

SECTION 8 RADIOACTIVE MATERIALS, RADIATION GENERATING EQUIPMENT (X-Rays) & RADIATION-CONTAINING ANALYTICAL EQUIPMENT

The management of the hazards associated with radioactive materials, radiation generating equipment (X-rays) and radiation-containing analytical equipment are but a subset of the other chemical, biological and physical hazards to which employees and students could be exposed in laboratory settings. Accordingly, the provisions below represent radiation hazard specific guidance regarding the use of such materials and equipment within Taylor Science Center laboratory facilities.

1. Background

For many years, the College maintained a “specific” license to procure, possess and use certain radioactive materials (and isotopes) in accordance with New York State Department of Health (NYSDOH) regulations and appendices, as codified in the following links:

- [10 NYCRR Part 16](#)
- [Appendix A: Exemptions](#)

In 2016, Hamilton terminated/surrendered this specific license and legally disposed of all licensable radioactive materials in its possession. While the College will retain certain exempt radioactive materials and isotopes (in addition to X-Rays and radiation-containing analytical equipment) under a “general” license, this plan’s purpose is to ensure all such materials and equipment are managed in a safe and compliant manner, and in accordance with the applicable rules/regulations noted above.

2. Acquisition/Procurement

The acquisition/procurement of any new materials or equipment identified in sections 3, 4 or 5 below (with the exception of naturally radioactive minerals, rocks or ores) must be approved by the Director of EP&S in accordance with the form in Appendix 8-1 below.

3. Radioactive Materials

Regulatory/Management Considerations:

Under a general license, there are various types and quantities of “loose source” and “exempt sealed source” radioactive materials the College may legally possess. Additionally, naturally radioactive minerals, rocks and ores are exempt from NYSDOH under certain situations. All such radioactive materials at the College will be managed as follows:

Loose Source Radioactive Materials

The College may possess up to 15 lbs of loose uranium and thorium source material, examples of which are depicted below. Loose source materials in their original manufacturer’s provided container (or their temporary storage container) must be radiation flagged and bar coded for tracking purposes by the Science Stockroom. The containers will primarily be stored within the stockroom’s “Special Hazard Storage” space (G083), until/unless they are episodically required by the academic departments who own the source material. The only exception to this storage rule is for the Physics department’s 10 radiation detectors containing small amounts of thorium oxide integral to the devices, which are to be stored/secured at all times in a departmental cabinet in G037 when not in use.

Thorium Oxide



Radiation Detector



XRF Standards



Safety Considerations with Loose Source Radioactive Materials:

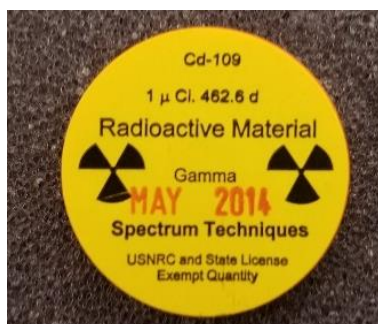
Loose source radioactive materials, by the very nature of the College's ability to possess them under the 15 lb threshold without a special license, are typically more hazardous from a chemical perspective as opposed to their radioactivity. As a general rule, these materials may exert their toxic (and residual radioactive) effects only if they gain entry into the body via inhalation or ingestion routes of exposure. In order to prevent personnel exposure to loose source radioactive materials, adhere to the following:

- Personnel actively using loose source radioactive materials will be trained and in immediate possession of the respective SDS or MSDS for the product, and the SDS/MSDS will be posted in the lab where the work is ongoing.
- All physical transfers of loose source radioactive materials will be performed inside fume hoods, with personnel wearing appropriate PPE (at a minimum to include lab coats, safety glasses and nitrile gloves).
- Articles/items contaminated with loose source radioactive material during physical transfer activities (like spatulas, weigh boats, glass/plastic containers, etc.) are to be wholly disposed of as waste associated with the host chemical, i.e. thorium oxide contaminated debris.
- Small, incidental spills within a fume hood may be collected with suitably absorbent material—paper towels if the material is a liquid, or paper towels wetted with water if the material is a powder. Small, incidental spill waste may be collected by the same strategy noted above.
- Any spill of loose source radioactive material outside of a fume hood is considered to be a Level 2 emergency, requiring an evacuation of the lab and immediate notification to Campus Safety and EP&S for spill response purposes.

Never mix loose source radioactive material with a chemical (or chemicals) that have other hazards, such as flammable solvents, corrosives or poisons.

Exempt Sealed Source Radioactive Materials

The College may possess exempt sealed source radioactive materials (commonly called “disc sources”) of many different isotopes, so long as they are in exempt quantities as specified in the applicable regulations. Examples of such sealed sources are depicted to the right. All sealed sources will be individually packaged in small plastic containers with radiation flags, and bar coded for tracking purposes by the Science Stockroom. Exempt sealed sources will primarily be stored within the stockroom's “Special Hazard Storage space (G083), until/unless they are episodically required by the academic departments who own them.



Safety Considerations with Exempt Sealed Source Radioactive Materials:

While exempt sealed sources represent a minimal risk to personnel, the following safety considerations shall apply:

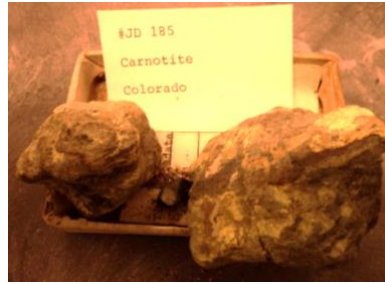
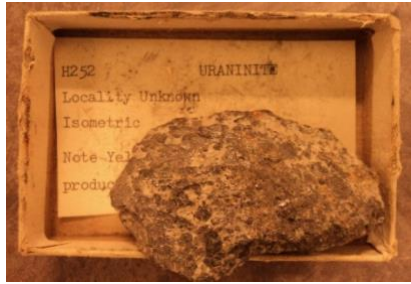
- Exempt sealed sources should be minimally handled. In instances where they must be physically manipulated, they should be held at the edges of the disk. Avoid touching the flat surfaces on the labeled or unlabeled sides.
- Standard lab safety practices (no eating, drinking, applying cosmetics, etc.) apply in labs or other locations where exempt sealed sources are utilized. Always wash hands after handling exempt sealed sources.

- Since exempt sealed sources are small and easy to misplace, always return them to their radiation flagged and bar coded plastic container following use.

Never intentionally damage exempt sealed sources (by cutting, breaking, sectioning, etc.), which would otherwise increase the hazard associated with the material. Further, exempt sealed sources that are accidentally damaged must be immediately taken out of service and given to EP&S for disposal purposes.

Naturally Radioactive Minerals, Rocks and Ores

All minerals, rock and ores (to some extent) have the capacity to contain trace amounts of uranium or thorium, thereby making such materials naturally radioactive. Examples of such materials (uraninite and carnotite) are depicted below. The NYSDOH specifically exempts naturally radioactive minerals, rocks and ores from their regulations, so long as they are not processed or reduced in any way, shape or form (i.e. grinding, shaping, etc.).



Safety Considerations with Naturally Radioactive Minerals, Rocks and Ores:

Regardless of the fact that these materials are exempt from the NYSDOH regulations if the above criteria apply, personnel exposure to radiation hazards should be controlled and/or minimized by adhering to the following:

- Materials known to possess radioactive characteristics should always be minimally handled, and personnel should always wear disposable gloves if handling is a necessity.
- The display of materials known or suspected to contain radiation hazards should employ shielding tactics to prevent personnel exposure. Similarly, the storage of such materials should provide mechanisms to both shield the materials and prevent access to them by unauthorized personnel.

Field work that collects material samples from outcrops or other locations where there is the potential for a radiation hazard should be led by individuals knowledgeable in recognizing this hazard, and hand-held Geiger-Mueller counters should be used as necessary to evaluate this hazard.

4. Radiation Generating Equipment (X-Rays)

The College currently maintains an inventory of 10 X-ray units, as follows:

- Archeology—2 Olympus and 1 Bruker portable XRF's
- Biology—1 Quanta SEM
- Chemistry—1 Rigaku x-ray diffractometer
- Geoscience—1 Thermo XRF
- Physics—4 3B Scientific Tel-X-Ometers

Regulatory/Management Considerations:

NYSDOH regulations require both X-ray unit registration and a regular fee to be paid on a per device basis. The Assistant Director of EP&S will maintain and display the X-ray facility registration certificate in office #G076 of the Taylor Science Center, and the registration process (or de-registration process, where/when applicable) will be managed as follows:

- As noted above, the Director of EP&S must approve requests for new X-ray devices at least 30 days before ordering.
- Within 10 days of 1—the receipt of a new X-ray unit, or 2—the disposal/scraping or sale of an existing registered X-ray unit, EP&S will make the appropriate notification to the NYSDOH. When such notifications

are related to disposal/scraping or sale transactions, EP&S will utilize and submit the form to the NYSDOH found at this [LINK](#).

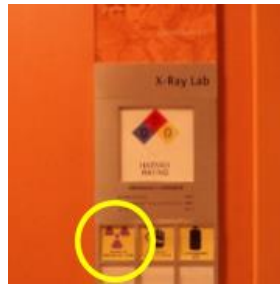
- And, EP&S will be responsible for paying any/all X-ray fees to the NYSDOH as necessary to maintain the facility registration certificate.

X-Ray Device Safety Considerations:

- Departments and PI's shall develop written equipment SOP's and lab hazard evaluations (with the assistance of EP&S) to both serve as training tools for X-Ray users and to complement existing information provided by unit manufacturers. All such units will be maintained and operated strictly in accordance with such documentation, and EP&S will maintain copies of all written documentation.
- On an initial and bi-annual basis (or otherwise following X-Ray device relocation, tampering, modification or repair), documented inspections shall be performed on all College X-ray units as stipulated in Appendix 8-2 below.
- X-Ray safety signage and labeling for hazard awareness purposes will be employed as per the below:

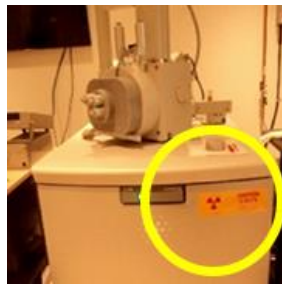
Lab Signage

Labs or rooms where X-Ray devices will primarily be used shall be labeled with either stand-alone signs, or icons integrated into facility hazard signage, indicating "Radiation Generating Equipment" (or the like) is located within the space.



X-Ray Device Labels or Lights

Individual X-Ray devices shall be identified with either "Caution—X-Rays" signs, or warning lights indicative of the same.



Open Beam Caution Labels

Lastly, in the case of the 3 portable XRF units that can be operated as an "open beam", warning labels are required at the tube head.



Use of Portable X-ray Devices for Outdoor Field Work:

The configuration and utility of the Archeology department's 3 portable XRF's permit them to be used in outdoor field work environments. In such instances, the following considerations apply:

- Since outdoor XRF use is typically performed without a shielded test chamber, appropriate safe work practices must be utilized to effectively shield device users from scattered X-ray hazards. This could include, but is not limited to, using lead blankets or foil to shroud the beam and sample area.
- Using the portable XRF's in most outdoor field work areas of New York State is generally permissible. However, the use of such devices within the 5 boroughs of New York City, or any other non-New York State locality, must comply with the local or NYSDOH equivalent regulations that apply. Planned field work excursions to these areas must take appropriate measures to assure compliance, which could include but are not limited to the following:
 - Obtaining the necessary reciprocity agreements with other states; and
 - Possession of the NYSDOH's facility registration certificate, the device's operating guidelines and this SOP when in the field.
- All short-term/temporary uses of a portable XRF in an outdoor field work environment shall be approved by EP&S in accordance with Appendix 8-3 below. EP&S will maintain a copy of the approval form (and any other supporting documentation from other regulatory agencies) during periods when a portable XRF is outside of Hamilton College property. EP&S will also terminate the approved off campus use by completing the appropriate portions of the form, and will retain completed forms as a part of the program's permanent record.

5. Radiation-Containing Analytical Equipment

Certain analytical devices (and other types of equipment used in lab settings—see below) are often manufactured with sealed internal radiation sources. Very specific NYSDOH and/or federal Nuclear Regulatory Commission (NRC) regulations apply with regard to the management of these devices and their radiation hazard, which often are both equipment and manufacturer specific. The procurement of any radiation-containing analytical (or other) equipment must be approved and authorized by EP&S. Currently, the College has 2 such devices in the Taylor Science Center that must be managed as described below.

Agilent Electron Capture Detector (ECD)

This device contains a sealed radioactive source, nickel-63 at 15 mCi, which is a low energy beta emitter with a half-life of 100 years. Radiation from this source cannot be detected outside of the source housing so does not normally pose a radiation hazard to personnel. College personnel are not authorized to remove this source, and only the manufacturer (or other authorized designees) may perform repair, cleaning or maintenance activities. The device shall be labeled to indicate it has an internal radiation source.



Wallac Liquid Scintillation Counter (LSC)

This device contains a sealed radioactive source, europium-152 at 20 uCi, which is a beta emitter with a half-life of 13.5 years. Radiation from this source cannot be detected outside of the source housing so does not normally pose a radiation hazard to personnel. College personnel are not authorized to remove this source, and only the manufacturer (or other authorized designees) may perform repair, cleaning or maintenance activities. The device

shall be labeled to indicate it has an internal radiation source.



Other Regulatory Requirements:

Both the Agilent ECD and the Wallac LSC are considered to be “generally licensed devices”, for which manufacturers are required to notify the NRC within 10 days following purchase transactions by end users, like the College. The College is obligated to notify the NRC and NYSDOH within 30 days if it sells/transfers such devices to other qualified end users, or disposes of them outright. For generally licensed devices with sealed radioactive sources <100 uCi in activity (like the LSC), end users are not required to regularly perform any leak detection activities. However, for generally licensed devices at or >100 uCi in activity (like the ECD), the following rules apply.

- The Agilent ECD must be inventoried and leak tested every 6 months, and samples are to be sent off site for assessment by an authorized lab. The following actions apply based upon leak test results:
 - No action required if leak test reveals removable contamination <0.005 uCi.
 - If the leak test reveals contamination >0.005 uCi, the device must be taken out of service and the NRC/NYSDOH must be notified.

All leak test (and other related maintenance activities) associated with the Agilent ECD will be performed by the Science Center instrumentation specialist, and records will be forwarded to EP&S for permanent recordkeeping.

Other Types of Radiation-Containing Equipment in Lab Settings:

Other types of radiation-containing equipment (like static eliminators placed inside balances, as on the right) contain very specific radioactive isotopes, and special compliance obligations apply to the College’s use, possession and disposal of the equipment. In this specific situation, the static eliminator contains polonium-210 at 500 uCi in activity, with a half-life of 138 days. This alpha emitter is only effective as a static eliminator for about 1 year, after which the College is obligated to return the equipment to the manufacturer for disposal.



Appendix 8-1

Acquisition/Procurement Approval Form for Radioactive Materials, Radiation Generating Equipment (X-Rays) & Radiation-Containing Analytical Equipment

The acquisition/procurement of certain radioactive materials (loose source materials or exempt sealed sources), radiation generating equipment (X-Rays) & radiation-containing analytical equipment must be approved by the Director of EP&S a minimum of 30 days before the ordering of such materials using the form below. Approval may be noted as granted, conditional or denied, based upon general licensee compliance (or other) obligations in accordance with this section of the CHP.

Requestor name:	Department:	Lab #:
Email:	Phone #:	Date:
Requestor signature:		
Dept. Chair Signature/Date:		
Provide sufficient material/equipment description below to facilitate approval determination, such as:		
<ul style="list-style-type: none"> • The isotope, weight and activity level of loose source material • The isotope, half-life and activity level of exempt sealed sources • The manufacturer, model # and type of X-Ray • The manufacturer, model #, source isotope and activity level of radiation-containing analytical equipment 		

Will the use of loose source material result in the generation of radioactive or mixed radioactive/hazardous waste?		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> N/A
If yes, does the department have sufficient funding to cover such disposal costs?		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> N/A
Are sufficient laboratory control measures in place where the materials/equipment are to be used? If no, please provide a description of how/when such lab control measures will be implemented, and who will pay for any such upgrades. _____		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> N/A

Will there be disposal costs associated with source disposal for radiation-containing analytical equipment?		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> N/A
If yes, does the department have sufficient funding to cover such disposal costs?		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> N/A

EP&S Approval Determination		
<input type="checkbox"/> Approval Granted	<input type="checkbox"/> Conditional Approval Granted	<input type="checkbox"/> Approval Denied
Determination Justification:		

EP&S Signature:		Date:

**Appendix 8-2
Initial, Bi-Annual & Episodic X-Ray Inspection Form**

Use table below to evaluate radiation survey

survey meter readings (milliRem/hr)	findings	action needed
< 0.5	desirable	none
0.5-0.9	acceptable	increase monitoring frequency
1.0-2.0	not acceptable	remove from service

3B Scientific Tel-X-Ometers (4) in Science G037

Background	milliRem/hr
Serial #	037205
Operating Conditions	30kV 50mA
Scatter shield	milliRem/hr
Backstop area	milliRem/hr
Action needed:	

Background	milliRem/hr
Serial #	060402
Operating Conditions	30kV 50mA
Scatter shield	milliRem/hr
Backstop area	milliRem/hr
Action needed:	

Background	milliRem/hr
Serial #	60002539
Operating Conditions	30kV 50mA
Scatter shield	milliRem/hr
Backstop area	milliRem/hr
Action needed:	

Background	milliRem/hr
Serial #	013309
Operating Conditions	30kV 50mA
Scatter shield	milliRem/hr
Backstop area	milliRem/hr
Action needed:	

Bruker Tracer Vi pXRF

Background	milliRem/hr
Serial #	900F3976
Operating conditions	kV mA
Probe housing	milliRem/hr
Grip	milliRem/hr
30 cm	milliRem/hr
100 cm or test stand	milliRem/hr
Action needed:	

Thermo Perform'X XRF Spectrometer in 1037

Background		milliRem/hr
Serial #	PFX-302	
Operating conditions	45kV 45mA	
Sample intro. shutter		milliRem/hr
Tube housing		milliRem/hr
Goniometer housing		milliRem/hr
Action needed:		

Rigaku Mini-Flex XRD Spectrometer in 1071

Background		milliRem/hr
Serial #	BD09696	
Operating conditions	30kV 15mA	
Sample chamber door		milliRem/hr
Xray tube housing		milliRem/hr
Detector housing		milliRem/hr
Action needed:		

FEI Quanta 400 Scanning Electron Microscope in 2040

Background		milliRem/hr
Serial #	D7584	
Operating conditions	30kV 150uA	
Sample chamber housing		milliRem/hr
Detector housing		milliRem/hr
Column		milliRem/hr
Action needed:		

(inspector name)	(signature)	(date)
Survey meter used:		Calibration date:

Appendix 8-3 Portable XRF Outdoor Field Work Use Approval Form

Whenever a portable XRF registered to Hamilton College is to be taken off campus for field work, such use shall be approved by the Director of EP&S, in accordance with the form below. This use approval form shall be maintained in the office of the Assistant Director of EP&S.

Requestor name:	Department:	Lab #:
Email:	Phone #:	Date:
Device type and serial #:		
Requestor signature:		
Dept. Chair Signature/Date:		
Provide a description of what the portable XRF will be used for:		

Provide a description of the appropriate safety measures to be employed:		

Provide information regarding the expected dates of departure and return with the device:	Expected departure date:	
	Expected return date:	
Will the device be taken to any of the 5 boroughs of New York City, or to any other non-NYS locality?	<input type="checkbox"/> Y <input type="checkbox"/> N	
If yes, please describe what measures have been taken to assure compliance:		

<p>*Note—Always bring a copy of the NYSDOH’s facility registration certificate, the device’s operating guidelines and the Radiation Safety SOP with you when leave campus with a pXRF. Also be sure to bring copies of documentation from other regulatory agencies, like temporary registration forms or reciprocity agreements when out of NYS.</p>		

EP&S Approval Determination & Other		
<input type="checkbox"/> Approval Granted	<input type="checkbox"/> Conditional Approval Granted	<input type="checkbox"/> Approval Denied
Determination Justification:		

EP&S Signature:		Date:
Actual date of the return of the device to the Hamilton College campus:		
Was the device returned in good working order?	<input type="checkbox"/> Y <input type="checkbox"/> N	
If no, please provide a disposition:		

