

Massachusetts Institute of Technology

Accelerator Radiation Protection Manual

Radiation Protection Program

Revision 0

Radiation Protection Committee
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Approval

This document, *Accelerator Radiation Protection Manual*, has been reviewed, accepted, and approved for implementation by:

**Radiation Protection Staff
Process Owner**

Date

Radiation Protection Officer

Date

Director EHS

Date

Radiation Protection Committee

Date

The requirements of this document are effective upon its publication.

Revision Log

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Preface:

The M.I.T. Radiation Protection Committee is responsible for the establishment and continuing review of an adequate radiation protection program at the Institute and its off-campus sites. The Committee is also responsible for the Institute's compliance with the radiation protection regulations promulgated by the state, Federal, and local agencies for both ionizing and non-ionizing radiation producing equipment, RF generators, and lasers. These devices must be registered with the M.I.T. Radiation Protection Program.

If you have any questions concerning Accelerator Safety, please contact the M.I.T. Radiation Protection Program - Room N52-496, 617-452-EHSS (3477).

Executive Summary

This manual serves as the foundation for registering accelerator facilities with the Radiation Protection Program as required by Massachusetts Department of Public Health Regulations, MDPH, (105CMR) and to establish a framework for hazard evaluation and control during commissioning, operation, and decommissioning of accelerator facilities here at MIT. In addition, this manual describes the roles and responsibilities of the various organizations involved in ensuring a continual emphasis on radiological safety at the accelerator facilities at MIT.

Through the registration process, the Radiation Protection Program provides services to assist departments, supervisors, students and technicians in maintaining a comprehensive accelerator safety program. As part of this service the Radiation Protection Program:

- Provides training and instruction in the safety procedures and practices required for all persons who work with or near *accelerator facilities*
- Maintains a current registration of *accelerator facilities* and its authorized users
- Evaluates each installation as to the control of radiation exposures including recommendations for placement of radiation warning signs and/or warning devices
- Performs as a minimum, annual radiation safety inspections of *accelerator facilities*
- Performs more frequent surveys as necessary
- Reviews and approves modifications to *accelerator facilities* that affect radiation protection.
- Provides personnel radiation monitoring and area radiation monitoring badges
- Investigates any unusual radiation exposures to personnel or to the environment and take remedial/compensatory actions as appropriate and if necessary
- Assists in achieving compliance with all applicable federal, state, and local rules and regulations
- Registers accelerator facility with the Massachusetts Department of Public Health pursuant to 105 CMR 120.600 as applicable
- Has the authority to take action(s) as appropriate and pursuant to 105CMR120.704 (B), to terminate the operations at a particle accelerator facility if such action is deemed necessary to minimize danger to public health and safety or property.

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Appendices

Appendix 1: 105CMR120.700 “Radiation Safety Requirements for Particle Accelerators”

Appendix 2: 105CMR120.020 “Registration of Radiation Machine Facilities and Services”

Appendix 3: RP-81 “Application to Possess and Use Radiation Producing Equipment”

1. Purpose

This manual serves as the foundation for registering accelerator facilities with the Radiation Protection Programs as required by Massachusetts Department of Public Health Regulations, MDPH, (105CMR) and to establish a framework for hazard evaluation and control during commissioning, operation, and decommissioning of accelerator facilities here at MIT.

The primary objective of this program is to maintain exposures to radiation as low as reasonably achievable (ALARA) while operating accelerators in a manner consistent and compliant with the MDPH rules and regulations. This program establishes MIT's policies and procedures for the safe operation of accelerator facilities and any associated radiological hazards.

2. Scope

The Massachusetts Department of Public Health through the Radiation Control Program (105CMR120.005) has uniquely defined an accelerator as follows:

Accelerator means any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 MeV. For purposes of this definition, "particle accelerator" is an equivalent term.

MIT operates a number of different types of accelerators with varying complexity. These accelerators range from fully self contained units presenting minimal radiation hazards to fairly large systems requiring extensive shielding and controls. The accelerator radiation protection program's approach is therefore a graded one which is based upon the potential radiological hazards it may present.

This program is designed for accelerators used throughout the main campus and other sites under the radiation protection program's purview and control.

For accelerators which may not meet the definition as provided under 105CMR120.005, registration of this equipment with the radiation protection program is still required either as an accelerator under this program or as a machine producing radiation source consistent with 105CMR120.600 or 105CMR120.020 as appropriate.

This program describes the requirements necessary for the registration and safe operation of an accelerator facility. The generation of induced or residual radioactivity as a consequence of operating this facility may require the project to obtain an authorization for the possession and use of radioactive material along with its commensurate requirements.

3. Delegation of Authority

In addition to the over arching delegation of authority and responsibilities set forth in MIT's Required Procedures for Radiation Protection, the following is provided either for purposes of emphasis or in addition to those presented in the Required Procedures document. Those

requirements not set forth in the required procedures and are specific to accelerator program are italicized.

3.1. Radiation Protection Committee

3.1.1. General

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

3.1.2. Charge

The committee is charged with the following responsibilities:

- 3.1.2.1. The establishment and continuing review of an adequate radiation protection program at the Institute and its off campus sites.
- 3.1.2.2. The Institute's compliance with radiation protection regulations promulgated by governmental agencies.
- 3.1.2.3. Auditing at least annually of the Radiation Protection Program.

3.1.3. Authority

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

- 3.1.3.1. To grant authorization to an individual, project, or department for the use of radioactive material or *radiation producing equipment* on MIT property or at MIT field sites.
- 3.1.3.2. To suspend an individual's or project's MIT authorization to use radioactive material or *radiation producing equipment*.
- 3.1.3.3. To apply restrictions on the amount of occupational radiation exposure that an individual may receive during their association with MIT.
- 3.1.3.4. To apply conditions of approval that must be adhered to with the project's proposed uses of radioactive materials or *radiation producing equipment*.

3.2. Radiation Protection Program

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

3.2.1. Implementing the Institute's radiation protection program

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

- 3.2.1.1. Provide training and instruction in the safety procedures and practices required for all persons who work with or near *accelerator facilities*
- 3.2.1.2. Maintain a current registration of *accelerator facilities* and its authorized users
- 3.2.1.3. Evaluate each installation as to the control of radiation exposures including recommendations for placement of radiation warning signs and/or warning devices
- 3.2.1.4. Perform as a minimum, annual radiation safety inspections of *accelerator facilities*
- 3.2.1.5. Perform more frequent surveys as necessary
- 3.2.1.6. Review and approve modifications to *accelerator facilities* that affect radiation protection.
- 3.2.1.7. Provide personnel radiation monitoring and area radiation monitoring

- badges
- 3.2.1.8. Investigate any unusual radiation exposures to personnel or to the environment and take remedial/compensatory actions as appropriate and if necessary
- 3.2.1.9. Assist in achieving compliance with all applicable federal, state, and local rules and regulations
- 3.2.1.10. Register accelerator facility with the *Massachusetts Department of Public Health pursuant to 105 CMR 120.600* as applicable
- 3.2.1.11. *Pursuant to 105CMR120.704 (B), the radiation protection committee or the radiation protection officer shall have the authority to terminate the operations at a particle accelerator facility if such action is deemed necessary to minimize danger to public health and safety or property.*
- 3.2.1.12. *The M.I.T. Radiation Protection Program provides services to assist departments, supervisors, students and technicians in maintaining a comprehensive accelerator safety program.*

3.3. Department, Laboratory, or Center

Each Department, Laboratory, or Center's 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 and this program manual.

3.3.1. Project Supervisor

Each *accelerator project supervisor* will be responsible for:

- 3.3.1.1. *Providing the Radiation Protection Program with the information as required in/of this manual*
- 3.3.1.2. *All operations carried out with the equipment*
- 3.3.1.3. *Ensuring that all personnel under their supervision are registered with and receive general training from the Radiation Protection Program in accelerator radiation protection*
- 3.3.1.4. *Compliance with the specific recommendations made by the Radiation Protection Program, and also the general equipment and safety requirements specified in this manual and to the conditions specified in the registration*
- 3.3.1.5. *Ensuring that only authorized users will enter the areas that are restricted due to the use of the accelerator when a radiation hazard exists*
- 3.3.1.6. *Providing or have provided specific hands-on training to the authorized users and operators*
- 3.3.1.7. *Ensuring that the project has an appropriate and properly operating survey instrument as specified in the registration with RPP*

3.3.2. Individual

Each authorized *accelerator user* is responsible for:

- 3.3.2.1. *Attend the radiation protection course (351) prior to work with an accelerator*
- 3.3.2.2. *Wearing the assigned personnel radiation monitoring badge(s) when issued*

- 3.3.2.3. *Performing area monitoring of the accelerator.*
- 3.3.2.4. Notifying the Radiation Protection Program when:
 - 3.3.2.4.1. *It is necessary to alter safety devices, such as bypassing interlocks. The exception would be generic bypassing for test purposes that has been authorized by the Radiation Protection Program in accordance with a written procedure*
 - 3.3.2.4.2. *It is known or suspected that a radiation exposure of personnel or environment may have occurred*
 - 3.3.2.4.3. *An existing system is moved or beam path is altered*
 - 3.3.2.4.4. *There are changes in operating parameters beyond that which were approved by the Radiation Protection Program previously*
 - 3.3.2.4.5. *There are changes in the approved shielding arrangement*
 - 3.3.2.4.6. *There is any major service performed on the system that may affect radiation field environments*

4. Registration and Approval Process

- 4.1.** Each accelerator facility shall be registered with the Radiation Protection Program in accordance with this manual.
- 4.2.** Commonwealth of Massachusetts Regulations requires that all accelerators be registered with the Radiation Protection Program. The Project Supervisor must complete form RP-81 either online or through submission of the form to RPP, Room N52-496 (see Appendix 3).
- 4.3.** The registration shall include appropriate supporting documentation necessary for an adequate review to evaluate radiological safety. These documents may include a Safety Analysis Document (SAD), Accelerator Safety Envelope (ASE), Radiation Safety System (RSS) description, Shielding Assessment, Operating procedures, Emergency Procedures and other information as appropriate based on the complexity and radiological potential of the accelerator.
- 4.4.** Upon receipt of the registration information, the Radiation Protection Program will perform a review and either approve, approve for ratification by the Radiation Protection Committee, or defer directly to the Committee for review and approval based on the complexity of the installation. As part of the approval process, specific conditions for operation may be required.
- 4.5.** The registration information must be updated in a timely manner to reflect any changes. Any changes that are outside of the scope of the original review may require a new review prior to implementing those changes. Any proposed changes that may result in changes to the dose or dose rate fields (i.e., beam path changes, target material changes, shielding configurations) to personnel in restricted or unrestricted areas must be reviewed in advanced and reflected in the registration.

Accelerator Facility Features		Approval	SAD/ASE
Small non-complex facilities with local work area impacts only <ul style="list-style-type: none"> • Radiation generating devices • Small single purpose units • X-ray or neutron generators • Not capable of high radiation area • Developmental/experimental units • Bench top, or single room 		RPP Approval	Exemptions may be used.
Complex facilities with negligible ¹ offsite impacts <ul style="list-style-type: none"> • External/extractable beam(s) • Multiple points of entry, caves, users • Multiple active safety systems 		RPP and RPC Ratification	Tailored, as needed, to address workplace/ onsite hazards and demonstrate no more than negligible offsite impacts
Facilities with credible potential for more than negligible ¹ offsite impacts <ul style="list-style-type: none"> • Normal operations, > 10 mrem/yr at site boundary² from potential pathways, and/or • Accident conditions, expect > 1 rem³ 		RPP and RPC Approval	Tailored, as needed, to address hazards and assess potential workplace/site/offsite impacts
1	<p>“Major” is that level of impact at which permanent health effects or environmental damage could occur. (Criteria: injuries that require extensive professional medical attention; > 25 rem effective dose equivalent);</p> <p>“Minor” is that level of impact at which permanent health effects or environmental damage are not expected. (Criteria: minor injuries; 1 - 25 rem effective dose equivalent);</p> <p>“Negligible” is that level of impact at which the potential for health effects or environmental damage is very slight. (Criteria: injuries requiring only superficial professional medical attention; < 1 rem effective dose equivalent).</p>		
2	The site boundary will need definition for each facility.		
3	EPA Protective Action Guide (PAG): US EPA, Office of Radiation Programs, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents (400-R92-001)		

5. Design Criteria and Shielding

The basic design criteria of any accelerator facility are to ensure that the dose limits to workers and the public are met and are ALARA. 105CMR120.706 states in part “Each particle accelerator installation shall be provided with such primary and/or secondary barriers as are necessary to assure compliance with 105 CMR 120.211 and 120.221.” The following Table summarizes the dose limits for this purpose.

In general, the accelerator facility design shall be ALARA and the criteria used should be at the “ALARA Investigation Level” of 10% of the regulatory annual occupational worker limits. No

credit for duty factors (except pulse duty cycles provided the values used are conservative for the design criteria) or occupancy factors should be used unless explicitly ratified/approved by Radiation Protection. Duty Factors and occupancy factors may be used in demonstrating operational compliance if needed and explicitly approved.

The design criteria shall include direct exposure pathways, airborne contaminants, and effluents as appropriate in determining appropriate measures to attain the design criteria.

	Upper limit (TEDE)	ALARA Investigation Level/ Facility Design Criteria (TEDE)
Occupational	5000 mrem	10%
Public	100 mrem/y and 2 mrem in any one hour	10%

5.1. Documentation

Shielding design and supporting information should be included in the registration information submitted to radiation protection program as part of the review process. This information may be submitted as a separate document.

5.2. Surveys

Verification surveys of radiation fields, effluents, airborne radioactivity, and shielding effectiveness shall be performed by RPP during facility commissioning as appropriate to the design.

6. Hazard Identification

All hazards associated with the operation of the facility needs to be identified. Radiological hazards need to be uniquely identified in the registration process. All other hazards such as those described in "Ancillary Hazards" section need to be considered and addressed through the EHS-management system process and is generally beyond the scope of this manual.

7. Engineering and Hazard Control Requirements

7.1. Shielding

In addition to the information presented in the basic design criteria specified in section 5, a shielding assessment may be necessary dependent upon the complexity of the installation to assure proper control of prompt and residual radiation hazards. This assessment may be included in the safety analysis documentation if required. The topics that might be covered by such an assessment and adapted to the needs and conditions of individual facilities include:

- 7.1.1. Radiation exposure related calculations and measurements, radiation shielding, beam optics, soil and groundwater contamination, airborne radionuclide releases and any associated required monitoring activities where relevant.
- 7.1.2. Conditions and controls that serve to limit the intensity of the maximum beam loss and/or its duration
- 7.1.3. The occupancy status and radiological posting requirements of affected areas
- 7.1.4. Changes to shielding when determined to be significant. Modifications to shielding should be formally reviewed and the need for a revision to the registration determined.

7.2. Accelerator Controls [105 CMR 120.707: Particle Accelerator controls and interlocks]
Instrumentation, readouts, and controls on the particle accelerator control console shall be clearly identified and easily discernible

7.3. Interlocks [105 CMR 120.707 Particle Accelerator controls and interlocks]

- 7.3.1. Each entrance into a target room or other high radiation area shall be provided with a safety interlock that shuts down the machine under conditions of barrier penetration.
- 7.3.2. Each safety interlock shall be on a circuit which shall allow it to operate independently of all other safety interlocks.
- 7.3.3. All safety interlocks shall be designed so that any defect or component failure in the safety interlock system prevents operation of the accelerator.
- 7.3.4. When a safety interlock system has been tripped, it shall only be possible to resume operation of the accelerator by manually resetting controls at the position where the safety interlock has been tripped and, lastly, at the main control console so that the accelerator cannot be restarted remotely.
- 7.3.5. A scram button or other emergency power cutoff switch shall be located and easily identifiable in all high radiation areas. Such a cutoff switch shall include a manual reset so that the accelerator cannot be restarted from the accelerator control console without resetting the cutoff switch.
- 7.3.6. Any changes to the interlock design shall be documented including any diagrams in accordance with the configuration change requirements of this manual

7.4. Warning Devices [105 CMR 120.708] and High Radiation Area Control

In addition to the requirements for the control of Access to High [105 CMR 120.227 Control of Access to High radiation Areas] and Very High [105 CMR 120.228 Control of Access to Very High Radiation Areas] Radiation Areas, the following are additional requirements

- 7.4.1. Each location designated as high radiation area, and each entrance to such location shall be equipped with easily observable warning lights that operate when, and only when, radiation is being produced.
- 7.4.2. Except in facilities designed for human exposure, each high radiation area shall have an audible warning device which shall be activated for 15 seconds prior to the possible creation of prompt radiation. Such warning device shall be clearly discernible in all high radiation areas.
- 7.4.3. Barriers, temporary or otherwise, and pathways leading to high radiation areas shall be posted in accordance with 105 CMR 120.227 and 120.247.

7.5. Beam Containment systems

Whenever practical, beams should be contained as appropriate to minimize possible exposure to the direct beam and the generation of airborne radioactivity.

8. Administrative Controls

8.1. Operating Procedures [105 CMR 120.709]

- 8.1.1. Particle accelerators, when not in operation, shall be secured to prevent unauthorized use
- 8.1.2. The safety interlock system shall not be used to turn off the accelerator beam except in an emergency
- 8.1.3. All safety and warning devices, including interlocks, shall be checked for proper operation in accordance with a written procedure at intervals not to exceed three months unless the facility has not been operating during this interval in which case the interlocks shall be tested prior to next use. Results of such tests shall be maintained at the accelerator facility for inspection
- 8.1.4. Electrical circuit diagrams of the accelerator and the associated safety interlock systems shall be kept current and maintained for inspection and shall be available to the operator at each accelerator facility
- 8.1.5. If, for any reason, it is necessary to intentionally bypass a safety interlock or interlocks, such action shall be:
 - 8.1.5.1. Authorized by the radiation protection committee and/or radiation protection officer
 - 8.1.5.2. Recorded in a permanent log and a notice posted at the accelerator control console; and
 - 8.1.5.3. Terminated as soon as possible.
- 8.1.6. A copy of the current operating and the emergency procedures shall be maintained at the accelerator control panel.
- 8.1.7. A "Use Log" shall be established that would contain as a minimum the information required in this section, a summary of operations, personnel involved, the total time of operation (beam on), and any other parameter as appropriate to describe the nature of the use of the facility with respect to radiological conditions or safety.

8.2. Posting and Labeling Requirements

Posting and labeling of areas, rooms, and equipment is made so as to warn and communicate to individuals entering those areas of specific radiological conditions. Posting and labeling requirements are specified herein, within the required procedures for radiation protection, 105 CMR 120.238, and as required by radiation protection.

Specific areas/items requiring posting and labeling may include:

- 8.2.1. **CAUTION RADIATION AREA**" to identify an area where a person could receive a whole body exposure of 5 mrem or greater in the course of one hour at 30 cm (1 foot) from a source or shielding

- 8.2.2. **"CAUTION HIGH RADIATION AREA"** to identify an area where a person could receive a whole body exposure of 100 mrem or greater in the course of one hour at 30 cm (1 foot) from a source or shielding. Such areas must also be controlled as specified within this manual.
- 8.2.3. **"VERY HIGH RADIATION AREA"** to identify areas where radiation levels **500 rads** in one hour at 1 meter from the source or shielding. (Note: Such areas could present lethal radiation hazards.) These areas must be under interlock controls where the interlocks are subject to specified testing requirements detailed within this manual.
- 8.2.4. **"CAUTION RADIOACTIVE MATERIAL"** signs to identify spots along the beam line where observable induced radioactivity has been produced. In addition to having the standard warning label, signs include columns for specific information to be written on them with a grease pencil (the signs are coated with plastic). The column headings are labeled (1) observer, (2) date, (3) hour, (4) distance (inches or cm), and (5) exposure rate (mR/hour).
- 8.2.5. **"Caution Airborne Radioactivity Area"** signs to identify rooms, areas, or enclosures that contain airborne radioactivity meeting the definition for airborne radioactivity.

Radiological conditions that are considered types (1) (2) and (3) should have already been installed to warn against prompt radiation, but additional signs of all types may be required to warn persons if residual radioactivity and radiation are present.

In addition to the permanent postings, additional postings may be required for transient or temporal conditions. These postings should be reviewed periodically to ensure appropriateness.

Radioactive sources used to check or calibrate experimental equipment are also subject to posting and labeling requirements as specified in the Required Procedures manual and as required by the specific authorization if issued. These sources are subject to a six month physical inventory by RPP and a leak test (3 month or 6 month) may be required depending on the isotope and activity levels.

In addition to the contents of signs and labels, additional information shall be provided on or near the signs and labels to make individuals aware of potential radiation hazards and to minimize exposures (ALARA) as appropriate.

8.3. Configuration changes

System changes that may affect radiation exposure to personnel or the public should be documented and if outside of the scope of the registration submitted to RPP for review prior to implementing the change.

Example of configuration changes may include; changes in beam delivery (voltage current, pulse rate), operation capacity or duty factors, Shielding configurations, target materials, beam diverters/splitters, bending magnet changes, interlock changes, and etc.

8.4. Control of Radioactive Material

Radioactive material may be present/used at an accelerator either as a result of accelerator operation or in support of accelerator operation. Examples include the use of radioactive

targets, activation of beam line components, and use as calibration sources for instrumentation calibration and/or checks.

- 8.4.1. The control of radioactive material may be specified as part of these registration approvals or under a separate authorization issued by the Radiation Protection Committee depending on the nature and quantities of the material produced. Regardless, the control of such material shall be in compliance with the requirements of this registration and/or authorization as appropriate.
- 8.4.2. Radioactive material required for the operation of the facility (target material, calibration sources, and etc) shall have a radioactive material authorization issued by the Radiation Protection Committee

8.5. Radiation Monitoring requirements [105 CMR 120.710]

- 8.5.1. There shall be available appropriate portable monitoring equipment which is operable and has been appropriately calibrated for the radiations being produced at the facility. Such equipment shall be tested for proper operation before use or once every three months, whichever is the lesser.
- 8.5.2. A radiation protection survey shall be performed when changes have been made in shielding, operation, equipment, or occupancy of adjacent areas.
- 8.5.3. Radiation levels in all high radiation areas (>100 mrem/h) shall be continuously monitored. The monitoring devices shall be electrically independent of the accelerator control and safety interlock systems and capable of providing a readout at the control panel
- 8.5.4. All area monitors shall be calibrated at intervals not to exceed one year and after each servicing and repair
- 8.5.5. Whenever applicable, periodic surveys shall be made to determine the amount of airborne particulate radioactivity present
- 8.5.6. Whenever applicable, periodic smear surveys shall be made to determine the degree of contamination
- 8.5.7. All surveys shall be made in accordance with the written procedures
- 8.5.8. Records of all radiation protection surveys, calibrations, and instrumentation tests shall be maintained for inspection
- 8.5.9. Any person(s) entering a High Radiation Area shall be monitored for radiation exposure

8.6. Access Control for Visitors

Members of the general public are not permitted into any area that that exceeds the dose for a member of general public (>2 mrem in any one hour and < 100 mrem/y). (See design criteria) No member of the general public are permitted into areas greater than those that define a high radiation area and are not permitted to handle or work with radioactive material.

8.7. Training [105 CMR 120.703 General Requirements ...]

All personnel having access to the accelerator facility shall have training commensurate with the hazards. Basic training in radiation protection fundamentals is provided by the Radiation Protection Program (Course 365: Accelerator Safety).

Training of operators in the specific issues associated with facility operations is to be provided by the project. A record of accelerator specific training shall be kept and shall be made available for inspection.

9. Ancillary Hazards and Controls

The following are a number of ancillary hazards that may be found in accelerator facilities. This is not intended to be exhaustive nor fully inclusive. It is expected that the facility will identify all hazards and institute controls for these hazards as appropriate. EHS can assist in the identification of these hazards.

9.1. Induced Radioactivity (Accelerator-produced material)

Accelerator facilities may, based on design, produce radioactivity either as an intended process or as consequence of operation. Any accelerator facility capable of liberating a charged particle from the nucleus (exceeding the binding energy of the last nucleon) or capturing a charged particle is capable of inducing radioactivity. Generally speaking proton or other heavier ion machines have this capability and for electron accelerators only those typically exceeding 10 MeV (photo-nuclear) are capable of producing radioactivity

- 9.1.1. If radioactivity is produced as the result of accelerator operation, then such material shall be controlled. The amount of radioactivity that could be produced should be provided in the submission of the documents in the registration process.
- 9.1.2. The type and nature of controls will be specified in the approvals of this registration or an authorization as appropriate.

9.2. Airborne Hazards

Any airborne hazard generated as the result of accelerator operation shall be controlled to limit the exposure to individuals and the environment in accordance with applicable regulations.

9.2.1. Radiological [105 CMR 120.711 Ventilation systems]

- 9.2.1.1. Ventilation systems shall be provided to ensure that personnel entering any area where airborne radioactivity may be produced will not be exposed to airborne radioactive material in excess of those limits specified in 120.296: *Appendix B, Table I.*
- 9.2.1.2. A registrant, as required by 105 CMR 120.221, shall not vent, release, or otherwise discharge airborne radioactive material to an unrestricted area which exceeds the limits specified in 105 CMR 120.296: *Appendix B, Table II*, except as authorized pursuant to 105 CMR 120.221(A)(3) or 120.222(C). For purposes of 105 CMR 120.711(B), concentrations may be averaged over a period not greater than one year. Every effort should be made to

maintain releases of radioactive material to unrestricted areas as far below these limits as is reasonably achievable.

9.2.2. Non-radiological

Non radiological airborne hazards (such as ozone) can be generated in higher power electron accelerators where the electron (photon) doses are sufficient to generate significant disassociation of airborne molecules with the resultant formation of hazardous chemical constituents. A classic example is the formation of ozone. If the accelerator type and power is such that the formation of non-radiological contaminants may be of concern, then the exposure to personnel and the release of these contaminants must be taken into consideration and compared to the applicable standard.

9.3. Other hazards

9.3.1. Radio-Frequency

Radiofrequency devices are used for various accelerator applications to impart energy to the particle to be accelerated. These devices may emit RF fields that may be concern and should be evaluated for potential human exposure to these RF devices. Generally speaking these RF sources are confined to wave guides or cavities and would not normally pose a hazard; however, system leakage could be of concern particularly post maintenance activities.

These devices may or may not be required to be registered under the Radiation Protection Program's RF safety program.

9.3.2. Ancillary Sources

Accelerators employ devices to impart energy to particles of interest or to redirect them during the acceleration process. These devices may emit ionizing radiation while they are operating. Examples may include Klystrons, radiofrequency cavities, electrostatic separators, bending magnets, and others.

If access to these devices is possible during operation, the potential for doses from these devices should be evaluated.

These devices may or may not be required to be registered with the radiation protection program under the radiation producing machine safety program.

9.3.3. Lasers

Lasers may be used in a host of possibilities in accelerator facilities. They range from use in simple alignment, to generate free electron lasers as the device of interest from accelerator operation, timing, scattering, and most recently as an accelerator itself.

As a result of the wide use of lasers in accelerator operation, the hazards from laser operation for each facility needs to be evaluated.

All class 3b and 4 laser systems shall be registered and compliant with the radiation protection program's Laser safety program.

9.3.4. Electrical

Electrical safety needs to be considered for accelerator facilities due to the high voltage and currents used in such facilities. Electrical safety is outside of the scope of this program manual; however, its importance is not diminished. Electrical safety program requirements are the purview of the EHS Safety Program and any questions should be directed there. At a minimum there are electrical safety training requirements and typically, Lock-out Tag-out (LOTO) training and program requirements.

9.3.5. Cryogenics

Cryogenics are used in various accelerator operations and although outside the scope of this manual should be considered in the overall safety of accelerator operation. Appropriate gloves and face shields must be made available for transfers of cryogenic materials.

9.3.6. Compressed gases

Compressed gases are used in a variety of different applications including as an insulating medium for high voltage applications. Regardless of the use, consideration towards compressed gas safety needs to be made as appropriate. Compressed gas safety is outside of the scope of this manual; however, information regarding compressed gas safety may be obtained through EHS's Safety Program.

EHS provides guidance in the form of SOPs that may be adopted for a given facility's operation as required.

10. Definitions

ACCELERATOR (105 CMR 120.005: Definition) means any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 MeV. For purposes of this definition, "particle accelerator" is an equivalent term.

ACCELERATOR (DOE G 420.2-1 Definition) is a device employing electrostatic or electromagnetic fields to impart kinetic energy to molecular, atomic or sub-atomic particles and, for purposes of this Guide, capable of creating a radiological area as defined in Title 10, Code of Federal Regulations, Part 835 entitled *Occupational Radiation Protection* (10 CFR 835).

ACCELERATOR-PRODUCED MATERIAL means any material made radioactive by a particle accelerator.

ACCELERATOR FACILITY is the accelerator and associated plant and equipment utilizing, or supporting the production of, accelerated particle beams to which access is controlled to protect the safety and health of persons. It includes injectors, targets, beam dumps, detectors, experimental halls, experimental

enclosures and experimental apparatus utilizing the accelerator, regardless of where that apparatus may have been designed, fabricated, or constructed.

ACCELERATOR SAFETY ENVELOPE (ASE) is a set of physical and administrative conditions that define the bounding conditions for safe operation at an accelerator facility.

ANCILLARY SOURCES: Accelerators employ devices to impart energy to particles or redirect them during the acceleration process. These devices may emit ionizing radiation while they are operating.

DUTY CYCLE: The time that the accelerator facility is on (Beam) and is analogous to capacity factor

DUTY CYCLE (pulse) for a pulsed system is defined the product of the pulse duration and the pulse-repetition frequency

EXPERIMENTERS means all persons directly involved in experimental efforts at the accelerator facility utilizing the accelerator or its beams, including visiting scientists, students and others who may not be employees of the operating contractor

RADIOLOGICAL AREA means any area within a controlled area defined as a radiation area, high radiation area, very high radiation area, contamination area, high contamination area, or airborne radioactivity area.

SAFETY ANALYSIS is a documented process to systematically identify the hazards of a given operation; describe and analyze the adequacy of measures taken to eliminate, control, or mitigate the hazards and risks of normal operation; and identify and analyze potential accidents and their associated risks.

SAFETY ASSESSMENT DOCUMENT (SAD) is the document containing the results of a safety analysis for an accelerator facility pertinent to understanding the risks of the proposed undertaking. Safety Analysis Review (SAR) is a term that is used interchangeably with SAD

DOSE, ABSORBED (rad): The amount of energy deposited per unit mass in medium. The special unit of absorbed dose is the rad which is equal to 100 ergs/gm or 0.01 joule/kilogram.

DOSE EQUIVALENT (rem): Risk adjusted absorbed dose. The absorbed dose is weighted by the radiation type and tissue susceptibility to biological damage. This puts all doses in the perspective of biological risk. Units: rem and Sv. For radiation protection purposes in this safety program, the dose equivalent in rems may be considered numerically equivalent to the absorbed dose in rads and exposure in roentgens.

EXPOSURE (ROENTGEN): A measure of the ionization produced in air by x or gamma radiation. This special unit of exposure is the roentgen which is equal to 2.58×10^{-4} coulomb of charge collected per kilogram of air exposed.

INTERLOCK: A device for precluding access to an area in which radiation is present by automatically reducing the exposure rate upon entry by personnel or parts of their body.

PRIMARY BEAM: Radiation which passes through an aperture of the source housing by a direct path from either the generating device or a radioactive source located in the radiation source housing which is either un-scattered or un-deflected.

SCATTERED RADIATION: Radiation that, during passage through matter, has been deviated in direction.

11. References/Suggested Readings

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2. MASSACHUSETTS INSTITUTE OF TECHNOLOGY RADIATION PROTECTION PROGRAM LASER SAFETY PROGRAM Eighth Edition (interim) April 2008 MIT RADIATION PROTECTION COMMITTEE
3. Massachusetts Institute of Technology, *Analytical X-Ray Equipment Safety Program*, Forth Edition September 2007 Radiation Protection Program
4. MIT ALARA Program
5. 105CMR120.700 "Radiation Safety Requirements for Particle Accelerators"
6. 105CMR120.020 "Registration of Radiation Machine Facilities and Services"
7. NCRP (1986) National Council on Radiation Protection and Measurements, *Radiation Alarms and Access Control Systems*, NCRP Report No. 88, (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
8. NCRP (2003) National Council on Radiation Protection and Measurements, *Radiation Protection for Particle Accelerator Facilities*, NCRP Report No. 144 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
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10. NCRP (1989). National Council on Radiation Protection and Measurements. *Medical X-Ray, Electron Beam and Gamma-Ray Protection for Energies Up to 50 MeV (Equipment Design, Performance and Use)*, NCRP Report No. 102 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
11. NCRP (1983). National Council on Radiation Protection and Measurements. *Radiation Protection and Measurements for Low Voltage Neutron Generators*, NCRP Report No. 72 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
12. NCRP (1977). National Council on Radiation Protection and Measurements. *Radiation Protection Design Guidelines for 0.1 – 100 MeV Particle Accelerator Facilities*, NCRP Report No. 51 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).
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14. DOE O 420.2B, *Safety of Accelerator Facilities* (7/23/04)

15. DOE G 420.2-1 Accelerator Facility Safety Implementation Guide for DOE O 420.2B, *SAFETY OF ACCELERATOR FACILITIES* (7/1/2005).
16. NRC Title 10, Code of Federal Regulations, Part 20
17. 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
18. DOT Title 49, Code of Federal Regulations
19. DOE HANDBOOK RADIOLOGICAL TRAINING FOR ACCELERATOR FACILITIES DOE-HDBK-1108-2002 May 2002 Change Notice No 1. with Reaffirmation January 2007
20. SLAC-327 UC-41 HEALTH PHYSICS MANUAL OF GOOD PRACTICES FOR ACCELERATOR FACILITIES W. R. CASEY, BNL A. J. MILLER, LANL J. B. MCCASLIN, LBL L. V. COULSON, FNAL *Stanford Linear Accelerator Center Stanford University, Stanford, CA 94309* April 1988
21. RADIATION PHYSICS FOR PERSONNEL AND ENVIRONMENTAL PROTECTION FERMILAB REPORT TM-1834 Revision 9B, May 2007 J. Donald Cossairt Fermi National Accelerator Laboratory
22. *Accelerator health physics*, Wade Patterson, 1973, Academic Press (New York)

Appendices

Appendix 1: 105CMR120.700 "Radiation Safety Requirements for Particle Accelerators"

Appendix 2: 105CMR120.020 "Registration of Radiation Machine Facilities and Services"

Appendix 3: "Application to Possess and Use Radiation Producing Equipment"

Appendix 1

105 CMR Department of Public Health

120.700: RADIATION SAFETY REQUIREMENTS FOR PARTICLE ACCELERATORS

120.701: Purpose and Scope

(A) 105 CMR 120.700 establishes procedures for the registration and the use of particle accelerators.

(B) In addition to the requirements of 105 CMR 120.700, all registrants are subject to the requirements of 105 CMR 120.001, 120.020, 120.750, 120.100 and 120.200. Registrants engaged in industrial radiographic operations are subject to the requirements of 105 CMR 120.300, and registrants engaged in the healing arts are subject to the requirements of 105 CMR 120.430 and/or 105 CMR 120.500, and registrants engaged in wireline operations are subject to 105 CMR 120.900. Registrants whose operations result in the production of radioactive material are subject to the requirements of 105 CMR 120.100.

120.702: Registration Requirements

No person shall receive, possess, use, transfer, own, or acquire a particle accelerator except as authorized in a registration issued pursuant to 105 CMR 120.020 or 120.100.

120.703: General Requirements for the Issuance of a Registration for Particle Accelerators

In addition to the requirements of 105 CMR 120.020 or 120.100, a registration application for use of a particle accelerator will be approved only if the Agency determines that:

(A) The applicant is qualified by reason of training and experience to use the accelerator in question for the purpose requested in accordance with 105 CMR 120.700, 120.200 and 120.750 in such a manner as to minimize danger to public health and safety or property;

(B) The applicant's proposed or existing equipment, facilities, and operating and emergency procedures are adequate to protect health and minimize danger to public health and safety or property;

(C) The issuance of the registration will not be inimical to the health and safety of the public, and the applicant satisfies any applicable special requirement in 105 CMR 120.704;

(D) The applicant has appointed a radiation safety officer;

(E) The applicant and/or the applicant's staff has substantial experience in the use of particle accelerators and training sufficient for application to its intended uses;

(F) The applicant has established a radiation safety committee to approve, in advance, proposals for uses of particle accelerators, whenever deemed necessary by the Agency; and,

(G) The applicant has an adequate training program for operators of particle accelerators.

120.704: Human Use of Particle Accelerators

In addition to the requirements of 105 CMR 120.020, a registration for use of a particle accelerator in the healing arts will be issued only if the applicant or registrant meets the requirements of 105 CMR 120.430 "THERAPEUTIC RADIATION MACHINES".

120.705: Limitations

(A) No registrant shall permit any individual to act as an operator of a particle accelerator until such individual:

- (1) Has been instructed in radiation safety and shall have demonstrated an understanding thereof;
- (2) Has received copies of and instruction in 105 CMR 120.700 and the applicable requirements of 105 CMR 120.200 and 120.750, pertinent registration conditions and the registrant's operating and emergency procedures, and shall have demonstrated understanding thereof; and,
- (3) Has demonstrated competence to use the particle accelerator, related equipment, and survey instruments which will be employed.

(B) The radiation safety committee or the radiation safety officer shall have the authority to terminate the operations at a particle accelerator facility if such action is deemed necessary to minimize danger to public health and safety or property.

120.706: Shielding and Safety Design Requirements

(A) A qualified expert, acceptable to the Agency, shall be consulted in the design of a particle accelerator installation and called upon to perform a radiation survey when the accelerator is first capable of producing radiation.

(B) Each particle accelerator installation shall be provided with such primary and/or secondary barriers as are necessary to assure compliance with 105 CMR 120.211 and 120.221.

120.707: Particle Accelerator Controls and Interlock Systems

(A) Instrumentation, readouts, and controls on the particle accelerator control console shall be clearly identified and easily discernible.

(B) Each entrance into a target room or other high radiation area shall be provided with a safety interlock that shuts down the machine under conditions of barrier penetration.

(C) Each safety interlock shall be on a circuit which shall allow it to operate independently of all other safety interlocks.

(D) All safety interlocks shall be designed so that any defect or component failure in the safety interlock system prevents operation of the accelerator.

(E) When a safety interlock system has been tripped, it shall only be possible to resume operation of the accelerator by manually resetting controls at the position where the safety interlock has been tripped and, lastly, at the main control console.

(F) A scram button or other emergency power cutoff switch shall be located and easily identifiable in all high radiation areas. Such a cutoff switch shall include a manual reset so that the accelerator cannot be restarted from the accelerator control console without resetting the cutoff switch.

120.708: Warning Devices

(A) Each location designated as high radiation area, and each entrance to such location, shall be equipped with easily observable warning lights that operate when, and only when, radiation is being produced.

(B) Except in facilities designed for human exposure, each high radiation area shall have an audible warning device which shall be activated for 15 seconds prior to the possible creation of prompt radiation. Such warning device shall be clearly discernible in all high radiation areas.

(C) Barriers, temporary or otherwise, and pathways leading to high radiation areas shall be posted in accordance with 105 CMR 120.227 and 120.247.

120.709: Operating Procedures

(A) Particle accelerators, when not in operation, shall be secured to prevent unauthorized use.

(B) The safety interlock system shall not be used to turn off the accelerator beam except in an emergency.

(C) All safety and warning devices, including interlocks, shall be checked for proper operation at intervals not to exceed three months. Results of such tests shall be maintained at the accelerator facility for inspection by the Agency.

(D) Electrical circuit diagrams of the accelerator and the associated safety interlock systems shall be kept current and maintained for inspection by the Agency and shall be available to the operator at each accelerator facility.

(E) If, for any reason, it is necessary to intentionally bypass a safety interlock or interlocks, such action shall be:

- (1) Authorized by the radiation safety committee and/or radiation safety officer;
- (2) Recorded in a permanent log and a notice posted at the accelerator control console; and,
- (3) Terminated as soon as possible.

(F) A copy of the current operating and the emergency procedures shall be maintained at the accelerator control panel.

120.710: Radiation Monitoring Requirements

- (A) There shall be available at each particle accelerator facility appropriate portable monitoring equipment which is operable and has been appropriately calibrated for the radiations being produced at the facility. Such equipment shall be tested for proper operation before use or once every three months, whichever is the lesser.
- (B) A radiation protection survey shall be performed and documented by a qualified expert, acceptable to the Agency, when changes have been made in shielding, operation, equipment, or occupancy of adjacent areas.
- (C) Radiation levels in all high radiation areas shall be continuously monitored. The monitoring devices shall be electrically independent of the accelerator control and safety interlock systems and capable of providing a readout at the control panel.
- (D) All area monitors shall be calibrated at intervals not to exceed one year and after each servicing and repair.
- (E) Whenever applicable, periodic surveys shall be made to determine the amount of airborne particulate radioactivity present.
- (F) Whenever applicable, periodic smear surveys shall be made to determine the degree of contamination.
- (G) All surveys shall be made in accordance with the written procedures established by a qualified expert, acceptable to the Agency, or the radiation safety officer.
- (H) Records of all radiation protection surveys, calibrations, and instrumentation tests shall be maintained at the accelerator facility for inspection by the Agency.

120.711: Ventilation Systems

- (A) Ventilation systems shall be provided to ensure that personnel entering any area where airborne radioactivity may be produced will not be exposed to airborne radioactive material in excess of those limits specified in 120.296: *Appendix B*, Table I.
- (B) A registrant, as required by 105 CMR 120.221, shall not vent, release, or otherwise discharge airborne radioactive material to an unrestricted area which exceeds the limits specified in 105 CMR 120.296: *Appendix B*, Table II, except as authorized pursuant to 105 CMR 120.221(A)(3) or 120.222(C). For purposes of 105 CMR 120.711(B), concentrations may be averaged over a period not greater than one year. Every effort should be made to maintain releases of radioactive material to unrestricted areas as far below these limits as is reasonably achievable.

Appendix 2:

105 CMR Department of Public Health

120.020: REGISTRATION OF RADIATION MACHINE FACILITIES AND SERVICES

120.021: Purpose and Scope

(A) 105 CMR 120.020 through 120.040 provides for the registration of radiation machine facilities and for the registration of persons providing radiation machine installation, servicing, and/or services to Department registrants or registrable facilities. For the purposes of 105 CMR 120.020, particle accelerators, whether used primarily for x-ray production or other purposes, shall be considered a radiation machine facility.

(B) In addition to the requirements of 105 CMR 120.020 through 120.040, all registrants are subject to the applicable provisions of other parts of 105 CMR 120.000.

120.022: Definitions

As used in 105 CMR 120.020 through 120.040, "facility" means the location at which one or more devices or sources are installed and/or located within one building, vehicle, or under one roof and are under the same administrative control.

120.023: Exemptions

(A) Electronic equipment that produces radiation incidental to its operation for other purposes is exempt from the registration and notification requirements of 105 CMR 120.020 through 120.040, providing dose equivalent rate averaged over an area of ten square centimeters does not exceed 0.5 millirem (5 μ Sv) per hour at five centimeters from any accessible surface of such equipment. The production, testing, or factory servicing of such equipment shall not be exempt.

(B) Radiation machines while in transit or storage incident thereto are exempt from the requirements of 105 CMR 120.020 through 120.040.

(C) Domestic television receivers are exempt from the requirements of 105 CMR 120.020 through 120.040.

120.024: Plan Review

(A) Prior to construction, the floor plans and equipment arrangements of all new installations, or modifications of existing installations, utilizing ionizing radiation for diagnostics or therapeutic purposes shall be submitted to the Agency for review and approval. The installation shall meet the requirements of 105 CMR 120.420: *Appendix A* and 105 CMR 120.422: *Appendix C* unless specifically exempted. Additional shielding and design requirements are specified elsewhere in 105 CMR 120.000.

(B) The Agency may require the applicant to utilize the services of a qualified expert to determine the shielding requirements prior to the plan review and approval.

(C) The approval of such plans shall not preclude the requirement of additional modifications should a subsequent analysis of operating conditions indicate the possibility of an individual receiving a dose in excess of the limits prescribed in 105 CMR 120.211, 120.217, 120.218 and 120.221.

120.025: Application for Registration

Each person who owns or possess and administratively controls a facility, unless specifically exempted in 105 CMR 120.023 shall:

(A) Apply for registration of such facility with the Agency prior to the operation of a radiation machine facility. Application for registration shall be completed on forms furnished by the Agency and shall contain all the information required by the form and accompanying instructions.

(B) Designate on the application form an individual to be responsible for radiation protection.

(C) Each registrant shall prohibit any person from furnishing radiation machine servicing or services as described in 105 CMR 120.026(D) to his radiation machine facility until such person provides evidence that he has been registered with the Agency as a provider of services in accordance with 105 CMR 120.026.

120.026: Application for Registration Services

(A) Each person, prior to engaging in the business of installing or offering to install radiation machines or engaging in the business of furnishing or offering to furnish radiation machine servicing or services in this Commonwealth shall apply for and receive registration for such services with the Agency.

(B) Application for registration shall be completed on forms furnished by the Agency and shall contain all information required by the Agency as indicated on the forms and accompanying instructions.

(C) Each person applying for registration under 105 CMR 120.020 through 120.040 shall specify:

(1) That he has read and understands the requirements of 105 CMR 120.020 through 120.040;

(2) The services for which he is applying for registration; and,

(3) The training and experience that qualify him to discharge the services for which he is applying for registration;

(D) For the purpose of 105 CMR 120.026, services may include but shall not be limited to:

(1) Installation and/or servicing of radiation machines and associated radiation machine components;

- (2) Calibration of radiation machines or radiation measurement instruments or devices;
- (3) Radiation protection or health physics consultations or surveys; and,
- (4) Personnel dosimetry services.

120.027: Certificate of Registration

- (A) No person shall maintain a facility that is required by 105 CMR 120.000 to be registered unless such a person has obtained a valid certificate of registration for such facility.
- (B) A person who applies for registration and whose application meets the requirements of 105 CMR 120.000, shall, upon payment of the required fee, be issued a certificate of registration effective on the date stated on such certificate.
- (C) A current certificate of registration or a legible copy thereof shall be posted conspicuously at each registered facility.
- (D) The Director of the Radiation Control Program may incorporate in the certificate of registration, at the time of issuance or thereafter, any such additional requirements and conditions with respect to the registrant's receipt, possession, use, and transfer of radiation machines as said Director finds appropriate and necessary for the protection of the general public or individuals against radiation hazards.

120.028: Expiration of Notice of Registration

Each certificate of registration shall expire at the end of the specified day in the month and year stated therein.

120.029: Renewal of Notice of Registration

- (A) Application for renewal of registration shall be filed in accordance with 105 CMR 120.025 or 105 CMR 120.026.
- (B) In any case in which a registrant not less than 30 days prior to the expiration of his existing notice of registration has filed an application in proper form for renewal, such existing notice of registration shall not expire until the application status has been finally determined by the Agency.

120.030: Report of Changes

The registrant shall notify the Agency in writing before making any change which would render the information contained in the application for registration and/or the certificate of registration no longer accurate. In the case of disposition of an x-ray system, such notification should specify the recipient of the system. In the case of modification involving a structural change, or the addition or relocation of an x-ray system, the Director of the Radiation Control Program may require the registrant to submit the information contained in 105 CMR 120.420: *Appendix A* and/or 105 CMR 120.421: *Appendix C*.

120.031: Approval Not Implied

No person, in any advertisement, shall refer to the fact that he or his facility is registered with the Agency pursuant to the provisions of 105 CMR 120.025 or 120.026, and no person shall state or imply that any activity under such registration has been approved by the Agency.

120.032: Assembler and/or Transfer Obligation

(A) Any person who sells, leases, transfers, lends, disposes, assembles, or installs radiation machines in this Commonwealth shall notify the Agency within 15 days of:

- (1) The name and address of persons who have received these machines;
- (2) The manufacturer, model, and serial number of each radiation machine transferred; and,
- (3) The date of transfer of each radiation machine.
- (4) In the case of diagnostic x-ray system which contain certified components, a copy of the assembler's report prepared in compliance with requirements of the Federal Diagnostic X-Ray Standard (21 CFR 1020.30 (d)) shall be submitted to the Agency within 15 days following completion of the assembly. Such report shall suffice in lieu of any other by the assembler.

(B) No person shall make, sell, lease, transfer, lend, assemble, or install radiation machines or the supplies used in connection with such machines unless such supplies and equipment when properly placed in operation and use shall meet the requirements of 105 CMR 120.000.

120.033: Out-of-state Radiation Machines

(A) Whenever any radiation machine is to be brought into the Commonwealth, for any temporary use, the person proposing to bring such machine into the Commonwealth shall give written notice to the Agency at least ten working days before such machine is to be used in the Commonwealth. The notice shall include:

- (1) The type of radiation machine;
- (2) The nature, duration, and scope of use;
- (3) The exact location(s) where the radiation machine is to be used; and,
- (4) States in which this machine is registered.

(B) The person referred to in 105 CMR 120.033 shall:

- (1) Comply with all applicable regulations of the Agency;
- (2) Register the radiation machine(s) with the Agency; and,
- (3) Submit payment of the required fee for registration.

(C) A pre-operational inspection may be required at the discretion of the Director of the Radiation Control Program.

(D) If, for a specific case, the ten working day period is not practical, notification to the Agency by telephone and hardcopy, permission to proceed sooner may be granted.

120.040: Notification to Fire Department

The user shall notify the local fire department of the presence on his premises of any radioactive material that may present special fire-fighting problems or require special precautionary measures in case of fire or other natural catastrophe, and he shall establish effective liaison with the fire department in regards to this matter.