MASSACHUSETTS INSTITUTE OF TECHNOLOGY

RADIATION PROTECTION PROGRAM

REQUIRED PROCEDURES FOR RADIATION PROTECTION

Eighth Edition
April 2013

ISSUED BY THE MIT RADIATION PROTECTION COMMITTEE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

REQUIRED PROCEDURES FOR RADIATION PROTECTION

Preface

Radiological health and safety at the Massachusetts Institute of Technology is controlled by the MIT Radiation Protection Committee (RPC), a presidentially appointed committee composed of senior faculty and administrators. The requirements of the RPC are delineated in these ***Required Procedures for Radiation Protection***. The required procedures are administered by the Radiation Protection Program (RPP), a staff of health physicists, radiation protection technicians, and administrative support personnel functioning as the operational arm of the RPC.

Under the direction of the MIT Radiation Protection Officer, radiological safety is managed at the Cambridge campus, Lincoln Laboratories, the Bates Linear Accelerator Laboratory, and the MIT Research Reactor. RPP may be reached at the following telephone extensions: Campus (2-3477), Nuclear Reactor (3-4203), and Bates Linear Accelerator (3-9217). After hour or weekend emergency notification is provided through Campus Police (100) or Facilities Operation Center (3-1500).

The RPP provides health physics and radiation safety services to all persons using sources of ionizing and non-ionizing radiation. Projects using radioactive materials are authorized through the RPP in accordance with Commonwealth of Massachusetts Department of Public Health license conditions. The following services related to the safe use of unsealed radioactive materials and sealed sources are provided by RPP:

* Training of all radiation workers, emergency personnel and ancillary workers;
* Monitoring workers for external and internal radiation exposures;
* Radioactivity analysis;
* Environmental monitoring for potential releases of radioactive material;
* Routine surveillance for radiation and contamination in radiation laboratories;
* Calibration and repair of radiation survey instrumentation;
* Collection, disposal, and management of low level radioactive waste;
* Design and construction of radiation shielding; and
* Assistance in the design of radiation laboratories.
* 24 hour emergency response

Registration, worker training, and surveillance are also part of the established RPP programs for safe use of analytical x-ray equipment, medical x-ray units, and high dose irradiators. A laser safety program which requires registration of all lasers, worker training, and laser safety evaluations is maintained by RPP. With respect to other non-ionizing radiation, RPP measures and evaluates electromagnetic radiation field strengths from sources such as VDTs, power lines, microwave generators, radar installations, and magnetic imaging devices.

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REQUIRED PROCEDURES FOR RADIATION PROTECTION

1. PURPOSE

1. The required procedures contained in this document have been established for the following purposes:

    1. To provide for the protection of the Institute population and of the general public against radiation hazards associated with MIT's possession, use, transportation, and disposal of radioactive material.

    2. To provide for the Institute's compliance with applicable radiation protection regulations of Federal, State and Local governmental agencies.

2. DELEGATION OF AUTHORITY

1. The Radiation Protection Committee (RPC) receives its authority from the Office of the President of MIT.

2. The Committee is charged with the following responsibilities:

    1. The establishment and continuing review of an adequate radiation protection program at the Institute and it’s off campus sites.

    2. The Institute's compliance with radiation protection regulations promulgated by governmental agencies.

    3. Auditing at least annually of the Radiation Protection Program.

3. To meet these responsibilities, the RPC has been given the following authority:

    1. To grant authorization to an individual, project, or department for the use of radioactive material on MIT property or at MIT field sites.

    2. To suspend an individual's or project's MIT authorization to use radioactive material.

    3. To apply restrictions on the amount of occupational radiation exposure that an individual may receive during his MIT association.

    4. To apply conditions of approval that must be adhered to with the project's proposed uses of radioactive materials.

4. The Radiation Protection Program, under the direction of the Institute Radiation Protection Officer, of the Environment, Health and Safety Office has the following responsibilities:

1. Implementing the Institute's radiation protection program.

2. Operating the Institute's Central Radioisotope Laboratory and Storage Facility.

3. Providing such services as may be required for radiation protection and compliance with governmental regulations. The services include the following:

    1. Registration and training of radiation workers.

    2. Training of ancillary personnel.

    3. Personnel monitoring of internal and external radiation exposure.

    4. Radioisotope laboratory inspections, audits and radiation surveys.

    5. Radioactive waste collection, management, measurement and disposal.

    6. Calibration and repair of radiation protection survey instruments.

    7. Approval of all purchases of radioactive material.

    8. Environmental monitoring.

    9. Leak testing and physical inventory of sealed radioactive sources.

    10. Monitoring and laboratory delivery of incoming shipments of radioactive material.

    11. Preparation and monitoring of outgoing shipments of radioactive materials.

    12. Supervision of radiation emergencies, and special decontamination operations.

    13. Operation of an MIT vehicle for transportation of radioactive material.

    14. Maintenance of radiation protection records.

4. In addition, the Radiation Protection Program staff is available for:

    1. Consultation on laboratory design, shielding, and other radiation exposure control methods, and

    2. Presenting lectures and training exercises on radiation protection

techniques.

5. Each Department, Laboratory, and Project Supervisor is responsible for providing adequate facilities, equipment, instruments, supervision, and instructions to control radiation hazards and to comply with the Institute's radiation protection requirements.

6. Each Project Supervisor possessing or using radioactive material or radiation sources has the following responsibilities:

    1. Maintaining an up-to-date listing with the Radiation Protection Program of rooms in which radioactive material is stored or used.

    2. Maintaining an up-to-date listing with the Radiation Protection Program of the names of personnel who may use radioactive material.

    3. Allowing only those persons who are registered with, and trained by, the Radiation Protection Program to use radioactive material.

    4. Promptly completing and returning authorization renewal packages and scheduling retraining sessions.

    5. Providing experiment-specific training to radiation workers in their laboratories.

    6. The maintenance of an adequate written inventory of the amount of radioactive material possessed and the establishment of an adequate system to alert the project of any deliberate diversion of radioactive material.

    7. Establishing procedures to comply with the institute policies for security of radioactive materials.

    8. Keeping adequate records of disposal of radioactive material on forms that are supplied by the Radiation Protection Program.

    9. Allowing only authorized persons to enter rooms that are specified as restricted areas for reasons of radiation protection.

    10. Informing the Radiation Protection Program of new radioactive material work, or changes in existing work, which may potentially increase radiation exposure.

    11. Ensuring that personnel wear assigned personnel monitoring devices during periods of possible exposure and the timely exchange of used dosimeters with the RPP.

    12. Establishing appropriate procedures to ensure compliance with the

Caution sign and labeling requirements of Section III.K. of this document.

13. Establishing routine radioisotope laboratory monitoring procedures adequate to ensure that the following conditions exist at the conclusion of work with radioactive materials:

    1. Survey meter measurements have established that external radiation and contamination levels are within permissible limits and as low as reasonably achievable.

    2. Radiation sources are properly labeled, stored and secured.

    3. Experiments that will be in progress after normal work hours will be properly attended and posted.

    4. Each laboratory is secured against unauthorized access.

    5. Records are maintained as required by the Radiation Protection Program.

7. Each individual who may use radioactive material has the following responsibilities:

    1. Complying with the procedures and precautions contained in this document, and with those established by his/her Project.

    2. Complying with the conditions of approval found in the project's authorization.

    3. Handling radioactive material in a responsible manner to maintain occupational radiation exposure as low as is reasonably achievable.

    4. Notifying the RPP of any emergency, spill or personnel contamination involving radioactive material.

    5. Informing the RPP prior to transferring any radioactive material between authorized projects. Transfers must be approved by the RPP and the transfer must be documented in the project's inventory control system.

3. REQUIRED PROCEDURES PERTAINING TO RADIOACTIVE MATERIAL

1. Scope

    1. These procedures apply to all departments, laboratories, and persons at the Institute or at its off-campus sites that receive, possess, use, transport, or dispose of radioactive material.

2. Control of Radiation Exposure and Contamination

1. Exposure to ionizing radiation shall be kept as low as is reasonably achievable (ALARA). See Appendix 7 for MIT's ALARA Program.

2. Occupational external and internal exposure from radioactive material shall be controlled such that no individual shall receive a radiation dose in excess of the values listed in Appendix 1.

3. Compliance with Regulations of Governmental Agencies

1. The use, storage, transfer, transportation, and disposal of radioactive material must conform with the applicable regulations of the Massachusetts Department of Public Health (MDPH), the US Nuclear Regulatory Commission (NRC), and the US Department of Transportation (DOT).

2. The applicable regulations are as follows:

1.	NRC	Title 10, Code of Federal Regulations, Part 20
2.	MDPH	"Rules and Regulations to Control the Radiation Hazards of Radioactive Material and of Machines Which Emit Ionizing Radiation", CMR 120, Section 5B, Chapter III, General Laws
3.	DOT	Title 49, Code of Federal Regulations

4. Registration and Authorization

1. Prior to possessing or using radioactive material on MIT property, authorization must be obtained from the Radiation Protection Committee. The procedure for obtaining authorization and the procedures for procuring radioactive material are described in Appendix 3.

2. Each room or laboratory in which radioactive material is to be handled or stored must be registered with the Radiation Protection Program and approved for such use by the Radiation Protection Program.

3. Each person who may work with or handle radioactive materials must register with the Radiation Protection Program. Worker registration consists of completion of the form entitled "Registration and Radiation Record", attendance at an RPP radiation safety training course, and successful completion of a written examination demonstrating adequate radiation safety knowledge.

4. Each user must be approved for a proposed use of radioactive material with specific regard to the adequacy, for the proposed use, of his/her training and experience.

5. In general, undergraduate students using radioactive materials as part of an undergraduate course will be under the supervision and in the physical presence of an instructor approved by the Radiation Protection Committee. One exception to this rule is when small numbers of students undertake specific projects involving long-term use of small quantities of tracer material. Such students (usually seniors) are specifically trained for this work, are registered as radiation workers, and are only authorized to undertake such projects when RPP is satisfied that their potential for exposure is within limits suitable for such students.

5. Bioassay Tests, Including In Vivo Measurements

1. Depending on radiation exposure history and proposed work at MIT, persons registering with the Radiation Protection Program may be given appropriate bioassay tests to determine body burden of radioactive material prior to starting such work at MIT. Subsequently, as required by the Radiation Protection Program, periodic bioassay tests shall be performed.

2. In the event of accidental internal deposition of radioactive material, bioassay tests shall be performed as appropriate.

3. The action levels for bioassay measurement results are as follows:

    1. Investigation action levels: Any measurement result that exceeds 5% of the annual limit on intake (ALI) initiates an investigation to evaluate the source of the exposure and the means of improving handling techniques. All such investigations will be fully documented.

    2. Administrative action levels: Any measurement result that exceeds 25% of the ALI would initiate suspension of the work operations until satisfactory control measures are implemented.

4. Failure of a radiation worker to comply with the bioassay submission deadline will result in a notification to his supervisor of the suspension of that worker's permission to work with the involved radioactive material until a satisfactory bioassay measurement has been obtained.

5. The bioassay submission criteria and deadlines for radionuclides are as follows:

    1. ***Unsealed alpha, beta, and/or gamma emitters other than unbound radioiodine and tritium***: People working with more than 10 times the Annual Limit on Intake at any one time, appropriate bioassay is required within 5 working days for infrequent users and monthly for those performing procedures routinely. Typically, urinalysis for alpha or beta emitters, and in

vivo measurements for gamma emitters.

2. ***Unbound radioiodine***: Thyroid burden measurements are scheduled monthly for persons routinely handling 0.1 - 20 mCi of ^{125}I and/or ^{131}I and within 5 working days for handling more than 20 mCi. For occasional users (less than one iodination per month) handling more than 0.1 mCi, thyroid measurements are performed within 5 working days.

3. ***Tritium***: individuals who use more than 10 mCi of ^{3}H in a non-contained form, other than metallic foil, are scheduled for urinalysis within:

   (1) Five working days following a single operation,

   (2) One month intervals for continuous operations,

   (3) One week intervals for handling more than 100 mCi routinely, and

   (4) Daily for handling one curie or more routinely.

4. ***Phosphorous-32:*** individuals who use more than 10 mCi of P-32 are scheduled for urinalysis within five working days following a single operation.

6. Radiation Surveys and Monitoring

1. Each project/laboratory using radioactive material must have appropriate radiation detection instruments.

2. When significant radiation levels or contamination are possible, personnel shall use an appropriate radiation detection instrument to establish that radiation exposure and contamination spread are being adequately controlled.

3. Radiation workers will perform "close down" radiation surveys at the end of each use of unsealed radioactive material. The survey will include contamination measurements of the worker's lab coat/clothing, the laboratory surfaces where the radioactive material was handled, and the adjacent areas/equipment.

4. The Radiation Protection Program will provide each radiation worker who may receive a radiation dose in excess of 10% of the limits of Appendix 1 with an appropriate personnel monitoring dosimeter.

5. When provided, the personnel monitoring dosimeter shall be worn in the manner specified by the Radiation Protection Program whenever occupational radiation exposure may be received. When not being worn,

dosimeters shall be stored in a location where they will receive minimal radiation exposure above background.

7. Storage/Security of Radioactive Material

    1. Radioactive material shall be stored/secured as follows:

        1. All stock/stored radioactive material will be stored in a locked container (e.g. freezer, refrigerator or secured locked box). The container will remain locked at all times except when material is being accessed from the locked container.

        2. An accurate record of the inventory/use of stock/stored material will be kept at the secured storage location.

    2. Radioactive material shall be stored in a manner that:

        1. Provides adequate radiation shielding.

        2. Provides adequate protection against fire, explosion, or flooding.

        3. Provides adequate protection against accidental breakage of primary storage containers.

    3. Radiation laboratories will be locked when all radiation workers have left the area and at the end of each workday.

8. Transportation of Radioactive Material

    1. Pedestrian transportation within MIT Property boundaries

        1. Radioactive material may be hand-carried outside of laboratory areas, and between buildings within MIT property boundaries, provided that the following conditions are met:

            (1) The radioactive material is doubly contained and the outer container is a shatter-proof container that is properly labeled.

            (2) The emitted radiation dose rate does not exceed the following levels:

                (1) 0.05 cGy/hour (50 mrad/hour) at any point of readily accessible surface of the container, and

                (2) 0.002 cGy/hour (2 mrad/hour) at 1 meter from any point on the accessible surface of the package.

(3) There is no detectable contamination on the container's exterior surface as determined by an appropriate wipe test and survey meter measurement of the wipe test.

(4) During transit, the radioactive material is always in the possession and responsible charge of an individual who is authorized to use or to transport the material.

2. Pedestrian transportation between MIT buildings where the route includes public roadways.

1. Radioactive material may be hand-carried between buildings of the MIT complex over routes that include public streets and sidewalks provided that the following conditions are met:

(1) The conditions of (1), (2), (3), and (4) of Section 1.1. above are met, and

(2) The transportation container is approved by the Radiation Protection Program as being in conformance with DOT specifications, and

(3) The total activity being carried does not exceed 1000 times the value specified in Appendix 5, unless otherwise authorized by the Radiation Protection Program.

3. Pedestrian transportation outside of the MIT complex

1. There will be no pedestrian transportation of radioactive materials outside of the MIT complex without specific approval of the Radiation Protection Program.

4. Transportation of radioactive material by mail or by vehicle

1. The mailing or transporting of radioactive material shall be done in a manner that is approved by the Radiation Protection Program as being in compliance with appropriate governmental regulation (i.e., DOT or Postal regulations).

2. Vehicular transportation of MIT-possessed radioactive material shall be conducted as follows:

(1) Unless otherwise approved by the Radiation Protection Program, an MIT-owned vehicle or a commercial carrier must be used.

(2) For local transportation, a privately owned vehicle may be used, only if specifically authorized by the Radiation Protection Program.

(3) All persons transporting radioactive material in private vehicles must attend a safety training course in transportation provided by the Radiation Protection Program.

3. Transportation to other licensed facilities and institutions

(1) Radioactive material may be transported to non-MIT facilities provided that the following conditions are met:

(1) The project notifies the Radiation Protection Program of, and secures prior to approval for, all transportation and transfers, and

(2) The Radiation Protection Program has a current copy of the facilities radioactive materials license.

9. Disposal of Radioactive Material

1. Radioactive material must be disposed of in accordance with the provisions of Appendix 3.

2. Incineration of radioactive waste is not permitted at MIT under current State licenses.

10. Transfer of Possession of Radioactive Material Between MIT Departments or Projects

1. Radioactive material shall not be transferred outside of a project without the prior authorization of the Radiation Protection Program.

2. A record of all authorized transfers must be kept with the project's inventory control records.

11. Caution Signs and Labels

1. Laboratory Posting of Caution Signs

1. The entrance to each laboratory storing or using radioactive material shall be posted by the Radiation Protection Program with appropriate caution signs in conformance with 105 CMR 120. These signs shall be removed only by, or with the approval of, the Radiation Protection Program.

2. Each sign that is posted by the Radiation Protection Program will contain a section in which emergency notification information is to be inserted by the project. It is the Project Supervisor's

responsibility to ensure that the appropriate emergency notification information is inserted and kept up-to-date.

3. The Radiation Protection Program shall be notified when a posted caution sign needs replacement or removal.

2. Labeling of Containers

1. Each container of radioactive material will be labeled by the user in conformance with the following procedures, which meet state regulations:

(1) Unless exempted by the Radiation Protection Program, each container holding radioactive material in excess of those quantities listed in Appendix 5 must have a durable, clearly visible label bearing the radiation caution symbol and the words: ***CAUTION RADIOACTIVE MATERIAL***

(2) The color and design of the label are specified in 105 CMR 120. These labels must also state the quantities and kinds of radioactive materials in the containers and the date of measurements of the quantities.

(3) Each container holding less than those quantities listed in Appendix 5 should be identified with the words ***Radioactive Material*** and the principal radionuclide specified.

(4) Labeling is not required for laboratory containers, such as beakers, flasks, and test tubes used transiently in the laboratory procedures <u>while the user is present</u>.

(5) For purposes of these labeling requirements, where there is involved a combination of isotopes in known amounts, the limit of the combination will be derived as follows:

(1) Determine for each isotope in the combination, the ratio between the quantity present and that quantity listed for the nuclide in Appendix 5.

(2) The sum of such ratios for all radionuclides in the combination may not exceed 1.

12. General Radiation Protection Requirements and Precautions

1. There shall be no smoking, eating, drinking, storage of food, or use of cosmetics in any area where unsealed and unpackaged sources of radioactive materials are being used, handled, transferred, or stored.

2. There will be no mouth pipetting of radioactive solutions in any area where unsealed and unpackaged sources of radioactive materials are being used, handled, transferred, or stored.

3. Whenever practical, the user should perform a trial experiment procedure using stable (or low activity) material to establish the adequacy of procedures and equipment.

4. Prior to performing an operation on a source of radioactive material, radiation levels will be measured. Handling tongs, or a suitable remote handling device, must be used for handling a source or container that emits a dose rate, at contact, in excess of 1000 mrad/hr unless otherwise specifically authorized by the Radiation Protection Committee.

5. When performing operations that might produce airborne contamination (i.e., evaporations, sanding or grinding, transfers of unsealed powdered or volatile radioactive material), approved exhaust ventilation shall be used. When recommended by the Radiation Protection Program, appropriate filtration for effluent air shall be provided.

    1. Approved exhaust ventilation means a hood, glovebox, or local exhaust ventilation that is:

        (1) Registered with the Radiation Protection Program, and

        (2) Approved for adequacy of ventilation by the Industrial Hygiene Program of the MIT Environment, Health and Safety Office.

    2. All registered and approved hoods, glove boxes, and local exhaust systems are so designated by printed labels that are attached to the ventilation units by the Industrial Hygiene Program.

6. When hand or clothing contamination is probable, protective gloves and a lab coat shall be worn during operations involving the handling of radioactive materials.

7. After handling unsealed radioactive material, hands shall be washed before leaving the laboratory, and exposed skin, hair, and clothing shall be surveyed for contamination. The Radiation Protection Program shall be notified immediately if, after decontamination, residual contamination of skin, hair, or personal clothing is detected.

8. Objects and equipment that may have been contaminated with radioactive material shall be surveyed for exterior surface contamination prior to their removal from a laboratory. If surface contamination is detected, the contaminated object shall not be removed from the laboratory without the authorization of the Radiation Protection Program.

9. The Radiation Protection Program shall be notified immediately if any of the following circumstances is known or suspected:

    1. An accident/spill of radioactive material has occurred.

    2. Exposure to inhalation, ingestion, or injection of radioactive material.

    3. Accidental release of radioactive material to laboratory atmosphere, surfaces, drains, or ventilation system.

13. Emergency Procedures

    1. In the event of external exposure in excess of the values listed in Appendix 1, or accidental release of radioactive material, the Radiation Protection Program must be notified immediately using the notification procedures of Appendix 4.

    2. Emergency procedures to be followed in the event of a radiation contamination accident are specified in Appendix 4 for the following situations:

        1. Serious injury with contamination.
        2. Minor injury with contamination.
        3. Contamination incident without injury.

Appendix 1

Occupational / Non-Occupational Dose Limits

MIT Annual Limits for Radiation Dose

Total Effective Dose Equivalent[1]	5,000 mrem
Skin and Extremities (Shallow Dose Equivalent)[2]	50,000 mrem
Lens of the Eye	15,000 mrem
Declared Pregnant Worker[3]	500 mrem
Minors	500 mrem
Ancillary Personnel/General Public	100 mrem

Notes:

[1] Total Effective Dose Equivalent means the sum of the deep dose equivalent for external exposures and the Committed Effective Dose Equivalent for internal exposures.

[2] Shallow Dose Equivalent which applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeter averaged over an area of 1 square centimeter.

[3] Declared Pregnant Worker dose equivalent limit applies to the time of the entire pregnancy. RPP requires all pregnant workers who wish to declare their pregnancy to follow the MIT Radiation Protection Committee *Policy Regarding Pregnant Employees and Staff Who Are Potentially Exposed to Ionizing Radiation*.

Appendix 2

MIT Procedure for Procurement of Radioactive Material

I. Procedures for obtaining MIT Authorization to Possess and Use Radioactive Material

A. Complete the form entitled ***Application for Authorization to Possess and Use Radioactive Material*** and forward a type-written copy to the Radiation Protection Program.

B. When the application has been reviewed and approved, a copy containing the designated Authorization Number will be returned to the Project Supervisor.

C. If any changes are to be made to the information supplied in Section I of an approved authorization application, the Project Supervisor should apply in writing for an amendment. Amendment requests should be sent to the Radiation Protection Program.

II. Procedures for Procuring Radioactive Material

A. Procurement from a Commercial Supplier

1. Prepare and forward the purchase requisition in the usual way, but include on the requisition the words ***Radioactive Material***, and your Project's Authorization Number (see I.B. above).

2. If a supplier's catalogue number is used to designate the material wanted, also specify on the requisition the radionuclide and the amount of activity.

3. For the radioactive material to be ordered, provide an accurate activity level for the radionuclide currently in the project's inventory.

B. Procurement from the MIT Reactor

Contact the Reactor Business Office to obtain irradiation request forms and information.

C. Procurement or Transfer from Non-Commercial Supplier (labs, institution, hospitals, etc.)

1. Notify the Radiation Protection Program of anticipated receipt of any radioactive material.

2. Specify to supplier to ship all such radioactive material to the Radiation Protection Program.

3. Projects will immediately notify the RPP of any incoming radioactive shipments that have been transported directly to the laboratory.

Appendix 3

Laboratory Disposal of Radioactive Waste

In order to comply with 105 CMR 120, MIT must maintain control of the amounts of radioactivity discharged into the sewerage system, or released to the atmosphere, so that both the required limits on concentration and total activity (per day and per year) are not exceeded. The procedures listed below meet MDPH regulations and must be followed for laboratory disposal of radioactive wastes.

A. Disposal into Sewerage System

Radioactive wastes may be discharged into laboratory drains provided that the following conditions are met:

1. The sink or pipe opening into which the material is to be disposed has been labeled by the RPP as being approved for radioactive waste disposal.

2. The radioactive material is readily soluble or readily dispersible biological material in water. Projects must prove solubility of waste by reference to the CRC Handbook of Chemistry and Physics, the manufacturer's technical data information or material safety data sheet.

3. The average concentration of the material being disposed will not exceed, for each nuclide, ten times the value listed in Appendix B, Table III, of 105 CMR 120. (Concentration values are posted by the RPP on the label that designates that the sink has been approved for waste disposal.)

4. Aqueous wastes contaminated with short-lived radioactive material (i.e., ^{32}P) in concentrations that exceed item 3 above will be held for radioactive decay to the allowable concentrations for sink disposal.

5. A record shall be kept of the amount of each nuclide disposed into the laboratory drains, using the forms posted by RPP at each approved sink. The record forms are collected periodically by RPP.

6. Unless otherwise authorized by RPP, each laboratory area shall discharge into laboratory drains no more than 10 millicuries of total activity per calendar quarter.

7. Unless authorized by RPP, scintillation solutions containing radioactive material shall not be discharged into laboratory drains.

8. Unless authorized by RPP, organic liquids containing radioactive material shall not be discharged into laboratory drains.

B. Disposal into Waste Collection Containers

All radioactive waste not discharged into the laboratory drains shall be put into the special collection containers (solid or liquid) supplied by RPP, according to the following

rules:

1. General Rules

    a. All radioactive material waste must be segregated by the half-life of the radionuclides. Specifically, three categories are segregated: ^{32}P waste, waste with half-lives between 20 and 120 days, and wastes with half-lives greater than 120 days.

    b. The total amount of radioactive material put into any container must be controlled such that the radiation level at one foot from the container is less than 2 mrad/hr and the radiation level at contact with any surface of the container is less than 200 mrad/hr.

    c. Material must not be put into the waste collection containers if there is any possibility of a chemical reaction during storage that might cause fire or explosion, or cause the release of chemically toxic or radioactive gases. Solutions must be adjusted to pH 4-10 prior to disposal into a liquid waste container, unless otherwise authorized by RPP.

    d. Animal tissue or excreta, or biohazardous, carcinogenic, or toxic material shall not be put into a radioactive material waste collection container, unless the procedure has been specifically authorized by RPP,. Special disposal procedures must be arranged with RPP prior to the start of work that will produce this kind of waste material.

    e. Any biohazardous, carcinogenic, or toxic material contaminated with radioactive material must be rendered harmless prior to disposal as radioactive waste.

    f. A record must be kept of the quantity and kinds of radioactive material disposed into each collection container. A summary record of these disposals must be available to the RPP technician at the time of collection of the container.

    g. When a container is full or its emitted radiation is approaching the limits specified in item 1.b., contact the Radioactive Waste Management Program??? (ext. 3-3674) for waste removal.

2. Specific Rules for Disposal into ***Solid Radioactive Waste Collection Containers:***

    a. Do not put liquids into a collection container designated for solid waste.

    b. Put powdered material into a metal or plastic container that is sealed prior to disposal.

    c. Unless otherwise authorized by RPP, do not put more than 25 pounds of material into a collection container.

d. Unless otherwise authorized by RPP, do not put objects into a collection container that individually weigh more than 5 pounds.

e. Hypodermic needles and other sharp objects are segregated by half-life and placed in RPP provided, shatterproof, protective containers. Hypodermic needles should be capped.

f. Special one-gallon solid containers will be installed for projects generating volatile solid waste (e.g., ^{125}I iodinations). These containers will be stored in approved fume hoods. Projects generating such wastes should call RPP to arrange for set up of these containers.

3. Specific Rules for Disposal into ***Liquid Radioactive Waste Collection Containers:***

a. Do not put solid objects, such as test tubes and bottles into a liquid waste collection container.

b. Pour liquid radioactive wastes (organic and aqueous) into one gallon containers specifically designated for the collection of such solutions. RPP provides these one gallon containers.

c. Do not combine aqueous and organic waste in the same container.

4. Specific Rules for Disposal into ***Liquid Scintillation Vial Collection Containers***:

a. Scintillation fluids containing ^{3}H and ^{14}C in quantities less than or equal to 0.05 µCi/gram of material will be disposed of in 30 gallon drums clearly marked for their disposal.

b. Scintillation fluids containing ^{32}P will be disposed of in 30 gallon drums clearly marked for their disposal ("^{32}P Liquid Scintillation Vials Only").

c. Scintillation fluids containing any other radionuclide beside those in a. and b. above will be disposed of in appropriate containers provided by RPP.

5. Specific Rules for Disposal of Animal Carcasses and Tissues:

a. Radioactive animal carcasses and tissues shall be wrapped in polyethylene bags or plastic backed absorbent paper, sealed, labeled, and stored for disposal in a freezer designated by RPP.

b. The project will attach a completed ***Radioactive Material Certification Tag*** to all animal carcass packages. The RPP provides the tags.

6. The RPP must be notified prior to the start of work that will produce radioactive waste material not covered by the above regulations.

C. Release of Radioactive Material into Ventilation Exhaust Systems

1. Unless otherwise authorized by RPP, the 24 hour average concentration of radioactive material entering the duct system of each laboratory must not exceed the limits of Appendix B, Table II, Column 1 of 105 CMR 120.

2. RPP must be notified immediately if there is a release into the environs of airborne radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed the limits specified for such material in Appendix B, Table II, Column 1, 105 CMR 120.

3. Determinations of the average concentration of radioactive material shall be made with respect to the point where the material leaves the exhaust duct. Concentrations may not be averaged over a period longer than one day, without prior authorization of RPP.

Appendix 4
Emergency Procedures

Minor Radiation Spill

- The activity threshold for which a minor spill is considered a major spill is 1 millicurie.
- Isolate the spill area and guard against re-entry. Alert others in the immediate area that the spill has occurred. Assemble all potentially contaminated persons and monitor them before allowing them to leave the area. Carefully monitor persons' shoes.
- **During work hours, call the Radiation Protection Program at 2-3477. After hours or on weekends, call Campus Police at 100.**
- Remove significantly contaminated clothing and begin decontamination of any exposed skin. Continue to wash exposed skin until all contamination is removed or no further reduction in contamination levels is achieved.
- Remain available at the spill site until contacted by RPP. Spreading of radioactivity beyond the spill area can easily occur by the movement of personnel through the affected area. This will greatly increase decontamination time and effort. Isolation of the spill area and the control of laboratory personnel is very important. Monitoring personnel for contamination is also very important in reducing the spread of radioactivity and minimizing total dose to affected individuals.
- Small localized spills with no spread of contamination may be cleaned by lab personnel responsible for the spill. The clean-up of larger spills with spread of radioactivity needs to be supervised by RPP. All spills must be reported to allow RPP the opportunity to independently monitor the area.

Radiation Spill Involving Volatile Radioactive materials

For a release of powered, volatile, or gaseous activity, immediately evacuate lab personnel, assemble outside the laboratory, and stay in this location to prevent any spread of contamination. Isolate the room and prevent re-entry.

Major Radiation Spill or Injured Contaminated Personnel

- Attend to contaminated or injured persons and remove them from the spill area/exposure.
- Provide necessary first aid to injured persons.
- Call Campus Police at 100 and report the location of the spill and the extent of the injuries. State your name, phone number, the fact that radioactivity is involved, and the location where someone is seriously injured
- Assemble potentially contaminated personnel in one location of the laboratory and carefully monitor contamination levels. Carefully monitor persons' shoes.
- Remove significantly contaminated clothing and begin decontamination of any exposed skin. Continue to wash exposed skin until all contamination is removed or no further reduction in contamination levels is achieved.
- Isolate the spill area and guard against re-entry.
- During work hours, call the Radiation Protection Program at 2-3477.
- Remain available at the spill site until contacted by RPP. RPP will supervise and assist in the spill clean-up and decontamination.

Appendix 5

Reference List of Radionuclides

Quantities which require labeling

Radionuclide	105 CMR Appendix C Value
Calcium-45	100 µCi
Carbon-14	100 µCi
Chlorine-36	10 µCi
Chromium-51	1000 µCi
Cobalt-60	1 µCi
Hydrogen-3	1000 µCi
Iodine-125	1 µCi
Iodine-131	1 µCi
Iron-59	10 µCi
Phosphorous-32	10 µCi
Phosphorous-33	100 µCi
Potassium-42	1000 µCi
Rubidium-86	100 µCi
Sodium-22	10 µCi
Sulphur-35	100 µCi
Technetium-99	100 µCi
Zinc-65	10 µCi

Appendix 6

Glossary of Terms

Radiation	**Energy transmitted as electromagnetic waves or particles from a source.**
Ionizing Radiation	**Any electromagnetic or particulate radiation capable of producing charged particles (ions), directly or indirectly, in its passage through matter: Alpha particles, beta particles, neutrons, gamma rays, x-rays, high speed electrons, high speed protons, and other particles are capable of producing ions.**
Alpha particle (α)	**A charged particle emitted from the nucleus of an atom having a mass and charge approximately equal in magnitude of a helium nucleus - LOW penetration ability.**
Beta particle (ß)	**Charged particle emitted from the nucleus of an atom, with a mass and charge equal to that of an electron - MODERATE penetration ability.**
Gamma ray (γ)	**Short wavelength electromagnetic radiation of nuclear origin.** Gamma **rays are VERY penetrating.**
X-ray (χ)	**Short wavelength electromagnetic radiation of extranuclear origin. X rays are VERY penetrating.**
Radioactivity	**The property of certain nuclides of spontaneously emitting particles or gamma radiations or of emitting x radiations following orbital electron capture.**
Curie (Ci**)**	**Special unit of activity equal to 3.7 x 10^{10} nuclear transformations (disintegrations) per second or 2.22 x 10^{12} disintegrations per minute (dpm). Commonly used quantities:** **millicurie (mCi) - one thousandth of a curie, 2.22 x 10^{9} dpm** **microcurie (μCi) - one millionth of a curie, 2.22 x 10^{6} dpm**
Becquerel (Bq**)**	**Système International (S.I.) unit of activity defined as one atomic transformation (disintegration) per second. 1 Bq = 1 d/s** or **1 Ci = 3.7 x 10^{10} Bq.**
Half-life ($T_{1/2}$)	**Time required for a radioactive substance to lose 50% of its activity by decay. Each radionuclide has a unique half-life, e.g. ^{32}P - 14 days.**
Exposure	**A measure of the ionization produced in air by x or gamma radiation.**
Roentgen (R**)**	**The unit of exposure. One roentgen equals 2.58 x 10^{-4} coulombs per kilogram of air at STP.**

Absorbed Dose — **The energy imparted to matter by ionizing radiation per unit mass or irradiated material at the place of interest.**

Rad — **The unit of dose (Radiation Absorbed Dose). One rad equals 100 ergs per gram, or 0.01 Joules/kg, of absorbing material.**

Gray (Gy) — **Système International (S.I.) unit of absorbed dose equal to 100 rad or 1 Joule/kg.**

Dose Equivalent — **A quantity used in radiation protection. It expresses all radiation on a common scale for calculating the effective absorbed dose. It is the product of the absorbed dose in rad and certain modifying or quality factors.**

Rem — **The unit of dose equivalent. The numerical dose equivalent in rem is numerically equivalent to the absorbed dose in rads multiplied by the quality factor, the distribution factor, and any other modifying factors.**

Sievert (Sv**)** — **Système International (S.I.) unit of dose equivalent equal to 100 rem.**

Quality Factor — **Modifying factor used to derive dose equivalent from absorbed dose.**

Type of Radiation	Quality Factor
x, gamma**, and beta radiation**	**1**
neutrons	**10**
alpha **particles**	**20**

Annual Limit on Intake (ALI**)** — **The amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year that would result in a committed effective dose equivalent of 5 rem or a committed dose equivalent of 50 rem to any individual organ or tissue.**

Bremsstrahlung — **Secondary photon radiation produced by the deceleration of charged particles through matter.**

Contamination — **Radioactive material where it is not wanted.**

Derived Air Concentration (DAC**)** — **The concentration of a given radionuclide in air which, if inhaled at a rate of 1.2 m^3 of air per hour, results in an intake of one ALI.**

External Dose Radiation dose absorbed in human tissues from exposure to radiation sources outside the body.

Internal Dose Radiation dose absorbed in human tissues from exposure to radiation sources that have entered the body thorough inhalation, ingestion or through skin transport.

Appendix 7

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ALARA PROGRAM

1. Management Commitment

a. The management of this teaching and research facility are committed to the program described herein for keeping individual and collective doses as low as is reasonably achievable (ALARA). In accord with this commitment, we hereby describe an administrative organization for radiation protection and will develop the necessary written policies, procedures, and instructions to foster the ALARA concept within MIT. The organization will include a Radiation Protection Committee (RPC) and a Radiation Protection Officer (RPO).

b. We will perform a formal annual review of the radiation protection program, including ALARA considerations. This will include reviews of operating procedures, past dose records, inspections, laboratory audits, etc., and consultations with the radiation protection staff.

c. Modifications to operating, maintenance, and experimental procedures as well as changes in equipment and facilities will be made if they will reduce exposures unless the cost, in our judgment, is considered to be unjustified. We will be able to demonstrate, if necessary, that improvements have been sought, that modifications have been considered, and that they have been implemented when reasonable. If modifications have been recommended but not implemented, we will be prepared to describe the reasons for not implementing them.

d. In addition to maintaining doses to individuals as low as reasonably achievable, the sum of doses received by all exposed individuals will also be maintained at as low as reasonably achievable levels. It would not be desirable, for example, to hold the highest doses to individuals to some fraction of the applicable limit if this involved exposing additional people and significantly increasing the sum of radiation doses received by all involved individuals.

e. The RPC will review the MIT ALARA program and monitoring results at their quarterly meetings and as part of the annual audit.

4. Review of ALARA Program

(1) The RPC encourages all users together with the staff of the Radiation Protection Program to review current procedures and develop new procedures as appropriate to implement the ALARA concept.

(2) The RPC will perform a quarterly review of occupational radiation exposures with particular attention to instances in which the investigational levels in Table 1 are

exceeded. The principle purpose of this review is to assess trends in occupational exposure as an index of the ALARA program quality and to decide if action is warranted when investigational levels are exceeded.

(3) The RPC will evaluate MIT's overall efforts for maintaining doses ALARA on an annual basis. This review will include the efforts of the RPO, project supervisors, and radiation workers as well as those of management. The RPP will present an annual summary of exposure levels to the RPC.

a. Review of Proposed Users and Uses

(1) The RPC will thoroughly review the qualifications of each project supervisor with respect to the types and quantities of byproduct materials and methods of use for which application (RP-01) has been made to the RPP to ensure that the applicant will be able to take appropriate measures to maintain exposure ALARA. The RPC will meet quarterly to review applications.

(2) When considering a new use of significant quantities of byproduct material, the RPC will review the past efforts of the applicant at maintaining exposures ALARA.

(3) The RPC will ensure that the users justify their procedures and that individual and collective doses will be ALARA. The RPC will specify conditions of approval which must be followed to maintain exposures ALARA.

b. Delegation of Authority

(1) The RPC will delegate authority to the RPP for enforcement of the ALARA concept.

(2) The RPC will support the RPP when it is necessary for the RPP to assert authority. If the RPC has overruled the RPO, it will record the basis for its action in the minutes of the quarterly meeting.

c. Review of ALARA Program

(1) The RPC encourages all users together with the staff of the Radiation Protection Program to review current procedures and develop new procedures as appropriate to implement the ALARA concept.

(2) The RPC will perform a quarterly review of occupational radiation exposures with particular attention to instances in which the investigational levels in Table 1 are exceeded. The principle purpose of this review is to assess trends in occupational exposure as an index of the ALARA program quality and to decide if action is warranted when investigational levels are exceeded.

(3) The RPC will evaluate MIT's overall efforts for maintaining doses ALARA on an annual basis. This review will include the efforts of the RPO, project supervisors, and radiation workers as well as those of management. The RPP will present an annual summary of exposure levels to the RPC.

Table 1
Investigational Levels

	(mrem) Level I	Level II
Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	**500**	**1000**
Hands and forearms; feet and ankles, skin of the whole body	**5000**	**10,000**

3. Radiation Protection Officer

a. Annual and Quarterly Review

(1) Annual review of the Radiation Protection Program.

The RSO will perform an annual review of the radiation protection program for adherence to ALARA concepts. The review will be reported to the RPC.

(2) Quarterly review of occupational exposures.

The RPP will review at least quarterly the external radiation doses of authorized users and workers to determine that their doses are ALARA in accordance with the provisions of Section 6 of this program and will prepare a summary report for the RPC.

(3) Quarterly review of records of radiation surveys.

The RPP will review radiation surveys in restricted, controlled and uncontrolled and areas to determine that dose rates and amounts of contamination were at ALARA levels during the previous quarter and will report for the RPC.

b. Education Responsibilities for ALARA Program

(1) The Radiation Protection Program staff schedule radiation worker training seminars and educational sessions to inform workers of ALARA program efforts. Also, the RPP staff attend MIT departmental safety meetings on a routine basis and several times per year give presentations regarding radiation protection matters including ALARA concerns.

(2) The RPP will ensure that project supervisors, radiation workers, and ancillary personnel who may be exposed to radiation will be instructed in the

ALARA philosophy and informed that management, the RPC, and the RPP are committed to implementing the ALARA concept.

c. Cooperative Efforts for Development of ALARA Procedures

Project supervisors and radiation workers will be given opportunities to participate in formulating the procedures that they will be required to follow.

(1) The RPP will work closely with all projects and workers in order to develop ALARA procedures for working with radioactive materials.

(2) The RPP will evaluate the suggestions of individual radiation workers and ancillary workers for improving health physics and ALARA practices and will encourage the use of those suggestions as formalized procedures.

d. Reviewing Instances of Deviation from Good ALARA Practices

The RPP will investigate all known instances of deviation from good ALARA practices and, if possible, will determine the causes. When the cause is known, the RPP will implement changes in the program to maintain doses ALARA. All deviations from good ALARA practices will be reported to the RPC at the next scheduled quarterly meeting.

4. Project Supervisors

a. General Requirements

(1) The project supervisor will explain the ALARA concept and the need to maintain exposures ALARA to all supervised radiation workers.

(2) The project supervisor will ensure that supervised individuals who are subject to occupational radiation exposures attend the Radiation Protection Program mandatory radiation worker training seminar and are further trained in specific handling procedures and good health physics practices in the laboratory to keep exposures ALARA.

b. New Methods of Use Involving Potential Radiation Doses

(1) Project supervisors will consult with the RPP during the planning stages for experiments involving significant quantities of radioactive materials for new uses. These proposed uses will then be forwarded to the RPC for review and approval.

(2) The project supervisor will review each planned use of radioactive materials to ensure that doses will be kept ALARA. Trial or practice procedure using non-radioactive material or reduced quantities will be required prior to the handling of significant quantities of material for the first time.

5. Individuals Who Receive Occupational Radiation Doses

a. Radiation workers and ancillary personnel will be instructed in the ALARA concept and its relationship to work procedures and work conditions.

b. Radiation workers will be instructed in resources available if they feel that ALARA is not being promoted on the job.

6. Establishment of Investigational Levels in Order to Monitor Individual Occupational External Radiation Doses

MIT hereby establishes investigational levels for occupational external radiation doses which, when exceeded, will initiate review or investigation by the RPC and/or the RPO. The investigational levels that we have adopted are listed in Table 1. These levels apply to the exposure of individual workers.

The RPP will review and record on Form NRC-5, "Current Occupational External Radiation Exposures," or an equivalent form (e.g., R.S. Landauer dosimeter processors' report) results of personnel monitoring as required by 120.226 of 105 CMR. The following actions will be taken at the investigational levels as stated in Table 1:

a. Personnel Dose Less Than Investigational Level I.

Except when deemed appropriate by the RPO, no further action will be taken in those cases where an individual's dose is less than Table 1 values for the Investigation Level I. Typically an investigation is performed by an RPP staff member and documented.

b. Personnel Dose Equal To or Greater Than Investigational Level I but Less Than Investigational Level II.

The RPP will review the dose of each individual whose dose equals or exceeds Investigational Level I and will report the results of the reviews at the first RPC meeting following the quarter when the dose was recorded. If the dose does not equal or exceed Investigational Level II, no action related specifically to the exposure is required unless deemed appropriate by the RPC. The RPC will, however, review each such dose in comparison with those of others performing similar tasks as an index of ALARA program quality and will record the review in the Committee minutes.

c. Personnel Dose Equal To or Greater Than Investigational Level II.

The RPP will investigate in a timely manner the cause of all personnel doses equaling or exceeding Investigational Level II and, if warranted, will take action. A report of the investigation, any actions taken, and a copy of the individual's form NRC-5 or its equivalent will be presented to the RPC at its first meeting following completion of the investigation. The details of these reports will be included in the RPC minutes.

d. Reestablishment of investigational levels to levels above those listed in Table 1.

In cases where a radiation worker's or a group of radiation workers' doses exceed an investigation level, a new, higher investigational level may be established for that individual or group on the basis that it is consistent with good ALARA practices. Justification for new investigational levels will be documented.

The RPC will review the justification for and must approve or disapprove all revisions of investigational levels prior to these new levels being put into practice.

Appendix 8

RADIATION INFORMATION SHEET

Information

Most radionuclides used in the laboratories at MIT and the Whitehead Institute are beta and/or X and gamma ray emitters. The following is a list of the most commonly used radionuclides:

Isotope	Major Radiations	Intensities (keV)	Half Life	Liquid Waste Sink Disposal as 10 times 105 CMR 120 Appendix B, Table III	Recommended Detection Method
^{3}H	Beta	18.6	12.6 yrs	100 µCi/l	LSC
^{14}C	Beta	156	5730 yrs	3.0 µCi/l	GM (pancake), LSC
^{35}S	Beta	167	88 days	10 µCi/l	GM (pancake), LSC
^{32}P	Beta	1710	14 days	0.9 µCi/l	GM
^{33}P	Beta	249	25 days	8.0 µCi/l	GM (pancake)
^{36}Cl	Beta	714	3.05×10^{5} yrs	2.0 µCi/l	GM
^{45}Ca	Beta	252	165 days	2.0 µCi/l	GM (pancake)
^{51}Cr	Gamma	320	27.8 days	50 µCi/l	GM
^{59}Fe	Beta Gamma	273, 466 1099, 1292	45.6 days	1.0 µCi/l	GM
^{86}Rb	Beta Gamma	1780 1078	18.6 days	0.7 µCi/l	GM
^{99}Tc	Beta	293	2.12×10^{5} yrs	6.0 µCi/l	GM (pancake)
^{125}I	X, Gamma	28, 31	60 days	0.2 µCi/l	NaI
^{131}I	Beta Gamma	606 364	8.05 days	0.1 µCi/l	GM

GM = Geiger Mueller detector, LSC = Liquid Scintillation Counter, NaI = Sodium Iodide detector

Note: Any radioactive waste that may be discharged into the laboratory drains (as listed above) must meet the conditions in Appendix 3 of the MIT *Required Procedures for Radiation Protection*. The total activity disposed in each laboratory must not exceed the following quantities: ^{3}H = 25 mCi per calendar quarter and ^{14}C = 10 mCi per calendar quarter. All other radionuclides: 10 mCi total per calendar quarter.

Personnel External Exposure Control

The three basic methods used to control external radiation exposure are:

TIME	-	Minimize time
DISTANCE	-	Maximize distance
SHIELDING	-	Use proper shielding

Any one method or any combination of the three methods should be used to keep personal exposure As Low As Reasonably Achievable (ALARA).

The Inverse Square Law

If one doubles the distance, one reduces the absorbed dose or absorbed dose rate by a factor of four due to the divergence of photons from a point. Formula: $R_1D_1^2 = R_2D_2^2$

Example: For an exposure rate of 1000 mR/hr at 1 cm, what is the exposure rate at 10 cm?

$R_2 = (R_1D_1^2) / D_2^2$
$R_2 = [(1000 \text{ mR/hr})(1 \text{ cm})^2\}] / (10 \text{ cm})^2$
$R_2 = 1000 / 100 \text{ mR/hr}$
$R_2 = 10 \text{ mR/hr @ } 10 \text{ cm}$

RULES OF THUMB

1. It requires a beta particle of at least 70 keV to penetrate the protective layer of the skin (0.07 mm thick).

2. The average energy of a beta particle is 1/3 times the maximum energy: $E_{avg} = 1/3 (E_{max})$

3. The range of a beta particle in air is approximately 12 feet per MeV; for example, a 1.7 MeV (E_{max}) beta particle has a range of about 20 feet in air.

4. The intensity of Bremsstrahlung (braking) radiation increases as the energy of the beta particle and the atomic number of the absorbing material increases. Thus, a shield consisting of low atomic number material should be used for ^{32}P.

5. When beta particles of 1 to 2 MeV pass through light materials such as water, plexiglass, or glass, less than 1% of their energy is dissipated as Bremsstrahlung.

6. The beta particles from the decay of ^{32}P are stopped in 1/4 inch of plexiglass.

7. Lead is an excellent shield for low energy X and gamma ray emitters. The thickness of lead needed is determined by the intensity and energy of the X and gamma rays.

8. The half value layer (HVL) is the thickness of an absorber (e.g., lead) that will reduce the X and gamma ray intensity by a factor of 2.

RULES FOR WORKING WITH RADIOIODINE

1. All persons who handle ≥ 100 µCi of unbound radioiodine are required to have a baseline thyroid measurement prior to beginning such work. Call the RPP Administrative Assistant at 3-2180 for appointment.

2. All purchase orders for radioiodine must specify the end user(s) name. Orders not in compliance will not be approved.

3. All persons handling ≥ 100 µCi unbound radioiodine, including persons involved in the iodination procedure are required to report to the RPP for a thyroid burden measurement within 5 working days after using the material. Call the RPP Administrative Assistant at 3-2180 for appointment. Persons not in compliance will be restricted from future use of radioiodine.

4. Iodinations will be performed in the charcoal filtered hood in room*. All users must sign the logbook located in that laboratory.

Appendix 9

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
RADIATION PROTECTION COMMITTEE

POLICY REGARDING PREGNANT EMPLOYEES AND STAFF WHO ARE POTENTIALLY EXPOSED TO IONIZING RADIATION

Introduction:

Current regulations of the Massachusetts Department of Public Health (MDPH) governing the occupational exposure to ionizing radiation require that the radiation dose to the fetus of occupationally exposed declared pregnant women be held to 0.5 rem (5 mSv) or less during the pregnancy. The National Council on Radiation Protection (NCRP) has recently recommended that this dose be controlled such that no more than 0.05 rem (0.5 mSv) be delivered to the fetus in any one month.

For the majority of radiation workers in this institution, the occupational exposures received through normal work practices as measured by the film badges fall well below these more restrictive limits for declared pregnant workers. Hence, it is anticipated that there should generally be little difficulty in complying with the applicable limits. All radiation workers, women of child-bearing age especially, are encouraged to carefully monitor their film badge readings and become familiar with their potential sources of exposure and means of minimizing the same.

It is the responsibility of the MIT Radiation Protection Committee to formulate, implement and review radiation protection policies such that they are compliant with federal and state regulations. The purpose of this memo is to set forth the policy of this committee with respect to the occupational duties of pregnant employees who may be exposed to ionizing radiation.

MIT's Policy:

The following are the formal MIT policies for the employee who informs her supervisor that she believes she is pregnant.

1. It is the responsibility of the pregnant radiation worker to decide when or whether she will formally declare her condition to her employer. Formal declaration of pregnancy by the woman is initiated when the Radiation Protection Program receives a completed copy of the RP-520 "Declaration of Pregnancy for Radiation Workers". This form must be completed by both the pregnant women and her supervisor. Undeclared pregnant radiation workers are protected under NRC regulations for all occupational workers.

2. In keeping with state and federal recommendations to hold embryo/fetus exposures ALARA (As Low As Reasonably Achievable), if the pregnant employee is currently assigned to duties whereby her potential exposure is significantly above the average of her peers in her department, she may request to be reassigned to duties involving lower potential for exposure for the duration of her pregnancy if such temporary reassignment is deemed administratively practical.

3. Pregnant radiation workers are encouraged to be particularly diligent in avoiding unnecessary exposure during their regular work assignment, by minimizing their time of exposure, maximizing their distance from the radiation source, and by taking maximum advantage of available protective equipment such as bench shields.

4. After reassignment, if practical, and while implementing the above procedure where practical to minimize potential radiation dose to the fetus, the pregnant employee will be expected to perform all duties assigned.

5. A copy of this policy will be given to all women radiation workers at the time of their training with the Radiation Protection Program. A second copy will be provided if and when a pregnant employee informs her supervisor of her pregnancy. The pregnant employee is encouraged to discuss the potential for fetal exposure and methods for controlling the same with her supervisor and the Radiation Protection Program in her consideration of this issue.

The above policy is believed to be conservative in many respects. Typically radiation workers at MIT do not receive significant radiation exposures due to their work with radioactive materials. Average exposures for all radiation workers at MIT are less than 5% of the permissible levels. However, pregnant radiation workers will be carefully monitored to assure that they are kept as low as practical.

RP-520
4/97

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
DECLARATION OF PREGNANCY FOR RADIATION WORKERS

I. DECLARATION OF PREGNANCY

Name of Individual
MIT ID Number
Date of Conception (Mo/Yr)
By providing this information to my immediate supervisor, in writing, I am declaring myself to be pregnant as of the date shown above. Under the provisions of 105 CMR 120.218 I understand that my exposure will not be allowed to exceed 5 mSv (500 mrem) during my pregnancy, from occupational exposure to radiation. I understand that this limit includes exposure I have already received. If my estimated exposure since the above date of conception has already exceeded 5 mSv (500 mrem), I understand that I will be limited to no more than 0.5 mSv (50 mrem) for the remainder of my pregnancy. If I should find out that I am not pregnant, or if my pregnancy is terminated, I will inform my supervisor as soon as practical.
Signature of Individual
Date Signed

II. DESCRIPTION OF CURRENT WORK WITH IONIZING RADIATION

Note principal radioactive materials used & include maximum amount used/use per experiment:

III. RECEIPT OF DECLARATION OF PREGNANCY

Name of Supervisor
Authorization Number
I have received notification from the above named woman that she is pregnant. I have explained to her the potential risks from exposure to radiation as provided in Regulatory Guide 8.13, Revision 3. I have evaluated her prior exposure and established appropriate limits to control the dose to the developing embryo/fetus in accordance with limits in 105 CMR 120.218. I have explained to her options for reducing her exposure to as low as reasonably achievable (ALARA).
Signature of Supervisor
Date Signed

Appendix 10

105 CMR 120.750
NOTICES INSTRUCTIONS AND REPORTS TO WORKERS: INSPECTIONS

120.750: NOTICES INSTRUCTIONS AND REPORTS TO WORKERS: INSPECTIONS

120.751: Purpose and Scope

105 CMR 120.750 establishes requirements for notices, instructions and reports by licensees or registrants to individuals engaged in activities under a license or registration and options available to such individuals in connection with Agency inspections of licensees or registrants to ascertain compliance with the provisions of M.G.L. c. 111, §§ 3, 5M, 5N, 5O, and 5P and regulations, orders, and licenses issued thereunder regarding radiological working conditions. 105 CMR 120.750 applies to all persons who receive, possess, use, own, or transfer sources of radiation registered with or licensed by the Agency pursuant to 105 CMR 120.020 and 105 CMR 120.100.

120.752: Posting of Notices to Workers

(A) Each licensee or registrant shall post current copies of the following documents:

(1) The regulations in 105 CMR 120.750 an in 105 CMR 120.200,

(2) The license, certificates of registration, conditions or documents incorporated into the license by reference and amendments thereto;

(3) The operating procedures applicable to activities under the license or registration; and,

(4) Any notice of violation involving radiological working conditions, proposed imposition of civil penalty, or under order issued pursuant to 105 CMR 120.001, and any response from the licensee or registrant.

(B) If posting a document specified in 105 CMR 120.752(A)(1), (2) or (3) is not practicable, the licensee or registrant may post a notice which describes the document and states where it may be examined.

(C) Form MRCP 120.750-1 ***Notice to Employees***, shall be posted by each licensee or registrant as required by 105 CMR 120.000.

(D) Agency documents posted pursuant to 105 CMR 120.752(A)(4) shall be posted within five working days after receipt of the documents from the Agency; the licensee's or registrants response, if any, shall be posted within five working days after dispatch from the licensee or registrant. Such documents shall remain posted for a minimum of five working days or action correcting the violation has been completed, whichever is later.

(E) Documents, notices, or forms posted pursuant to 105 CMR 120.752 shall appear in

a sufficient number of places to permit individuals engaged in work under the license or registration to observe them on the way to or from any particular work location to which the document applies, shall be conspicuous, and shall be replaced if defaced or altered.

120.753: Instructions to Workers

(A) All individuals who in the course of employment are likely to receive in a year an occupational dose in excess of one mSv (100 mrem)

(1) Shall be kept informed of the storage, transfer, or use of sources of radiation in the licensee's or registrant's workplace;

(2) Shall be instructed in the health protection problems associated with exposure to radiation or radioactive material to the individual and potential offspring, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed;

(3) Shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of 105 CMR 120.000 and licenses for the protection of personnel from exposures to radiation or radioactive material;

(4) Shall be instructed of their responsibility to report promptly to the licensee or registrant any condition which may constitute, lead to, or cause a violation of the Act, 105 CMR 120.000, and licenses or unnecessary exposure to radiation or radioactive material;

(5) Shall be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and,

(6) Shall be advised as to the radiation exposure reports which workers shall be furnished pursuant to 105 CMR 120.754.

(B) In determining those individuals subject to the requirements of 105 CMR 120.753(A), licensees must take into consideration assigned activities during normal and abnormal situations involving exposure to radiation and/or radioactive material which can reasonably be expected to occur during the life of a licensed facility. The extent of these instructions shall be commensurate with potential radiological health protection problems present in the workplace.

120.754: Notifications and Reports to Individuals

(A) Radiation exposure data for an individual and the results of any measurements, analyses, and calculations or radioactive material deposited or retained in the body of an individual shall be reported to the individual as specified in 105 CMR 120.750. The information reported shall include data and results obtained pursuant to 105 CMR 120.000, orders, or license conditions, as shown in records shall maintained by the licensee or registrant pursuant to 105 CMR 120.267. Each notification and report shall:

(1) Be in writing;

(2) Include appropriate identifying data such as the name of the licensee or registrant, and the name of the individual;
(3) Include the individual's exposure information; and
(4) Contain the following statement: ***This report is furnished to you under the provisions of 105 CMR 120.750. You should preserve this report for further reference.***

(B) Each licensee or registrant shall furnish to each worker annually a written report of the worker's exposure to radiation or radioactive material as shown in records maintained by the licensee or registrant pursuant to 105 CMR 120.267.

(C) Each licensee or registrant shall furnish a written report of the worker's exposure to sources of radiation at the request of a worker, formerly engaged in activities controlled by the licensee or registrant. The report shall include the dose record for each year the worker was required to be monitored pursuant to 105 CMR 120.226. Such report shall be furnished within 30 days from the date of the request, or within 30 days after the dose of the individual has been determined by the licensee or registrant, whichever is later. The report shall cover the period of time that the worker's activities involved exposure to sources or radiation and shall include the dates and locations of work under the license or registration in which the worker participated during this period.

(D) When a licensee or registrant pursuant to 105 CMR 120.282, 120.283, 120.284, 120.285 or 120.286 to report to the Agency any exposure of an individual to sources of radiation, the licensee or registrant shall also provide the individual a written report on the exposure data included therein. Such reports shall be transmitted at a time not later than the transmittal to the Agency.

(E) At the request of a worker who is terminating employment with the licensee or registrant in work involving exposure to radiation or radioactive material, during the current year, each licensee or registrant shall provide at termination of each such worker, or to the worker's designee a written report regarding the radiation dose received by that worker from operations of the licensee or registrant during the current year or fraction thereof. If the most recent individual monitoring results are not available at that time, a written estimate of the dose shall be provided together with a clear indication that this is an estimate.

120.755: Presence of Representatives of Licensees or Registrants and Workers During Inspection

(A) Each licensee or registrant shall afford to the Agency at all reasonable times opportunity to inspect materials, machines, activities, facilities, premises, and records pursuant to 105 CMR 120.00

(B) During an inspection, Agency inspectors may consult privately with workers as specified in 105 CMR 120.756. The licensee or registrant may accompany inspectors during other phases of an inspection.

(C) If, at the time of inspection, an individual has been authorized by the workers to represent them during Agency inspections, the licensee or registrant shall notify inspectors of such authorization and shall give the worker's representative an opportunity to accompany the inspectors during the inspection of physical working conditions.

(D) Each worker's representative shall be routinely engaged in work under control of the licensee or registrant and shall have received instructions as specified in 105 CMR 120.753.

(E) Different representatives of licensees or registrants and workers may accompany the inspectors during different phases of an inspection if there is no resulting interference with the conduct of the inspection. However, only one workers' representative at a time may accompany the inspectors.

(F) With the approval of the licensees or registrant and the workers' representative, an individual who is not routinely engaged in work under control of the licensee or registrant, for example, a consultant to the licensee or registrant or to the workers' representative shall be afforded the opportunity to accompany Agency inspectors during the inspection of physical working conditions.

(G) Notwithstanding the other provisions of 105 CMR 120.755, Agency inspectors are authorized to refuse to permit accompaniment by any individual who deliberately interferes with a fair and orderly inspection. With regard to areas containing information classified by an agency of the U.S. Government in the interest of national security, an individual who accompanies an inspector may have access to such information only if authorized to do so. With regard to any area containing proprietary information, the workers' representative for that area shall be an individual previously authorized by the licensee or registrant to enter that area.

120.756: Consultation with Workers During Inspection

(A) Agency inspectors may consult privately with workers concerning matters of occupational radiation protection and other maters related to applicable provisions of 105 CMR 120.000 and licensees to the extent the inspectors deem necessary for the conduct of an effective and thorough inspection.

(B) During the course of an inspection, any worker may bring privately to the attention of the inspectors, either orally or in writing, any past or present condition which the worker has reason to believe may have contributed to or caused any violation of M.G.L. c. 111, §§, 5N, and 5P, 105 CMR 120.000, or license condition, or any unnecessary exposure of an individual to sources of radiation under the licensee's or registrant's control. Any such notice in writing shall comply with the requirements of 105 CMR 120.75 7(A).

(C) The provisions of 105 CMR 120.756(B) shall not be interpreted as authorization to disregard instructions pursuant to 105 CMR 120.753.

120.757: Requests by Workers for Inspections

(A) Any worker or representative of workers believing that a violation of the Act, 105 CMR 120.000, or license conditions exist or has occurred in work under a license or registration with regard to radiological working conditions in which the worker is engaged may request an inspection by giving notice of the alleged violation to the Agency. Any such notice shall be in writing, shall set forth the specific grounds for the notice, and shall be signed by the worker or representative of the workers. A copy shall be provided to the licensee or registrant by the Agency no later than at the time of inspection except that, upon the request of the worker giving such notice, his name and the name of individuals referred to therein shall not appear in such copy or on any record published, released, or made available by the Agency, except for good cause shown.

(B) If, upon receipt of such notice, the Agency determines that the complaint meets the requirements set forth in 105 CMR 120.757(A), and that there are reasonable grounds to believe that the alleged violation exists or has occurred, an inspection shall be made as soon as practicable to determine if such alleged violation exists or has occurred. Inspections pursuant to 105 CMR 120.757 need not be limited to matters referred to in the complaint.

(C) No licensee, registrant, or contractor or subcontractor of a licensee or registrant shall discharge or in any manner discriminate against any work because such worker has filed any complaint or instituted or caused to be instituted any proceeding under 105 CMR 120.000 or has testified or is about to testify in any such proceeding or because of the exercise by such worker on behalf of himself or others of any option afforded by 105 CMR 120.750.

120.758: Inspections Not Warranted; Informal Review

(A)(1) If the Agency determines with respect to a complaint under 105 CMR 120.757, that an inspection is not warranted because there are no reasonable grounds to believe that a violation exists or has occurred, the Agency shall notify the complainant in writing of such determination. The complainant may obtain review of such determination by submitting a written statement of position with the Department. The Department will provide the licensee or registrant with a copy of such statement by certified mail, excluding, at the request of the complainant the name of the complainant. The licensee or registrant may submit an opposing written statement of position with the Department. The Department will provide the complainant with a copy of such statement by certified mail.

(A)(2) Upon the request of the complainant, the Department may hold an informal conference in which the complainant and the licensee or registrant may, orally present their views. An informal conference may also be held at the request of the licensee or registrant, but disclosure of the identity of the complainant will be made only following receipt of written authorization from the complainant. After considering all written and oral views presented, the Department shall affirm modify, or reverse the determination of the Agency and furnish the complainant and the licensee or registrant a written notification of the decision and the reason therefore.

(B) If the Agency determines that an inspection in not warranted because the requirements of 105 CMR 120.757(A) have not been met, the complainant shall be notified in writing of such determination. Such determination shall be without prejudice to the filing of a new complaint meeting the requirement.