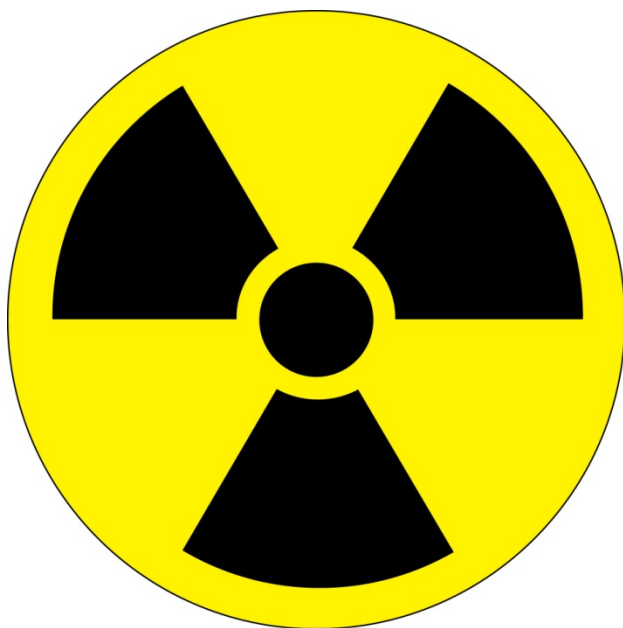


Colgate University

Radiation Safety Manual



Colgate University

13 Oak Drive

Hamilton, New York 13346

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Radiation Safety Manual

Contact Information

Colgate University Campus Safety	(315) 228-7333	General Information
	(315) 228-7911	24-Hour Emergency
Colgate University Environmental Health and Safety	(315) 228-7994 / 6411	
Colgate University Radiation Safety Officer	(315) 228-7393	
NYS Bureau of Environmental Radiation Protection	(518) 402-7550	
U.S. Nuclear Regulatory Commission	(301) 415-7000	General Information
	(301) 816-5100	24-Hour Emergency

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Chapter 1: Radiation Safety Committee

The Radiation Safety Committee (RSC) is responsible for ensuring that all individuals who work with or in the vicinity of radioactive materials or radiation producing equipment (other than background radiation) have sufficient training and experience to enable them to perform their duties safely and in accordance with U.S. Nuclear Regulatory Commission (NRC) 10 CFR Part 20 *Standards For Protection Against Radiation* (see Appendix A), New York State (NYS) 10 NYCRR Part 16 *Ionizing Radiation* (see Appendix B), and the conditions of the Colgate University Radioactive Materials License (see Appendix C). The RSC is also responsible for ensuring that all use of radioactive materials and radiation producing equipment is conducted in a safe manner, in accordance with the previously cited state and federal regulations and the conditions of the Colgate University Radioactive Materials License.

The RSC shall perform the following duties:

- Be familiar with the pertinent NRC and NYS Department of Health regulations, the terms of the Colgate University Radioactive Materials License, and information submitted in support of the request for the license and its amendments.
- Review the training and experience of all individuals who use radioactive materials or radiation producing equipment and determine that their qualifications are sufficient to enable them to perform their duties safely in accordance with NRC and NYS Department of Health regulations, the conditions of the Colgate University Radioactive Materials License, and the Colgate University radiation installation registration.
- Be responsible for monitoring the institution's program to maintain individual and collective doses as low as reasonably achievable (ALARA).
- Review semi-annually, with the assistance of the Radiation Safety Officer (RSO), occupational radiation exposure records of all personnel working with radioactive materials and radiation equipment.
- Establish a table of investigational levels for occupational radiation exposure, which when exceeded, will initiate an investigation and consideration of action by the RSO.
- Establish a program to ensure that all individuals whose duties may require them to work in the vicinity of radioactive materials or radiation equipment are properly trained as required by 10 NYCRR Section 16.13 *Notices, Instructions, and Reports to Workers*.
- Review and approve all requests for use of radioactive materials and radiation equipment within the institution.
- Prescribe special conditions that will be required for any proposed use of radioactive materials and radiation equipment (ex. bioassays, physical examinations of users, special monitoring procedures).
- Review the entire radiation safety program at least annually to determine that all activities are being conducted safely and in accordance with NRC and NYS Department of Health regulations and the conditions of the Colgate University Radioactive Materials License. The review shall include examination of all records, reports from the RSO, results of the NYS Department of Health inspections, written safety procedures, and the adequacy of the institution's management control system.

- Recommend remedial action to correct any deficiencies identified in the radiation safety program.
- Maintain written records of all RSC meetings, actions, recommendations, and decisions.
- Ensure that the Radioactive Materials License and radiation installation registration are amended, when necessary, prior to any changes in facilities, equipment, policies, procedures, radioactive materials, possession limits, and personnel, as specified in the Radioactive Materials License and radiation equipment registration respectively.

The RSC shall meet as often as necessary to conduct its business, but not less than once in each calendar quarter. An RSC quorum shall consist of at least one-half the RSC's membership, including the RSO and the management representative.

Chapter 2: Radiation Safety Training Program

All Colgate University personnel working with radioactive materials and/or involved in the programmatic oversight of radioactive materials use at the university are required to take Laboratory Radiation Safety Training on an annual basis. Personnel in this category include all authorized users, RSC members, and the RSO. All ancillary personnel (ex. Campus Safety officers, Facilities custodial staff, administrative assistants) whose duties require them to work in the vicinity of radioactive materials (whether escorted or not) are required to take General Radiation Safety Training on an annual basis. Since the training includes licensure conditions and emergency response procedures specific to Colgate University, past training and/or training at an alternate site are not acceptable substitutions for the annual Colgate University approved radiation safety training requirements. Training anniversary dates and record-keeping will be maintained by Department of Environmental Health and Safety (EHS) via the Colgate University training management system (Traincaster).

Colgate University personnel will be instructed:

- Before assuming duties with, or in the vicinity of, radioactive materials.
- During annual refresher training.
- Whenever there is a significant change in duties, regulations, or the terms of the license.

Colgate University radiation safety training will include the following:

- Applicable regulations and license conditions.
- Areas where radioactive materials are used or stored.
- Potential hazards associated with the radioactive material in each area where the employees work.
- Appropriate radiation safety procedures.
- Colgate University safe / prudent radioactive materials work practices.
- Each individual's obligation to report unsafe conditions to the RSO.
- Unsafe conditions reporting
- Emergency response procedures.
- Worker's right to be informed of occupational radiation exposure and bioassay results.
- Locations of the Colgate University radioactive materials related licenses and regulations (as required by 10 NYCRR Part 16 *Ionizing Radiation*).

All training records will be maintained for five years and will include the following: date and time the training was conducted; duration of the training; name(s) of the instructor; names of course attendees; and a list of topics covered.

Chapter 3: Radiation Survey Instrument Calibration

Colgate University radiation survey meters shall be calibrated with a radioactive source. Electronic calibrations are not acceptable. All university survey meters must be calibrated at least annually and after servicing. Please note that battery changes are not considered servicing. Commercial service providers conducting survey meter calibrations must be U.S. NRC licensed and a copy of the license shall be kept on file with the calibration certificates. Calibrations performed by commercial service providers or Colgate University personnel must conform to either the ANSI N323AB-2013 *American National Standard for Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments* (see Appendix D) or the following survey meter calibration procedures:

- The source must be approximately a point source.
- Either the apparent source activity or the exposure rate at a given distance must be traceable by documented measurements to a standard certified within 5 percent accuracy by the National Bureau of Standards.
- A source that has the same photon energy as the environment in which the calibrated device will be used for calibration.
- The source will be of sufficient strength to give an exposure rate of approximately 30 mR/hr at 100 cm. Minimum activities of typical sources are 85 millicuries of cesium 137 (Cs-137), 21 millicuries of cobalt 60 (Co-60), and 34 millicuries of radium 226 (Ra-226).
- The inverse square law and the radioactive decay law must be used to correct for change in exposure rate due to changes in distance or source decay.
- A single point on a survey meter scale may be considered satisfactorily calibrated if the indicated exposure rate differs from the calculated exposure rate by less than 10 percent.
- The survey meter scale will determine the number of calibration points:
 - Meters on which the user selects a linear scale must be calibrated at no less than two points on the scale. The points should be at approximately 1/3 and 2/3 of the decade.
 - Meters that have a multi-decade logarithmic scale must be calibrated at no less than one point on each decade and no less than two points on one of the decades. Those points should be at approximately 1/3 and 2/3 of scale.
 - Meters that have an automatically ranging digital display device for indicating rates must be calibrated at no less than one point on each decade and at no less than two points on one of the decades. Those points should be approximately 1/3 and 2/3 of the decade.
- Readings above 1000 mR/hr do not require calibration. However, such scales should be checked for operation and approximately correct response.
- At the time of calibration, the apparent exposure rate from a built-in or owner-supplied check source must be determined and recorded.
- A report must be made for each survey meter calibration. The survey meter calibration report shall include the procedure used and data obtained including the following:
 - The owner or user of the equipment.
 - A description of the instrument that includes manufacturer, model number, serial number, and type of detector.

- A description of the calibration source, including exposure rate at a specified distance on a specified date.
- For each calibration point, the calculated exposure rate, the indicated exposure rate, the deduced correction factor (i.e. the calculated exposure rate divided by the indicated exposure rate), and the scale selected on the instrument.
- The reading indicated with the instrument in the “battery check” mode (if available on the instrument).
- The angle between the radiation flux field and detector. For external cylindrical Geiger-Muller or ionization-type detectors, this will be “parallel” or “perpendicular” indicating photons traveling either parallel with or perpendicular to the central axis of the detector. For instruments with internal detectors, this should be the angle between the flux field and a specified surface of the instrument.
- For detectors with removable shielding, an indication of whether the shielding was in place or removed during the calibration procedure.
- The apparent exposure rate from the check source.
- The name of the person who performed the calibration and the date on which the calibration was performed.
- The following information will be attached to the instrument as a calibration sticker or tag:
 - The source that was used to calibrate the instrument.
 - The proper deflection in the battery check mode (unless this is clearly indicated on the instrument).
 - For each scale or decade, one of the following as appropriate:
 - the average correction factor;
 - a graph or graphs from which the correction factor for each scale or decade may be deduced; or
 - an indication that the scale was checked for function but not calibrated or an indication that the scale was inoperative.
 - The angle between the radiation flux and the detector during the calibration.
 - The apparent exposure rate from the check source.

EHS will maintain an inventory of all Colgate University radiation survey instrumentation (see Appendix E) and documentation of all associated survey meter calibrations. Radiation survey instrument calibration records shall be retained for a minimum of five years.

Chapter 4: Radioactive Materials / Equipment Ordering and Receipt Procedures

The RSO will approve all orders for radioactive materials and radiation equipment. The RSO will also ensure that the requested materials, quantities, and equipment are authorized by the license and that possession limits are not exceeded. Radioactive material and radiation equipment orders must be placed using a purchase order. The Colgate University Purchasing Department will not process any order where radioactive materials or radiation equipment is indicated unless it is countersigned by the RSO. Radioactive material and radiation equipment orders using a credit card will not be accepted at the mailroom, Central Receiving, or EHS Receiving. Upon approving a radioactive material or radiation equipment order, the RSO will contact EHS and inform them of the pending order.

Upon notification of the pending radioactive materials order, EHS will perform the following receipt procedures:

- Record the supplier, isotope, compound, and activity levels and ensure receipt of the purchase order from the Purchasing Department.
- Reference the order record at the time of receipt, opening, inspection, and storage of the radioactive material shipments.
- Maintain a written record of all radioactive material orders and receipts.
- Ensure radiation safety signage is posted at the radioactive materials order destination.
- Ensure that the prospective radioactive materials order users have received the required radiation safety training.

Upon notification of the pending radiation equipment order, EHS will perform the following receipt procedures:

- Ensure radiation safety signage is posted at the radioactive materials order destination.
- Ensure that the prospective radioactive materials order users have received the required radiation safety training.

During normal working hours (Monday – Friday, 7 a.m. to 4:00 p.m.), carriers will be instructed to deliver radioactive material shipments to EHS Receiving at Ho Science Center Room B07. During off-duty hours, carriers are instructed to call the EHS Duty Officer per signage posted at EHS Receiving (see Appendix F). The EHS Duty Officer will receive the radioactive material shipment and ensure that positive control of the package is maintained at all times.

Chapter 5: Radioactive Materials Package Opening Procedures

Special requirements will be followed for packages containing quantities of radioactive material in excess of the “A” quantities specified in 49 CFR 173.435 *Table of A Values for Radionuclides* (see Appendix G). In accordance with 10 NYCRR Section 16.16(b) *Procedures for Picking Up, Receiving, and Opening Packages*, these packages will be monitored for surface contamination and external radiation levels within 3 hours after receipt if received during normal working hours or not later than 3 hours from the beginning of the next working day if it is received after working hours. The NYS Department of Health will be notified in accordance with regulations if removable contamination exceeds 0.01 uCi/100 square centimeters (22,000 dpm) or if external radiation levels exceed 200 mR/hr at the package surface or 10 mR/hr at 3 feet (or 1 meter).

For all packages, the following procedures for opening packages will be carried out:

- Don appropriate glove protection to prevent hand contamination
- Visually inspect package for any sign(s) of damage (ex. wetness, crushed). If any damage is noted, stop procedure and notify the RSO.
- Measure the exposure rate at 3 feet (or 1 meter) from package surface and record. If it is higher than usual, stop and notify the RSO.
- Open the package with the following precautionary steps:
 - Open the outer package (following manufacturer’s directions if supplied) and remove packing slip.
 - Open inner package and verify that the contents agree with those listed on the packing slip. Compare requisition, packing slip, and label on container.
 - Check integrity of final source container (ex. inspect for breakage of seals or vials, loss of liquid, and discoloration of packaging material).
- If there is any reason to suspect contamination, wipe external surface of final source container and remove wipe to low background area. Assay the wipe and record amount of removable radioactivity (i.e. dpm/100 square centimeters). Check wipes with a thin–end window GM survey meter, and take precautions against the spread of contamination as necessary.
- Survey the packing material and packages for contamination before discarding.
 - If contaminated, treat as radioactive waste.
 - If not contaminated, destroy radiation labels before discarding the packaging in regular trash.

Maintain records of the results radioactive materials package opening (including inspection and associated survey) using the Radioactive Materials Shipment Receipt Record (see Appendix H) or a form containing the same information.

Chapter 6: Radioactive Materials / Radiation Equipment Operating Procedures

Radioactive material and radiation equipment users must abide by the following radiation safety operating procedures:

Prior to performing operations with radioactive material or radiation equipment which may produce significant external or internal exposure, consideration shall be given by the user to radiation safety measures including the use of remote handling devices, hoods, shielding, personal protective equipment (PPE), etc. The RSO must be consulted prior to any new use of radioactive material.

Eating, drinking, storing and/or preparing food or beverages, smoking, applying cosmetics, and mouth pipetting are prohibited in Colgate University laboratories and any space containing radioactive materials or radiation equipment.

Laboratory equipment used in direct contact with radioactive materials, including pipetting devices, shall be segregated from laboratory equipment not in direct contact with radioactive materials.

Laboratory coats, protective eyewear, and disposable gloves shall be worn as appropriate in Colgate University laboratories including during operations involving the use of radioactive materials. The laboratory coats and gloves shall be removed before leaving the laboratory. Extreme care shall be taken to not handle laboratory items (ex. pens / pencils, notebooks, door knobs, telephones, etc.) with gloves used during work with radioactive materials.

Personnel that have been issued radiation monitoring devices (whole-body or ring badges) as prescribed by the RSO shall wear them whenever working with radioactive material / radiation equipment. Personnel monitoring devices shall be stored in a designated low background area whenever they are not being worn to monitor occupational exposures.

Any work which may result in contamination of work surfaces shall be done over plastic backed absorbent paper. Trays made of impervious materials (ex. stainless steel, porcelain coated) and lined with absorbent paper will be used whenever practicable to prevent the spread of contamination.

Work surfaces and personnel shall be monitored after working with radioactive materials. Any objects or equipment determined to be contaminated shall be decontaminated prior to removal from the laboratory.

Radioactive materials shall be stored in covered containers plainly identified and labeled with the name of the compound, radionuclide, date, and activity / radiation level if applicable.

All transport of radioactive materials shall be in shielded containers.

All radioactive waste will be properly disposed of by EHS.

In the event of a radioactive material spill, personnel shall be monitored for contamination regardless of the spill size / category. Potentially contaminated clothing shall be removed as soon as possible. Contact EHS to perform an area survey, determine contamination levels, and decontaminate as necessary. Report the spill to the RSO.

In accordance with 10 NYCRR Section 16.13 *Notices, Instructions, and Reports to Workers*, radioactive material / radiation equipment operating procedures will be posted at a prominent location in each laboratory where use of radioactive materials or radiation equipment is authorized.

Chapter 7: Radioactive Materials Spill Procedures

Minor spills are defined as spills that can be safely cleaned up by an authorized (principal) user, an independent user, or qualified Colgate University emergency response personnel without risk to life or health. Major spills are defined as spills that require non-Colgate university emergency response assistance and/or cannot be safely cleaned up without risk to life or health. Spill procedures are as follows:

Minor Spills

1. **NOTIFY:** Immediately notify persons in the area that a spill has occurred. Permit only the minimum number of persons necessary for spill clean up to remain in the room.
2. **PREVENT THE SPREAD:** After donning protective gloves and eyewear, cover a liquid spill with dry absorbent paper / cover a dry spill with thoroughly dampened pad.
3. **CLEAN UP:** Use disposable gloves and remote handling tongs. Carefully fold the absorbent paper / pad. Insert paper / pad and any other disposable contaminated materials into a plastic bag and place in the radioactive waste container.
4. **DECONTAMINATE:** Conduct a wipe down of all contaminated equipment and work surfaces (including floors and walls if necessary) using laboratory detergents, acids, or cleaning solutions as appropriate.
5. **SURVEY:** With a low-range thin-window GM survey meter, check the area around the spill, hands, and clothing for contamination. Repeat decontamination and re-survey as necessary.
6. **REPORT:** Report the incident to the RSO and EHS. The RSO will submit the required notifications / reports to the NYS Department of Health Bureau of Environmental Radiation Protection (BERP).

Major Spills

1. **CLEAR THE AREA:** Immediately notify all persons not involved in the spill to vacate the room.
2. **PREVENT THE SPREAD:** If it can be done safely and without further contamination or without significantly increasing personnel radiation exposure, cover a liquid spill with dry absorbent paper / cover a dry spill with thoroughly dampened pad. Do not attempt to clean up spill. Confine the movement of all personnel potentially contaminated to prevent the spread. Direct shutdown of ventilation system to prevent the spread of contaminated airborne particles.
3. **SHIELD THE SOURCE:** If it can be done safely and without further contamination or without significantly increasing personnel radiation exposure, shield the spill with the appropriate materials based on the type of radioactive source (ex. paper for alpha particles, Lucite plastic / glass / wood for beta particles, concrete / lead for gamma radiation).

4. CLOSE THE ROOM: Leave the room and lock the door(s) to prevent entry.
5. CALL FOR HELP: Notify Campus Safety, EHS, and the RSO immediately. EHS and the RSO will respond and take charge of all remaining spill response efforts.
6. DECONTAMINATE: Stabilize any trauma / medical conditions prior to decontamination. Remove contaminated clothing and store for evaluation or disposal. Survey personnel to ascertain potential for contamination. If the spill / contamination is on the skin and/or widespread, shower with mild soap and warm water. Resurvey personnel to determine any remaining localized contamination. Rinse remaining localized personnel contamination areas thoroughly, dry, and re-survey. Repeat personnel decontamination process as necessary.
7. SURVEY: Do not permit personnel back into affected work area until spill response / decontamination efforts are complete and a survey has designated the area as safe to reoccupy.
8. REPORT: The RSO will submit any required notifications / reports to the NYS Department of Health Bureau of Environmental Radiation Protection (BERP).

In accordance with 10 NYCRR Section 16.13 *Notices, Instructions, and Reports to Workers*, radioactive materials spill procedures signage will be posted in a prominent location at all radioactive materials receipt, use, and storage areas (see Appendix I).

Chapter 8: Area Survey Requirements and Procedures

Area Surveys are required in accordance with 10 NYCRR Section 16.10 *Inspections, Surveys, Checks and Test* and are designed to ensure that contamination levels remain ALARA. Laboratory areas where radioactive materials are used and /or stored and radioactive material waste storage areas shall be surveyed at least monthly. All surveys will consist of the following:

- Measurement of radiation levels with a survey meter sensitive enough to detect 0.1 mR/hr.
- Wipe tests to measure contamination levels using a method sensitive enough to detect 1000/dpm per 100 square centimeters for the contaminant involved.

Area surveys shall be conducted by EHS and, in accordance with 10 NYCRR Section 16.14 *Records*, survey records shall be maintained for 3 years. Area survey records will include the following:

- Location, date, and identification of equipment used including the survey meter serial number and pertinent counting efficiencies.
- Name of person(s) conducting survey.
- Drawing of area surveyed, identifying relevant features such as active storage areas, active waste areas, etc.
- Measured exposure rates, keyed to a location on the area survey drawing, and identification of any rates that require corrective action.
- Detected contamination levels, keyed to locations on drawing.

See Appendix J: Radioactive Materials Area Survey Form.

Meter Survey

Meter surveys provide a direct measurement of external radiation dose rates and associated shielding requirements. In addition, meter surveys provide detection of localized contamination hot spots. Meter survey procedures are as follows:

Check the meter for proper operation:

- Check the meter calibration label to ensure the most recent calibration has not exceeded 12 months.
- Check the batteries using the battery test function on the meter and replace as necessary.
- Determine that the background dose rate is normal (typically 0.02 – 0.05 mR/hr for a portable meter with a GM type probe and 250 – 500 cpm for a portable meter with a low energy gamma / thin window NaI type probe). Zero background indicates a non-functional meter. High background indicates contamination of the probe or a meter malfunction. Intermittent response typically indicates a damaged probe cable.
- If applicable, check meter / probe reproducibility to the check source to ensure the meter reading is within range.

Note: Label non-functional meters as “Out of Service” and send out for service and recalibration via EHS.

During survey, move the probe at a rate of approximately 1 – 2 seconds per inch to ensure adequate response time. Due to background rates varying by a factor of 2, evaluate a reading as a positive result when the dose rate exceeds twice the background dose rate. Mark positive result / suspected contamination areas (using a grease pencil, non-permanent marker, tape, etc). Perform a wipe survey on all marked areas prior to decontamination.

Wipe Surveys

Wipe surveys provide the only method for determining if contamination is removable or fixed. Wipe surveys also provide a measurement of the amount of removable contamination. Wipe test procedures are as follows:

Collect Wipe Samples

- Don nitrile gloves and moisten a 2.5 cm soluble surface sampling pad or filter paper with distilled water or laboratory cleaner.
- Using the adhesive / tacky side of the pad, wipe designated areas per the corresponding lab survey map as well as any suspected contamination areas marked during the meter survey. Wipes should consist of an approximate 100 cm² area (this can be achieved by wiping an S-shape about 40 cm long).
- Wipe additional non-designated / frequent contact location areas such as doorknobs, sink handles, light switches, telephones, etc.

Prepare Samples

- Alpha / Beta Emitters
 - (1) Using nitrile gloves or tweezers, place pad in a 20 ml counting vial
 - (2) Add 20 ml of liquid scintillation cocktail
 - (3) Label vial cap with wipe identification
 - (4) Seal vial with cap
 - (5) Shake vial and verify that the pad is dissolved in the vial
 - (6) Repeat steps 1 – 6 for each wipe sample taken
 - (7) Prepare a background sample using a clean prep pad and repeat steps 1 – 6
- Gamma Emitters
 - (1) Using nitrile gloves or tweezers, place pad into a 7 ml counting vial
 - (2) Label vial cap with a wipe identification
 - (3) Seal vial with cap
 - (4) Repeat steps 1 – 3 for each sample taken
 - (5) Prepare a background sample using a clean pad and repeat steps 1 – 3

Count Samples

Use a liquid scintillation counter for area surveys of alpha / beta emitting isotopes and a gamma counter for area surveys of gamma emitting isotopes. (Note: the Hidex Triathler

Multilabel Tester is a combination liquid scintillation counter and gamma counter.) If the area survey is for both alpha / beta and gamma emitters, perform sample counts using the gamma counter first and the liquid scintillation counter second.

Liquid Scintillation Counter / Gamma Counter Procedures

- (1) Perform counts on the wipe samples, background sample, and appropriate standard (H-3 for alpha / beta emitters and I-129 for gamma emitters). All samples must be counted for a period of 1 minute.
- (2) Observe the proper channel perimeters (or window settings) for the isotope(s) in use.
- (3) Retest all positive samples and their associated background sample.

Note: Luminescence and static may result in false positive results due to higher liquid scintillation counts per minute. Consider storing samples in the dark for at least 2 hours to allow luminescence to dissipate before counting.

Results

Demonstrate Counter Reproducibility: Verify the counter is functioning properly by comparing current standard count rate result to past standard count rate results. Assume the equipment is functioning properly if the current standard count rate is within 5 percent of past standard count rate results. If the count rates are greater than 5 percent, then the liquid scintillation counter / gamma counter equipment shall be serviced and recalibrated.

Review the meter and wipe survey results to ensure that the radiation exposure levels and removable radioactive surface contamination do not exceed the regulatory limits promulgated in 10 NYCRR Section 16.6 *Occupational Dose Limits* and Appendix 16-A Table 7 *Radioactive Surface Contamination Limits* (see Appendix K) respectively.

Chapter 9: Radioactive Waste Minimization and Disposal

Radioactive Waste Minimization

Prior to conducting experimentation, radioactive materials users shall consider all available waste minimization practices in an effort to reduce the amount of radioactive waste generated. Examples of waste minimization practices include the following:

- Use alternative non-radioactive materials / methods if possible.
- Order only the minimum amount of radioactive material(s) necessary for the experiment.
- Whenever possible, use radioisotopes with half-lives less than 65 days which, after appropriate decay-in-storage, can be disposed of as regular waste by EHS.
- Segregate radioactive waste from non-radioactive waste. Survey potentially contaminated items in a low background area and dispose of non-contaminated materials (those less than two times background) as regular trash. If only a small area of an item is found to be radioactive, dispose of only the contaminated portion of that particular item.
- Modify protocols to reduce the amount of waste generated or use alternative non-radioactive materials / methods.
- Clean and reuse lab equipment and supplies instead of disposing as radioactive waste whenever possible. Use easily decontaminated items (ex. stainless steel trays) to aid in cleaning process of removable surface contamination.

Radioactive Waste Disposal

Disposal and transportation of radioactive waste shall be in accordance with 6 NYCRR Part 380 *Prevention and Control of Environmental Pollution by Radioactive Materials* and Part 381 *Transporters of Low-Level Radioactive Waste* (see Appendix L). EHS manages all Colgate University radioactive waste disposals. Radioactive materials users are directed to contact EHS to coordinate collection of radioactive waste for disposal. Radioactive waste collection is only authorized in EHS issued waste containers and must be properly labeled with a radioactive waste tag (see Appendix M). Consult EHS for waste collection procedures involving mixed wastes (i.e. radioactive waste that includes biowaste and/or hazardous waste). Upon collection, radioactive waste will be stored in the radioactive waste storage area until disposal. Disposal of radioactive materials via the sink (or any other mode of entry into the sewer system) or in the regular trash is strictly prohibited.

Disposal by Decay-in-Storage

In accordance with the Colgate University Radioactive Materials License, disposal by decay-in-storage (DIS) is only authorized for radioactive materials with a physical half-life of less than 65 days and must be held for a minimum of ten half-lives. Radioactive material users are not authorized to conduct their own disposal by DIS. EHS radioactive waste disposal by DIS is only authorized when the decay by half-lives can be calculated to background or below levels and then confirmed by a survey of the waste material activity level with all shielding removed. Radioactive material disposal by DIS will be documented on a Radioactive Waste Decay-In-Storage Record Sheet (see Appendix N).

Disposal by Transfer for Incineration or Burial

Radioactive materials users are not authorized to conduct their own disposal by transfer for incineration or burial. EHS radioactive waste disposal by transfer for incineration or burial shall be conducted by licensed radioactive waste service providers.

All radioactive waste disposal records shall be maintained until termination of the New York State Radioactive Materials License.

Chapter 10: Leak Testing Requirements and Procedures

Leak testing is required in accordance with 10 NYCRR Section 16.10 *Inspections, Surveys, Checks and Tests* and is designed to ensure that contamination levels remain ALARA. Sealed sources containing radioactive materials designed to emit beta or gamma particles with a half-life greater than 30 days and in any form other than gas shall be tested for leakage prior to initial use and at successive intervals thereafter not to exceed 6 months. Sealed sources containing radioactive materials designed to emit alpha particles with a half-life greater than 30 days and in any form other than gas shall be tested for leakage prior to initial use and at successive intervals not to exceed 3 months. Sealed sources are exempt from this periodic leak test requirement when the sealed source contains 100 microcuries or less of beta and/or gamma emitting material or 10 microcuries or less of alpha emitting material. The periodic leak test requirement shall not apply to sealed sources that are in storage, however, a leak test must be performed prior to use or transfer if one has not been conducted within the previous 6 months.

Leak tests shall be conducted by EHS and, in accordance with 10 NYCRR Section 16.14 *Records*, test records shall be maintained for 3 years. Leak test records will include the following:

- Location and date.
- Name of person(s) conducting test.
- Isotope(s), activity on a specified date, and physical form.
- Equipment used including the serial number(s) and pertinent counting efficiencies.
- Leak test results in units of microcuries per sample.

Leak Test

Prepare a separate wipe sample for each source. Label each wipe sample with its corresponding source. Leak test procedures are as follows:

- For small sealed sources, wipe the entire accessible area. Pay particular attention to seams and joints. Note: Do not wipe the port of a beta applicator.
- For larger sealed sources and devices, take the wipe sample near the radiation port and on the activating mechanism.
- Radium sources shall also be checked for radon leakage by submerging the source in a vial of fine-grained charcoal or cotton for 24 hours and then analyzing the absorbent.
- Use a liquid scintillation counter for leak tests of alpha / beta sources and a gamma counter for leak tests of gamma sources. (Note: the Hidex Triathler Multilabel Tester is a combination liquid scintillation counter and gamma counter.) If the leak test is for both alpha / beta and gamma emitters, perform sample counts using the gamma counter first and the liquid scintillation counter second.
- Assay a check source that has the same isotope as the sealed source and whose activity is certified by the supplier. If one is not available, use a certified check source with a different isotope that has a similar spectrum in order to estimate the detection efficiency of the analyzer used to assay the wipe samples.
- Assay the wipe sample. Ensure the wipe sample is in the same geometry to the detector as the certified check source was to the detector.

- Calculate the estimated activity on the wipe sample in microcuries.

Results

Sign and date all leak test result documents. Report all sealed source leak tests with a wipe sample of 0.005 microcuries or greater to the RSO, remove the sealed source from use (to be repaired or disposed), and notify the BERP.

Chapter 11: Occupational Dose Limits and Personnel Exposure Monitoring

Individual radiation monitoring devices shall be worn in accordance with 10 NYCRR Section 16.11 *Personnel Monitoring* and are designed to ensure that radiation exposure levels remain below occupational dose limits and ALARA. Occupational dose limits are as follows:

Radiation Workers / Users

Whole Body Total Effective Dose Equivalent From Internal and External Sources	5,000 mR / year
Total Organ Dose Equivalent From Internal and External Sources	50,000 mR / year
Lens of the Eye Dose Equivalent	15,000 mR / year
Skin or Extremities Dose Equivalent	50,000 mR / year
Embryo / Fetus Dose	500 / gestation period

Note: The maximum permissible dose for radiation workers under the age of 18 years old is 10 percent of the above listed values.

Non-Radiation Workers / Non-Users

Whole Body Total Effective Dose Equivalent	100 mR / year
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Personnel monitoring devices will be provided by EHS on either a monthly or quarterly basis dependent upon the individual user's radiation exposure potential with consideration given to type and amount of radioactive materials and/or radiation equipment in use. Personnel monitoring devices shall be worn as follows:

- An individual monitoring device used for monitoring the dose to the whole body shall be worn at the unshielded location of the whole body likely to receive the highest exposure.
- An individual monitoring device used for monitoring the dose to an embryo / fetus of a declared pregnant women, pursuant to 10 NYCRR Section 16.6(h) *Occupational Dose Limits*, shall be located at the waist under any protective apron that is being worn.
- An individual monitoring device used for monitoring the eye dose equivalent shall be located at the neck outside any protective apron being worn or at an unshielded location closer to the eye.
- An individual monitoring device used for monitoring the dose to the extremities shall be worn on the extremity likely to receive the highest exposure. The device shall be oriented to measure the highest dose to the extremity being monitored.

Personnel monitoring devices will be processed and evaluated by a dosimetry service provider accredited from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology. Upon receipt, EHS will review all dosimetry reports

prior to forwarding them to the individual users to determine any occupational dose limitations, additional ALARA radiation exposure measures, and continued monitoring frequency. Individual users will receive an accompanying dose notification letter from EHS with their dosimetry report when they reach 10 percent of the maximum permissible dose limit. The 10 percent dose notification letter will include the following: most recent wear period dose, year to date dose (including the percent left before reaching the Colgate University investigation level of 25 percent maximum permissible dose limit), and information concerning limiting further exposure. Individual users will receive an ALARA investigation notification letter from EHS with their dosimetry report when they reach 25 percent of the maximum permissible dose limit. The 25 percent ALARA investigation notification letter includes the same items as the 10 percent dose notification letter and also specifies the investigation requirements including an interview and assessment of work practices by the RSO and EHS. EHS will provide a summary of all personnel monitoring to the RSO on a quarterly basis. EHS shall maintain a copy of all personnel monitoring reports until disposition is authorized by the BERP.