to dismantle any equipment prior to decontamination procedures, careful survey should be made during the operation. Contaminated equipment shall not be released from the control of the laboratory for repair, or for any other purpose, until there is no detectable transferable contamination measurable with the survey meter. In many cases, if the items are cheap or easily replaced, it may be simpler to dispose of such equipment. Equipment that is contaminated with long-lived isotopes, and that cannot be satisfactorily decontaminated must be regarded as radioactive waste. Decay must be considered one of the best decontaminating agents for short-lived materials.

2. Glass and porcelain articles may be cleaned with detergents, mineral acids, ammonium citrate, trisodium phosphate, cleaning solution (chromic acid) or ammonium bifluoride. Metal objects may be decontaminated with detergents, dilute mineral acids (nitric), a 10% solution of sodium citrate, or ammonium bifluoride.

3. Where radioactive materials may be present, or where danger of personal contamination exists, workers involved in decontamination shall wear protective clothing; footwear, gloves, and self-contained breathing apparatus as the circumstances dictate.

4. Where contamination of room air has occurred, thorough ventilation is required, with passage of air from uncontaminated areas through the contaminated areas to the out-of-doors. This should be done preferable by discharging the air into a hood that has a filtered exhaust system.

B. Skin

1. Extreme personal cleanliness is the first rule in preventing contamination of the skin. Persons working with radioactive materials should wash exposed parts of the body frequently, as a matter of routine while on the job. Thorough washing and monitoring shall be mandatory whenever leaving the area.

2. Thorough washing with soap and water is the best general method of decontamination of the hands and other parts of the body regardless of the contaminant. If the contamination is localized, it is often more practical to mask off the affected area and cleanse with swabs, before risking the danger of spreading the contaminant by general washing.

3. If the exact nature of the contaminant is known, it may sometimes be more effective to immerse the hands in a suitable reagent immediately after contamination. Thorough washing in tepid water with mild soap and thorough rinsing in clean water should follow this. Detergents and wetting agents may also prove useful, although sometimes a specific one may be required for a particular contamination problem in order to secure maximum cleaning efficiency. A list of detergents and wetting agents that have been used successfully to remove some contaminants is presented in section E of this appendix. The skin may become sensitive following repeated application of detergents to the same area, therefore, care should be taken to avoid this practice. In any case, one must avoid the use of organic solvents that may increase the probability of the radioactive materials penetrating through the pores of the skin. The recommended procedures for washing hands are as follows:

    a. Wash for not less than two minutes with a mild pure soap in tepid water with a good lather, covering the entire affected area thoroughly. Give special attention to areas between the fingers and around the fingernails. The outer edges of the hands are readily contaminated and often neglected in washing. Do not use highly alkaline soaps or abrasives. Rinse thoroughly and repeat, as monitoring indicates, until the desired degree of decontamination is achieved.

b. If the above procedure is not sufficient to remove the contamination, scrub the hands with a soft brush using a heavy lather and tepid water. This scrubbing is primarily to agitate the cleansing agent, therefore, and hence prolonged scrubbing without change of reagent is of questionable value. For this reason, at least three washes, including rinses, should be made within eight minutes of which at least six minutes should be devoted to scrubbing. Only light pressure should be applied to the brush not sufficient to bend the bristles out of shape or to scratch or erode the skin. Rinse thoroughly and monitor.

c. Apply lanolin or hand cream to prevent chapping. Chemicals may be used for cleaning other parts of the body or the hands, if the above procedures do not successfully remove the contamination. There are two processes in general use. Procedure (1) following has been used successfully for heavy contamination; however, if this procedure is unsuccessful, it may be followed by (2).

4. Apply a liberal portion of titanium dioxide paste to the hands. Work this paste over the affected surface and adjacent areas of the skin for at least two minutes. Use water sparingly to keep the paste moist. Rinse with warm water, and follow by thorough washing with soap, brush and water. Be sure that no paste is allowed to remain around the nails. Monitor, and repeat the entire process, if necessary. It should be noted that the condition of the titanium dioxide paste is very important. In order to be effective, the paste must be prepared by mixing precipitated titanium dioxide (a very thick slurry, never permitted to dry) with a small amount of lanolin.

5. Mix equal volumes of a saturated solution of potassium permanganate and .2 N sulfuric acid. Pour this over the wet hands, rubbing the entire surface and using a hand brush for not more than two minutes. (Note: this application will remove a layer of skin if allowed to remain on contact with the hands too long; consequently, the times stated here should not be exceeded for any single application).

6. Be sure that all areas are thoroughly covered. Rinse with warm water and then apply a freshly prepared 5% solution of sodium acid sulfite ($NaHSO_3$) in the same manner as above, using a hand brush and tepid water for not more than two minutes. Wash with soap and water, and rinse thoroughly.

The above procedure may be repeated several times as long as the permanganate solution is not applied for more than two minutes during any one washing. Application to other parts of the body than the hands may be facilitated by the use of swabs steeped in the solution. Lanolin or hand cream should be applied after washing.

C. Wounds

Extreme precautions must be taken to avoid cuts or puncture wounds. In the event that the skin is broken in accidents while working with radioactive substances, immediate action should be taken to remove possible contamination. Wash the wound under large volumes of running water immediately (within 15 seconds) and spread the edges of the gash to permit flushing action by the water. Light tourniquet action to stop venous return (but not to restrict arterial flow) may be desirable to stimulate bleeding. Report all wounds to the responsible medical or radiological officer as soon as emergency precautions have been taken.

D. Clothing

Contaminated clothing shall not be released to a general service laundry. Clothing contaminated with radioactive material having short half-lives may be labeled and stored for decontamination by decay. Clothing contaminated with long-lived material shall be disposed of or sent to a laundry that is licensed by the NRC or IDNS if local decontamination is not successful.

E. For a summary of Decontamination Methods, refer to the Radiological Health Handbook.

SECTION 3: POLICIES RELATING TO USE OF RADIOISOTOPES

Illinois State University is authorized to obtain, use, store, and dispose of radioactive materials through a license granted to it by the Illinois Department of Nuclear Safety. The University in turn grants professors, who have the proper training and experience, the privilege of using its license to work with radioactive materials. Because the University is the licensed entity it requires that personnel who wish to work with radioactive material be granted this privilege by the Radiation Safety Committee, or work under the supervision of someone who has this privilege. The University also reserves the right, through the Radiation Safety Committee, to revoke any professor's privilege when warranted. This is so that other User's radiation work is not stopped because of the actions of one person.

3.1: Application for Use of Radioactive Materials

3.1.1 Radioisotopes will be procured and used in accordance with conditions stated in the current stated in the current Illinois Department of Nuclear Safety license issued to Illinois State University. **NOTE:** The entire contents of this manual are part of the license and must be adhered to accordingly.

3.1.2 Prospective Users will review and become familiar with the Illinois State Nuclear Safety license issued to Illinois State University; the Illinois State University's Radiation Safety Manual; and pertinent Illinois Department of Nuclear Safety regulations prior to applying for use of radioactive materials or radiation-producing machines. Copies of the above material can be obtained from the Radiation Safety Officer or Environmental Health and Safety.

3.1.3 Prospective Users must meet the following qualifications prior to filling out an application:

3.1.3.1 A college degree at the Bachelor level or equivalent training and experience in the physical or biological sciences or in engineering.

3.1.3.2 At least 40 hours of training and experience in the safe handling of radioactive materials and in the characteristics of ionizing radiation, units of radiation doses and quantities, radiation detection instrumentation and biological hazards of byproduct materials to be used.

3.1.4 Prospective Users who are qualified and wish to use radioisotopes in their studies will prepare an application outlining the proposed uses, requirements in equipment, supplies, scientific assistance, technical assistance, safety procedures, disposal means, and location of use and storage. The Radiation Safety Officer, who will make recommendations to the Radiation Safety Committee to approve or reject the application must review all applications. Appendix 3-A is a copy of the application.

3.1.5 An applicant must describe the procedures to be used in sufficient detail to allow a reasonable evaluation. Since the Radiation Safety Officer will make no evaluation of the scientific worth of the proposed project, the applicant need only describe those activities that may result in contamination or exposure to personnel.

3.1.6 Only after the Radiation Safety Committee authorizes the applicant to use a radioactive material or radiation-producing machine may the applicant order and use that material or equipment.

3.1.7 The applicant, after being authorized by the Committee to use radioisotopes or radiation-producing machines, will be on probation for a period of six months to ensure that the work being conducted meets the approved standards. A member of the Committee will be assigned to oversee the probation. If during or after the probation period the new User has not met the standards of performance they may be denied the privilege to continue work with radiation on the University campus.

3.1.8 If the applicant decides to use another isotope other than what is listed on the protocol, permission must be obtained from the committee before the additional material may be ordered or used.

3.1.9 Environmental Health and Safety will request an annual update on all PIs. The update will request the types of isotopes to be used, location of isotopes, changes in procedures, etc. for the upcoming year. Any changes from previous work will need to be authorized by the committee. Failure to provide the update information could cause action to be taken by the Committee.

3.1.10 In the event that a faculty member wishes to conduct an experiment or perform a classroom demonstration involving radioactive materials but does not possess a user's permit because of the lack of qualifications, the faculty member may:

3.1.10.1 Contact the Radiation Safety Committee or any of its members, who will attempt to find a person who does have a permit and is willing to assume responsibility for the safe conduct of the experiment or demonstration, or

3.1.10.2 Arrange to have a person having a permit assume the responsibility. The permit holder acknowledging acceptance of the responsibility and identifying the faculty member who will conduct the experiment or demonstration must send a memorandum to the Committee.

3.1.11 The Radiation Safety Committee will assign each Authorized User an approval number that will be used when submitting protocol applications for research.

3.1.12 Applications for the Use of Radioactive Materials and Radiation-Producing Machines must be re-submitted to the Radiation Safety Officer for review by the Radiation Safety Committee every three years.

3.2: Application for Radioactive Material Not on the University's License

3.2.1 PIs desiring to use radioisotopes that are not permitted by the University's license need to obtain permission from the Radiation Safety Committee.

3.2.2 The PI may contact any member of the Committee and make the request known. This request should provide an overview of what isotope is to be used, what form it will be in, what type of experiments are to be conducted, and the disposal method to be used. If the isotope is to be mixed with other chemicals, then those chemicals should be identified.

3.2.3 The Radiation Safety Committee will review the request and if there are no objections to that isotope being at the University, a request will be made to the Illinois Department of Nuclear Safety to amend the University's license. Users will not be able to order or use the newly requested isotopes until the license is amended. This process generally takes a month or more.

3.3: Purchase of Radioactive Materials

3.3.1 Material can be purchased through any authorized vendor or in special instances other institutions.

3.3.2 Orders for radioactive materials originate with the authorized user. The University Purchasing Department sends these orders to the Radiation Safety Officer for approval. The Radiation Safety Officer checks the isotope type and amount against a current inventory list to see that the amount of that isotope does not exceed the limit established

under the University's license. After giving approval, the request is returned to the Purchasing Department for processing. In the absence of the Radiation Safety Officer, the Chairman of the Radiation Safety Committee or the Assistant RSO may sign the orders.

3.3.3 No radiation sources, including "exempt" radioactive material, will be moved on or off the campus without prior consent of Environmental Health and Safety.

3.3.4 Incoming packages containing radioisotopes are delivered to Environmental Health and Safety during working hours. A record of the date, P.O. number, isotope and amount are recorded prior to the transfer of these packages to the Radiation Safety Officer. If radioisotope packages arrive after hours, the University Police Department, who will place these packages in a designated storage area and notify the Safety Officer on Call, receives them. No other departments or personnel are authorized to accept radioisotope deliveries. All P.O.s and/or requisitions must indicate that the material is to be shipped to Environmental Health and Safety.

3.3.5 The Radiation Safety Officer or Assistant RSO inspects all radioisotope packages for signs of damage or leaks. If leaks are present, specific procedures are followed, as outlined in Appendix 3-B. If the package is not damaged or leaking then the package is delivered to the user along with the appropriate inventory sheets.

3.4: Transfer of Radioactive Material

3.4.1 The following conditions must be met before the transfer of radioactive materials can occur to or from Illinois State University:

3.4.1.1 The Radiation Safety Officer or the Chairman of the Radiation Safety Committee must authorize all radioactive material transfers to or from the University.

3.4.1.2 The material being transferred must be material that has been authorized to be transferred in accordance with the Illinois Department of Nuclear Safety and the University.

3.4.1.3 The receiving agency must be licensed to accept the proposed transfer material

3.4.1.4 A Licensed Material Transfer Report must be filled out with the proper information. Appendix 3-D is a copy of this form. This form must be completely filled out and signed by the University's Radiation Safety Committee representative, the person transferring the material and the receiver.

3.4.1.5 A copy of this form must accompany the material when it is transferred. A copy must be on file at Environmental Health and Safety. The PI may keep a copy for his/her files, if desired.

3.4.1.6 All radioactive materials must be shipped in accordance with the Illinois Department of Nuclear Safety, the Nuclear Regulatory Commission, the U.S. Department of Transportation regulations and the U.S. Postal Regulations, as applicable.

3.4.2 Transfer of radioactive materials within the University also requires certain items be completed prior to the transfer. However since the transfer is not between licenses the requirements are not as elaborate.

3.4.2.1 Whenever the responsibility of control over radioactive material is to be given to another PI, the Radiation Safety Officer must be notified.

3.4.2.2 The Radiation Safety Officer will ensure that the new User is authorized for that particular isotope. The Radiation Safety Officer will make note of the transfer in his records.

3.4.2.3 The original PI will then transfer the radioactive material and the inventory sheet to the new PI. The new PI will then become the Principal User and responsible agent for the material. Tracking with appropriate forms must be accomplished even for partial transfer of materials.

3.5: Records for Radioactive Material Use

3.5.1 Environmental Health and Safety will maintain a record of all incoming packages of radioactive material.

3.5.2 The Radiation Safety Officer will provide the User with a Radioisotope Inventory Sheet for each shipment that arrives at the University. A copy of the sheet is in Appendix 3-C.

3.5.2.1 Each isotope in each shipment will be noted on a separate inventory sheet.

3.5.2.2 Each User will maintain a complete and accurate inventory of all materials stored in the various laboratories. No material is to be added to or removed from the area without appropriate notation on the inventory form.

3.5.2.3 When all material on an inventory sheet has been used up or discarded, the inventory sheet or a copy is to be returned to the Radiation Safety Officer.

3.5.3 Any radioactive material transferred to or from Illinois State University must have a Licensed Material Transfer Report filled out. This report will be on file at Environmental Health and Safety. (See Appendix 3-D).

3.5.4 Environmental Health and Safety will maintain all Monitoring reports and RMA-1 forms.

3.5.5 All other records, such as investigations, correspondence, inspections, etc. will be kept on file with either Environmental Health and Safety or the Radiation Safety Officer.

3.6: Training Requirements for Personnel Using Radioisotopes

3.6.1 All personnel who come in contact or may come in contact with the use, storage, transportation, or disposal of radioisotopes are required to be trained in the proper safety precautions for handling such materials. Such personnel shall include but not be limited to the following:

3.6.1.1 Laboratory technicians, graduate students, undergraduate students, etc. that may be working for the Principal Investigator.

3.6.1.2 Ancillary personnel, including Building Service Workers, ISU Police Officers, Environmental Health and Safety staff, Facilities Craft Trades, Heating Plant staff, and Property Control staff.

3.6.2 The training shall be of sufficient detail to avoid radiological health protection problems and shall be given to each worker either in writing or in an orientation course.

3.6.3 The training for the personnel working directly with the isotopes needs to consist of the following items:

3.6.3.1 Define radiation and the terms used in radiation work.

3.6.3.2 Identify what health risks are associated with radiation exposure including exposure to embryo and fetus.

3.6.3.3 Identify the general and specific procedures for handling, storing, transporting, and disposing of radioisotopes.

3.6.3.4 Identify the general and specific safety procedures and devices that are needed to prevent unnecessary exposure. In particular identify the use of monitoring devices such as film badges and survey meters.

3.6.3.5 Identify the specifics about the type or types of isotopes the individuals are to be using or will be in the laboratories.

3.6.3.6 Identify the rules and regulations that pertain to the individuals and where they can find copies of these, if they desire to study them further. This is to include the Illinois State University Radiation Safety Manual rules and procedures.

3.6.3.7 Identify the conditions that may lead to exposure and ensure that individuals know who to call for assistance.

3.6.3.8 Identify the instrumentation that is to be used in dealing with the radiation and ensure personnel know how it is to be used.

3.6.4 The training for the ancillary workers will include the items listed in 3.6.3.1-3.6.3.7, but in lesser detail. These workers will also need to know what they can specifically do and not do in the areas where they may come in contact with radioactive material.

3.6.5 Any procedures that are not in accordance with this manual or that require something out of the ordinary will need to be in writing. These procedures will need to be sent to the EHS and the Radiation Safety Committee as well as being included in the training.

3.6.6 All personnel receiving the training must be afforded a chance to ask questions so that there is a definite understanding of the procedures. An exam may be given to the group to ensure that there is understanding.

3.6.7 All training must be documented and the records kept on file. Appendix 3-E is the form that needs to be signed by the individual.

3.6.8 The training shall be given on an annual basis or at any time new personnel will be involved with radioisotopes.

APPENDIX 3-A

Application to the Radiation Safety Committee for the Use of Radioactive Materials and Radiation-Producing Machines

DATE: Click here to enter a date.

NAME:

DEPARTMENT:

BUILDING AND ROOM WHERE MATERIAL(S) OR DEVICE WILL BE USED:

BUILDING AND ROOM WHERE MATERIALS(S) WILL BE STORED:

SPECIFIC AREA IN WHICH MATERIAL(S) WILL BE STORED:

APPROXIMATE # OF PERSONS WORKING WITH MATERIAL OR DEVICE UNDER YOUR SUPERVISION:

Graduate Students Undergraduates Lab Technicians Other Faculty

PLEASE IDENTIFY OTHER FACULTY:

Please list the specific training, including Radiation Safety Training, and experience you have had using the above radioactive material(s) or radiation-generating equipment:

Identify the isotopes you intend to use, the maximum quantity in mCi per year, the chemical form you will use, and your experience with it. *Example: 1) P-32, Maximum of 10mCi per year in 1 mCi increments. The P-32 will be incorporated into dCTP. I have been using this material for the past XX years in my research to study the synthesis of XX.*

Describe how you will store the radioactive waste produced, both liquid and dry:

Describe how this waste will be safely disposed of:

☐ **I have read and understand the rules and procedures outlined in the ISU Radiation Safety Manual and the regulations of the IEMA Bureau of Nuclear Safety.** (check the box / no signature required)

Submission Instructions: Save a completed copy of this application. Submit the completed form by clicking on the following hyperlink and attaching the saved document: sysenvironmental@ilstu.edu

FOR RSC USE ONLY
Date of Committee Meeting Click here to enter a date.
☐ Application Approved
☐ Application Withheld Pending Modifications
☐ Application Denied
Comments

APPENDIX 3-B

Inspection of Radiation Shipments

The Radiation Safety Officer or Assistant RSO upon receipt of the radiation shipment will inspect the package in accordance with the following procedures:

1. Monitor the external surfaces of the package for radioactive contamination caused by leakage of the radioactive contents. Such monitoring need not be performed on:

a. Packages containing less than 1 milliCurie of beta and/or gamma emitting radioactive material or 10 microCuries of alpha emitting radioactive material;

b. Packages containing no more than 10 milliCuries of radioactive material consisting solely of tritium, carbon-14, sulfur-35, or iodine-125;

c. Packages containing only special form radioactive material or gases;

d. Packages containing non-liquid form radioactive material less than the quantities specified in Table A, Appendix A of Section 341.

2. The procedures for monitoring the packages will consist of the following:

a. Observe the outer package for any signs of damage that may have an effect on the material in the package.

b. Use the appropriate direct reading instrument and measure the activity present on the outside of the package at approximately one foot and one inch from the surface of the package on all sides of the package. This reading should be equal to or less than the amount identified by the originator.

3. If removable contamination is in excess of 0.01 microCurie per 100 square centimeters of the package surface, the RSO will immediately notify the EHS, the carrier, and IDNS by phone.

Appendix 3-C

Sanitary Sewer = SS

Solid Waste = SW

Haz. Waste = HW
-solid
-liquid

RADIOISOTOPE INVENTORY SHEET

ILLINOIS STATE UNIVERSITY
RADIATION SAFETY COMMITTEE
Chairman: John Goodman RSO: Adam McCrary

Isotope Inventory #_____ Responsible Investigator_____

Isotope & Amount_____ Department_____

Chemical Carrier_____ Purchase Order #_____

Date Received_____ Date Returned_____

Return this form to EHS, Campus Box 1320, immediately after completion.

USE			DISPOSAL						
Date	Amount Used (µCi)	User Initials	Date	Amount Disposed (µCi)	Chemical Constituents	Total Volume (L)	SS	SW	HW

TOTALS: Sanitary Sewer (S.S.) _____ µCi Solid Waste (S.W) _____µCi Hazardous Waste (H.W.)_____ µCi
(general refuse)

Amount Lost: Decay _____µCi In Storage _____ µCi **TOTAL** _____ µCi * This should equal the amount that was received (P-32, P-33, S-35)

Questions? Contact EHS at 438-8325

APPENDIX 3-D

ILLINOIS STATE UNIVERSITY
RADIATION SAFETY COMMITTEE
Chairman: John Goodman RSO: Adam McCrary

LICENSED MATERIAL TRANSFER REPORT

Material being transferred from:

Institution: _____

Individual: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone Number: _____

Radioactive material license number (include state name):
_____

Material to be transferred to:

Institution: _____

Individual: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone number: _____

Radioactive material license number (include state name):
_____

Material to be transferred:

Isotope Amount (mCi) Chemical Form

_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

Method by which the transfer will occur: _____

_____

Approval of ISU's

Radiation Safety Committee: _____ Date: _____

Approval of other Agency's

Radiation Safety Committee: _____ Date: _____

Transferred by_____ Date: _____

Received by: _____ Date: _____

SECTION 4: SAFEGUARDS APPLICABLE TO WORKING WITH RADIOACTIVE MATERIALS

4.1: External Radiation Precautions

The dose received during exposure to gamma and beta emitters is a function of time, distance, shielding, and manipulative technique.

4.1.1 Time: The radiation dose one receives is directly proportional to the time of exposure to a radiation source. The maximum exposure time should be estimated in advance allowing a margin of safety. It is often preferable to use simple equipment and finish an operation quickly rather than to use complicated apparatus which may reduce dose rate but requires more time for the procedure. This does not mean that appropriate manipulative techniques should be omitted in order to decrease the exposure time.

4.1.2 Distance: Radiation emanates from a point source or a series of point sources. The amount reaching a given area decreases with the square of the distance from the source. Therefore, a point twice the distance will receive one-fourth the radiation. Distance is the most useful and sometimes the best way to decrease the radiation dose received.

4.1.3 Shielding: Absorbing material introduced between a radiation source and an individual will decrease radiation exposure to the individual by a factor which depends upon the energy of the radiation and the nature and thickness of the shield. For gamma rays lead is generally employed, and for Beta plexiglass is generally used. For

determination of how thick the layer of each material should be please check with a half value layer table.

4.1.4 Handling Procedures: Two basic isotope laboratory rules are: Isotopes in any chemical form are to be handled with suitable tools, never with the hands. Pipetting by mouth is absolutely forbidden. Remote pipettes should always be used for pipetting activity. To avoid exposure from pipetting, the pipette should be tilted sufficiently so that the hand is never over the open mouth of the bottle.

4.2: Ingestion Precautions

Good housekeeping practice will prevent accidental ingestion of radioactive materials. Smoking, eating, pipetting by mouth and application of make-up are not permitted in the laboratory.

Under no circumstances are human subjects to be used for research involving internal and external dosages of radiation.

4.3: Inhalation Safeguards

To prevent inhalation of toxic or radioactive materials, the process and equipment should be designed to prevent escape of radioactivity into the air. This is accomplished by elimination of dust-producing operations, proper selection of the chemical and physical form of the materials and total enclosure of the process. When volatile or gaseous materials are used, it is essential that such material be handled inside a hood approved for such use.

4.4: Posting Requirements

4.4.1 The Nuclear Regulatory Commission has designed a radioactivity symbol. This symbol with an appropriate subheading is to be conspicuously displayed in all areas where radioactivity is stored or used and/or where radiation levels meet those outlined below. Signs, labels, and tags with proper headings are available from Environmental Health and Safety.

4.4.2 Areas accessible to personnel where a major portion of the body could receive a dose in excess of 100 millirem in any hour shall be designated as a "High Radiation Area". All such areas shall be conspicuously posted with a sign or sign bearing the radiation caution symbol and the words:

CAUTION

RADIATION AREA

4.4.3 Areas accessible to personnel, where a major portion of the body could receive a dose in excess of 5 millirem in any one hour or a dose in excess of 100 millirem in any 5

consecutive days, shall be designated a "Radiation Area". All such areas shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION

RADIATION AREA

4.4.4 Every area or room in which radioactive material in amount exceeding 10 times the license exempt quantity specified in 32 Illinois Administration Code: Chapter II, Section 330.40, Appendix B is used or stored, should have a sign bearing the radiation caution symbol and the words CAUTION RADIOACTIVE MATERIALS posted in a conspicuous spot.

4.4.5 Each container used to transport or store an amount of any radioactive material greater than that specified in 32 Illinois Administration Code: Chapter II, Section 330.40, Appendix B shall display a label bearing the radiation caution symbol and the words:

CAUTION

RADIOACTIVE MATERIALS

The labels are not required for laboratory containers such as beakers, flasks and test tubes used transiently in laboratory procedures when the user is present. When containers are used for storage, the labels shall also state the quantities and the kinds of radioactive materials.

4.4.6 Besides the radiation signs all doors to laboratories will be posted with an emergency notification sign. This sign will identify the principal User's name, office phone number, and home phone number. It will also identify the number to call for the Safety Officer in case the User cannot be reached.

4.4.7 Within each isotope laboratory, Users will have Notices to Workers posted in a conspicuous location. These notices will include:

4.4.7.1 A Notice identifying the location of the current IDNS regulations, a copy of the registration, the University's license, all the pertinent documents to the license, and copies of the University's Radiation Safety Manual.

4.4.7.2 Copies of any violation notices that laboratory has received. This must be posted within five days after receipt and left there until the violation has been corrected.

4.4.7.3 A copy of the IDNS Form KLA.001 "Notice to Employees".

4.4.7.4 A copy of procedures that are to be followed in that laboratory.

4.5: Storage and Security of Radioactive Sources

4.5.1 Users will be directly responsible for the security of all radioisotopes under their control.

4.5.2 Storage of isotopes.

4.5.2.1 Storage of the isotopes will be in locations that are appropriate for the type of isotope present.

4.5.2.2 All locations will be identified to the committee by means of the application and update reports.

4.5.2.3 All rooms and areas within the rooms having radioisotope storage will be properly labeled.

4.5.2.4 Changes to the storage locations will require a notice to be given to the RSO so he may check the old storage area for contamination and update the records of the new location.

4.5.3 Security of isotopes.

4.5.3.1 All isotopes will be safeguarded against unauthorized access and use. Storage of any radiation material is to be in an area that is not accessible to the general public.

4.5.3.2 All rooms with radiation material is to be locked when no one is in the room.

4.6: Required Use of Laboratory Hoods

The radioactive material regulations have set specific levels for the amount of radioactive material that can be found in the air. Therefore to reduce the probability of exposing personnel to radioactive materials in the air the following rules pertaining to the required use of laboratory hoods are to be implemented.

4.6.1 Any experiment or research involving the use of radioactive materials in the following manner will be conducted under a hood.

4.6.1.1 A gaseous form.

4.6.1.2 An aerosol or very volatile liquid.

4.6.1.3 Any procedure that would cause the radioactive material to become airborne in any manner.

4.6.1.4 Any procedure using the isotope I-125 in volatile form.

4.6.2 Prior to working with the experiment or research the User must do the following items and review them with the Radiation Safety Officer.

4.6.2.1 Develop procedures for routine use.

4.6.2.2 Develop emergency procedures in case of an accidental release of the radioactive material.

4.6.2.3 Determine the air concentration of radioactive material in the restricted area based on normal release and an accidental release of the largest activity present. See Appendix 4-A for the means to determine the concentration.

4.6.2.4 Determine the air concentration of radioactive material in the nearest non-restricted area based on normal release and an accidental release of the largest activity present.

4.6.2.5 The Radiation Safety Officer will assist the User in determining these concentrations and insuring they do not exceed the amounts specified in section 340 of the IDNS regulations.

4.6.3 A hood will not be required if the User can demonstrate to the Radiation Safety Officer that:

4.6.3.1 There are procedures in place that will present any routine exposure to personnel.

4.6.3.2 That if a total release occurs, the amount of radioactive material in the restricted area is equal to or less than the amount specified in section 340 of the IDNS regulations.

4.6.3.3 There is no circulation of air from the restricted area to any other area in the building.

SECTION 5: PROCEDURES TO BE USED WHEN RADIOACTIVE SOURCES ARE USED IN CLASSROOM DEMONSTRATIONS AND/OR LABORATORY EXPERIMENTS

As indicated in section 3.1.9, no faculty member can use radioactive sources in a classroom demonstration/experiment unless the faculty member possesses a User's permit or arranges with a User to supervise the demonstration/experiment.

5.1: Demonstrations/Experiments That Do Not Involve Direct Student Involvement

5.1.1 All radioactive sources used intermittently for laboratory experiments and/or classroom demonstration shall be stored, when not in use, in a safety shielded location in the department or in a place specified by the Radiation Safety Officer.

5.1.2 The department representative to the Radiation Safety Committee will maintain an inventory record of all sources assigned to the department.

5.1.3 Sources will be signed out to responsible persons for use and returned to the storage location immediately after use.

5.1.4 A "dry run" of the procedure should be carried out whenever practicable.

5.1.5 After the "dry run", a pre-class radiation survey should be conducted with sources in place. Measurements should be made at all points to be occupied by the instructor, personnel assisting in the demonstration, and the front row of the lecture room. See Appendix 5-A for survey form.

5.1.6 Where the experiment involves the use of unsealed sources, special precautions must be taken to prevent contamination by personnel, equipment or laboratory surfaces. Appropriate monitoring should be conducted using an appropriate instrument at the conclusion of the procedure.

5.2: Experiments That Have Direct Student Involvement

5.2.1 The instructor and/or User must prepare a written protocol of the experiment and all the procedures to be conducted in the experiment. This protocol should include the type of isotope, activity, procedures to be used, safety measures and equipment.

5.2.2 The written protocol will be given to the Radiation Safety Committee for review and approval. This will mean that the protocol will need to be prepared and given to the Committee well in advance of the class in order for the Committee to have sufficient time to review it.

5.2.3 Once the protocol is approved, copies of the protocol will need to be given to the students and teaching assistants that will be in the class.

5.2.4 All students that are involved with the experiment must be trained in at least the following areas: what is radiation, health effects of radiation, the specifics of the isotope being used, and the procedures and safety measures to be followed in their experiment. This training must be documented and retained by those in charge. Appendix 3-E is a copy of the form that the students need to sign to indicate they have received the training.

5.2.5 Students under the age of 18 are not allowed to participate in the experiment. It is recommended that females who are pregnant or who are likely pregnant should not be allowed to work with the isotopes. It is not that the experiment is overly dangerous but the liability issues in either case would be extremely high if anything, related or not, should happen.

5.2.6 Absorbent material will be used in all work areas during the experiment. Immediately after the experiment is finished for the day, the absorbent material will be

disposed of properly. Then the underlying material will be cleaned using the proper cleaning agents. Readings should be made at all location which may have been occupied by the students or others working with radioisotopes. These readings will be taken with the appropriate monitor or wipe test.

5.2.7 Monitoring requirements.

5.2.7.1 At the present time only experiments involving minute amounts of C-14 and H-3 will be allowed in classroom experiments. As stipulated in our manual and in accordance with the regulations no personal monitoring is required for these isotopes.

5.2.7.2 If higher MeV value isotopes (i.e.: P-32) are allowed by the Committee for use in classroom demonstrations, then personal dosimetry will be required.

5.2.7.2.1 For isotope experiments that occur only one time and/or involve very short exposure to the isotopes, the monitoring method will be with direct read pocket dosimeters.

5.2.7.2.2 For experiments that will be for a long duration, then the department will be required to acquire film badges for each student.

5.2.8 Each student, before leaving the classroom, will remove any protective clothing and will conduct a personal survey to ensure they are not contaminated with any radioisotope material. This survey will be conducted using the appropriate survey equipment.

5.2.9 Since the experiment involves the use of radioisotopes, the primary User needs to be present during the experiment. Sufficient assistance will be present to properly supervise the students.

5.2.10 The room will need to be labeled with the appropriate signs as long as the isotopes are in the room. Once the isotopes are removed and the room is found to be non-contaminated, the signs may be removed.

5.2.11 All accidents (i.e.: spills, injuries, etc.) will be reported immediately to the Radiation Safety Officer.

APPENDIX 5-A

ILLINOIS STATE UNIVERSITY
RADIATION SAFETY COMMITTEE
Chairman: John Goodman RSO: Adam McCrary

RADIATION SAFETY CHECK SHEET

To be completed by instructor prior to initiating classroom demonstrations involving radioactive materials or radiation producing equipment.

1. Type of experiment_____

2. Carried out by _____

3. a. Source of radiation_____

b. Activity or strength_____

c. Physical form_____

4. Description of experiment and procedure_____

_____

5. a. Expected doses at various positions_____

_____

b. Expected exposure rate at various positions_____

_____

c. Measured_____ Calculated_____

6. Is there a possibility of leakage or contamination? _____

7. Is shielding material needed? _____

8. Is there a need for: Protective clothing? _____

Bench cover? _____

9. Is there a waste disposal problem?_____If so, how will the material be disposed of?

_____

10. Should personnel monitors be worn?_____By whom?_____

_____

11. Are sources properly labeled and properly stored when not in use?
_____

Signed _____ Date _____

SECTION 6: MONITORING PROCEDURES

6.1: Personnel

6.1.1 Film badges are issued and discontinued by the department in which the user is employed.

6.1.1.1 Supervisors will ensure badges are acquired and worn in accordance with section 2.5.2.

6.1.1.2 Personnel who need or desire to wear to badge shall be issued a whole body film badge to be worn in accordance with 2.5.3.

6.1.1.3 Personnel who will work, on a continual basis, with quantities of 1 mCi of P-32 or more and who will have only their hands exposed to the radiation will be required to wear a film badge and ring badge.

6.1.1.4 Where badges are required, work with radiation will not be allowed until appropriate badges are issued.

6.1.1.5 A completed Film Badge Information Sheet needs to be sent to the EHS prior to issuing a badge. Appendix 6-A is a copy of the Film Badge Sheet.

6.1.2 The supervisors and departments are responsible for turning in the badges to the film Badge Company.

6.1.2.1 The film badges are to be turned in by the users to the appropriate department on a monthly basis. A new badge of the same number should be obtained at that time.

6.1.2.2 The appropriate department will turn in all the old badges to the film Badge Company on a monthly basis.

6.1.2.3 Copies of the film badge company's reports are to be forwarded to the EHS. These results are recorded by EHS on the RMA-1 forms.

6.1.3 Environmental Health and Safety maintains records of individual exposures, cumulative, and lifetime, for later reference. Individuals and their immediate supervisors may review their exposure history. Except for reports required by law, radiation exposure histories are not released without the written consent of the individual concerned.

6.1.4 Departments or supervisors observing exposures approaching or exceeding the amounts listed below should notify the Radiation Safety Officer and Environmental Health and Safety. EHS, during their recording of the film badges, will also identify any exposures approaching the levels below.

Radiation exposure dose limits:	
Gonads and red bone marrow (and in the case of uniform Irradiation, the whole body)	1.25 rem/qtr
Skin, thyroid; bone	7.50 rem/qtr
Hands and forearms; feet and ankles	18.75 rem/qtr
All other organs	3.75 rem/qtr

6.1.5 EHS will notify the individual of their exposure in writing by use of the Notification of Exposure Form. Appendix 6-E is a copy of this form. The principal Investigator will also be notified of the exposure through the use of the supervisor's form. Appendix 6-F is a copy of this form. The User will be required to determine why there was an exposure and how it will be prevented in the future. The individual and the supervisor will sign this Notification of Exposure Form and return a copy to EHS where it will remain part of the individual's permanent record.

6.1.6 The Radiation Safety Officer and/or the EHS will assist the User in the investigation of the high exposure and assist in determining the means to reduce or eliminate the exposure.

6.1.7 No PI shall possess, use, or transfer sources of radiation in such a manner to cause any individual within a controlled area who is under 18 years of age, to receive in any period of one calendar quarter from all sources or radiation in such user's possession a dose in excess of 10 percent of the limits specified above. These young people shall not be occupationally exposed to radiation. (They shall not be employed or trained in a radioisotope laboratory or industrial radiation facility).

6.1.8 No user shall possess, use or transfer sources of radiation in such a manner as to crease in any uncontrolled area radiation levels which, if an individual were continuously present in the area, could result in receiving a dose in excess of:

a) 0.25 millirem in any one hour.

b) 10 millirem in any one week.

c) 500 millirem in any one year.

6.1.9 Declared Pregnant Workers

6.1.9.1 A written declaration of pregnancy will immediately initiate dosimetry and lower dose limitations. The written declaration of pregnancy must be submitted to Environmental Health and Safety in order to apply dosimetry and lower dose limitations. The estimated date of contraception in not required, but is requested as a part of the written declaration of pregnancy.

6.1.9.2 The dose limit to an embryo/fetus during the entire pregnancy due to occupational exposure of a declared pregnant woman is 500 millirem. Care shall be taken so that no

more than 50 millirem be received during any one month during a declared pregnancy. Furthermore, efforts shall be made to avoid substantial variation above uniform monthly exposure rate to a declared pregnant woman

6.1.9.3 If the pregnant woman has not notified the Environmental Health and Safety of her estimated date of conception, the dose to the fetus shall not exceed 50 millirem per month during the remainder of the pregnancy.

6.2: Bioassay Services

Environmental Health and Safety will arrange bioassay services in cases where ingestion or absorption of radioactive materials warrants such a survey. Bioassays will be performed in cases that the Illinois Department of Nuclear Safety requires a survey, such as a person receiving an extremely high exposure (above the quarterly allowable level) of if it is determined by a physician that a Bioassay is needed, or if the individual opens a container with an activity of 50 millicuries or more of Tritium. When possible the Radiation Safety Officer will conduct a survey of the individual's condensed breath. If any other body fluid needs to be examined, the University will contract with an appropriate physician to conduct the survey and analysis.

6.3: Medical Examinations

Environmental Health and Safety will arrange medical examinations in cases of confirmed or suspected gross overexposure. Medical examinations may be requested by the Radiation Safety Committee in order to establish physical base line levels prior to initiating work with radioactivity.

6.4: Sealed Source Monitoring

Radioactive material that is enclosed in a container designed to prevent leakage and in which the material remains while in use is defined as a sealed source. Such sources are leak tested periodically (once every six months) by or under the direction of the Radiation Safety Officer. Leak test analysis will state sensitivity of equipment and calibration reference source used. See Appendix 6-B for procedure.

6.5: Safety Surveys

Safety surveys will be made in all laboratories using radioisotopes at regular periodic intervals by or under the direction of the Radiation Safety Officer. Records will be kept in such form that the State of Illinois inspectors can satisfy themselves of these inspections.

6.5.1 On a monthly basis, work surfaces where radioactivity is used are to be scanned with an appropriate survey instrument. Beta and alpha activities that cannot readily be detected with portable survey equipment are to be checked by wiping a representative area with filter paper(s) and counted in an appropriate detector. Users will conduct weekly safety survey of their areas using the same procedures outlined above. The PI

must maintain records of these surveys so the Radiation Safety Officer or IDNS inspector can review them at any time. Appendix 6-C is a copy of the Isotope Survey Report Form. Appendix 6-D identifies the procedures for the monthly and weekly surveys. Appendix 6-G outlines the calibration and operability procedures for the survey instruments.

6.5.2 During the monthly walk through the Radiation Safety Officer will briefly inspect the condition of the laboratory areas to ensure that proper techniques, working conditions, and procedures are being adhered. If problems are identified the Radiation Safety Officer will notify the Principal Investigator of the problem, so corrective action can be instituted.

6.5.3 Each month the Radiation Safety Officer will conduct an audit of two laboratories to ensure that their records are up to date. See Appendix C for the check off list. This check off list does not limit the Radiation Safety Officer from observing, checking, or inspecting any other aspect of the laboratory or users.

6.5.4 Each year the Radiation Safety Officer will conduct a final audit of the isotope usage and disposal records of each PI.

6.6: Fume Hood Surveys

All fume hoods that are being used in conjunction with radioactive material will be surveyed every six months for appropriate face velocity. In accordance with the ACGIH Industrial Ventilation Guide, this velocity should be between 125-200 fpm average over the face of the hood opening. The survey of the hoods will be accomplished by using a TSI Velocicalc to determine the fpm at the face of the hood. The hoods will be tested in the completely open position and at the optimum opening. In the completely open position each hood will be divided into six-nine sampling points and the airflow measured, these will be averaged to determine the fpm for the hood. In the optimum position the hood will be divided into three-four sampling points and the airflow measured.

APPENDIX 6-A

ILLINOIS STATE UNIVERSITY
RADIATION SAFETY COMMITTEE
Chairman: John Goodman RSO: Adam McCrary

FILM BADGE INFORMATION SHEET

Badge No. _____

Name _____ Social Security No. _____

Date of Birth _____

Home Address_____ City _____ Phone _____

Office _____ Phone _____

Department_____Office_____Phone_____

Supervisor_____Office_____Phone_____

Rooms in which you may be using radioisotopes or x-rays
_____

_____

If you are using x-rays, please indicate: Diagnostic_____

Other _____

Radioisotopes you are presently using _____

Describe your duties with radioisotopes or x-rays_____

_____

****

Have you previously worked anywhere that you may have been exposed to ionizing radiation?

Yes_____ No _____

If yes, please indicate name of employer_____

Address_____ City _____

Supervisor _____ Dates of employment _____

Date started work with radioisotopes or x-rays at I.S.U. _____

Date terminated work with radioisotopes or x-rays at I.S.U. _____

****

To be completed by Radiation Safety Officer or designate, Illinois State University

Skin Extremities Whole Body

Previous exposure record: _____mrem _____mrem _____mrem

I.S.U. Exposure record: _____mrem _____mrem _____mrem

****

Remarks:

APPENDIX 6-B

Sealed Source Monitoring

Our Cs-137 sealed source will be tested in the following manner:

The source will be wiped with a dampened piece of absorbing paper. This paper will be placed in a liquid scintillation vial, scintillation medium will be added, and the activity counted in a Packard, Tri-Carb, Model 1600 CA Liquid Scintillation System or its equivalent.

The following example calculations will be used to demonstrate how the activity in uCi, is determined.

Count from wipe = 60 cpm, Background = 40 cpm, Net count = 20 cpm

A 90% counting efficiency will be assumed to determine the dpm*.

Net dpm = (net cpm)/0.9 Net dpm = 20/0.9 = 22dpm

Activity of wipe = net dpm divided by 2.22×10^{12} dpm/Ci

Activity of wipe = 22 dpm/2.22×10^{12} = 10^{-11} Ci

Activity of wipe = 10^{-5} microcuries.

If the test reveals the presence of 0.005 microcuries or more of contamination, the sealed source shall be removed from use and decontaminated. After decontamination it will be repaired or disposed of accordingly and a report filed with the Illinois Department of Nuclear Safety. Records of the leak tests will be kept by the Radiation Safety Officer for inspection by IDNS.

*Liquid Scintillation counting efficiency is an increasing function of the energy of beta particles that is to be detected. The counting efficiencies of the TRI_CARB unit for a few common isotopes are:

Tritium (H-3), beta energy: 0.0186 MeV; about 50%

Carbon 14 (C-14), beta energy: 0.156 MeV; 85 to 90%

Phosphorus 32 (P-32), beta energy: 1.71 MeV; near 100%

The energy of the beta emitted from Cesium 137 (Cs-137) is 0.514 MeV. It, therefore, appears to be a conservative assumption to use a counting efficiency of 90% for Cs-137.

APPENDIX 6-C

ILLINOIS STATE UNIVERSITY
RADIATION SAFETY COMMITTEE
Chairman: John Goodman RSO: Adam McCrary

MONTHLY WIPE TEST SURVEY and INTERVIEW FORM

Date _____ Person performing survey _____

SWIPES					SURVEYS				
Rm. No. Bldg.	Vial	Isotope	Swipe Location	LS 6500 WIDE cpm	Rm. No. Bldg.	Isotope	Survey Location	Survey Meter Serial No.	mR/hr
Bkgnd		XXXX	XXXXX		Bkgnd	XXXX	XXXXX		

Laboratory Room # and PI _____
Person(s) Interviewed _____
Weekly Wipe Test/Survey Records ___ Inventory Records ___ Instrument Check ___
Comments:

APPENDIX 6-D

Procedures for the Monthly Survey

Routine surveys of radioactive material usage and storage areas are conducted monthly. These surveys are conducted unannounced by or under the direction of the Radiation

Safety Officer. The Radiation Safety Officer will use calibrated survey meter and/or wipe tests of the various surfaces. Each PI will produce his/her records of the weekly wipe tests upon request of the Radiation Safety Officer.

Any contamination, above background, detected by the survey meter will be noted and the PI notified of the problem. The PI will then be responsible for decontamination.

The wipe tests are used primarily as a detection method for H-3 and C-14, as the survey meter generally will not detect these isotopes very well. A liquid scintillation counter will be used to analyze these wipes. Notification and decontamination will be required if the test results reveal that the wiped surfaces have an activity greater than 15 times background. The Radiation Safety Officer will maintain records.

APPENDIX 6-E

Notification of Exposure--Individual's Form

TO: Exposed Individual

FROM: Environmental Health and Safety

RE: Occupational External Radiation Exposure

DATE: December XX, 10XX

During the period of time from XX/XX/XX to XX/XX/XX, the Radiation Dosimetry Report indicated that you were exposed to YY millirems of skin of whole body radiation and YY millirems of whole body radiation. There is no reason for alarm as the amount of your exposure is well below the following U.S. Nuclear Regulatory Commission maximum exposure guidelines.

TYPE OF EXPOSURE	GUIDE VALUE
Whole body; head and trunk; blood forming organs; lens of eye; or gonads.	1250 millirems per quarter and 5000 millirems per year.
Skin of whole body.	7,500 millirems per quarter.
Hand, forearms, feet and ankles.	18,750 millirems per quarter.

I encourage you to contact your supervisor to discuss your exposure and methods to prevent/limit any future exposure.

Thank you for your cooperation. If you have any questions please give me a call.

APPENDIX 6-F

Notification of Exposure--Supervisor's Form

TO: Principal User

FROM: Environmental Health and Safety

RE: Occupational External Radiation Exposure

DATE: December X, 19XX

During the period of time from XX/XX/XX to XX/XX/XX, (this individual) was exposed to YY millirems of skin of whole body radiation and YY millirems of whole body radiation. This person has been advised to contact you to discuss the exposure and methods to prevent/limit any future exposure.

Following is a summary of the U.S. Nuclear Regulatory Commission maximum exposure guidelines**:**

TYPE OF EXPOSURE	GUIDE VALUE
Whole body; head and trunk, blood	1250 millirems per quarter
forming organs; lens of eye; gonads	and 5000 millirems per year.
Skin of whole body.	7,500 millirems per quarter.
Hand, forearms, feet and ankles.	18,750 millirems per quarter.

In the space below, please provide the following:

(1) Probable reason(s) for the exposure.

(2) Action(s) to be taken to prevent/limit any future exposure.

(3) Signature of person exposed and the date counseling with the supervisor was completed.

_____ (PERSON EXPOSED) (DATE OF COUNSELING)

(4) Signature of supervisor and the date counseling with the employee was completed.

_____

(SUPERVISOR) (DATE OF COUNSELING)

Use an additional sheet if necessary. After completing, please return this form to Environmental Health and Safety. Thank you for your cooperation.

APPENDIX 6-G

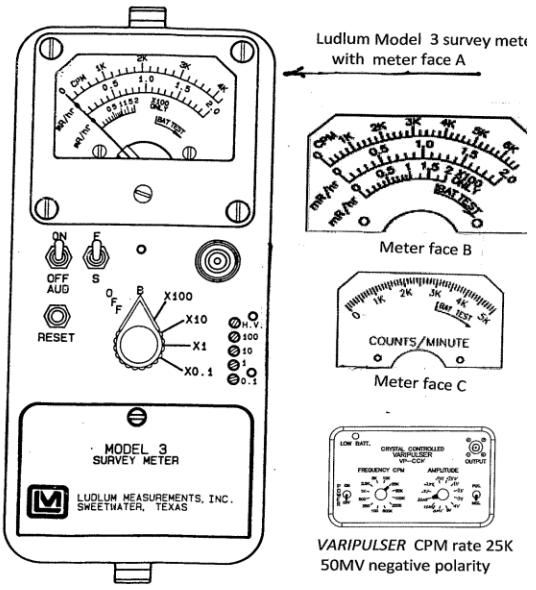
Instrument Calibration and Operability Procedures

Illinois State University's Radiation Safety Officer is responsible for calibrating radiation survey instruments on a bi-annual basis. Below is the written procedure for calibrating survey meters: ISU has two brands of survey meters: **Ludlum**, six Model 3 and **Wm. B. Johnson**, one Model GSM-110 and one Model GSM-115. The calibration procedure for both types is essentially the same, but the emphasis in these instructions will be for the Ludlum models.

These instruments consist of a metal box with handle, inside of which are the electronics, and a probe connected by a cable. The probe detects the radiation and sends it to the electronics, in the form of electrical pulses, for processing and meter display. The basic display is Counts Per Minute (CPM) but may also be expressed as gamma radiation exposure in milliRem per hour (mR/hr). This calibration uses an electrical pulse rate generator, the *VARIPULSER*, to send pulses to the electronics by direct cable connection. The Wm. B. Johnson VP-CC *VARIPULSER* is a precision, pocket-sized pulse generator.Each of the unit's scales is adjusted to match the pulse rate from the *VARIPULSER*.

Finally the probe is reconnected to the unit and its performance is determined by placing a beta emitting radioactive source on the probe's face followed by a gamma-emitting source. One should keep in mind that the detection efficiency of GM probes is different for beta than for gamma radiation, it being greater for beta than for gamma. In addition the efficiency between probes of the same model and brand will differ due to aging, contamination, protective plastic film, etc. Beta and gamma check sources will be used to verify that the probe is functioning properly.

At the left is a drawing of the Ludlum Model 3 survey meter with face A. Two additional meter faces are shown for the Model 3.



Below is the V*ARIPULSER* shown with its frequency set to 25 K CPM and the output pulse set to 50 MV, negative polarity, correct for meter calibration. During calibration the *VARIPULSER* is connected to the meter by a cable.

To begin, make sure that the survey meter and *VARIPULSER* batteries are not below operating threshold, and then connect the units together using the connecting cable. Set the *VERIPULSER* "AMPLITUDE" to 50 MV and the polarity switch to "NEG", as shown in the figure above. Both the Ludlum and Wm. B. Johnson units are designed to operate with negative 50 MV pulses, which are

delivered to the electronics when the probe is connected and beta and/or gamma radiation is being detected. The following procedure assumes that the unit has meter face B, which has a full scale CPM of a bit more than 6 K.

1. Set the FREQUENCY CPM selector switch to 25 K, as shown in the figure, and the Ludlum to the X10 position then turn on both units. The needle should rise to halfway between the 2K and the 3K location on the CPM scale indicating it is detecting 25 K CPM. Now switch the FREQUENCY CPM selector to the 50 K position and the meter needle should rise to near the 5 K position indicating that 50 K pluses are being detected. Adjust the X10 screw so that the needle is exactly at the 5 K position and the X10 scale is now calibrated. For a check, switch the *VARIPULSER* to the 10 K position and the needle should fall to the 1 K point.

2. To calibrate the X100 scale, switch the unit to the X100 position and the *VARIPULSER* to the 500 K position. Adjust the X100 screw so that the needle is at the 5 K position. For a check, switch the *VARIPULSER* to the 100 K position and the needle should fall to the 1 K position.

3. To calibrate the X 1 scale, switch the *VARIPULSER* to the 5K position and then the unit to the X 1 scale. Adjust the X 1 screw so that the needle is at the 5 K position. To check, switch the *VARIPULSER* to the 1 K position and the needle should drop to the 1 K mark.

4. To calibrate the X 0.1 scale, switch the *VARIPULSER* to the 500 position and then the unit to the X 0.1 scale. Adjust the X 0.1 screw so that the needle is at the 5 K position. To check, switch the *VARIPULSER* to the 100 position and the needle should drop to the 1 K position.

This basic technique should be followed for all survey meter calibration. Accommodation must be made for the full-scale meter face of each survey meter. In the case of Ludlum Model 3, face A, half way between the 2 K and 3 K position will have to be used as the high read out place on that unit. For the Wm. B. Johnson units, full scale is 500 CPM.

Survey meter calibration also includes probe high voltage check.

The survey meter probes are designed to operate at 900 volts which is produced by the electronics inside the metal box and should be checked each time the units are calibrated.

The **Wm. B. Johnson** units have a built-in voltmeter to accomplish this check. Turn the meter on to battery check, switch to H.V. The meter should indicate 9 (X100). Adjustment to the 900 volt point is by the H.V. pot in the electronics.

The **Ludlum** units have their adjustment pot available in the same location as the CPM adjusting screws.

1. With the probe removed, use the cable to connect the tan voltage divider box.
2. Connect a Fluke Model 179 voltmeter, or its equivalent, to the "banana jacks" on the box.
3. Turn the Ludlum meter on to the BAT position and adjust the H.V. screw until the Fluke indicates 0.9 volts. (The voltage divider divides the 900 volts by 1000 to 0.9 volts. Do NOT adjust the calibration screw on the voltage divider box which is used in calibrating the voltage divider.)

Strontium 90 Check Source

The Strontium-90 (Sr-90) check source is located in the small clear plastic box in the Varipulser Survey Meter Calibration case. It is the green plastic disk approximately one inch

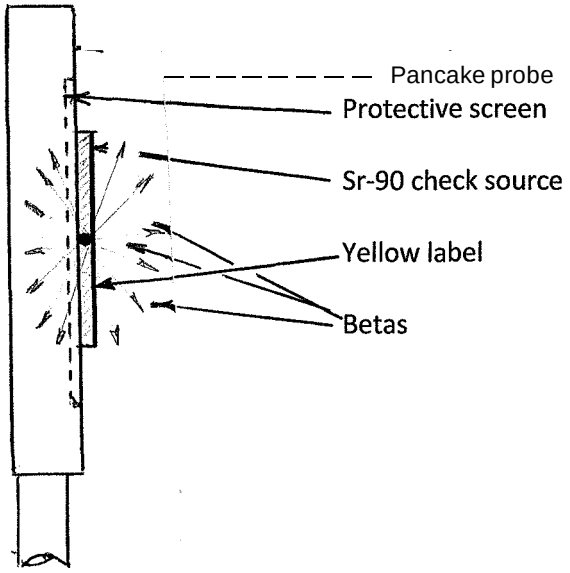
in diameter and 1/8 inch thick, one side of which is a yellow label identifying that it contained one-tenth micro-curie (0.1uCi) of Sr-90 on January 2013, and has a half-life of 28.8 years.

Sr-90 is a radioactive substance emitting $^{11}beta$ particles with energies of 0.546 MeV (million electron volt). This check source is used to verify the operation of our survey meters after they have been calibrated using our pulse generator.

A 0.1uCi of a radioactive substance is undergoing 2.22ES disintegrations per minute (dpm) and it emits a beta particle with each. From the tiny dab of Sr-90 deposited at the center of the plastic disk, these betas are emitted, more or less, uniformly in all three directions, and some of which are absorbed by the plastic. Thus one would expect that about half are emitted from each side. Checking the disk with a survey meter one discovers that the side with the yellow label is absorbing more betas that the "back" side.

Placing this side gently on the protecting screen of the "pancake" probe of a calibrated instrument indicates a count rate of about 100,000 CPM (counts per minute). One would expect this detected rate to be less than half 2.22ES because less than half will be captured by the probe and its counting efficiency is less than 100%. Thus a count rate of 100,000 CPM is a good indication that the survey meter is properly working. Because of the way in which this beta source is fabricated, when the paper label side is placed against the protective screen the count rate is approximately only 30,000 CPM.

Keep in mind that the quantity of Sr-90 in the disk will decrease over time with a half-life of 28.8 years and so too the measured count rate.



SECTION 7: DISCIPLINARY ACTION AND PROCEDURES

The Radiation Safety Committee has been given the responsibility for ensuring that all personnel on the University campus are safe from unnecessary radiation exposure. To assist in that endeavor they are granted the authority to discipline those personnel who violate any state, federal, or University regulations, policies, or procedures. The Radiation Safety Committee by virtue of obtaining this privilege subject to any disciplinary action deems personnel, who are granted the privilege to use radioactive material on the University campus, appropriate and necessary.

7.1: Procedures to be followed prior to disciplinary action is taken.

7.1.1 When an infraction of the regulations, policies, or procedures is alleged to have occurred, the members of the Radiation Safety Committee will be informed. At this time the Committee will appoint an investigating officer to investigate the allegations. Investigations will only by conducted on other than minor infractions. **SPECIAL NOTE:** The lack of an investigation will not prevent the Radiation Safety Officer or Environmental Health and Safety from stopping an operation immediately, if that operation appears to present a serious problem.

7.1.2 If the investigation indicates there has been a violation then the Committee will invoke an appropriate disciplinary action.

7.1.3 If the PI feels the findings of the investigation was in error or that the disciplinary action was too harsh then the PI may appear before the Committee to plead his case. After hearing the PI the Committee will decide whether to change the disciplinary action or enforce it.

7.1.4 If the PI still feels that the Committee has committed an error he/she does have the right to appeal the ruling to the President of the University or his designee. The ruling handed down from this appeal will be final.

7.2: Disciplinary action

7.2.1 A written warning can be issued for minor infractions.

7.2.2 An official written reprimand can be issued for such things as continual disregard of warnings; failing to abide by known University procedures. Along with this reprimand, the PI may be called in to address the Committee on his/her actions.

7.2.3 Suspension of license privileges can be issued for such infractions that the Committee feel could lead to further problems. This suspension could be in two forms. First is that the PI is placed under probation where the research is monitored by another PI. Second is that the PI is prohibited from conducting radioactive research for a designated period of time. Then at the end of the suspension the PI must reapply for the privilege of using radioactive materials on campus.

7.2.4 PIs may forfeit their license privileges permanently for major infractions of the policies, procedures, or regulations. This action will be taken if it is determined that the actions of the PI could cause the University to lose its license or cause the University to be cited and fined for the PI's actions.

SECTION 8: RADIOACTIVE WASTE DISPOSAL

The proper handling of radioactive material once it becomes a waste product is as important to the health and safety of University personnel and the community as is the proper handling of the material during its use. The following outlines the basic concepts on how radioactive waste is to be handled.

8.1: Non-radioactive waste

Items associated with radiation that have not become contaminated by radioactive material may be disposed of as regular municipal waste. If there are any radioactive label, signs, or other types of radioactive identification on this material then it must be removed prior to disposal.

8.2: Radioactive Aqueous Waste

Aqueous solutions containing radioactive waste may be poured down the sanitary sewer as long as:

8.2.1 No more than 5 curies of H-3/year is disposed of in this manner.

8.2.2 No more than 1 curie of C-14/year is disposed of in this manner.

8.2.3 No more than 1 curie total of all other isotopes are disposed of in this manner.

8.2.3.1 Aqueous waste with high MeV values isotopes (i.e. P-32) will be allowed to decay 10 half-lives before disposal.

8.2.3.2 If storage of decaying aqueous solutions is a problem, please notify Environmental Health and Safety.

8.2.3.3 The amount of aqueous solutions to be disposed of per day via the sanitary sewer must not exceed the amounts outlined in the IEMA, Bureau of Radiation Safety regulations Section 340.3030. Excerpts of these regulations are contained in Appendix 8-B.

8.2.3.4 Prior to any large amounts of aqueous solutions being disposed of in this manner, please notify Environmental Health and Safety.

8.2.4 Inventory records are to be maintained by the RSO.

8.2.5 Please note that all the disposal limits identified above are the total amounts the University can dispose of, not each individual PI.

8.3: Radioactive Solvent Waste

Solvents containing radioactive material must be collected and given to Environmental Health and Safety. Two methods of collecting the solvent waste are authorized. The following guidelines apply:

8.3.1 The first method is to collect the solvent waste after it has been removed from the scintillation vials.

8.3.1.1 Collect waste material in small containers (i.e. one gallon) if possible, with the exception of H-3 and C-14 which may be collected in 5 gallon containers.

8.3.1.2 Keep the isotopes separate. Only one isotope per container with the exception of H-3 and C-14, they can be mixed together.

8.3.1.3 Label the containers with radioactive warnings, type of isotope, the date the container was filled, and the activity level of the material.

8.3.1.4 Call Environmental Health and Safety when the container is full.

8.3.1.5 Maintain inventory records as required.

8.4: Radioactive Contaminated Solid Waste

8.4.1 Contaminated solid waste (i.e. paper, glassware, empty scintillation vials, etc.) can be discarded in regular trash, if the items have been contaminated with a scintillation medium containing less than 0.05 uCi of H-3 or C-14 per gram of medium.

8.4.2 All other items contaminated with other isotopes or non-scintillation medium are held until the activity level has decayed to an activity level below background. This decay must be verified by a survey.

8.4.3 If a User is not able to store the dry waste until the proper level is reached, please contact Environmental Health and Safety.

8.4.4 All material must have proper documentation. The material is to be labeled with the appropriate isotope present (no mixing of isotopes), the activity level, the date placed in storage, the date of decay, the survey date and results, and the disposal date and method.

8.5: Animal Carcasses

Animal carcasses containing radioactive material can be handled in one of the following ways:

8.5.1 If the animal carcass contains no more than 0.05 uCi/gram then it can be disposed normally.

8.5.2 If the animal carcass contains more than the above amount, then the carcass is to be kept in a properly shielded deep freeze until sufficient quantities are accumulated for burial at an authorized burial site. The deep freeze storage areas shall be designed so as to prevent accidental exposure to unauthorized personnel.

8.6: Environmental Health and Safety's Disposal of Radioactive Solvent Waste

Solvent waste collected from the Users by Environmental Health and Safety shall be disposed of in one of the following manners:

8.6.1 Solvent contaminated waste with short half-life isotopes will be kept in a holding area for ten half-lives after which it can be disposed of as a non-radioactive hazardous waste.

8.6.2 Tritium, C-14, and other long half life isotopes will be held until sufficient quantity is obtained and then disposed of by either:

8.6.2.1 Determining if the activity is less than 0.05 uCi/gram of medium and if so, disposed of as non-radioactive hazardous waste, or

8.6.2.2 If the activity is above 0.05 uCi/gram of medium then dispose of the waste through an approved radiation disposal firm.

8.6.2.3 Determination of activity level is described in Appendix 8-A.

8.6.3 The quantity of radioactive waste held in storage is considered as a part of the total licensed quantity of radioactive material that may be possessed by the University at any one time.

APPENDIX 8-A

Determination of Activity

The activity level in solvent waste is determined by mathematical calculations. Since the University maintains inventory records on each shipment of radioactive material from the time it arrives until it is placed for disposal with Environmental Health and Safety, the total activity of the waste containers is known.

The activity (in uCi) of the total solvent waste is divided by the volume (in milliliters) times the density of the scintillation medium (g/ml) producing the result in uCi/gram of medium.

Example:

55 gallons of medium with an activity level of 9mCi

9000 uCi divided by 55 gallons (3785 ml/gal) X .0866 g/ml*

or

9000 uCi divided by 208175 ml X .0866 g/ml*

or

9000 uCi divided by 180279.55 g

equals

0.49 uCi/gram of medium

* Not the actual density of the medium used. The actual density of the medium used is 1 g/ml.

NOTE: The above method will result in activity levels higher than the actual level because it does not take into effect possible loss of material in the experiments, etc.

APPENDIX 8-B

Disposal By Release Into Sanitary Sewer Systems

Users are responsible for ensuring that the amount of aqueous radioactive material they dispose of via the sanitary sewer does not exceed the amounts detailed below.

"Section 340.3030 of the IEMA, Bureau of Radiation Safety Regulations.

a) No licensee or registrant shall discharge radioactive material into a sanitary sewage system unless:

1. It is readily soluble or dispersible in water; and

2. The quantity of any radioactive material released into the sanitary sewage system by the licensee or registrant in any one day does not exceed the larger of:

a. The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee or registrant, will result in an average concentration equal to the limits specified" in column 2 below, "or

b. 10 times the quantity of such material specified in" column 3 below; "and

3. The quantity of any radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee or registrant, will not result in an average concentration exceeding the limits specified in" column 2 below; "and

4. The gross quantity of radioactive material, excluding hydrogen-3 and carbon-14, released into the sewage system by the licensee does not exceed 1 curie (37GBq) per year. The quantities of hydrogen-3 and carbon-14 released into the sanitary sewage system may not exceed 5 curies (185GBq) per year for hydrogen-3 and 1 curie (37GBq) per year for carbon-14."

Column 1--Isotopes	Column 2	Column 3
Hydrogen-3	$1x10^{-1}$uCi/ml	10,000uCi max.
Carbon-14	$2x10^{-2}$uCi/ml	1,000uCi
Phosphorus-32	$5x10^{-4}$uCi/ml	100uCi
Sulfur-35	$2x10^{-3}$uCi/ml	1,000uCi
Iodine-125	$5x10^{-9}$uCi/ml	10uCi
Zinc-65	$1x10^{-7}$uCi/ml	100uCi

If the isotope being used is not listed above please contact Environmental Health and Safety for assistance.

ISU buys more than 200 million gallons of water per year which flows into the sewer system. This is approximately 17 million gallons per month, i.e., 17E6 gal/month. Since one gallon is approximately 4 liters this amounts to 6.8E10 milliliters per month.

SECTION 9: EXEMPTIONS FROM THIS MANUAL

9.1: Exemption From Above recommendations.

If any of the above recommendations cannot be implemented because of justified reasons, such as equipment design or procedures that cannot be altered, then deviation from the above recommendations may be necessary. To obtain an exemption the following must occur:

9.1.1 The request for any deviation must be requested in writing of the Radiation Safety Committee.

9.1.2 The Radiation Safety Committee will review the request and inspect the area before making a determination.

9.1.3 The Radiation Safety Committee will then determine whether or not to grant an exemption.

9.1.4 No deviation from the procedures, responsibilities, or policies outlined in this manual can occur unless the Radiation Safety Committee authorizes it in writing.