

# **Radiation Protection Manual**

**Minnesota State University,  
Mankato**

2018

## Statement of Commitment

The University is committed to maintaining radiation exposures to faculty, staff, students and the public, resulting from the use of radiation sources in teaching and research, As Low As Reasonably Achievable (ALARA). The Radiation Safety Committee, the Office of Environmental Health and Safety and the Radiation Safety Office will advise and assist faculty, staff and students in all matters regarding radiation safety. The Committee will recommend to the campus administration, through the Office of Environmental Health and Safety, policies and procedures to be required for maintaining radiation exposures ALARA through the safety handling, storage, use transport and disposal of radiation sources and will assist in the interpretation of the rules and regulations of the Nuclear Regulatory Commission, U.S. Environmental Protection Agency, Minnesota Department of Health and any others that pertain to the protection against radiation.

Sources of radiation including materials and equipment that are capable of emitting ionizing or non-ionizing radiation. Ionizing radiation sources include radioactive material, nuclear reactors, particle accelerators, x-ray machines and electron microscopes, Non-ionizing radiation sources include lasers, high-intensity sources of ultraviolet light, microwave transmitters and other devices that produce high intensity radio-frequency radiation. Both types are of concern and are under the purview of the Committee and the Office of Environmental Health and Safety.

Policies and procedures for radiation safety are delineated in the MSU,M Radiation Safety Manual, copies of which may be obtained from the Radiation Safety Office or the Office of Environmental Health and Safety. Question relating to radiation hazards should be directed to those offices.

Approved:

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Richard Davenport

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Date

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## Introduction

The purpose of this manual is to present regulations and recommended procedures for the work with radiation at Minnesota State University, Mankato in order to protect the individual, prevent the spread of contamination and to assist in fulfilling the responsibilities of the University to its student, its staff, and its neighbors. The Manual is issued by the Radiation Safety Committee of Minnesota State University, Mankato.

Radiation can be an invaluable tool in teaching and research and, properly used, can provide great benefits to mankind with little or no attendant risk. However, improper use can bring risk of high radiation exposure resulting in chronic illness, cause injury, even death. The known hazards in order of their importance are the deposition of radioactive material in the body, external exposure to neutrons, to gamma and x-rays, and to beta radiation.

Use of radiation sources implies acceptance by the user of some increased exposure above the natural radiation to which man has always been exposed. Common sense dictates that such increase in personnel exposure and contamination levels should be kept to the minimum consistent with reasonable effort and expense. Maintaining level lower than the "Maximum Permissible Level" can be maintained provided the user has:

- 1. Adequate knowledge**
- 2. Adequate equipment**
- 3. The skill and disposition to use them.**

Proper disposition means a balanced perspective towards radiation entailing a healthy respect, free of both the blind fear of the novice and the familiar contempt one sometimes encounters in the "old hand." See Section V entitled, "Guidelines for Supervisors for Assessing Appropriate Employee Disposition for Using Radiation."

This Manual is designed to help University staff in performing teaching and research with radiation sources in a safe, legal and efficient manner without imposing unnecessary restrictions on anyone's work. Detailed rules and recommendations concerning all eventualities cannot be presented in concise form because of the wide variety of radiation sources and facilities and situations. Some of the rules were generated out of the combined experience of the Committee members and therefore may be subject to modification in the circumstances involving new or unanticipated conditions. Some of the rules come from Federal and State Regulations which, having the force of the law, permit no modifications unless specifically provided by law. Those who feel that these rules require unreasonable effort or expense on their part are urged to present their cases to the Radiation Safety Committee and/or the Radiation Safety Office for review. However, deviations from the rules and procedures in this Manual will be permitted only upon written prevent personal injury or serious property loss.

Materials containing natural radioactivity in concentrations not exceeding that of natural potassium ( $10^{-9}$  curies/gram) are exempt from these regulations.

In general, it is the responsibility of the individual radiation user to understand and conduct his/her operations in an acceptable manner to minimize hazards to themselves and others.

It is the responsibility of the laboratory supervisor to insure that all personnel, particularly new personnel, in his area are properly instructed with respect to the nature of the radiation hazards and the necessary radiation safety procedures in his laboratory and that they possess the necessary skills and disposition to cope with radiation safety problems safely.

The Health Physics staff is responsible for assisting all users and supervisors by providing consultation and certain services in matters of radiation safety.

The Radiation Safety Committee, a standing committee of the Office of the President of the University, is responsible for establishing policies for the Radiation Safety Program, for reviewing the work of the Health Physics staff, and advising both them and the radiation users on particular problems. (Greater details of the above responsibilities are listed in Section I of this Manual.)

All individuals using radiation sources or responsible for the supervision of persons using radiation sources, must familiarize themselves with all portions of this Manual that apply to their operations.

While the RSO, Radiation Safety Office, Supervisor and other safety personnel are responsible for the safety for of materials covered in this manual, you may contact the Minnesota Duty Officer at 1-800-422-0798 to report and incident of concern.

## **I Responsibility of Groups and Individuals**

### **A. Management Team**

The University President has ultimate responsibility for the Radiation Safety Program within the institution and is dedicated to providing a safe and healthful work environment for all employees and students.

The University Radiation Safety Officer is responsible to the implementation of the Radiation Safety Program. This includes informing all individuals of the Minnesota Department of Health, Radiation Control requirements the use of all licensed radioactive material.

All individuals working on University property where radioactive materials are present and/or being used are responsible for the health in their laboratories, storeroom, and classrooms.

### **B. Laboratory Supervisors**

Any person or persons using university space for teaching and/or research purposes are designated as the laboratory supervisor and has the overall responsibility for the daily functioning of that laboratory, storeroom, classroom and/or workshop. In addition to assuming the responsibilities of individual radiation user\*, the Laboratory Supervisor shall:

1. Be responsible that all personnel, particularly new personnel, who have access to radiation sources under his /her jurisdiction, are properly instructed and that they possess the necessary skills and disposition to cope with radiation safety. Laboratory Supervisors must insure that people in their area know that they need to know about:
  - a. This manual as it applies to their work.
  - b. Applicable Federal, State and Local regulations.
  - c. The nature of particular radiation sources and their hazards.
  - d. Proper use of instruments in the area, especially their limitations.
  - e. Routine procedures for handling work safely.
  - f. Emergency procedures.
  - g. Availability, function and services of the Radiation Safety Office.
2. Determine the types of radiation sources, equipment and facilities and procedures needed for his/her work.

3. Prepare for his/her personnel specific written routine and/or emergency procedures applicable to their operation and on file in the Radiation Safety Office.
4. Insure that the procedures for purchase, acquisition, use and transfer of radioactive materials followed in work under their supervision. This includes keeping accurate records of inventory and disposal of sources or portions thereof.
5. Routinely check protective equipment and instruments to insure they are working properly and adequately performing their intended functions.
6. Actively seek the assistance of and cooperate with the Radiation Safety Office in solving radiation safety problems unique to his/her situation.
7. Provide whatever action and information necessary with respect to their operation to assist the Radiation Safety Office in complying with existing laws and license requirements (maintenance of records, preparation of reports, etc.).

\* Radiation users are those persons authorize by the Radiation Safety Office and listed as users on the University Radioactive Material Licenses.

### C. University Employees and Students

The individual user is the one ultimately responsible for the safe use of the radiation sources to which he/she has access. They shall:

1. Keep their exposure as low as practical
2. Wear assigned personnel monitoring devices in an approved manner.
3. Be familiar with and comply with all sections of this Manual applicable to their work.
4. Be familiar with the nature of their area's radiation sources, the extent of their potential risk and use the proper mean of coping with them safely.
5. Monitor their area frequently for contamination.
6. Clean up minor spills immediately.
7. Dispose of radioactive waste in an approved manner.
8. See that sources, containers and the area are properly labeled and posted.
9. Assist their supervisor in maintaining required records and inventories.
10. Prevent unauthorized persons from having access to radiation sources in their area.
11. Protect service personnel, allowing no maintenance or repairs of area facilities or equipment unless approved by the area supervisor and/or the Radiation Safety Office.
12. Notify their supervisor and the Radiation Safety Office of unexpected difficulties.
13. Be prepared to handle accidents or injuries with common sense and the spirit of the emergency Procedures (**Section II, Part J.**) They shall notify and seek the assistant of their immediate supervisor and the Radiation Safety Office as soon as possible in emergencies.
14. Take no action which would interfere with the responsibilities of their laboratory supervisor (**Section I Part B.**)

#### **D. Radiation Safety Committee**

The Radiation Safety Committee is advisory to the President of the University, through the Vice-President of University Operations and the Office of Environmental Health and Safety, on matters related to the campus Radiation Safety Program. Members of this committee include but are not limited to: Vice-President of University Operations, Radiation Safety Officer, Director of Environmental Health and Safety, and a member of any affected department.

The President delegates to the Radiation Safety Committee the authority to oversee the use of radiation sources throughout the MSU,M campus. Thus, the Radiation Safety Committee has the authority to permit, deny or revoke authorization for individuals to obtain and use radiation sources at MSU,M.

The responsibilities of the Radiation Safety Committee include the following:

1. Review proposals for unusually hazardous uses of radiation sources and establish criteria for equipment and procedures to ensure employee, student and public safety.
2. Review cases which involve repeated infraction of the rules and regulation for protection against radiation.
3. Review accidents which may involve over-exposure or serious economic loss, and other cases for which reports to the outside regulatory authorities are required.
4. Review public relation problems which involve radiation sources.
5. Review appeals from radiation user to modify rules or decisions of the Radiation Safety Office.
6. Meet formally as often as necessary, but at least once per calendar year to review the campus Radiation Safety Program.
7. Recommend the establishment or modification of the campus Radiation Safety Program.

**Note: Due to the relatively low activity at MSU,M the duties of the Radiation Safety Committee are being attending to by the Radiation Safety Officer and the Radiation Safety Office.**

#### **E. Radiation Safety Office/Officer**

The Radiation Safety Committee charges the Radiation Safety Officer/Office with the responsibility to:

1. Provide advice and assistance to all concerned on all aspects of radiation safety.
2. Approve proposals for procurement, use and transfer of radiation sources except proposals involving unfamiliar or extreme hazards which the staff judges to require review by the Radiation Safety Committee.
3. Receive and monitor all shipments of radioactive materials, delivering acceptable incoming shipments to the consignee and insuring that outgoing shipment conform to shipping regulations.
4. Maintain permanent records of receipt, use, transfer and disposal of radioactive materials.
5. Supervise and assist in disposal of radioactive waste.
6. Supply the necessary personnel monitoring devices (film badges, dosimeters, etc.), give instructions in their use, and maintain personnel monitoring records.



7. Check radiation monitoring and survey instruments for proper operation and calibrate as often as necessary.
8. Assist in the design and selection of equipment, shielding and facilities and in the formulation of operating procedures for new or modification of existing installations or buildings.
9. Calculate the level of radiation intensity, time limits of personnel exposure and minimum working distance around accelerators, x-ray machines and other intense radiation sources.
10. Perform and keep records of leak tests on sealed sources.
11. Make and keep records of systematic surveys in areas where the presence of radiation or contamination of surfaces, air or water is suspected and notify the area supervisor of the results. In some cases this may require detailed monitoring of an operation from beginning to end by a Radiation Safety Office staff.
12. Report hazardous radiological conditions promptly to the individual responsible and, when necessary, to his/her immediate supervisor and the Radiation Safety Committee.
13. Supervise and assist in decontamination of all but minor spills.
14. Schedule routine medical examinations in accordance with established policy; help establish criteria and make arrangements for such examinations as may be required in emergency situations.
15. Enforce all written directives of the Radiation Safety Committee.
16. Stop any operation or deny access of any individual to radiation sources in the interest of safety. Such action must be reported verbally and in writing to the Radiation Safety Committee as soon as possible.
17. Grant exemptions to the rules (or impose more stringent restrictions) in emergency situations only, when, in the judgment of Health Physics, such action is necessary to reduce risk of serious injury or economic loss. Such actions must be reported verbally and in writing to the Radiation Safety Committee as soon as possible.
18. Maintain files of Federal, State, and local licenses and registrations concerned with radiation sources and to initiate applications for renewals and/or amendments of same.
19. Determine whether a radiation incident requires a report to any governing body and to prepare such reports for the approval of the Radiation Safety Committee. Exception: If an immediate report is required, the Radiation Safety Officer shall (with knowledge and approval of the Chairman if possible) file such report with the appropriate authorities and shall provide copies to the Radiation Safety Committee.
20. Be familiar with the Federal, State, and local laws relating to radiation and be aware of changes in such laws as they occur in order to inform the Radiation Safety Committee when such changes make modifications of policy desirable and in order to institute required immediate changes in the Radiation Safety Program.
21. Provide an "End of Service" report to all monitored personnel upon their termination with Minnesota State University, Mankato. Report to include total dose received during monitoring as per MN Rules 4730.1140 subpart 3.
22. Perform, as least annually, radiation safety program audits and report results to Radiation Safety Committee.

#### **F. Access to the Radiation Safety Plan**

Each employee or student has the opportunity review the University's Radiation Protection Plan upon request. All employees and students working in areas where licensed materials are being stored or used will be trained on the use of the radiation safety plan and specific radiation safety procedures for those areas. Copies of the Radiation Safety Plan may obtain from the Radiation Safety Office or the Office of Environmental Health and Safety.

## **II. General Laboratory Rules**

### **A. Laboratory Procedures**

1. To prevent accidental entry of radioactive material into the body, high standards of cleanliness and good housekeeping must be maintained in all laboratories where radioactive materials are present.
2. Visitors are not allowed without the approval of the laboratory supervisor.
3. Wash hands and arms thoroughly before handling any objects which go into the mouth, nose or eyes (e.g., cigarettes, cosmetics, food.). Keep fingernails short and clean.
4. Smoking and eating in radioisotope laboratories is strictly forbidden. Refrigerators are not to be used jointly for food and radioactive materials.
5. One or more trial runs beforehand with non-radioactive materials are recommended for new procedures and new personnel to test effectiveness of procedures and equipment.
6. Use shielding when desirable.
7. Do not work with radioactive material if there is a break in the skin beyond the wrist.
8. Always use rubber gloves when handling radioactive material that gives a few hundred counts per minutes. Wear protective clothing (lab coat, masks, shoe covers) as needed.
9. Never pipette by mouth. Use rubber bulb, syringes or mechanical devices.
10. Clean up minor spills immediately. For major spills follow emergency procedures.
11. Whenever possible, operations with radioactive materials should be conducted in a hood, dry box or some other type of closed system. Operations with materials susceptible to atmospheric distribution, such as boiling, evaporating, distilling or ashing, must be done in a hood with air flow approximately 100 linear feet per minute. Work with activities of more than a few hours half-life should be done over a tray. Work with finely divided powder must be done in a hood or closed system.
12. Table and bench top should be of a nonporous, chemical resistant material. It is recommended that the working surfaces be covered with absorbent paper regardless of the type of surface.
13. When work is completed each person will clean up his or her mess and equipment.
14. Vacuum pumps used in systems containing radioisotopes must not be permitted to exhaust into room air or out windows.
15. Exhaust stacks must not be vented near operable windows or buildings air intake vents.
16. Special radioactive waste cans shall be provided. These will bear the words "Caution, Radioactive Waste," and a warning to janitors against handling.
17. Cleaning crews should not touch benches and instruments, etc., but are permitted to clean floors and windows only. Laboratory personnel are responsible for cleaning the rest of the housekeeping.

18. Repairs such as plumbing, etc., should not be undertaken unless the Radiation Safety Office has need notified.
20. When use and storage of radioactive material is to be terminated at a facility, notify the Radiation Safety Officer who must make a terminal survey before an area can be released for other uses.

**B. Rules for Using Radioisotope in Animals (Currently not allowed on MSU,M Campus)**

1. The area in which animals are kept must be posted in all State and Federal regulations.
2. Cages and pens must bears labels on which are listed: the isotope used, the quantity and date administered, measured external radiation levels, and the name of the responsible individual. These cages and pens should be separated from those housing non-radioactive animals.
3. Ventilation should be adequate to handle possible evolution of air borne radioactivity. This may, in some instances, require the use of a fume hood or self-contained controlled environmental system.
4. Disposal of excreta via sewer is permissible if the activity does not exceed the Part 340, Appendix A, Table 1, Column 2, concentrations at the point of entry into the sewer.
5. If excreta is mixed with bedding material, it shall be handled as dry radioactive waste.
6. Disposal methods for carcasses must be approved by the Radiation Safety Office.
7. Animal caretakers shall be instructed and adequately trained by the laboratory supervisor with respect to general and specific handling procedures, dose levels, occupancy time limits and other special conditions.
8. Administration to animal outpatients and other non-University-owned animals shall be approved by the Radiation Safety Office.. The Radiation Safety Office will establish the criteria for the release to the owners in each case.

**C. Storage of Radioactive Material**

1. Radioisotope laboratories and storage areas (rooms, cabinets, safes, etc.) must be locked at all times when not in actual use to prevent theft and unauthorized use of radioactive materials.
2. Radioactive materials should be stored as far as practical from normal working areas and behind sufficient shielding as to reduce the radiation exposure level below 10 mr/hr at one meter from the source.
3. A good rule for selecting storage containers and in designing equipment is that the radiation level be less than 200 mR/hr at accessible surfaces and less than 10 mR/hr at one meter from the source, provided the normal operating distance to frequently occupied area is such that no one is likely to exceed 25% of the permissible radiation doses set forth in MN Rules 4731.2030.
4. Unbreakable containers are recommended for storage of radioactive liquids. Bottles and other breakable container used for storage must be kept in non-breakable, leak-proof containers or trays capable of containing the entire volume of liquid waste stored therein.
5. Radioactive gases must be stored in a well ventilated area, preferably in a hood or dry box.
6. All active samples including calibration sources regardless of strength should be clearly labeled giving accurate information about the contents as well as the name of the person or area responsible for the sample. They must also carry the words "Caution, Radioactive Material." Unlabeled sources will be picked up and disposed of as waste.

#### **D. Transporting Radiation Material Outside the Laboratory**

1. Spills of radioactivity in areas such as corridors, stairs and sidewalks are generally more serious than similar spill in laboratories because of the difficulty in controlling access to the contaminated area. Therefore, extra precautions, i.e., double containers or special packing, are necessary when transporting radioactive material from one laboratory or storage room to another.
2. The outer container in which radioactive material is transported should be sealed and should be of unbreakable material. When the nature of the work requires frequent and routine transporting of radioactivity between laboratories and storage areas, it is strongly suggested that special equipment designed for maximum safety and ease of handling be acquired.
3. When radioactive liquid is transported in a breakable container, it must be surrounded by enough absorbent material to readily soak up all the radioactive liquid.
4. A warning sign or label shall be attached to the outside of the container if a quantity of radioactive material greater than one millicurie is being transported or if the radiation level at any accessible surface of the container is greater the 5 milliroentgens per hour gamma equivalent. The sign shall carry the words "Caution, Radioactive Material" readily legible at the distance if 5 feet.
5. A remote handling device shall be use in carrying a container of radioactive material whose surface radiation is greater than 200 milliroentgens per hour. The device shall be constructed so as to provide enough distance or shielding to reduce the radiation level to less than 200 milliroentgens per hour at the operator's position. Ease of handling and sureness of operation shall be prime consideration in the design of such devices so as to reduce time of exposure. Crucible tongs are generally neither sure nor quick.
6. To lessen the chance of mishap and to reduce random exposure to the members of the general population, moment of radioactivity should be restricted to periods when traffic in corridors and stair is light. Make transit time short. Avoid unnecessary stop along the way. Never leave radioactivity unattended in any place but a locked storage area. Also do not store radioactivity anywhere but authorized radiation laboratories and storage areas.
7. Check the container for contamination after removal of the source. This will not only prevent re-use of contaminated containers but will serve as a check for seriously leaking sources.
8. If a spill should occurs outside the laboratory, do not leave the area unattended unless it is necessary to render immediate emergency attention to personnel involved in the spill. Post a guard and restrict access to contaminated area until such time as procedures allow.
9. Transportation off campus must comply with the Department of Transportation regulations. Consult the Radiation Safety Office for details and approval.

#### **E. Radiation Waste Management (General)**

The Radiation Safety Office operates a central waste disposal facility for each type radioactive waste generated at MSU,M. General procedures for the transportation, handling and storage of wastes are described in this document. In special circumstances, The Radiation Safety Officer may impose additional procedures if necessary.

Note: Laboratory supervisor must ensure, prior to the procurement of any radioactive materials, a method of disposal of the material either presently exists or can be worked out to the satisfaction of the Radiation Safety Committee.

1. Each Radioisotope Laboratory Supervisor must maintain accurate records of the types, quantities and forms of radioisotopes which are placed in the radioactive waste which is released from his/her radioisotope laboratory. Otherwise, the disposal of such waste cannot be approved by the Radiation Safety Office. Records kept by the Laboratory Supervisor may be based on either calculation or on measurements.
2. Radioactive waste containers should be stored as close to the work area as possible to minimize the probability of spillage during the transfer of waste to the containers.
3. Waste containers shall not be stored in hallways, stairwell or other uncontrolled areas.
4. Radioactive waste container should be covered at all times when not in use.
5. Regardless of its contents, each radioactive waste container shall be labeled with a "Caution, Radioactive Material" label or sticker.
6. When handling or transferring radioactive waste, the individual should wear a laboratory coat and disposable gloves.
7. Radioactive wastes containing carcinogens, biohazards or very hazardous chemical must be inactivated, if possible, and packaged in such a way that presents minimal hazard to people who handle the waste.

### **Liquid Radioactive Waste**

There are basically two type of liquid radioactive waste generated by the research laboratories at MSU,M. The most common is aqueous in which the waste materials are either dissolved in water or else evenly distributed in a liquid which is mainly composed of water. Such waste must be collected or solidification and disposed of through the RSO. The other, less common, form of liquid waste is liquid scintillation cocktail which is composed of volatile, flammable, toxic, organic material which cannot be disposed of through the sewer system. This material must either be burned or evaporated. Other liquid waste which is not soluble or readily dispersible in water must be treated in accordance with specifications worked out in advance by the Radiation Safety Office.

All liquid radioactive waste shall be stored and disposed or according to the following requirements:

1. Non-aqueous (less than 10% water content) waste shall be stored in spill-proof, unbreakable plastic containers of one to five gallon capacity. The container must be approved by the Environment Health and Safety Office before being used.
2. Non-aqueous waste shall be free of all filterable solids before it can be collected for disposal by the Environment Health and Safety Office. Filtering liquid scintillation waste, a 60 mesh screen is recommended.
3. The pH range of any aqueous waste shall be adjusted to between 6.8 and 8.0.

Note: There are many special problems involving chemical reactions between mixtures of liquid wastes. The disposal of cyanides into acidic liquid waste will result in the production of hydrogen cyanide, a very toxic gas. Special care also must be taken when disposing of tissue which has been digested in nitric acid, as oxides of nitrogen may be formed that could cause the waste container to explode. The Laboratory Supervisor must ensure that chemical reactions will not occur in the liquid waste containers.

4. Low activity aqueous waste may be disposed of through the sewer by flushing down the laboratory sink drains. The amount and concentration of radioactivity which may be disposed of in this manner

are limited by Minnesota Rules. Coordinate with the Radiation Safety Office on the amount and concentration that your laboratory may dispose of down the sewer system.

5. Other aqueous waste should be solidified with plastic of Paris or cement.
6. Special sink for washing contaminated glassware should be designated and appropriately labeled.
7. Organic solvent wastes or scintillation cocktail shall not be released into the sewer system under any circumstances. All liquid scintillation counting waste shall be turned over to the Radiation Safety Office for disposal. To prepare the waste for disposal, the user must determine the type of isotopes, the concentration ( $\mu\text{Ci/ml}$ ), and the chemical form of the waste. This information must be attached to the waste container before it will be picked up.

Note: The Environmental Health and Safety Office and the Radiation Safety Office reserve the right to refuse to accept any material if, in the opinion of the staff, the materials have been improperly prepared or packaged, or if the staff feels that the movement of the materials would pose an unacceptable hazard to the MSU,M personnel or to the public.

#### **Liquid Scintillation Counting Vials**

1. Liquid scintillation counting vials should be washed, decontaminated if necessary (see below), and either recycled or disposed of as non-radioactive dry waste.
2. Vial which contained media in which the concentration of  $^{14}\text{C}$  or  $^3\text{H}$  was originally less than  $.05 \mu\text{Ci/ml}$  need not be decontaminated and should be disposed of with the regular, non-radioactive solid waste after having been properly emptied and washed.
3. After contaminated vial have been washed, a representative sample of the batch of vials just washed should be counted to determine the effectiveness of the washing. If the average count rate is less the twice the background level, the vials may be disposed of in the non-radioactive waste. Vial which cannot be sufficiently decontaminated must be disposed of in the solid radioactive waste after been properly emptied and dried.
4. The Radiation Safety Office will collect the liquid scintillation vials only if the vials cannot be decontaminated. It is conceivable that certain unique situations might present themselves in some laboratories. In such cases, exceptions to these procedures may be possible based upon prior approval of the Radiation Safety Office.

#### **Non-Acceptable Methods for Disposal of Radioactive Wastes**

1. NO LIQUIDS may be disposed of in the solid waste.
2. DISPOSAL BY BURIAL IN THE SOIL. Under no circumstances shall any quantity of radioactive waste be buried in the soil by personnel using radioisotopes.
3. DISPOSAL INTO THE SEWER SYSTEM. Under no circumstances shall radioactive waste be released into the sewer system without the authorization of the Radiation Safety Office.

#### **F. Radiation Machines**

1. All radiation protection rules contained in foregoing section of this manual apply equally well to the ionizing radiation emitted by any machine or device. By definition, "Radiation Machine" Van de Graff and other electron or heavy ion accelerators, electron microscopes, x-ray machines, color TV sets, high voltage rectifiers and any other device capable of producing ionizing radiation outside the components of the device.

**As of July 1<sup>st</sup>, 2009, the Minnesota Department of Health has dropped the requirement for electron microscopes registration. As a result of this action MSU,M Radiation Safety Office will cease its supervision of this type of equipment unless the microscope has a radioactive source included. Please feel free to contact the Radiation Safety Office if you are unsure if this includes a piece of equipment you are operating.**

2. Radiation Machines shall be registered with the Radiation Safety Office. Since an installation's shielding plans and operating restrictions are best discussed and most easily during architectural planning stages, it is advisable to discuss potential radiation machine hazards with the Radiation Safety Officer before purchase, construction, or installation.
3. The Committee is authorized to require the use of such equipment and procedure as it deems necessary to insure radiation safety, for example: shielding, safety interlocks, warning signs and devices, operating restrictions, radiation monitoring area monitors, personnel monitoring.
4. A complete radiation survey shall be made and found satisfactory by the Radiation Safety Office:
  - a. For each new installation before it begins routine operation.
  - b. For each old installation, before resuming routine operations whenever a machine, the installation, or an operating procedure is modified in a manner resulting in an increase in intensity, penetration or distribution of radiation output.
5. Where necessary, written routine operating procedure and emergency procedures (subject to approval of the Committee) shall be provided for the radiation machine operators.

#### **G. Laser Registration**

The State of Minnesota presently requires all lasers in the State to be registered with the Minnesota Department of Health with an eye towards gathering data for possible future laser safety regulations.

It is strongly recommended that laser warning signs and/or safety interlocks be used where significant laser hazard exists.

The Radiation Safety Office maintains a file of current recommended laser safety codes and practices. Copies will be made available on request. Since laser uses and designs are rapidly developing and changing, the Radiation Safety Officer will appreciate any assistance that the many laser users on campus can offer in preserving the file from the dangers of creeping obsolescence.

#### **H. Emergency Procedures**

In any radiation emergency, personnel protection comes first, confinement of radioactivity next.

In each case, the Radiation Safety Office must be notified as soon as possible. However, the emergency may demand other immediate action by those on the scene before this can be done. It is impossible to draw up a set of specific rules and procedures which would cover each eventuality. Therefore the following paragraphs present a set of general guidelines which each individual faced with an unexpected hazardous situation will remember and modify as circumstances and common sense dictate.

It is further hoped to motivate the reader to develop a safety oriented attitude which actively anticipates potential hazards and accidents with an eye towards both prevention as well as predisposition to appropriate response to the unexpected. The laboratory supervisor in particular may find useful to draw up a written emergency plan suited to his own facility and operation. They might prearrange to have on hand specific equipment and supplies uniquely required for their operation to minimize hazards and enhance recovery. For example, chemical compounds in use might require special decontamination agents.

1. Serious Injury and Exposure or Contamination.

In the event that personnel have received high radiation exposure or radioactive contamination in addition to physical injury requiring immediate medical assistance, Call University Security (2111). When the ambulance arrives, inform emergency personnel that the patient might be contaminated.

It would also be helpful if someone familiar with the incident would accompany the injured to provide information such as: the nature of the injuries, radiation levels, the physical and chemical nature of the contamination, etc. Also follow instructions for Intermediate and High Level Spills below.

2. Fire or explosion in Radioisotope Area.

The case of fire or explosion, call University Security (2111). If possible, stay on the scene to acquaint the emergency personnel in charge with the nature of the radiation hazard present and assist them as required. Also, follow instructions for Intermediate and High Level Spills below.

3. High Radiation Exposure Without Contamination.

In case of simple overexposure, do what can be done to terminate or is overexposure to all or part of the body, the individual must be report to Local hospital for examination and , possibly, treatment. Notify the Radiation Safety Officer and assist him in collecting and preserving what data is available to estimate the nature and extent on exposure.

4. Intermediate and High Level Radioactive Spills.

In case of a serious accident involving contamination of personnel or equipment, (including 1 and 2 above) the following step should be taken in the order listed.

1. Protect Personnel

- a. If hazard is extreme (high radiation level or possibility of air contamination), evacuate the area immediately; close and lock door.
- b. Rid yourself of contamination; remove contaminated clothing and wash contaminated parts of the body thoroughly with detergent.
- c. Flush out any wounds with copious amounts of water.
- d. Warn fellow workers and keep other out of the area.

2. Confine Contamination

- a. Localize area of spill. Right tipped container; drop absorbent material at edges of spills.
- b. Do not loiter in the area of the dry spill without respiratory protection. Shut off or close ventilating system if possible and turn off fans and blowers.

After an accident has occurred, the experiment, procedure, or process will suspended until a follow-up corrective action report is completed and approved by the Radiation Safety Office.

### **III Purchase, Receipt, and Transfer of Radioactive Materials.**

#### **A. General**

The Radiation Safety Committee is responsible for the approval of purchase, receipt, transfer and disposal of all radioactive materials on the MSU,M campus. Radioactive material may not be purchased or



transferred on the MSU,M campus, regardless of total amount or concentration, except as specifically authorized by the Radiation Safety Committee through the Radiation Safety Office.

All purchases of radiation source or radiation producing equipment must be approved initially by the University Radiation Safety Officer to ensure that the University is in compliance with federal regulations, and the equipment is in good working order. The Radiation Safety Officer may approve by signature or by electronic communication (e-Mail, DG Mail, PCS Memo, etc.)

#### **B. Departmental Responsibility**

Requests for purchase must be initiated on the automated purchasing system and forwarded to the Radiation Safety Officer for approval. The purchase request is then approved and forwarded to the Purchasing Office, or disapproved and returned to the originating department. If approved, a copy of the purchase request or a memo is routed to the Receiving Clerk alerting of the pending purchase.

Note: Departments **MUST NOT** order products containing any radiation substance without securing the approval from the Radiation Safety Officer. All Requests for Requisition (CS1400's) must indicate that the purchase contains radiation content and that the Radiation Safety Officer has approved such purchase.

The Purchasing Office will not process purchase requests for products containing radiation substances without the approval of the Radiation Safety Officer.

#### **C. Radiation Safety Officer**

Upon receipt of requests for purchase, the Radiation Safety Officer will review the requests for compliance with applicable federal and state regulations and approve or disapprove the purchase. If approved, the Radiation Safety Officer will note such approval on the document and forward it to the Purchasing Office. If disapproved, the Radiation Safety Officer will return it to the department with an appropriate explanation. A copy is filed for future reference.

#### **D. Purchasing Office**

All requests for purchase noting radiation source materials or equipment will be reviewed for the appropriate approval of the Radiation Safety Officer. Lack of such approval will result in the return of the purchase request to the originating department. If approved, the Purchasing Office will procure the item(s) through routine purchasing procedures following state of Minnesota purchasing policy. A purchase order will be forwarded to the vendor after an encumbrance transaction is entered to the University accounting system department budget and copies will be routed to the appropriate locations:

- Original - Vendor
- Copy 1 - File copy, Purchasing Department
- Copy 2 - Open order copy - Accounts Payable
- Copy 3 - Receiving report - Receiving Department
- Copy 4 - Department return copy

#### **E. Receiving Department**

The materials/equipment is delivered to the Receiving Department as requested by the University or state purchase order. Upon receipt, the Receiving Clerk follows the following procedure:

1. Radiation materials/equipment may be signed for **only if** a purchase order receiving report is present.
2. All radiation materials/equipment receiving packages must be inspected carefully for damages that may have been incurred in transit **before the freight company vehicle leaves**. If damages are discovered, the Radiation Safety Officer must immediately be notified and the freight company is not

allowed to leave. Follow Emergency Procedures (Section H). Inform the freight company of any problems. A freight claim immediately filed with the freight company.

3. DO NOT OPEN PACKAGES! Place them into a secure area.
4. Contact the Radiation Safety Officer immediately.
5. The radiation materials/equipment parcels must be opened in the presence of the Radiation Safety Officer and a determination for where they are to be delivered will be made at that time.

#### **F. Delivery**

The delivery of any radiation source material or equipment will be determined by the Radiation Safety Officer and will be delivered to the requesting departmental staff person directly. All radiation source material or equipment must be signed for by that individual.

All radiation source material or equipment must be signed for before the material is left with the user or the user's location.

If no signature can be obtained, the material should be delivered to the Radiation Safety Office or returned to the Receiving Department.

### **IV Design and Use of Permanent Radioactive Sources**

It frequently becomes necessary to prepare source of a more or less permanent nature for calibrating instruments and for use in long-term experiments. Since these sources are usually subject to considerable handling, it is imperative that the maximum inherent safety be incorporated in the design of such sources and their corresponding handling equipment. The required amount of built-in safety will, of course, vary depending on the type of source being prepared. Precautions necessary for a one millicurie source are less exacting than for a similar source of several millicuries. Practices which are relatively safe for a short-lived source might be pitifully inadequate when applied to a long-lived source. In addition, source design will depend on the nature of the radiation given off, the chemical and physical form of the source, the biological activity of the source material, etc.

In work with radioactive sources, the problem of protection has two aspects: 1) the protection from the direct radiation from the source and 2) the protection of the equipment and personnel from contamination from leaking or ruptured sources leading to possible deposition of the radioactive material in the body through ingestion or inhalation. The first is adequately covered by the previous sections of the University's regulations. This section will discuss criteria for controlling contamination through adequate source design and methods of handling. The following are established as guidelines for the safe use of such fabricated sources are subject to rather frequent and routine use.

1. All radioactive sources whether purchase ready-made or fabricated at the University are subject to inspection and approval by the Radiation Safety Office. For sources already in existence, a description and annotated drawing shall be furnished to the Radiation Safety Office on request. From each new source, a drawing and/or a written description shall be submitted to the Radiation Safety Office for approval prior to purchase or fabrication of the source.
2. Fabricated sources shall be constructed of break-resistant material and the radioactive constituents of each source shall be sealed to prevent leakage of the radioactive material (except as provided in Paragraph 3 below). Such sources shall be routinely tested for leakage at intervals of approximately six months (three months for alpha emitting sources) and also whenever there is a reason to suspect leakage of a source. The deleterious effect of intense radiation on the structural properties of materials, especially plastics, should be considered before using them for source fabrication.

3. Open sources or fragile sources. Occasionally the nature of an experiment demands that the source be uncovered or that thin films be used in its construction in order to disturb the characteristics of the radiation as little as possible. Such sources, being apt to creep, flake, corrode, rupture are inherently very hazardous and therefore require special care in the design of the source holders, handling devices and storage containers. It is impossible to specify here design criteria for all sources of this nature. Therefore it is advisable to discuss any unique problems of nature with the Radiation Safety Office before applying for approval of the source.
4. Accurate identification of radioactive source is a prerequisite for safe handling. Therefore, as a minimum each source must be labeled with radiation warning symbols, an identification number and the words, "Caution, Radioactive Material." The following information should be included on the label whenever possible:
  - a. The name of the radioisotope
  - b. its chemical form
  - c. the source strength in curies or some sub-unit thereof
  - d. the radiation output in mR/hr at the surface or at some measure distance
  - e. the date of the measurement
  - f. any other information which would enhance the utility or safety of the source

Where practicable, this label should be placed directly on the source or on a durable tag permanently attached to the source by a chain or rod. It is strongly recommended that provisions be made in the design stage for permanently labeling new sources.

In cases where sources of such fragility or small size are required that adequate labeling of the source itself is impractical, the labeling requirement may be waived upon approval of the Radiation Safety Office. Such a waiver may be obtained provided a system of handling is devised to assure that the unlabeled source is at all times either in its storage container or experimental apparatus.

5. Storage container and apparatus in which radioactive sources are used must be labeled as described for sources.
6. All labels must be legible at such a distance that a person would receive less than 10 millireotgens in the time require reading the label.

## **Appendix**

### **I. Records**

#### **A. General Provisions**

All reports, records and correspondence shall use the units: curies, rad, rem including multiples and subdivision, and shall clearly indicate the units of all quantities on records required.

#### **B. RSO Recordkeeping**

Records for the Radiation Safety Program shall be maintain in the Radiation Safety Office and will contain the follow:

1. Current Minnesota Department of Health Material licenses

2. All operational procedures involving the use of licensed material
3. Minnesota Rules on radiation
4. State regulatory information
5. Radiation waste records
6. Records of surveys, personal dosimetry and training

**C. Area Recordkeeping**

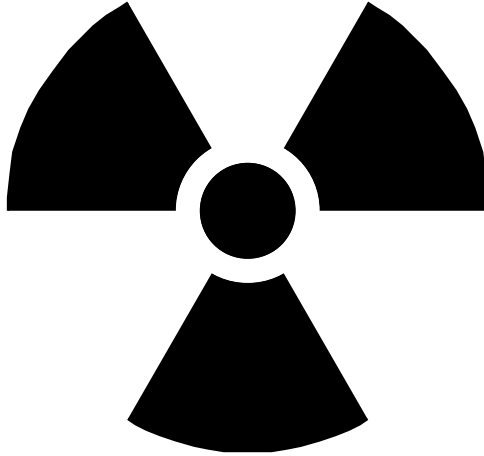
All areas in which radioactive material or radiation producing equipment is being used are required to:

1. Maintain a log on the material or equipment being used which contains:
  - a. Date of use.
  - b. Material being used.
  - c. Name of user.
  - d. Length of time being used.
2. Have a detailed procedure on all processes involving the uses of radioactive material or radiation producing equipment. A copy of these procedures shall also be on file in the Radiation Safety Office.
3. Have a detailed training procedure for all persons who will be using radiation material or radiation producing equipment. A copy of this procedure shall also on file in the Radiation Safety Office.
4. Have a log of AREA SURVEYS and Wipe Tests where radioactive materials are being using.

All records and procedures are subject to of the RSO and Radiation Safety Committee approval.

**II. Posting Signs and Labels**

**A. Standard Radiation Symbol**



1. Cross-hatched area is to be magenta or purple or black
2. Background is to be yellow.

Exceptions to the color requirement for the standard radiation symbol are labels for sources, source holders or device components containing sources of license materials that are subject to high temperature may be conspicuously etched or stamped radiation caution symbol without a color requirement.

#### **B Posting Requirements**

1. All radiation area shall be posted with a conspicuous sign or sign bearing the radiation symbol and the words "CAUTION, RADIATION AREA."
2. Posting of high radiation area shall be with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER HIGH RADIATION AREA."
3. Posting of very high radiation area shall be with a conspicuous sign or sign being the radiation symbol and words "GRAVE DANGER, VERY HIGH RADIATION AREA."
4. Posting of airborne radioactivity areas shall be with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."
5. Posting of areas or rooms in which the amount of licensed material being used or stored exceeds 10 times the quantity of such material specified in U.S. Regulations CFR Part 20 Appendix C "Quantities of Licensed Material Requiring Labeling" shall be with a conspicuous sign or signs, bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

#### **C Posting Exceptions**

1. Posting caution signs in areas or rooms which contain radioactive material for periods less than 8 hours, if the following requirements are met:
  - a. The material is constantly being attended during these periods by individuals who takes the precautions necessary to prevent the exposure of individuals to radiation or radioactive materials in excess of the limits established in Part B "Posting Requirements", and
  - b. The area or room is subject to the University's control.

#### **D. Labeling Containers**

1. All container of licensed material shall bear a durable, clearly visible label bearing the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label must also provide sufficient information (such as the radioisotope(s) present, an estimate of quantity of radioactivity, the date for which the activity is estimated, radiation levels, kind of materials, and mass enrichment) to permit individuals handling or using the containers, or working in the vicinity of the container, to take precautions to avoid or minimize exposures.
2. All container, prior to removal or disposal of uncontaminated containers to unrestricted areas, shall have the radioactive material label removed or defaced to indicate clearly that the container no longer contains radioactive material.

#### **E. Labeling Exemptions**

Container labeling is a vital part of radiation material control and always recommended. However there are instances that labeling is not required. Labeling is not required when:

1. Container holding licensed material in quantities less than the quantities listed in 4731.2800 part 3 "Quantities Requiring Labeling"; or
2. Containers holding licensed material in concentration less than those specified in 4731.2750 subpart 7, "*Table of ALI and DACs*"; or
3. Container attended by an individuals who take the precautions necessary to prevent the exposure of individual in excess of the limits established by current Minnesota Rules; or
4. Containers when they are in transport and package and label in accordance with regulations of the Department of Transportation<sup>1</sup>; or
5. Containers that are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individual by a readily available written record (examples of containers of this type are containers in locations such as water-filled canals, storage vaults, or hot cells). The records must be retained as long as the containers are in use for the purpose indicated on the record; or
6. Install manufacturing or process equipment, such as reactor components, piping and tanks.

<sup>1</sup> Labeling of packages containing radioactive materials is required by the Department of Transportation (DOT) if the amount and type of the radioactive material exceeds the limits for an excepted quantity or article as defined and limited by the DOT regulations 49 CFR 173.403 (m) and (w) and 173.421-424.

#### **F. Additional Information**

In addition to the contents of the signs and labels additional information should be posted near the required signs and labels to make other individuals aware of the potential radiation exposures and to minimize the exposures.

### **III Guidelines for Supervisors for Assessing Appropriate Employee Disposition for Using Radiation**

Purpose: This appendix is intended to serve as a guideline for supervisors, and is not intended to create employee rights or procedures for contesting decisions concerning an employee's use of radioactive materials.

A. What is the appropriate disposition for using radiation?

An appropriate disposition means a balanced attitude towards radiation entailing a healthy respect, free of both blind fear of the novice and familiar contempt one sometimes encounters in the "old hand."

B. Why is the appropriate disposition necessary?

The consequences of mishandling radiation are manifold and may affect the entire University and the surrounding community as well as individuals actually working in radiation. It is not enough, therefore, for workers to have adequate knowledge and skills for using radiation. They must also possess the disposition to use their knowledge and skill consistently and conscientiously.

C. Who determines whether a worker has the appropriate disposition?

The Radiation Safety Committee has delegated to the supervisor the authority to approve radiation workers. As part of this responsibility, supervisors must assess whether such employees have the proper disposition for handling radiation. Responsibility is assigned at this level because someone familiar with a worker's daily activities is usually in the best position to judge accurately and fairly that person's understanding of, compliance with, and attitude towards hazards and procedures involving the use of radiation.

D. How can a worker's disposition be known before that person has actually used radiation?

Reasonable estimates about the appropriateness of a worker's disposition to use radiation can be based on his/her behavior in similar situations. Someone who is calm, careful, responsible, reliable, honest, cooperative and who demonstrates good judgment when working in a laboratory setting not involving the use of radiation is likely (although not guaranteed) to exhibit these same qualities when using radiation. Someone who fails to display these qualities when doing laboratory work not involving radiation is unlikely to develop them for the specific purpose of using radiation.

E. What kind of actions indicates that a worker who is already authorized to use radiation actually possesses an appropriate disposition?

An authorized worker who has the proper disposition to use radiation will demonstrate the following types of behavior:

1. Conducts required laboratory surveys.
2. Cooperates with requirements for personnel monitoring.
3. Uses, stores, transfers and disposes of radiation sources safely and legally.
4. Maintain required documentation related to Items 1-3 above.
5. Minimize exposure of self/other to radiation.
6. Minimizes contamination of laboratory, equipment and the environment. When necessary, decontaminates promptly and thoroughly.
7. Use equipment appropriately for the task.
8. Seeks additional information about radiation before using unfamiliar procedures or sources, consulting co-workers, supervisors, Radiation Safety Office and reference materials as appropriate.
9. Plans ahead.

10. Works carefully with confidence.

11. Seek assistance when necessary.

12. Stay calm in emergencies.

The above list is illustrative, not all-inclusive.