STATE UNIVERSITY OF NEW YORK AT BINGHAMTON

Binghamton University

RADIOACTIVE MATERIALS & X-RAY EQUIPMENT

SAFETY MANUAL

For further information, contact
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I. REGULATIONS AND PROCEDURES

This section describes the policies and procedures to be followed by all faculty, staff, and students at State University of New York at Binghamton in the ordering, receipt, storage, use, and disposal of radioactive materials. This manual supercedes all other university documents related to radiation safety. A notice of the existence of the Safety Manual will be announced in Inside at the beginning of the Fall semester. A copy of the Safety Manual will be sent to all users of radioactive materials.

A. Radiation Safety Committee: Duties, Responsibilities and Authority

The Committee is responsible for:

1. Ensuring that all individuals who work with or in the vicinity of radioactive material have sufficient training and experience to enable them to perform their duties safely, and in accordance with New York State Department of Health regulations and the conditions of this license.

2. Ensuring that all use of radioactive material is conducted in a safe manner and in accordance with New York State Department of Health regulations and the conditions of the license.

The Committee shall:

1. Be familiar with all pertinent New York State Health Department regulations, the terms of the license, and information submitted in support of the request for the license and its amendments.

2. Review the training and experience of all individuals who use radioactive material and determine that their qualifications are sufficient to enable them to perform their duties safely and in accordance with New York State Health Department regulations and the conditions of the license.

3. Be responsible for monitoring the institution's program to maintain individual and collective doses as low as reasonably achievable.

4. Review semi-annually, with the assistance of the Radiation Safety Officer (RSO), occupational radiation exposure records of all personnel working with radioactive materials.

5. Establish a table of investigational levels for occupational radiation exposure, which when exceeded, will initiate an investigation and consideration of action by the Radiation Safety Officer.

6. Establish a program to ensure that all individuals whose duties may require them to work in the vicinity of radioactive material (e.g., security and housekeeping personnel) are properly instructed as required by Section 16.13, New York State Sanitary Code (10 NYCRR 16).

7. Review all requests for use of radioactive material within the institution.

8. Prescribe special conditions that will be required during a proposed use of radioactive material such as requirements for bioassays, physical examination of users, and special monitoring procedures.

9. Review the entire radiation safety program, at least annually, to determine that all activities are being conducted safely and in accordance with New York State Health Department regulations and the conditions of the license. The review shall include an examination of all records, reports from the Radiation Safety Officer, results of New York State Health Department inspections, written safety procedures, and the adequacy of the institution's management control system.

10. Recommend remedial action to correct any deficiencies identified in the radiation safety program.

11. Maintain written records of all Committee meetings, actions, recommendations, and decisions.

12. Ensure that the radioactive materials license is amended, when necessary, prior to any changes in facilities, equipment, policies, procedures, radioactive material, possession limits, and personnel, as specified in the license.

13. The Radiation Safety Committee shall meet as often as necessary to conduct its business, but not less than once in each calendar quarter.

14. A quorum shall consist of at least one-half of the Committee's membership, and must include the Radiation Safety Officer and the management representative.

The Radiation Safety Committee operates under New York State Department of Health Radioactive Materials License Number 588. Faculty or staff wishing to use radioactive materials must apply to the Radiation Safety Committee for permission. Upon approval of an application, the applicant will be informed as to maximum limits. A maximum limit for stock pulse stored as waste will be set by the committee.

Responsibility for minimizing radiation exposures and for proper storage and disposal of radioactive materials rests with the faculty member using such materials. This responsibility includes orientation and indoctrination of staff and students on the hazards involved, and on applicable procedures by which they may conduct their work safely. This is over and above training provided by the Radiation Safety Officer before work with radioactive materials began.

Personal Training.

It may not be assumed that safety instruction has been adequately covered by prior training at other institutions; even experienced professionals will need instruction in procedures and the conditions of our license. Ancillary personnel (e.g., clerical, housekeeping, security) whose duties may require them to work in the vicinity of radioactive material (whether escorted or not) need to be informed about radiation hazards and appropriate precautions. A training program that provides necessary instruction will be conducted by the Radiation Safety Officer.

Personnel will be instructed:

1. Before, assuming duties with, or in the vicinity of, radioactive materials.

2. During annual refresher training.

3. Whenever there is a significant change in duties, regulations, or the terms of the license.

Instruction for individuals in attendance will include the following subjects:

1. Applicable regulations and license conditions.

2. Areas where radioactive material is used or stored.

3. Potential hazards associated with radioactive material in each area where the employees will work.

4. Appropriate radiation safety procedures.

5. Licensee's in-house work rules.

6. Each individual's obligation to report unsafe conditions to the Radiation Safety Officer.

7. Appropriate response to emergencies or unsafe conditions.

8. Worker's right to be informed of occupational radiation exposure and bioassay results.

9. Locations where the licensee has posted or made available notices, copies of pertinent regulations and the Safety Manual, and copies of pertinent licenses and license conditions (including applications and applicable correspondence), as required by Section 16.13, New York State Sanitary Code (10 NYCRR 16).

Records that document training: Records of initial and refresher training will be maintained for five years and will include:

1. The name of the individual who conducted the training;

2. The names of the individuals who received the training;

3. The dates and duration of the training session; and

4. A list of the topics covered.

B. **Radiation Safety Officer (RSO): Duties, Responsibilities and Authority**

The appointment of the Radiation Safety Officer is made by the Vice Provost for Graduate Studies and Research. The Radiation Safety Officer is responsible for ensuring radiological safety as follows:

1. General surveillance over all activities involving radioactive material, including routine monitoring and special surveys of all areas in which radioactive material is used and stored.

2. Determining compliance with rules and regulations, license conditions, and the conditions of project approval specified by the Radiation Safety Committee.

3. Monitoring and maintaining absolute and other special filter systems associated with the use, storage or disposal of radioactive material.

4. Furnishing consulting services on all aspects of radiation safety to personnel at all levels of responsibility.

5. Receiving, delivering, and opening all shipments of radioactive material arriving at the institution and receiving, packaging, and shipping all radioactive material leaving the institution.

6. Meeting with the head janitor of the science buildings at the beginning of each academic year to brief him/her on procedures to be followed in labs where the radioactive symbol is displayed.

7. Distributing and processing personnel monitoring equipment, determining the need for bioassays, keeping personnel exposure and bioassay records, and notifying individuals and their supervisors of exposures approaching maximum permissible amounts and recommending appropriate remedial action.

8. Conducting training programs and otherwise instructing personnel in the proper procedures for the use of radioactive material prior to use, at periodic intervals (refresher training), and as required by changes in procedures, equipment, regulations, etc.

9. Supervising and coordinating the radioactive waste disposal program, including keeping waste storage and disposal records, and monitoring effluents.

10. Storing all radioactive materials not in current use, including wastes.

11. Performing leak tests on all sealed sources.

12. Maintaining an inventory of all radioisotopes at the institution and limiting the quantity of radionuclides at the institution to the amounts authorized by the license. The inventory should include the name of the person responsible for each quantity of radioisotope, where it will be used or stored, and the date the quantity was delivered to that person. Items are removed from the inventory by showing how and when the radioisotope was disposed of.

13. **The Radiation Safety Officer has the authority to terminate immediately, any project that is found to be a threat to health or property.** The Radiation Safety Officer will inform the Management Representative on the Radiation Safety Committee of any actions to terminate a project as soon as is possible.

14. Check all sealed sources, interlocks and x-ray machines not less than once every six months.

15. Maintaining other records not specifically designated above (e.g., receipt, transfer, and survey records as required by Section 16.14 of 10 NYCRR 16).

II. ACQUISITION, STORAGE, AND CONTROL

A. Procurement

1. The Radiation Safety Officer must approve all orders for radioactive materials and will ensure that the requested materials and quantities are authorized by the license and that possession limits are not exceeded. **All orders must have prior approval of the Radiation Safety Officer**. Faxed orders bearing the signature of the Radiation Safety Officer are permissible.

2. A system for ordering and receiving radioactive materials will be established and maintained. The system will consist minimally of the following:

   a. Written records will be used that identify the isotope, compound, activity levels, and supplier.

   b. The written records will be referenced when opening or storing radioactive shipments.

   c. It is essential that written records be maintained for all ordering and receipt procedures.

3. During normal working hours, carriers will be instructed to deliver radioactive materials directly to **James D. Brownridge**, The Radiation Safety Officer (RSO), in Science II, Room 507. (7-4370)

4. During off-duty hours' security personnel or other designated individuals will accept delivery of

radioactive packages in accordance with the procedures outlined in the license.

B. **Receipt**

All packages labeled "Radioactive Material" received at central receiving, by mail, or by personal carrier, will be delivered to the Radiation Safety Officer, Science II, Room 507. He will receive and record all radioactive materials delivered to State University of New York at Binghamton and forward the material to the addressee. It is imperative that the RSO know at all times the type, quantity, and location of radioactive materials received. This regulation also applies to instruments including radioactive material, e.g., gas chromatographs and x-ray equipment.

C. **Storage**

All radioactive material, regardless of activity, will be stored in a locked facility **when** no activities are in progress relating to the use of the radiation source. All containers in storage facilities should be properly labeled at all times. **NEVER LEAVE RADIOACTIVE MATERIALS IN A LABORATORY UNATTENDED; IF YOU HAVE TO LEAVE, THE DOOR MUST BE LOCKED.**

D. 1. **Use**

All use of radioactive materials for research or instructional purposes by faculty, staff, or students must be cleared with the Radiation Safety Committee. Prior to starting any experiments with radioactive isotopes, the faculty and staff must apply to the Radiation Safety Committee for a license. Only full time faculty and staff may apply for a license. All other users must work under the supervision of an approved faculty or staff member. Those who have not used radioactive materials in the last 24 months must be reinstated on the list of licensed users and must update their Application for Permission to Order and Use Radioactive Materials and X-ray Equipment (Form RSC-A) by contacting the Radiation Safety Officer (RSO).

2. **Fume Hoods**

A fume hood with a minimum air flow of 100 cfm is REQUIRED when the activity of the radioactive materials in use is 10% of the bioassay action levels listed in the U.S. NRC Regulatory Guides 8.20 and 8.32, or when the Radiation Safety Officer makes a determination that a hood is required. The Radiation Safety Officer will review the experimental protocol, chemical and biological forms of the materials to be used, the isotopes and the experience and training of the users.

E. **Steps to Obtain Approval**

1. Complete the Application for Permission to Order and Use Radioactive Materials and X-ray Equipment (Form RSC-A, at the end of this manual). Forms may also be obtained from the Radiation Safety Officer (RSO) 7-4370, Department of Physics, Science II, Room 507.

2. Submit the completed application to the Radiation Safety Officer.

3. The Radiation Safety Committee considers the proposal.

4. The applicant is notified by the Radiation Safety Officer of approval, the need for more or denial.

5. If approved, the applicant is notified of any conditions and maximum limits.

6. The applicant orders the radioactive isotope(s) approved by the Committee go **through the RSO.**

7. If a film badge is required it will be provided by the Radiation Safety Officer.

F. **Record of Use**

Radionuclide Use and Disposal Records (Form RSC-G) will be maintained by each faculty member using radioactive materials. This form includes: name of isotope, date received, storage area, activity (amount) and manner of disposal. Your inventory record (Form RSC-E) will be submitted to the RSO semiannually in September and February and at any other time at the request of the RSO. Failure to maintain these records and submit them promptly can result in suspension of permit to use radioactive materials. These forms are available from the RSO (7-4370).

G. **Enforcement Procedure**

When the Radiation Safety Officer determines that a University radiation material licensee is not in compliance with a rule or regulation and that this non compliance threatens health or property, he will:

1. **Suspend or terminate the program immediately.**

2. Report immediately to the chair of the Radiation Safety Committee and the Administration.

The Radiation Safety Committee will review the action of the Radiation Safety Officer and take additional action, as necessary.

When the Radiation Safety Officer determines that a licensee is not in compliance with a rule or regulation and that this noncompliance does not threaten health or property, he will notify the licensee and assist in taking corrective action within the time specified by Radiation Safety Officer.

If corrective action is not taken within the time specified by the Radiation Safety Officer, written notice will be given to the user with carbon copy to the chair of the Radiation Safety Committee.

The Radiation Safety Committee will notify the licensee that he/she will have his/her license suspended if corrective action is not taken within a specified time. (The specific time will be 30 days or less depending on the nature of the noncompliance).

H. Annual Audit and Program Review

The Annual Review of our Radiation Safety Program will consist of, but **NOT** necessarily be limited to,

1. An examination of records:

   A. Exposure records
   B. Laboratory surveys
   C. Training records and programs
   D. Meter calibration
   E. Incident reports
   F. Waste management
   G. Receipt of radioactive materials
   H. Review of quarterly inspections
   I. Inventory report

2. Reports from the Radiation Safety Officer,

3. Discussion of results of New York State Health Department inspection,

4. Discussion of written Safety Procedures, and

5. Discussion of adequacy of Management Control System.

I. Radiation Survey

Procedure for Area Surveys: It is recommended that these surveys be done by the students who are working with radioactive materials and should become a part of their training in the safe handling of radioactive materials.

1. Laboratory areas where only small quantities of radioactive material are used (less than 200 uCi) will be surveyed monthly.

2. Waste storage areas and all other laboratory areas will be surveyed weekly.

3. The weekly and monthly surveys will consist of:

    a. A measurement of radiation levels with a survey meter sensitive enough to detect 0.1 mR/hr.

    b. A series of wipe tests to measure contamination levels. The method for performing wipe tests will be sensitive enough to detect 1000\dpm per 100 square centimeters for the contaminant involved. Wipes made of "high background" areas will be removed to a low background area for measurement.

4. A permanent record will be kept of all survey results, including negative results. The record will include:

    a. Location, date, and identification of equipment used, including the serial number and pertinent counting efficiencies.

    b. Name of person conducting the survey.

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

    d. Measured exposure rates, keyed to a location on the drawing (point out rates that require corrective action).

    e. Detected contamination levels, keyed to locations on drawing.

5. Area will be cleaned if the contamination level exceeds 2000 dpm/100 square centimeters.

For Gamma Emitters:

1. Smear Survey (highest sensitivity)

    a. A smear survey is used for high sensitivity.

    b. Use filter paper about one inch in diameter.

    c. Smear an area of >100 cm^2.

    d. Count the filter paper with a sodium iodide, liquid scintillation or G.M. Counter equipped with a scalar. Use the appropriate detector (e.g., a G.M. Counter is useless for tritium, (H-3).

2. G.M. Survey

    a. A G.M. Survey is used when immediate information is needed and precision is not important.

    b. Indicates the presence of contamination only.

3. Ionization Chamber Survey

    a. Precision is high but sensitivity is low.

For Beta Emitters:

1. Smear Survey (highest sensitivity)

    a. A must for H-3 and will detect other beta emitters.

    b. Use filter paper about one inch in diameter.

    c. When possible smear an area of 1,000 cm^2 or more.

    d. Place each filter paper (H-3) in a vial containing liquid scintillation counting solution and count, or use a high sensitivity G.M. counter for C-14 and other beta emitters.

    e. For high energy beta a G.M. Counter equipped with a scalar may be used.

2. G.M. Survey (immediate information)

    a. Use a G.M. Survey Meter with a thin window probe.

    b. This method is poor for C-14 and **useless for H-3**.

Decontamination can usually be accomplished by washing with soap or detergent and water. Dilute acid or base of other strong cleaning agent may be required depending upon the chemical form of the contamination, and the nature of the surface. The materials used in decontamination should be disposed of as solid waste. Decontamination efforts should be continued until a smear taken on the surface indicates less than 1000 dpm of removable beta/gamma emitting material is present per 100 cm^2 in a controlled area. For G.M. Survey indicate whether contamination is present and model of meter used. Surface contamination should be kept as close to background as possible and should

never exceed the following limits:

Radioactive Surface Contamination Limits:

RADIOACTIVE SURFACE CONTAMINATION LIMITS

Application	Alpha		Beta/Gamma	
	Total (Mr/hr)	Removable (dpm/100cm^2)	Total (Mr/hr)	Removable (dpm/100cm^2)
Controlled area				
Basic guide	25,000 Max. 5,000 Av.	500	1.0	5,000
Clean area	1,000	100	0.5	1,000
Non-controlled area				
Skin, personal clothing	500	N.D.[2]	0.1	N.D.[2]
Release of material or facilities	2,500 Max. 500 Av.	100	0.2	1,000

1 Measured at 1 cm from the surface
2 N.D.--non-detectable

Anytime a smear or survey indicates contamination greater than twice the background, the area should be decontaminated. See Appendix A and Section V, page 45.

J. **General**

Rules for Safe Use of Radioactive Material: These rules must be posted as required by Section 16.13 (b), New York State Sanitary Code (10 NYCRR 16).

1. Prior to performing operations with quantities of radioactive material which may produce significant external or internal exposure, attention shall be given by the user to precautionary measures including the use of remote handling devices, hoods, shielding, etc. The Radiation Safety Officer must be consulted before beginning any new use of radioactive material.

2. There shall be no eating, drinking, applying cosmetics, or preparation of food in any location where unsealed sources of radioactive materials are used or stored.

3. Smoking is prohibited in all state buildings.

4. Do not store food, drink, or personal effects with radioactive material.

5. Pipetting of radioactive solutions by mouth is prohibited.

6. Segregate pipetting devices used with radioactive materials from those used with non-radioactive solutions.

7. Lab coats and disposable gloves shall be worn during operations involving the handling of unsealed sources of radioactive material. The lab coat and gloves should be removed before leaving the laboratory. Care must be taken such that other items (e.g., pens, pencils, notebooks,

door knobs, telephones, etc.) are not handled with gloves used during work with radioactive materials.

8. Work which may result in contamination of work surfaces shall be done over plastic-backed absorbent paper. Trays made of impervious materials (i.e., stainless steel, porcelain-coated, etc.) and lined with absorbent paper provide excellent work arrangements to help prevent the spread of contamination.

9. Work surfaces and personnel must be monitored after working with radioactive materials.

10. Where there may have been a spill of radioactive material (see posted Spill Procedures) which may have produced contamination of the person or clothing, both the person and the clothing shall be monitored. Personnel contamination shall be removed as soon as possible. Where contamination above action levels is noted during a laboratory survey decontamination must be immediately initiated by the user.

11. After working with unsealed sources of radioactive material, hands should be monitored and washed before leaving the laboratory.

12. Objects and equipment that may have been contaminated with radioactive material shall be surveyed and demonstrated to be free of contamination prior to their removal from a laboratory, or transferred to other laboratories, repair shops, surplus, etc. If found to be contaminated, such items must be decontaminated as soon as practical.

13. If personnel monitoring devices (whole-body or ring badge) have been issued to you for your work with radioactive material, they must be worn at all times when in areas where these materials are used or stored. These devices should be worn as prescribed by the Radiation Safety Officer. Personnel monitoring devices should be stored in a designated low background area when they are not being worn to monitor occupational exposures. They should **not** be left on your lab coat or shared by another individual.

14. Dispose of radioactive waste only in the manner designated by the Radiation Safety Officer and maintains records as instructed.

15. Store radioactive materials in covered containers plainly identified and labeled with name of compound, radionuclide, date activity, and radiation level, if applicable.

16. Always transport radioactive material in shielded containers.

K. **Personnel Monitoring**

1. Adults likely to receive, in one year from sources external to the body, a dose in excess of 10 percent of the limit for occupational dose limit will be issued and **MUST** use an individual monitoring device.

2. Minors and declared pregnant women likely to receive, in one year from sources external to the body, a dose in excess of 10 percent of limit for occupational dose limit will be issued and **MUST** use an individual monitoring device.

During your initial training and during annual refresher training the Radiation Safety Officer will review your work environment to determine if a monitoring device is required.

L. **Occupational Dose Limits**

1. **Occupational dose limits for adults.**

   No person shall transfer, receive, possess or use any radiation source so as to cause any individual adult to receive an occupational dose from all sources of radiation that exceeds any of the following limits:

   (i) The annual limit, which is the more limiting of:

      (a) The total effective dose equivalent being equal to 0.05 Sv (5 rem); or

      (b) The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.50 Sv (50 rem).

   (ii) The annual limits to the lens of the eye, to the skin, and to the extremities which are:

      (a) An eye dose equivalent of 0.15 Sv (15 rem), and

      (b) A shallow dose equivalent of 0.50 Sv (50 rem) to the skin or to any extremity.

2. **Occupational dose limits for minors.** (Individuals less than 18 years of age)

   The annual occupational dose limits for minors are 10 percent of the annual occupational dose limit for adult workers.

3. **Dose to an embryo/fetus.**

   The dose to an embryo/fetus shall not exceed a monthly exposure rate of 50 rem to a declared pregnant woman. Declaration of pregnancy is voluntary and must be done in writing. If you are pregnant and wish to declare, you should send a written statement to the Radiation Safety Officer.

4. **Dose limits for individual members of the public.**

   The dose in any unrestricted area from external sources may not exceed 2 rem in any hour.

M. **Thyroid Bioassay**

USNRC Regulatory Guide 8.20 provides criteria for the development and implementation of a bioassay program for any licensee handling or processing I-125 or I-131. It provides guidance for when bioassays should be performed, frequencies of bioassay, who should participate, and the actions to take based on bioassay results.

Bioassay Requirements

Thyroid bioassays are required after each used of a quantity of radioiodine shown on Table 1, waiting at least 6 hours but not more than 72 hours after such use. If there is no uptake, then the next bioassay should be performed after the next use. If an uptake is greater than an established action level (See Appendix C), a follow-up bioassay must be performed within 2 weeks of the original bioassay and before the next use of radioiodine. This will confirm the initial results and allow an estimate of the effective half-life of radioiodine in the thyroid. In addition, all those working in the lab must also report for a bioassay as soon as possible after an action level is reached. In those labs which have used a total quantity of radioiodine that requires bioassay in a 3-month period, all personnel are required to be bioassayed. Bioassay of lab personnel not directly involved

with radioiodine use must be performed quarterly if in those labs quantities of radioiodine that require bioassay (either single quantity or cumulative over 3 months) have been used. A record of radioiodine receipt must be maintained. This record must be reviewed frequently to verify that users are notifying the RSO after the use of their radioiodine.

Types of Bioassay:

Baseline: Prior to beginning work with radioiodine in an amount shown in Table 1.

Routine: At the frequency specified.

Emergency: As soon as possible after any incident that might cause potential exposure to radioiodine.

Post-operation: Performed within 2 weeks of the last possible exposure to radioiodine when operations are being discontinued or when the worker is terminating activities with potential exposure to radioiodine.

Follow-Up: Performed within 2 weeks of any measurement exceeding action levels.

Table 1

Activity Levels Above Which Bioassay for I-125 or I-131 is Necessary

Types of Operation	**Volatile**	**Non-Volatile**
Processes in an open room or bench	0.1 mCi	1.0 mCi
Processes in a fume hood	1.0 mCi	10 mCi
Processes in glove boxes	10 mCi	100 mCi

These quantities apply to both the quantity handled at any one time or integrated as the total amount of activity introduced into a process by a user over any 3-month period.

N. **Animals Containing Radioactive Material**

Faculty or staff wishing to work with animals containing radioactive materials must apply to the Radiation Safety Committee for permission. When the committee reviews an application it will require and or consider the following:

1. All cages and trays must be labeled with the appropriate label and signs.

2. Animal waste and animal carcasses must be treated as radioactive waste.

3. How animal waste and animal carcasses will be stored and disposed of.

4. Cages and equipment used in caring for radioactive animals may not be returned to general use prior to decontamination and written approval of the Radiation Safety Officer.

5. The method used to decontaminate cages must have the prior approval of the Radiation Safety Officer.

6. A description of the animal housing facilities. (i.e., a drawing showing such things as hood, doors, sink and the location of the cages).

7. Instruction for animal caretaker must be developed with the assistance of the Radiation Safety Officer.

8. Special attention must be given to animal room security.

9. The amount of radioactivity should be as low as is reasonably achievable.

III. DISPOSAL

A. General

Specific radioactive waste disposal procedures must be arranged with the Radiation Safety Officer. However, these general rules apply to all users. **No radioactive wastes shall be disposed of by conventional methods.** This means particularly that waste may **not** be placed in the standard waste containers to be collected by the housekeeping personnel, and that liquid waste may not be discharged into the sewer. No radioactive waste shall be released from a laboratory area for pickup and disposal prior to deactivation of infectious agent(s).

1. The RSO arranges for disposal of radioactive wastes. He will, on request, collect radioactive wastes and store them until picked up by the firm licensed by New York State to receive and dispose of radioactive materials. If you have any doubts on what is a permissible method of disposal after reviewing the appropriate regulations, please consult the RSO. A copy of the Record of Use form (RSC-G) must be submitted to the RSO when disposing of wastes.

2. All wastes must be placed in containers approved by the RSO.

3. Upon placing materials in the containers, the isotope, activity, date, Chemical Form, and percent by weight of chelating agents, if any must be entered on a card affixed to the top of the container.

4. Maximum radiation level at any container surface shall not exceed 200 mr/hr.

5. No container may contain materials **(whether radioactive or not)** which would create a hazard because of potential explosive or flammable properties.

6. Solid dry waste containers **must** not contain any liquids.

B. Liquid Scintillation Vials

Liquid scintillation vials must be intact with vial tops securely in place and kept separate from other waste. **They may contain only H-3 and/or C-14**. If you need to count other isotopes in liquid scintillation fluid, consult with the RSO.

IV. EMERGENCY PROCEDURES

In all emergency procedures, all steps following the notification of the RSO should be taken under his supervision.

Campus Emergency Number (x911)
Campus Safety Officer (x911)
Radiation Safety Officer (7-4370) (Home: 669-4282) (Weekends: 315-789-4965)

Spill Procedures

These procedures must be posted as required by Section 16.13 (b), New York State Sanitary Code (10 NYCRR 16).

Minor and Major Spills

Minor Spills

A spill is considered minor if:

1. It is confined to the immediate work area (i.e., table top or tray)
2. No one is contaminated.
3. No shielding is required to perform the experiment.
4. There are no gases, vapors or volatile solutions.
5. It is easily cleaned up by the user.

Steps to take:

1. NOTIFY: Notify persons in the area that a spill has occurred.
2. PREVENT THE SPREAD: Cover the spill with absorbent paper.
3. CLEAN UP: Use disposable gloves and remote handling tongs. Carefully fold the absorbent paper and pad. Insert into a plastic bag and dispose of in the radioactive waste container. Also insert into the plastic bag all other contaminated materials such as contaminated gloves.
4. SURVEY: With a low-range thin-window GM survey meter, check the area around the spill, hands, and clothing for contamination.
5. REPORT: Report incident to the Radiation Safety Officer.

Major Spills

A spill is considered major if:

1. Shielding is required to perform the experiment.
2. It is not confined to the immediate work area.
3. Anyone is contaminated or injured.
4. There are gases, vapors or volatile solution.
5. A fire is involved.
6. It is very difficult for the user to clean up. (i.e. more than three decontamination attempts).

Steps to Take:

1. CLEAR THE AREA: Notify all persons not involved in the spill to vacate the room.

2. PREVENT THE SPREAD: Cover the spill with absorbent pads, but do not attempt to clean it up. Confine the movement of all personnel potentially contaminated to prevent the spread.

3. SHIELD THE SOURCE: If possible, the spill should be shielded, but only if it can be done without further contamination or without significantly increasing your radiation exposure.

4. CLOSE THE ROOM: Leave the room and lock the door(s) to prevent entry.

5. CALL FOR HELP: Notify the Radiation Safety Officer immediately.

6. PERSONNEL DECONTAMINATION: Contaminated clothing should be removed and stored for further evaluation by the Radiation Safety Officer. If the spill is on the skin, flush thoroughly and then wash with mild soap and lukewarm water.

The Radiation Safety Officer will supervise the clean-up of the spill and will complete a report.

RADIATION SAFETY OFFICER: **James D. Brownridge**

OFFICE PHONE: **607-777-4370 HOME PHONE: 607-669-4282 WEEKEND: 315-789-4965**

ALTERNATE NAMES AND TELEPHONE NUMBERS DESIGNATED BY THE RADIATION SAFETY OFFICER: **Bret Pearsall**

OFFICE PHONE: 607/777-6835 or 777-2211

CELL PHONE: 607/343-1701

A. Injuries to Personnel Involving Radiation Hazard

1. Wash minor wounds immediately under running water while spreading the edges of the gash.

2. Dial Ext. 911 and ask for a ULED Officer to transport the injured person to the infirmary or hospital. Indicate to the Officer the amount of radioactivity and type used.

3. Report all radiation accidents to personnel to the University Safety Office (Ext. 911), and the RSO (Ext. 7-4370) as soon as possible. Complete the Accident Report form.

4. Permit no person involved in a radiation injury to return to work without the approval of the RSO and of the attendant physician.

5. Prepare a complete history of the accident for the RSO records.

B. Fires and Other Emergencies

1. In case of fire pull the nearest alarm box and dial Ext. 911 to report the fire -- indicate the presence of radioisotopes. Do not attempt to contain the fire.

2. Notify the Radiation Safety Officer, Ext. 7-4370 or home 669-4282.

3. Following the emergency, monitor the area and determine the protective devices necessary for

safe decontamination.

4. Decontaminate.

5. Permit no person to resume work without approval of the RSO.

6. Monitor all persons involved in combating the emergency.

7. Prepare a complete history of the emergency for the RSO. Unless otherwise specified by the RSO, the ULED Officers will form a perimeter cordon of the spill area to prevent access of unwanted personnel and to prevent personnel within the perimeter from leaving the area with contaminated clothing. All personnel leaving the area must be monitored and decontaminated, if necessary, by the Radiation Safety Officer.

C. Theft or Loss of Radiation Source

Any theft or loss of any radioactive material or sources must be reported to the Radiation Safety Officer immediately -- Room 507, Science II, Ext. 7-4370, home 669-4282.

V. **RULES OF THUMB** (From U.S. Department of Health, Education, and Welfare, Publication No. (NIH 79-18)

Beta Radiation

1. Beta particles of at least 70 keV energy are required to penetrate the nominal protective layer of the skin (7 mg/cm^2 or 0.07 mm).

2. The average energy of a beta-ray spectrum is approximately one-third the maximum energy.

3. The range of beta particles in air is 12 ft/MeV. (Maximum range of ^{32}P beta is 1.71 MeV x 12 ft/MeV 20 ft).

4. The dose rate in rads per hour in a solution by a beta emitter is 1.12 EC/p, where E is the average beta energy per disintegration in MeV, C is the concentration in microcuries per cubic centimeter, and p is the density of the medium in grams per cubic centimeter. The dose rate at the surface of the solution is one-half the value given by this relation. (For ^{32}P average energy of approximately 0.7 MeV, the dose rate from 1 Ci/cm^3 (in water) is 1.48 rads/hr.)

5. The surface dose rate through the nominal protective layer of skin (7 mg/cm^2) from a uniform thin deposition of 1 Ci/cm^2 is about 9 rads/hr for energies above about 0.6 MeV. Note that in a thin layer, the beta dose rate exceeds the gamma dose rate, for equal energies released, by about a factor of 100.

6. For a point source of beta radiation (neglecting self and air absorption) of activity in millicuries (mCi), the dose rate at 1 cm in rads/hour is approximately equal to 200 x mCi. The dose rate varies only slowly with beta energy. For example, dose rate for 1 mCi ^{32}P at 1 cm is approximately 200 rads/hour.

Gamma Rays

1. For a point source gamma emitter with energies between 0.07 and 4 MeV, the exposure rate (mR/hr) within 20% at 1 foot is 6 x mCi x E x n, where mCi is the number of millicuries; E, the

energy in MeV; and n, the number of gammas per disintegration.

2. The dose rate to tissue in rads per hour in an infinite medium uniformly contaminated by a gamma emitter is 2.12 EC/p, where C is the number of microcuries per cubic centimeter, E is the average gamma energy per disintegration in MeV, and p is the density of the medium. At the surface of a large body, the dose rate is about half of this.

X-Ray

1. The exposure rate at 2 feet from diagnostic x-ray equipment operated at 100 kVp and 100 milliamperes is approximately 2.3 roentgens/second.

2. Exposure rate at the fluoroscopy table with tube potential at 80 kVp and tube current of 1 milliampere should not exceed 2.1 roentgens/minute.

3. Scattered radiation can be as penetrating as the primary beam.

X-Ray Diffraction

1. The x-ray beam intensities from the primary beam can be as much as 400,000 Roentgens/min.

2. Scattered radiation 10 cm from the points of scatter about the x-ray tube head has been measured in the order of 150 Roentgens/hr.

3. The threshold dose sufficient to produce skin erythema is 300 to 400 roentgens.

4. The minimum cataractogenic single dose is 200 rads, while a dose of 750 rads exhibits a high incidence of cataract formation.

Miscellaneous

1. The activity of any radionuclide is reduced to less than 1% after 7 half-lives.
2. For material with a half-life greater than six days, the change in activity in 24 hours will be less than 10%.

VI. SUMMARY OF GENERAL LABORATORY REGULATIONS

1. Smoking, eating, drinking, and the application of cosmetics in the laboratory are not permitted.

2. Pipetting by mouth is never permitted. Use suction device such as a pipette filler.

3. Gloves and laboratory coats should be worn when working with all liquid radioisotopes.

4. Before leaving the laboratory, wash hands thoroughly, and then check for possible contamination with survey instrument.

5. All radioactive liquid wastes are to be poured into the liquid waste container **never** into a laboratory sink. All solid radioactive waste and contaminated materials should be placed in the trash receptacle marked "Radioactive Waste."

6. Report spills, wounds, or other emergencies to the RSO immediately.

7. Maintain good housekeeping at all times in the laboratory.

8. Store radioactive materials only in the designated storage area. Do not remove sources from the laboratory.

GLOSSARY[1]

Absorbed Dose: The amount of energy imparted to matter by ionizing radiation per unit mass of irradiated material. (See Rad).

Absorption: The phenomenon by which radiation imparts some or all of its energy to any material through which it passes.

Activity: The number of nuclear disintegrations occurring in a given quantity of material per unit of time. (See Curie)

ALAR: As low as is reasonably achievable.

Alpha Particle: A strongly ionizing particle emitted from the nucleus during radioactive decay having a mass and charge equal in magnitude to a helium nucleus, consisting of 2 protons and 2 neutrons with a double positive charge.

Alpha Ray: A stream of fast-moving helium nuclei (alpha particles), a strongly ionizing and weakly penetrating radiation.

Annihilation (Electron): An interaction between a positive and negative electron; their energy, including rest energy, being converted into electromagnetic radiation (annihilation radiation).

Atom: Smallest particle of an element which is capable of entering into a chemical reaction.

Autoradiograph: Record of radiation from radioactive material in an object, made by placing the object in close proximity to a photographic emulsion.

Background Radiation: Ionizing radiation arising from radioactive material other than one directly under consideration. Background radiation due to cosmic rays and natural radioactivity is always present. There may also be background radiation due to the presence of radioactive substances in other parts of the building, in the building material itself, etc.

Beta Particle: Charged particle emitted from the nucleus of an atom, having a mass and charge equal in magnitude to that of the electron.

Beta Ray: A stream of high speed electrons or positrons of nuclear origin more penetrating but less ionizing than alpha rays.

Bremsstrahlung: Electromagnetic (x-ray) radiation associated with the deceleration of charged particles passing through matter. Usually associated with energetic beta emitters, **e.g.,** phosphorus-32.

Calibration: Determination of variation from standard, or accuracy, of a measuring instrument to ascertain necessary correction factors.

Contamination, Radioactive: Deposition of radioactive material in any place where it is not desired, and particularly in any place where its presence may be harmful. The harm may be vitiating the validity of an experiment or a procedure, or in actually being a source of excessive exposure to personnel.

[1] State Sanitary Code, Chapter 1, Part 16, Ionizing Radiation.

Carrier Free: An adjective applied to one or more radionuclides of an element in minute quantity, essentially undiluted with stable isotope carrier.

Count (Radiation Measurement): The external indication of a device designed to enumerate ionizing events. It may refer to a single detected event or to the total registered in a given period of time. The term is often erroneously used to designate a disintegration, ionizing event, or voltage pulse.

Critical Organ: That organ or tissue, the irradiation of which will result in the greatest hazard to the health of the individual or his descendants.

Curie: The quantity of any radioactive material in which the number of disintegrations is 3.700×10^{10} per second. Abbreviated Ci. Millicurie: One thousandth of a curie (3.7×10^{7} disintegrations per second). Abbreviated mCi. Microcurie: One millionth of a curie (3.7×10^{4} disintegrations per second). Abbreviated Ci: Picocurie: One millionth of a microcurie (3.7×10^{-2} disintegrations per second or 2.22 disintegrations per minute). Abbreviated pCi.

Decay, Radioactive: Disintegration of the nucleus of an unstable nuclide by the spontaneous emission of charged particles and/or photons.

Dose,Absorbed: The energy imparted to matter by ionizing radiation per unit mass or irradiated material at the place of interest. The unit of absorbed dose is the rad, which is 100 ergs/gram.

Dose Equivalent: A quantity used in radiation protection expressing all radiation on a common scale for calculating the effective absorbed dose. The unit of dose equivalent is the rem, which is numerically equal to the absorbed dose in rads multiplied by certain modifying factors such as the quality factor, the distribution factor, etc.

Efficiency (Counters): A measure of the probability that a count will be recorded when radiation is incident on a detector. Usage varies considerably so it is well to make sure which factors (window, transmission, sensitive volume, energy, dependence, etc.) are included in a given case.

Electron: Negatively charged elementary particle which is a constituent of every neutral atom. Its unit of negative electricity equals 4.8×10^{-19} coulombs. Its mass is 0.00549 atomic mass units.

Electron Capture: A mode of radioactive decay involving the capture of an orbital electron by its nucleus. Capture from the particular electron shell is designated as “K-electron capture,” “L-electron capture,” etc.

Electron Volt: A unit of energy equivalent to the amount of energy gained by an electron passing through a potential difference of 1 volt. Abbreviated eV. Larger multiple units of the electron volt frequently used are: deV for thousand or kiloelectron volts, MeV for million electron volts and BeV for billion electron volts.

Exposure: A measure for the ionization produced in air by x or gamma radiation. It is the sum of the electrical charges on all ions of one sign produced in air when all electrons liberated by photons in a volume element of air are completely stopped in air, divided by the mass of air in the volume element. The special unit of exposure is the roentgen.

Film Badge: A packet of photographic film used for the approximate measurement of radiation exposure for personnel monitoring purposes. The badge may contain two or more films of differing sensitivity, and it may contain filters which shield parts of the film from certain types of radiation.

Filter (Radiology): PRIMARY: A sheet of material, usually metal, placed in a beam of radiation to remove, as far as possible, the less penetrating components of the beam. SECONDARY: A sheet of material of lower atomic number, relative to that of the primary filter, placed in the filtered beam of radiation to remove characteristic radiation produced by the primary filter.

Gamma Ray: Very penetrating electromagnetic radiation of nuclear origin. Except for origin, identical to x-ray.

Geiger-Mueller (G-M) Counter: Highly sensitive gas-filled detector and associated circuitry used for radiation detection and measurement.

Genetic Effect of Radiation: In heritable changes, chiefly mutations, produced by the absorption of ionizing radiations. On the basis of present knowledge these effects are purely additive, and there is no recovery.

Half-Life, Biological: The time required for the body to eliminate one-half of an administered dose of any substance by the regular process of elimination. This time is approximately the same for both stable and radionuclides of a particular element.

Half-Life, Effective: Time required for a radioactive nuclide in a system to be diminished 50 percent as a result of the combined action of radioactive decay and biological elimination.

$$\text{Effective half life} = \frac{\text{Biological half life x Radioactive half-life}}{\text{Biological half- life + Radioactive half-life}}$$

Half-Life, Radioactive: Time required for a radioactive substance to lose 50 percent of its activity by decay. Each radionuclide has a unique half-life.

Half Value Layer (Half Thickness): The thickness of any specified material necessary to reduce the intensity of an x-ray or gamma ray beam to one-half its original value.

Health Physics: A term in common use for that branch of radiological science dealing with the protection of personnel from harmful effects of ionizing radiation.

Inverse Square Law: The intensity of radiation at any distance from a point source varies inversely as the square of that distance. For example: if the radiation exposure is 100 R/hr at 1 inch from a source, the exposure will be 0.01 R/hr at 100 inches.

Ion: Atomic particle, atom, or chemical radical bearing an electrical charge, either negative or positive.

Ionization: The process by which a neutral atom or molecule acquires either a positive or negative charge.

Ionization, Specific: The number of ion pairs per unit length of path of ionizing radiation in a medium; **e.g.**, per centimeter of air or per micron of tissue.

Ionizing Radiation: Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter.

Isotopes: Nuclides having the same number of protons in their nuclei, and hence having the same atomic number, but differing in the number of neutrons, and therefore in the mass number. Almost identical

chemical properties exist between isotopes of a particular element.

Labelled Compound: A compound consisting, in part, of labelled molecules. By observations of radioactivity or isotopic composition this compound or its fragments may be followed through physical, chemical or biological processes.

Maximum Permissible Dose (MPD): Maximum dose of radiation which may be received by persons working with ionizing radiation, which will produce no detectable damage over the normal life span.

Milliroentgen (mR): A submultiple of the roentgen equal to one-thousandth (1/1000th) of a roentgen. (See Roentgen).

Monitoring, Radiological: Periodic or continuous determination of the amount of ionizing radiation or radioactive contamination present in an occupied region as a safety measure for purposes of health protection. AREA MONITORING: Routine monitoring of the the level of radiation or of radioactive contamination of any particular area, building, room or equipment. PERSONNEL MONITORING: Monitoring any part of an individual, his breath, excretions, or any part of his clothing. (See Radiological Survey)

Neutron: Elementary particle with a mass approximately the same as that of a hydrogen atom and electrically neutral. It has a half-life in minutes and decays in a free state into a proton and an electron.

Nuclide: A species of atom characterized by its mass number, atomic number, and energy state of its nucleus, provided that the atom is capable of existing for a measurable time.

Protective Barriers: Barriers of radiation absorbing material, such as lead, concrete, plaster, and plastic, that are used to reduce radiation exposure. PROTECTIVE BARRIERS, PRIMARY: Barriers sufficient to attenuate the useful beam to the required degree. PROTECTIVE BARRIERS, SECONDARY: Barriers sufficient to attenuate stray or scattered radiation to the required degree.

Radiation: 1) The emission and propagation of energy through space or through a material medium in the form of waves; for instance, the emission and propagation of electromagnetic waves; or of sound and elastic waves. 2) The energy propagated through a material medium as waves; for example, energy in the form of electromagnetic waves or of elastic waves. The term “radiation” or “radiant energy,” when unqualified, usually refers to electromagnetic radiation. Such radiation commonly is classified according to frequency as Hertzian, infrared, visible (light), ultra-violet, x-ray, and gamma ray. 3)By extension, corpuscular emissions, such as alpha and beta radiation, or rays of mixed or unknown type, as cosmic radiation.

Radiological Survey: Evaluation of the radiation hazards incident to the production, use or existence of radioactive materials or other sources of radiation under a specific set of conditions. Such evaluation customarily includes a physical survey of the disposition of materials and equipment, measures or estimates of the levels of radiation that may be involved, and a sufficient knowledge of processes using or affecting these materials to predict hazards resulting from expected or possible changes in material or equipment.

Radionuclide: A nuclide with an unstable ratio of neutrons the protons placing the nucleus in a state of stress. In an attempt to reorganize to a more stable state, it may undergo various types of rearrangement that involve the release of radiation.

Radiotoxicity: Term referring to the potential of an isotope to cause damage to living tissue by absorbing of energy from the disintegration of the radioactive material introduced into the body.

Relative Biological Effectiveness BE): For a particular living organism or part of an organism, the ratio of the absorbed dose of a reference radiation that produces a specified biological effect to the absorbed dose of the radiation of interest that produces the same biological effect.

Rem: The special unit of dose equivalent. The dose equivalent in rems is numerically equal to the absorbed dose in rads multiplied by the quality factor, distribution actor, and any other necessary modifying factors.

Roentgen (R): The quantity of x or gamma radiation such that the associated corpuscular emission per 0.001293 grams of dry air produces, in air, ions carrying one electrostatic unit of quantity of electricity of either sign. The roentgen is the special unit of exposure.

Scintillation Counter: A counter in which light flashes produced in a scintillator by ionizing radiation are converted into electrical pulses by a photomultiplier tube.

Shielding Material: Any material which is used to absorb radiation and thus effectively reduce the intensity of radiation, and in some cases eliminate it. Lead, concrete, aluminum, water, and plastic are examples of commonly used shielding material.

Smear (Smear or Swipe Test): A procedure in which a swab, **e.g.,** a circle of filter paper, is rubbed on a surface and its radioactivity measured to determine if the surface is contaminated with loose radioactive nuclide.

Tracer, Isotopic: The isotope or non-natural mixture or isotopes of an element which may be incorporated into a sample to make possible observation of the course of that element, alone or in combination, through a chemical, biological, or physical process. The observations may be made by measurement of radioactivity or of isotopic abundance.

Thermoluminescent Dosimeter: A dosimeter made of certain crystalline material which is capable of both storing a fraction of absorbing ionizing radiation and releasing this energy in the form of visible photons when heated. The amount of light released can be used as a measure of radiation exposure to these crystals.

X-Rays: Penetrating electromagnetic radiations having wave lengths shorter than those of visible light. They are usually produced by bombarding a metallic target with fast electrons in a high vacuum. In nuclear reactions it is customary to refer to photons originating in the nucleus as gamma rays, and those originating in the extranuclear part of the atom as x-rays. These rays are sometimes called roentgen rays after their discoverer, W.C. Roentgen.

APPENDIX A

Action Levels

RSO Action Levels:

Whenever the thyroid burden at the time of measurement exceeds 0.06 uCI of I-125 or 0.02 uCi of I-131, the following actions should be taken:

1) An investigation of the operations involved, including air and other in-lab surveys should be carried out to determine the causes of exposure and to evaluate the potential for further exposures.

2) Corrective actions that will eliminate or lower the potential for further exposures should be implemented.

3) A repeat bioassay should be taken within two weeks of the original measurement and evaluated within 24 hours after measurement in order to confirm the presence of internal radioiodine and to obtain an estimate of its effective half-life for use in estimating dose commitment.

Regulatory Guide Action Levels:

Whenever the thyroid burden at the time of measurement exceeds 0.12 uCi of I-125 or 0.04 uCi of I-131, the following action should be taken in addition to the actions required under the RSO Action Levels:

If the investigation indicates that further work in the area might result in exposure of a worker to concentrations that would exceed those established by 10CFR20.103, the worker should be restricted from further exposure until the source of exposure is discovered and corrected.

Emergency Action Levels:

Whenever the thyroid burden at the time of measurement exceeds 0.5 of I-125 or 0.14 uCi of I-131, the following steps in addition to those listed above should be taken:

1) As soon as possible, refer the case to appropriate medical consultation for recommendations regarding therapeutic procedures that may be carried out to accelerate removal of radioiodine from the body. This should be done within 2 -3 hours after exposure (when the exposure is known) so that any prescribed thyroid blocking agents would be effective.

2) Carry out repeated measurements at 1 week intervals until the thyroid burden is less than 0.12 uCi of I-125 or 0.04 uCi of I-131.

Review all internal exposure results to see if any require reporting to State or Federal agencies.

APPENDIX B

Permissible Occupational Dose

(a) From external exposure. [2]

(1) Except as otherwise permitted in paragraph (2) of this subdivision, no person shall transfer, receive, possess or use any radiation source so as to cause any individual to receive an occupational dose from external exposure in any period of one calendar quarter from all sources of radiation that exceeds any of the following limits:

(i) If the individual is 18 years of age, or over,

(a) a dose to the whole body[3] of three rems per calendar quarter or five rems in any 52 consecutive weeks; or

(b) a dose to the hands and forearms, or feet and ankles, of 25 rems per calendar quarter or 75 rems in any 52 consecutive weeks; or

(c) a dose to any portion of the skin of the whole body of 10 rems per calendar quarter or 30 rems in any 52 consecutive weeks; and

(ii) if the individual is under 18 years of age, a dose to any part of the body that exceeds 10 percent of the applicable limit specified in subparagraph (i) of this paragraph.

(2) Any person may permit an individual 18 years of age or over to receive an occupational dose to the whole body greater than that permitted under paragraph (1) of this subdivision, provided:

(i) such dose will not exceed three rems during any calendar quarter; and,

(ii) such dose will not, when added to the accumulated occupational dose to such individual's whole body, exceed 5 (N-18) rems, where N equals such individual's age in years at his last birthday; and

(iii) such person has complied with all the requirements contained in a form prescribed by the department for the calculation of such individual's previously accumulated occupational dose and excess dose permitted under this paragraph including the obtaining of certifications and reports of past exposures.

(b) From concentration of airborne radioactive material.

(1) No person shall transfer, receive, possess or use radioactive material in such a manner a to cause any individual in any controlled area to be exposed to any airborne radioactive material in an average concentration in excess of the limit thereof set forth in Appendix A, Schedule I, infra. Expose, as used in this subdivision, means that the individual is present in an airborne concentration.

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[2] For determining the doses specified in this Part, a dose from X or gamma rays up to 3 MeV may be assumed to be equivalent to the exposure measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of the highest dose rate.

[3] Dose to the whole body as used in this Part shall include a dose to any of the following: head and trunk; active blood forming organs; gonads; lens of eye.

(2) The limits given in Appendix A, Schedule I, infra are based upon exposure to the concentrations set forth therein for 40 hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than 40, the limits set forth in Schedule I may be increased proportionately. In any such period where the number of hours of exposure is greater that 40, the limits set forth in Schedule I shall be decreased proportionately.

(3) Except as authorized by the department, no allowance shall be made for particle size or the use of protective clothing or equipment in determining whether an individual is exposed to an airborne concentration in excess of the limits set forth in Appendix A, Schedule I, infra.