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## 1. Purpose

- 1.1. The McMaster University Radiation Safety Program for University Laboratories (RMM 700) establishes requirements for contamination monitoring in laboratories and areas where radioactive materials are used or stored. This procedure provides specific guidance on fulfilling those requirements.
- 1.2. Contamination monitoring programs which comply with the requirements of this procedure shall be implemented in all areas where unsealed radioactive material is used or stored.

## 2. Scope

- 2.1. This procedure applies to all areas where unsealed radioactive material greater than one Exemption Quantity is used.
- 2.2. In addition to the requirements for routine contamination monitoring described in this procedure, contamination monitoring must be performed frequently during work with radioactive materials, and upon completion of tasks, to verify that personnel and workplace contamination is as low as reasonably achievable and below allowable limits. This additional "operational" contamination monitoring is outside the scope of this procedure.

## 3. Related Documents

- 3.1. RMM 700 Radiation Safety Program for University Laboratories

## 4. Definitions

- 4.1. Exemption Quantity                      As defined in the Nuclear Substance and Radiation Devices Regulations. Generally, the quantity of nuclear substance above which activities may require CNSC licensing.

## 5. Responsibilities

- 5.1. Project Supervisors are responsible for:
  - ensuring that this procedure is implemented in all areas covered by their permit
  - assigning trained personnel to carry out the procedure
  - providing all equipment required to implement this procedure
  - maintaining records as specified
- 5.2. Authorized Radioisotope Users are responsible for:
  - performing contamination monitoring as assigned in a manner which is safe and compliant with this procedure
- 5.3. Health Physics is responsible for:
  - approving measurement techniques and trigger levels to be employed in each lab
  - auditing laboratories to verify the implementation of this procedure
  - performing supplemental contamination monitoring to verify the levels of contamination in labs and work areas
  - arranging for calibration of instruments to be used in contamination monitoring

## 6. Procedures

- 6.1. **Establish Contamination Monitoring Routine**
  - 6.1.1. Review the radioisotopes in use in the laboratory
  - 6.1.2. Obtain or create a simple floor plan of the laboratory.
  - 6.1.3. Referring to the information in Appendix A, select the appropriate monitoring method(s) for the laboratory.
  - 6.1.4. Determine the protective equipment required to carry out this procedure safely.

- 6.1.5. Identify locations in the laboratory where routine contamination monitoring should be performed.
- Include: Accessible working surfaces such as bench tops, fumehood ledges, centrifuges, pipettes, fridge interiors and other accessible surfaces: such as floors, fridge handles, telephone, light switch, sink taps etcetera.
  - Identify the locations on the laboratory floor plan.
  - Specify the number of random samples to be collected, or areas to be direct monitored, at the discretion of the person performing the monitoring.
- 6.1.6. Referring to Appendix A, select the appropriate Trigger Level for the surface and monitoring method to be used.
- NOTE: The Maximum Acceptable Trigger Levels for Working Surfaces and Non-Working Surfaces are given in Appendix B. To ensure that contamination levels are maintained as low as reasonably achievable, and for simplicity, it is generally conservative to select a Trigger Level of 50 cpm for any location and method. If it is difficult to maintain the area within this limit despite sufficient efforts in contamination control, a higher value up to the maxima shown in Appendix B may be chosen.
- 6.1.7. Complete the “Contamination Monitoring Routine Form” shown as Attachment A.
- 6.1.8. Arrange for Health Physics to review the completed form with you and provide a copy of the approved form to Health Physics.
- 6.1.9. Train laboratory personnel on the procedure to be followed and, if required, establish a duty roster.
- 6.1.10. Prepare a binder or file to keep the documented contamination monitoring routine and contamination monitoring results (see Attachments A and B for example contamination monitoring routine and results forms).
- 6.1.11. Review the contamination monitoring routine any time there is a change in the use of radionuclides in the laboratory. Changes of practice, equipment, location of work, radioisotopes used etcetera may necessitate a change to the contamination monitoring routine. Any proposed changes must be reviewed and approved by Health Physics.
- 6.2. Carry out the Contamination Monitoring Routine**
- 6.2.1. At the frequency established for the lab, and at least weekly, review recent radioisotope usage in the laboratory.
- 6.2.2. Initiate a contamination monitoring results sheet, indicating the permit number, room number(s), date and name of the person performing the measurements.
- 6.2.3. If no radioisotopes have been used, indicate that no activity has been used on the contamination monitoring results form for the period and proceed to step 6.2.10.
- NOTE: Before determining that no radioactivity was used it is necessary to consult all of the authorized users for the laboratory and review the inventory control sheets to confirm.
- 6.2.4. If radioisotopes have been used, carry out the monitoring routine for the laboratory.
- 6.2.5. Note the background, gross count rate and the net count rate for each location (see procedures in Appendix C, Appendix D and Appendix E.)
- 6.2.6. Compare all readings to the trigger level for the location, as specified by the contamination monitoring routine .
- 6.2.7. Areas and items with contamination above the trigger level must be decontaminated immediately.
- 6.2.8. Areas and items with detectable contamination, even if below the trigger level, should be decontaminated. If in doubt, readings that are twice background can generally be interpreted as an indication that contamination is present.
- 6.2.9. Re-monitor the location and record the result once decontamination is complete.
- 6.2.10. Check yourself for contamination on completion of this procedure with an instrument appropriate for the isotope used.
- 6.2.11. Review the results with the Project Supervisor or designate.

**7. Records**

- 7.1. The following completed records are to be retained by the Project Supervisor until disposal is authorized by Health Physics.

- Contamination monitoring routine
- Contamination monitoring results

## **8. EXCEPTIONS**

8.1.1. All exceptions to this procedure require the approval of the Senior Health Physicist.

## **9. Appendices**

- A. Contamination Monitoring Techniques
- B. Maximum Acceptable Trigger Levels
- C. Contamination Monitoring Procedure – Swipe Method Counted by LSC
- D. Contamination Monitoring Procedure– Swipe Method Counted by Portable Contamination Monitor
- E. Contamination Monitoring Procedure– Direct Monitoring Method

## **10. Attachments**

- Unsealed Radioisotope Inventory Control Form
- Sealed Source Inventory Form
- Radioactive Material Acquisition Approval Form
- Request to Acquire Unbound Radioiodine

**Appendix A. Contamination Monitoring Techniques**

| Isotope | Counting Method                                 | Nominal Efficiency | Conversion Factor, cpm to Bq/cm <sup>2</sup> | Radionuclide Class | Maximum Acceptable Trigger Level, Non-Working Surface (Bq/cm <sup>2</sup> ) | Net Count Rate Corresponding to Trigger Level (cpm) |
|---------|---|--------------------|--|--------------------|---|---|
| H-3     | Swipes counted on LSC                           | 0.3                | 6E-03  | C                  | 30  | 5400  |
| C-14    | Swipes counted on LSC                           | 0.5                | 3E-03  | C                  | 30  | 9000  |
|         | Swipes counted with pancake GM                  | 0.05               | 3E-02  |                    |   | 900   |
|         | Direct check with pancake GM                    | 0.05               | 2E-02  |                    |   | 1350  |
| F-18    | Swipes counted with pancake GM                  | 0.2                | 8E-03  | C                  | 30  | 3600  |
|         | Direct check with pancake GM                    | 0.2                | 6E-03  |                    |   | 5400  |
| P-32    | Swipes counted on LSC                           | 0.5                | 3E-03  | C                  | 30  | 9000  |
|         | Swipes counted with pancake GM                  | 0.25               | 7E-03  |                    |   | 4500  |
|         | Direct check with pancake GM                    | 0.25               | 4E-03  |                    |   | 6750  |
| In-111  | Swipes counted with pancake GM                  | 0.01               | 1E-01  | C                  | 30  | 252   |
|         | Direct check with pancake GM                    | 0.01               | 8E-02  |                    |   | 378   |
| I-125   | Swipes counted on LSC                           | 0.5                | 3E-03  | C                  | 30  | 9000  |
|         | Swipes counted with NaI                         | 0.1                | 2E-02  |                    |   | 1800  |
|         | Direct check with NaI                           | 0.1                | 1E-02  |                    |   | 2700  |
| I-131   | Swipes counted with pancake GM                  | 0.15               | 1E-02  | B                  | 3   | 270   |
|         | Direct check with pancake GM                    | 0.15               | 7E-03  |                    |   | 405   |
| Lu-177  | Swipes counted with pancake GM                  | 0.2                | 8E-03  | C                  | 30  | 3600  |
|         | Direct check with pancake GM                    | 0.2                | 6E-03  |                    |   | 5400  |
| Ac-225  | Swipes counted with benchtop Alpha/Beta counter | 0.3                | 6E-03  | A                  | 0.3   | 54  |
|         | Direct check with Alpha frisker                 | 0.2                | 6E-03  |                    |   | 54  |

Notes:

- Multiplying the Net Sample Count Rate in counts per minute by the Conversion Factor will give the approximate removable activity on the surface being monitored in Bq/cm<sup>2</sup> for swipe samples.
- Multiplying the Net Count Rate in counts per minute by the Conversion Factor will give the approximate total activity on the surface being monitored in Bq/cm<sup>2</sup> for direct checks.
- For LSC, the nominal efficiency is assumed to be 50% of the counter efficiency for an unquenched sample. This is generally conservative and takes into consideration that swipes collected from lab surfaces may have higher quench than normal laboratory samples.
- Swipes are all assumed to be 100 cm<sup>2</sup> with a collection efficiency of 10%

**Appendix B. Maximum Acceptable Trigger Levels**

| Radionuclide Class | Radionuclides  | Maximum Acceptable Trigger Levels |                        |
|--------------------|--|-----------------------------------|------------------------|
|                    |  | Working Surfaces                  | Non-Working Surfaces   |
| <b>A</b>           | All alpha emitters and their progeny radioisotopes<br><br>Ag-110m, Bi-210, Co-56, Co-60, Cs-134, Cs-137, I-124, Lu-177m, Mn-52, Na-22, Po-210, Pu-238, Pu-239, Pu-240, Sb-124, Sc-46, Sr-82, U-234, U-235, U-238, V-48, Zn-65  | 3 Bq/cm <sup>2</sup>              | 0.3 Bq/cm <sup>2</sup> |
| <b>B</b>           | Au-198, Ba-133, Br-82, Ce-143, Co-58, Cu-67, Fe-59, Hg-194, Hg-203, I-131, Ir-192, La-140, Mo-99, Nb-95, Pa-233, Ra-223, Re-186, Re-188, Ru-103, Sb-122, Sm-153, Sr-90, Xe-127, Y-86, Y-90, Yb-169, Zr-89, Zr-95   | 30 Bq/cm <sup>2</sup>             | 3 Bq/cm <sup>2</sup>   |
| <b>C</b>           | C-11, C-14, Ca-45, Cd-109, Ce-141, Cl-36, Co-57, Cr-51, Cu-60, Cu-61, Cu-64, F-18, Fe-55, Ga-67, Ga-68, Ge-68, H-3, I-123, I-125, In-111, In-113m, In-114, K-42, Kr-85, Lu-177, Mn-52m, Mn-56, N-13, Na-24, Nb-98, Ni-63, O-15, P-32, P-33, Pd-103, Pr-144, Pu-241, Rh-106, S-35, Sc-44, Sn-113, Sr-89, Tc-94m, Tc-99, Tc-99m, Te-127, Tl-201, V-49, W-181, W-188, Xe-133, Zn-63 | 300 Bq/cm <sup>2</sup>            | 30 Bq/cm <sup>2</sup>  |

**Appendix C. Contamination Monitoring Procedure – Swipe Method Counted by LSC**

- C.1. Obtain one or more racks (as required) for the scintillation counter, the required number of scintillation vials and the required number of swipes.
- C.2. Wear protective equipment specified in the Contamination Monitoring Routine. The minimum protective clothing required is disposable gloves and a lab coat.
- C.3. Prepare a set of scintillation vials, numbering the caps to correspond to the locations on the Contamination Monitoring Routine.
- C.4. Prepare a blank sample for the background reading. A blank sample is a wipe from the same wipe batch, but which has not been used, placed in a scintillation vial from the same batch, filled with the same liquid scintillation cocktail.
- C.5. For each location specified on the Contamination Monitoring Routine, wipe an area of 100 cm<sup>2</sup> and place the wipe directly in the scintillation vial.

NOTE: For a 5 cm wide swipe, cover a linear path of at least 20 cm, maintaining even pressure across the width of the swipe. For smaller wipes/contact areas, increase linear path proportionately. Adequate collection efficiency will normally be obtained with a dry swipe. Wet swipes are only required when advised by the Health Physics Department.

- C.6. Remove the lids from the vials one at a time and add scintillation fluid. Do not overfill the vial (not more than 80 % full). Ensure that the outside of the vial is wiped free of any spilled liquid scintillation cocktail.
- C.7. Following the instructions for the scintillation counter, count each sample for at least one minute on an open window.
- C.8. Initiate a Contamination Monitoring Record.
- C.9. Record the background count rate.
- C.10. Record the gross count rate for each location.
- C.11. Calculate the net count rate for each location as follows:  
Net Count Rate = Gross Count Rate – Background Count Rate
- C.12. Review and interpret results as specified in this procedure.
- C.13. Decontaminate and re-monitor as required.
- C.14. Check yourself for contamination on completion of this procedure.

**Appendix D. Contamination Monitoring Procedure– Swipe Method Counted by Portable Contamination Monitor**

- D.1. Obtain an instrument of the type and model specified on the Contamination Monitoring Routine.
- D.2. Initiate a Contamination Monitoring Record.
- D.3. Function test instrument according to manufacturer’s instructions and, in general, as follows:
  - Visually inspect the instrument, checking for any indication of damage.
  - Battery Check: Verify the battery voltage is within the acceptable range for the instrument
  - HV Check: Verify that the High Voltage Setting is within the approved range for the instrument
  - Calibration Check: Verify that the instrument has a valid calibration
  - Background Check: Turn the instrument on in an area of low background. Confirm that the background is acceptably low for the instrument and record the background reading in counts per minute.
  - Function Test: Using a check source or other known source of radioactivity, confirm that the instrument provides the expected response to activity needle deflection and audible response.
- D.4. Wear protective equipment specified in the Contamination Monitoring Routine. The minimum protective clothing required is disposable gloves and a lab coat.
- D.5. For instruments that require manual set-up, set the instrument to the most sensitive range possible with the audio set to “On” and the response set to “Fast”. For auto-scaling instruments, select the appropriate program and ensure the audio is on. Position the instrument so that you can place a swipe easily under the detector without moving it.
- D.6. Prepare a set of swipes numbered to correspond to the locations on the Contamination Monitoring Routine.
- D.7. For each location specified on the Contamination Monitoring Routine, wipe an area of 100 cm<sup>2</sup>.  
NOTE: For a 5 cm wide swipe, cover a linear path of at least 20 cm, maintaining even pressure across the width of the swipe. For smaller wipes/contact areas, increase linear path proportionately. Adequate collection efficiency will normally be obtained with a dry swipe. Wet swipes are only required when advised by the Health Physics department.
- D.8. Without touching the detector surface, carefully bring the “contaminated” side of the swipe to within 1cm of the detector. Observe the gross count rate, adjusting the range of the instrument as required.
- D.9. Dispose of the swipe in the radioactive waste receptacle.
- D.10. Hold your hand briefly under the detector to verify that you are not contaminated.
- D.11. Record the gross count rate for the location.
- D.12. Continue monitoring all locations listed on the Contamination Monitoring Routine.
- D.13. Calculate the net count rate for each location as follows:  
Net Count Rate = Gross Count Rate – Background Count Rate
- D.14. Review and interpret results as specified in this procedure.
- D.15. Decontaminate and re-monitor as required.
- D.16. Check yourself for contamination on completion of this procedure.

**Appendix E. Maximum Acceptable Trigger Levels**

NOTE: This method measures the combined fixed and removable contamination level on surfaces. Direct monitoring may be used when background levels are less than half of the corresponding trigger level.

- E.1. Obtain an instrument of the type and model specified on the Contamination Monitoring Routine.
- E.2. Initiate a Contamination Monitoring Record.
- E.3. Function test instrument according to manufactures instructions and, in general, as follows:
  - Visually inspect the instrument, checking for any indication of damage.
  - Battery Check: Verify the battery voltage is within the acceptable range for the instrument
  - HV Check: Verify that the High Voltage Setting is within the approved range for the instrument
  - Calibration Check: Verify that the instrument has a valid calibration
  - Background Check: Turn the instrument on in an area of low background. Confirm that the background is acceptably low for the instrument and record the background reading in counts per minute.
  - Response Check: Using a check source or other known source of radioactivity, confirm that the instrument provides the expected response to activity needle deflection and audible response.
- E.4. Wear protective equipment specified in the Contamination Monitoring Routine. The minimum protective clothing required is disposable gloves and a lab coat.
- E.5. For instruments that require manual set-up, set the instrument to the most sensitive range possible with the audio set to "On" and the response set to "Fast". For auto-scaling instruments, select the appropriate program and ensure the audio is on.
- E.6. Approach each location shown on the Contamination Monitoring Routine. Move the detector slowly over the surface to be monitored.
 

NOTE: Concentrate on moving slowly and carefully. Keep the detector a distance of approximately 1cm from the surface but avoid touching it. Maintain a linear speed of less than 1 inch (2.5 cm) per second. Watch the detector position, not the meter, and listen for deflections in count rate.
- E.7. If a deflection in the count rate is detected, stop and obtain a reading. Slowly move the detector back and forth and towards and away from you in a "cross" pattern, listening to the audio signal to locate the highest reading.
- E.8. Continue monitoring the location until complete.
- E.9. Note: If the scale of the instrument is adjusted to obtain the reading, remember to reset to the most sensitive scale before proceeding to the next location.
- E.10. Record the highest gross count rate for each location before proceeding to the next location.
- E.11. Continue monitoring each of the locations listed in the Contamination Monitoring Routine.
- E.12. Calculate the net count rate for each location as follows:  

$$\text{Net Count Rate} = \text{Gross Count Rate} - \text{Background Count Rate}$$
- E.13. Calculate the activity on the surface by multiplying the Net Count Rate by the Conversion Factor specified on the Contamination Monitoring Routine.
- E.14. Review and interpret results as specified in this procedure.
- E.15. Decontaminate and re-monitor as required.
 

NOTE: If no progress is made in decontamination, "fixed" activity may be present. Perform a swipe test as outlined in this procedure.
- E.16. Check yourself for contamination on completion of this procedure.



## Contamination Monitoring Routine Form

|  |                            |
|--|----------------------------|
| <b>Permit Number:</b>  | <b>Lab room number(s):</b> |
| <b>Radioisotope(s) in Use:</b>   | <b>Monitoring Method:</b>  |
| <b>Protective Equipment Required:</b> <ul style="list-style-type: none"> <li>▪ Disposable Gloves</li> <li>▪ Labcoat</li> <li>▪ Other (Specify):</li> </ul> |                            |

| #  | Area to be monitored/wiped | Method | Trigger Level |
|----|----------------------------|--------|---------------|
| 1  | Background                 |        | NA            |
| 2  |                            |        |               |
| 3  |                            |        |               |
| 4  |                            |        |               |
| 5  |                            |        |               |
| 6  |                            |        |               |
| 7  |                            |        |               |
| 8  |                            |        |               |
| 9  |                            |        |               |
| 10 |                            |        |               |
| 11 |                            |        |               |
| 12 |                            |        |               |
| 13 |                            |        |               |
| 14 |                            |        |               |
| 15 |                            |        |               |
| 16 |                            |        |               |
| 17 |                            |        |               |
| 18 |                            |        |               |
| 19 |                            |        |               |
| 20 |                            |        |               |
| 21 |                            |        |               |

A sketch of the area showing the locations by number should be attached or included on reverse.

Reviewed and Approved by Health Physics    Signature: \_\_\_\_\_ Date: \_\_\_\_\_



Health Physics

**Contamination Monitoring Results Form**

No Activity Used   
 I have confirmed that no radioactive material was used in  
 this laboratory during the period:  
 \_\_\_\_\_ to \_\_\_\_\_ and that  
 monitoring is not required. Initials \_\_\_\_\_

Permit Number: \_\_\_\_\_

Lab room number(s): \_\_\_\_\_

Date: \_\_\_\_\_

| Performed By:        |                      | Instrument(s) used: |                 | ALL areas and items with contamination greater than the Trigger Level must be decontaminated immediately. All detected contamination should be decontaminated immediately. |                               |          |
|----------------------|----------------------|---------------------|-----------------|--|-------------------------------|----------|
| #                    | Area wiped/monitored | Gross count (cpm)   | Net count (cpm) | Trigger Level  | Recount after decontamination | Comments |
| 1                    | Background           |                     | NA              | NA   | NA                            |          |
| 2                    |                      |                     |                 |  |                               |          |
| 3                    |                      |                     |                 |  |                               |          |
| 4                    |                      |                     |                 |  |                               |          |
| 5                    |                      |                     |                 |  |                               |          |
| 6                    |                      |                     |                 |  |                               |          |
| 7                    |                      |                     |                 |  |                               |          |
| 8                    |                      |                     |                 |  |                               |          |
| 9                    |                      |                     |                 |  |                               |          |
| 10                   |                      |                     |                 |  |                               |          |
| 11                   |                      |                     |                 |  |                               |          |
| 12                   |                      |                     |                 |  |                               |          |
| 13                   |                      |                     |                 |  |                               |          |
| 14                   |                      |                     |                 |  |                               |          |
| 15                   |                      |                     |                 |  |                               |          |
| 16                   |                      |                     |                 |  |                               |          |
| 17                   |                      |                     |                 |  |                               |          |
| 18                   |                      |                     |                 |  |                               |          |
| 19                   |                      |                     |                 |  |                               |          |
| 20                   |                      |                     |                 |  |                               |          |
| Results Reviewed By: |                      |                     |                 | Signature  |                               | Date     |