Connecticut College

Accelerator Radiation Safety Manual

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EMERGENCY CONTACT INFORMATION

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Contents:

1. Purpose

To establish policy and procedures for the safe use of the 1 MeV accelerator, located in the Olin Science Center

2. Scope

This policy/procedure applies to all researchers, students, visitors or others who may use the accelerator.

3. Policy

To keep radiation exposure to accelerator users as low as reasonably achievable (ALARA) and well within the limits established by the State of Connecticut.

The Radiation Use Committee (RUC) will ensure that all teaching experiments and research use of the accelerator is properly planned, so that radiation exposures to users are kept far below these limits.

4. Responsibilities

4.1. Connecticut College

The President and Board of Directors are responsible for establishing and maintaining a safety program for use of the accelerator at Olin Lab, which will minimize any risk, associated with its use, and will ensure full compliance with all applicable government regulations.

4.2. Radiation Use Committee (RUC)

The RUC is responsible to the President through the Associate Director of Physical Plant, for insuring the safe use of the accelerator. All faculty members who use the accelerator are entitled to membership on the committee. Responsibilities of this Committee include:

- Establishing policies on the safe use of the accelerator.
- Ensuring the accelerator is registered/annual renewal according to State law
- Reviewing and approving the qualifications of all requesters, i.e., principle investigators only, wishing to use the accelerator.
- Performing an annual audit of the accelerator safety program to determine that all activities are being conducted safely and in accordance with State regulations.

4.3. Radiation Safety Officer (RSO)

The RSO will perform the actions required to establish and maintain preventative measures to safeguard faculty and students from the harmful effects of ionizing radiation produced by the accelerator. Specific responsibilities include:

- Provide the RUC, accelerator operators, and students with advise and assistance on all matters pertaining to radiation safety at the accelerator.
- Review operational procedures to determine compliance with Connecticut Department of Environmental Protection.

- Perform any required radiation safety surveys or causing such surveys to be performed by trained assistants.
- Assuring that any required radiation-monitoring instruments are in place, operating properly and calibrated.
- Terminate any operation involving the use of the accelerator that he deems unsafe.
- Maintain any records required to meet compliance with regulations.

4.4. Accelerator Laboratory Supervisor

The Supervisor is a qualified faculty member, responsible to the RUC for assuring the safe use of the accelerator. Specific responsibilities include:

- Complying with all the radiation safety requirements prescribed in this manual.
- Assuring that all faculty and students are properly instructed in safe use of the accelerator.
- Assuring that researchers use all required radiation monitoring and protective devices.
- Assuring the integrity of all accelerator systems through regular inspection and testing.
- Assuring that any new procedures for use of the accelerator are submitted to the RUC/RSO for review before initial testing/implementation.
- Maintain required accelerator operation logbook, maintenance records, and circuit diagrams.

4.5. Accelerator Operators

Students and researchers trained to use the accelerator are responsible for:

- Ensuring that only prescribed procedures are used when operating the accelerator.
- Documenting accelerator operations by completing the accelerator operation logbook during each period of use.
- Reporting any malfunction, no matter how slight, to the Accelerator Laboratory Supervisor for evaluation before resuming use of the accelerator.

5. Accelerator Description

The Accelerator is a 1 MeV, Model 3SH Pelletron, Serial Number, 3. It was designed and built by National Electrostatics Corp., of Middleton, WI, and is located in the basement of the Olin Science Center, Room 020.

A copy of the unit instruction manual is available in the Accelerator Lab, and contains a complete description of its construction and capabilities. All students are required to review this document, in addition to their “hands-on” training.

The Accelerator is located within a lockable vault built within the lab (Refer to the floor plan in Appendix (B)). Accelerated particles exit the accelerator vault through an opening in one wall and can be directed down one of 4 existing steel vacuum tubes to 4 separate experiment sites.

No additional shielding is required in this lab, or at experiment sites/beam ports, due to the nature and quantity of the particles accelerated.

6. Radiation Safety Surveys

Radiation safety surveys are paramount in importance to an effective accelerator safety program. Surveys are performed by the Accelerator Laboratory Supervisor or RSO, using properly calibrated survey meters:

6.1. Initial Survey Results

When the accelerator was initially installed, the laboratory was surveyed for a three month operating period, by placing film badges in the general experimental area, on the most likely radiation producing experiment (PIXE), and on the control area. During that operational period the machine was run at its greatest energy (MeV) and highest currents (10-30 microamps, gross). The survey found no measurable ionizing radiation. We therefore believe that individuals working in the experimental area and the control area, are safe from radiation exposure.

The accelerator itself is housed in a vault with 6" cinder block walls and poured concrete floor and ceiling. The primary radiation from the accelerator is x-rays from backstreaming electrons. The following is the result of a survey taken with the calibrated meter for the accelerator vault:

Energy	Beam current μA	Reading and location
250 KeV	10	BG
500 KeV	13	BG
750 KeV	21.2	Side surfaces of accelerator: .9 mR/hr Sides at 1 m distance: .4 mR/hr End: BG Door to vault (closed): BG
1.06 MeV	30	Sides surfaces: 7 mR/hr Sides at 1 m: 4 mR/hr End: BG At surface of Door closed: .4 mR/hr Door open in doorway: .7 mR/hr

Another possible source of major exposure is that of neutron producing reactions. For accelerators under 2 MeV maximum energy, such reactions are rare, except when deuterium or tritium is used as a target or projectiles. Connecticut College does not use such targets, nor is deuterium used as an ion source gas for the accelerator. Therefore, neutrons are not produced by this facility.

The only other potential problem would be if there was an attempt to use the accelerator to produce electron beams. But since this machine is not capable of running negative voltages, no electron beams are produced.

6.2. Routine Operator Surveys

Accelerator operators will monitor the lab areas as warranted by experiment design and once/quarter to test/ensure system integrity to ensure radiation levels remain low. Radiation readings are recorded in the accelerator operation logbook, to enable the RSO and the Accelerator Laboratory Supervisor to review measurements and trends.

6.3. Special Surveys

The Accelerator Laboratory Supervisor or the RSO will make special radiation level surveys of the facility as deemed necessary in their view. (e.g., following any

maintenance, repairs, or modifications to any portion of the accelerator facility.) These will be recorded and evaluated with regard to operator safety.

All Surveys will be performed using a properly calibrated survey meter capable of **measuring** the x-ray radiation emitted, i.e., over broad energy range ± 20%. The meter will be sent out for calibration annually and calibrated using Cs-137 radiation.

7. Personnel Dosimetry

According to regulations, persons likely to receive radiation exposure levels at 10% or more of the annual limit of 5000 mRem/year must be assigned to wear a personnel dosimeter during work with the accelerator. All individuals are issued a film badge, that is collected and mailed off for analysis. The film badge should never leave the lab. At the end of the day, the film badge is removed and stored.

Although additional dosimeter monitoring would not likely provide additional information, it was decided to locate dosimeters at additional locations around the lab, to verify that radiation exposures continue to be negligible. These area monitors are located:

- At the accelerator control console (#1)
- On the beam support bar, near the experiment port in most use during the month (#2)
- On the wall of the accelerator vault, near the laboratory entrance. (#3)

The diagram in Appendix (B) – Radiation Survey Report (Accelerator) identifies the location within the lab where the area monitors are posted.

These area monitors will be collected and analyzed along with monitors worn by lab personnel. The Accelerator Laboratory Supervisor and the RSO are responsible for reviewing the resulting monitoring report, to ensure that the expected reading of "M" continues. If any doses are greater than 50 mR/month, an investigation will be undertaken to determine the cause of the change. If necessary, corrective action will be taken to reduce the exposure level.

8. Training of Student Operators

All student operators are required to read and understand ***"Instruction Concerning Risks from Occupational Radiation Exposure" – Appendix (H)*** in the Connecticut College Radiation Use Policy and Program. The Connecticut College Radiation Use Policy and Program can be found online at: http://www.conncoll.edu/offices/ehs/5957.htm

The Accelerator Laboratory Supervisor is responsible for ensuring that all students who work in the lab are instructed in the proper use of a calibrated radiation survey meter and proper use of the personal monitoring device (currently TLD film badges), and general radiation safety practices.

All student operators are required to read and understand the "Instruction Manual for Operation and Service of 3SH Pelletron Accelerator", maintained in the lab. The Accelerator Laboratory Supervisor provides additional "hands on" instruction regarding accelerator design and operation. This is so the operator understands the nature and purpose of the various controls.

Actual training in accelerator operation is done "hands-on" under the supervision of the Accelerator Laboratory Supervisor. The prospective operator is required to demonstrate to the Accelerator Laboratory Supervisor's satisfaction that he/she can operate the accelerator over its energy and current range: 0.1-1 MeV and 2-30 microamp gross beam. Gross beam is defined as net output of the machine before collimation and use in the experimental areas.

All students who receive this training will complete and sign a copy of Appendix (A), to record that this training was received.

9. Accelerator Operating Policies

- Access to the accelerator lab is controlled by a keypad lock system. Only authorized (trained) individuals are allowed access to this facility during operation of the accelerator.
- The accelerator key is kept locked in the laboratory desk. Only the Accelerator Laboratory Supervisor or authorized faculty members have access to the key.
- A logbook is located at the accelerator console. Operating data is recorded whenever the system is in use. The operator, individuals present, date, time on/off, and all necessary operating parameters are documented. This data will assist the Accelerator Laboratory Supervisor in monitoring the accelerator system safety on a continuous basis (See Appendix for sample log sheet)
- No one is allowed to perform maintenance, repairs, or modifications until the Accelerator Laboratory Supervisor has given permission to do so. The Accelerator Laboratory Supervisor will maintain records of all maintenance, repair and modifications.
- Operation and service of the accelerator will always be in accordance with the National Electrostatics Corporation instruction manual and with the instruction of the Accelerator Laboratory Supervisor.

The RUC and RSO will be kept informed of all unusual accelerator conditions/activities as they occur. A decision will be made as to actions necessary to ensure radiation levels are kept as low as reasonably achievable.

References

A. Instruction Manual for Operation and Service of 3SH Pelletron Accelerator (Located in Accelerator Laboratory)
B. 105 CMR 120.700 “Radiation Safety Requirements for Particle Accelerators”
C. Connecticut State Regulations (See Accelerator Laboratory Supervisor for copy)

Appendix (A) – Accelerator Safety Training Record

Student/Researcher's Name:	
Date of Birth: (Must be 18 years old.)	

I have received training in the use of the National Electrostatics Corp. 3SH Pelletron Accelerator

This training included the following topics:

- Risks from Occupational Radiation Exposure
- Procedures necessary to minimize exposure
- Purpose and function of protective equipment, monitoring equipment, and personnel dosimeters
- The Connecticut College Radiation Protection Program
- License conditions and State regulations governing the use of the Accelerator
- General radiation safety practices
- Emergency response procedures
- Operating procedures for the accelerator

"I have reviewed NRC Regulatory Guide 8.29, "Instruction Concerning Risks from Occupational Radiation Exposure."" (Appendix (H) of the Connecticut College Radiation Use Policy and Program.)

"I understand the health risks associated with radiation exposure and the precautions necessary to minimize my exposure. I accept the responsibility of performing my assignments in accordance with the procedures of the Connecticut College Radiation Protection Program and those taught to me by authorized faculty members."

The **"Radiation Use Policy and Program,"** and the **"Accelerator Safety Manual"** can be found online at: http://www.conncoll.edu/offices/ehs/5957.htm)

Signature of Researcher/
Student: _____ Date: _____

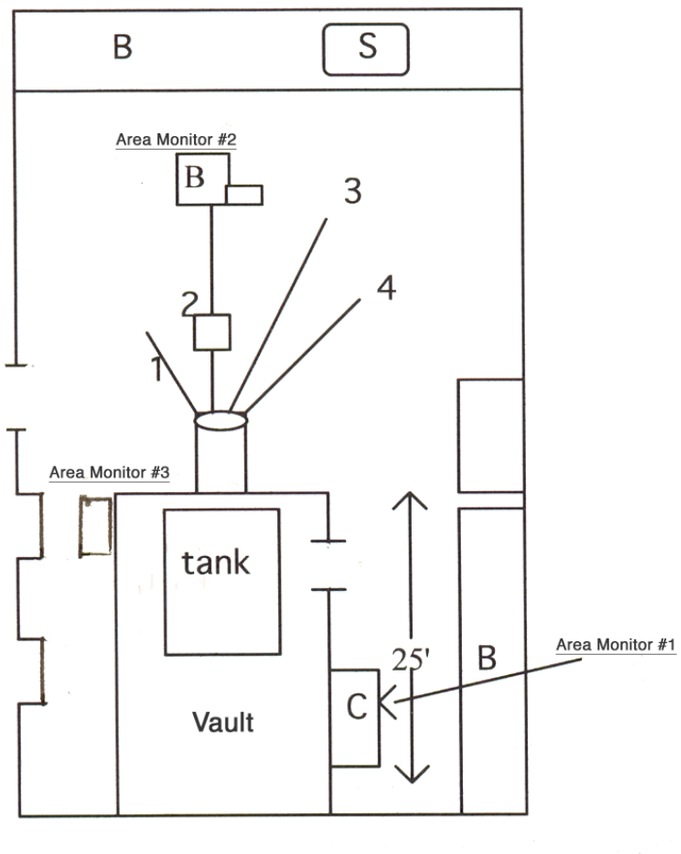
Signature of P.I.: _____ Date: _____

Appendix (B) – Radiation Survey Report (Accelerator)

☐ Initial	☐ Monthly	☐ Follow Up	☐ Other _____
Surveyor:		Date:	
Responsible P.I.:		Dept:	
Building:		Room #:	Olin 020
Type of Facility:		Radiation Source(s):	
Individuals Present:			

SURVEY DATA

Location **Findings**



CHECKLIST: