Radiation Safety User Guide for Cs-137 Irradiators

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1. Introduction

Self-shielded Cs-137 irradiators are self-contained devices in which the shielding required for operation is an integral part of the device, and the irradiation chamber is not accessible during operation. A Cs-137 source is used to irradiate a wide range of products and materials.

2. Regulatory Requirements

The US Nuclear Regulatory Commission (NRC) regulates the use of irradiators in Pennsylvania. The NRC granted Penn and associated facilities (e.g., Wistar Institute, CHOP & HUP) a license to use the irradiators in compliance with current NRC regulations. These regulations can be found in the Code of Federal Regulation: Title 10 CFR Chapter I and are available for review in the EHRS office.

The NRC requires all irradiators to be licensed with their agency. EHRS must be notified before any new irradiator purchase or replacement of an existing unit. EHRS must be notified if a unit is not in use or if it will be transferred to another facility (this includes disposal), so that the applicable requirements of the NRC will meet.

The NRC issues a document called the "Notice to Employees". This document includes information on employees' and employers' rights and responsibilities. A copy of the "Notice to Employees" is posted in a location that is visible to all individuals working with the unit. Copies of these notices are also available at EHRS.

3. Licensee Responsibility

All irradiator use must be under the supervision of a licensee who has been approved by the Radiation Safety Committee. The licensee must assure that the irradiator is under their control at all the times and that users are properly trained. It is the responsibility of the licensee to conduct operations in accordance with the Irradiator Users' Guide, operating and emergency procedures, and license conditions. To ensure proper operation of the unit, the licensee needs to perform visual inspections and operational checks according to the manufacturer's written instructions and recommendations.

EHRS must be notified promptly of any malfunction of the irradiator and before any maintenance or repair work is done.

4. Irradiator Users' Responsibility

All irradiator users are responsible for conducting operations in accordance with the Irradiator Users' Guide and operating and emergency procedures. All individuals who use the irradiator are responsible to promptly report any malfunction of the irradiator to EHRS.

5. Environmental Health and Radiation Safety (EHRS)

EHRS is responsible for ensuring that radiation and radioactive material is used safety at Penn and associated facilities. EHRS performs radiation surveys of each irradiator before it is put into service and periodically thereafter. Leak-tests of all sources, as well as safety operation checks, are performed every six months.

EHRS may be contacted Monday through Friday, and on weekends (24 hours a day) at (215) 898-7187.

6. Posting and Labeling

Labels bearing the radiation symbol, type of source, manufacturer and licensee information is required to be on each irradiator. Current copies of the following documents must be kept at each irradiator:

- Irradiator's Users' Guide
- Operation procedure
- Emergency procedure
- Irradiator use log

7. Training and Registration

Each user of the irradiator must be trained in appropriate radiation safety and operational procedures for the use of the irradiator. This training is separate from (and in addition to) other radiation safety training provided by EHRS.

A. Radiation Safety Training

All persons before using an irradiator must complete "Radiation Safety Training for Operators of Cs-137 Irradiators". This training is available through the EHRS webpage or by contacting EHRS.

B. Operational training

Before using an irradiator, all persons must be trained by the licensee (or his/her designee) in the safe and proper operation of the irradiator. Training by the licensee must cover the following:

- On-the-job training consisting of several irradiation procedures performed under the supervision of the licensee or his/her designee
- Design and operation of the unit
- Step-by-step operating procedures
- Emergency procedures
- Security procedures

C. Irradiator User Registration

Following radiation safety and licensee training, and before using the irradiator individuals must submit a "Request for authorization to use Cs-137 irradiator" form to EHRS.

8. Types of Irradiators

Self-shielded irradiators are self-contained devices in which the shielding required for operation is an integral part of the device, and the irradiation chamber is not accessible during operation. A Cs-137 source is used to irradiate a wide range of products and materials. The majority of the irradiators are not designed for large throughputs. The irradiation of explosive or flammable materials is prohibited.

Depending on the design, the Cs-137 source within the irradiator may be in a fixed position or may be movable.

A. Irradiators with the sources in a fixed position

In this type of irradiator, the sources are fixed and housed within the radiation shield. The shield contains a rotor that is operated by an electric drive. The sample chamber is contained within the rotor and has an electric turntable. During operation, the rotor turns 180 degrees and the sample chamber exposed to radiation. Most irradiators are of this type.

Exposure rates during sample's irradiation are typically from 0.05 to 0.1 mR/hr at contact with the irradiator, and high levels are impossible.

B. Irradiators with moving sources

In this type of irradiator, the sources are mounted on shielded operating rods which are moved from the completely shielded "off" position to the "irradiate" position behind an interlocked shield door. The interlocks are used to ensure that the source does not move into a position that, during normal use of the irradiators, may cause a radiation hazard to any individual. Bypassing or failure of interlock could cause persons to be exposed to high level of radiation. A survey meter or alarm meter must be used for determine the radiation level in the room while the irradiator with moving source (J.L.Shepherd irradiator) is operating.

Exposure rates are typically from 0.1 to 0.5 mR/hr at contact with the irradiator.

9. Radiation Hazard

Self-shielded irradiators typically contain several hundred to several thousand curies (Ci) of cesium-137 (Cs-137) and range in weight from several hundred to several thousand pounds. The Cs-137 radioactive sources are in the form of cesium chloride and the source material is doubly encapsulated in stainless steel.

The design of the irradiator is required to provide shielding (primarily lead) so that the external radiation levels are sufficiently low. For irradiators with moving sources, the radiation level increases up to 2 mrem/hour when the radiation source is in transit from the "off" to the "irradiate" position.

Interlocks, usually both mechanical and electrical to prevent opening of the access door with the sources exposed. Interlocks also prevent movement of the sources or sample chamber to the "irradiate" position while the door is open.

10. Personnel Exposure Monitoring

Exposure to radiation from the irradiator is extremely low. Therefore, personnel dosimeters are not required for routine operation.

11. General Safety

- No one under age of 18 may use the irradiator.
- Pregnant workers should contact EHRS.
- Access to the irradiator room and/or irradiator must be under the control of the licensee.

12. General Use

In general, the use of the irradiator involves:

- moving the sample chamber to the "load" position and/or opening the access door to the sample chamber
- placing the material to be irradiated in the chamber, and closing the access door
- moving the sample chamber to the sources or moving the sources to the sample chamber for the desired period of irradiation
- the loading procedure is reversed at the end of the desired period of irradiation.

The source and/or sample movements are controlled from a control panel mounted on the irradiator.

Good practice and compliance with ALARA concept indicate that time spent near the irradiator should be minimized insofar as it is practical. Each use of the irradiator must be recorded in a log book. Each record must include the last name of the individual using the irradiator and the date. Only registered and trained workers may operate an irradiator. EHRS inspects the logbook at frequent intervals.

13. Irradiator Malfunction

In the event of a malfunction, triggering of an alarm on a meter, or an unusual occurrence, use the following procedure:

- Do not attempt to fix the irradiator;
- Turn off the machine, if possible;
- Leave the room and lock the door;
- Call EHRS at 215-898-7187

14. Requirements for J. L. Shepherd Mark I Irradiators (Moving Sources)

J. L. Shepherd Mark I irradiators have moving sources and consequently the possibility of direct exposure to the sources exists if all the interlocks fail. To confirm that the sources are shielded, the NRC license conditions requires the extra precautions, including visual checks and a radiation alarm present at the unit. The following also apply:

- A unit may not be used unless a calibrated, alarming radiation meter is present, operating, and visible to the irradiator operator when he is next to the irradiator.
- The irradiator door must not be opened until the operator has checked visual indicators to verify that the source has returned to its safe storage position.
- If abnormal radiation levels or any malfunction of the irradiator is detected at any time, the user or licensee must discontinue use of the irradiator and immediately notify EHRS.