1.0 Statement

The level of radioactive contamination shall be kept **A**s **L**ow **A**s **R**easonably **A**chievable in order to protect the safety and health of staff students and the environment, and to contribute to the integrity of tracer-level work in authorized laboratories. Decontamination procedures shall be initiated when the contamination level exceeds the action level. To ensure that levels of radioactive contamination do not exceed legal limits and in order to protect employees, students, the public and the environment contamination monitoring shall be carried out on a weekly basis.

2.0 Definitions

2.1 Radioactive Contamination

Radioactive contamination is the presence of nuclear substances and radiation devices in any place where it is not desired, in particular where its presence may be harmful. Contamination may present a risk to a person's health or the environment. Contamination has also been determined to be the cause of failed experiments. Control of contamination is one of the key concerns whenever radioactive materials are used. At MUN, an item is considered contaminated when radioactivity is present at **greater than or equal to 0.5 Bq/cm^2** (for Class B and C isotopes; refer to Appendix A for a summary of action limits).

2.2 MUN Contamination Action Level

An action level refers to a specific parameter (in this case, level of radioactive contamination) that if reached may indicate the loss of control of part of the radiation protection program and must trigger (a) specific action(s) to regain control. In this case, the specific actions required are:

a) reporting the contamination to the RSO, and

b) a follow-up investigation by the RSO to determine the root cause of the excessive contamination and to implementation any required corrective actions.

The Action Levels for removable radioactive contamination at Memorial University are given in Table 2, CNSC Surface Contamination Limits and correspond to the "other areas" limits for Class A **(0.3 Bq/cm^2)**, B **(3 Bq/cm^2)** and C **(30 Bq/cm^2)** isotopes. The contamination level may be averaged over an area **not exceeding 100 cm^2**. Contamination above the MUN contamination action level requires immediate reporting to the RSO (refer to Appendix A for a summary of action limits).

2.3 CNSC Surface Contamination Limit (CNSC Reporting levels)

Levels of removable alpha, beta and gamma radioactive contamination on all normally accessible working surfaces in radioisotope laboratories shall vary with the isotope. The regulatory limits are listed in Table 2. Note that the table outlines two distinctive levels: **radioisotope areas** (i.e. authorized radiation laboratories) and **other areas** (i.e. public access areas). The contamination level may be averaged over an area **not exceeding 100 cm^2**. Contamination above the CNSC surface contamination action level requires immediate reporting to the RSO who will conduct and investigation and report the findings to the CNSC (refer to Appendix A for a summary of action limits).

2.4 Weekly Contamination Monitoring

Contamination monitoring shall be completed within **seven (7) days** of the use of nuclear substances. Contamination monitoring is required to ensure excessive radioactive contamination is not present in working and non-working areas (floors, light switches, etc). All contamination monitoring data shall be recorded on the Health & Safety Management System (HSMS).

2.5 Decommissioning

Decommissioning is the process of releasing equipment or areas for non-radioactive use or for renovation or servicing. Decommissioning requires documentation to record that all radioactive material has been removed and no radioactive contamination is present in excess of legal limits. Please refer to radiation safety operating procedure RSOP05 Decommissioning.

3.0 Responsibilities

The Permit Holder is responsible to ensure that:

a) A well-planned contamination monitoring program is established. The program should include preplanning and periodic review. It should be designed to detect contamination in radiation use areas as well as areas less likely to be contaminated. The Permit Holder is responsible to ensure that monitoring is conducted in accordance with this RSOP.

b) All rooms where open sources of radioactivity are used shall have a Decontamination/ Spill Kit ready and easily accessible. Each area that is used to manipulate nuclear substances has ready access to a scintillation counter and/or a survey instrument equipped with an appropriate probe for the type of radioisotope used.

i. Survey meters will be calibrated to the CNSC's *Regulatory Expectations for Calibration of Survey Meters* in RD/GD-371 appendix Z

c) Storage areas where nuclear substances are stored for longer than six months shall be monitored at least annually.

d) Contamination in excess of the permissible levels (MUN action level and/or CNSC Surface Contamination Limits) shall be reported to the Radiation Safety Officer immediately.

4.0 Procedure

4.1 Laboratory Map

4.1.1 Prepare a laboratory map that includes numbered locations of frequently used laboratory areas, storage locations and a description of equipment used for radioactive work.

4.1.2 Place the map in the Radiation Safety Records Binder or display it prominently in the lab.

4.1.3 The map may also be photocopied onto the back of the Log Sheet.

4.2 Nuclear Substance Inventory

4.2.1 An accurate and complete Nuclear Substance Inventory shall be maintained through the use of the Health & Safety Management System (HSMS) and all nuclear substances and radiation devices on the Radioisotope User Permit shall be entered and use history maintained.

4.2.2 Each use of open source radioisotopes shall be entered promptly into the Health & Safety Management System inventory. Wipe test results shall also be entered into the HSMS.

a) If using more than 18.5 MBq of isotopes other than H-3 or C-14, monitor all areas where nuclear substances and radiation devices are used with an appropriate survey meter <u>after each procedure</u>. Record the instrument used, the background reading and the maximum reading measured for these areas. Remember to include the units. Dates must include the year, month and date.

b) If using H-3, C-14 or less than18.5 MBq of other isotopes then only weekly contamination monitoring is required and the results shall be recorded on the HSMS contamination monitoring section.

4.2.3 Keep all records both electronic and paper forms for the last eight years in the Radiation Safety Records binder issued for the room.

4.3 Weekly Contamination Monitoring

4.3.1 Fill out the required information on the HSMS contamination monitoring section (date monitored, monitored by, and regular monitoring equipment used). A copy of the University Action Levels at the end of this procedure should be placed within the laboratory (Recommended to be photocopied onto the back of the lab map).

4.3.2 **Within one week** (7 days) of the **first use** of an isotope take wipes and count them for all isotopes in use. Continue to monitor **at least weekly** during periods of use of nuclear substances and radiation devices. Use the lab map numbers or make a sketch to identify the locations where wipes were taken.

a. Record reasons for **delays in counting wipes** on weekly record (i.e. Statutory Holiday, therefore no radioactive work was done).

b. Include random locations to increase variation of areas monitored. These areas must be properly described if they are not included on the map.

c. In general, for an average sized lab, ten (10) locations should be satisfactory. The number of locations monitored may be reduced, by limiting the number of locations used for radioactive work. As a rule, increase the number of locations monitored whenever there are new workers, new procedures or new equipment until you have confidence that the contamination control strategies are effective. Record the actual readings in the space provided.

d. If wipe tests are measured with liquid scintillation counting (LSC), keep the original count printout containing the counting parameters, indicate the locations corresponding to the wipe map and maintain with wipe test records. Count in DPM where possible.

e. When only P-32 is used, contamination monitoring may be done directly using survey meter only if the meter has a Radiation Safety Office sticker validating the action level for the meter and probe combination and the sticker is dated less than one year ago.

f. Other survey meters and probe combinations or gamma counters require specific written approval from Radiation Safety Officer to be considered acceptable. The Radiation Safety Officer will document approval in writing and the action level should be copied onto the copy of the University Action Levels and kept with the weekly contamination monitoring records in the Radiation Safety Records binder. The Radiation Safety Officer has specific information on the types of instrumentation required and can provide assistance in training personnel in the actual use.

4.3.3 Decontamination is required whenever readings are above **0.5 Bq/cm^2**.

4.3.4 Contamination above MUN's action level (see section 2.2) shall be reported to the RSO immediately. Decontaminate and record final readings. Where decontamination is not possible, consider isolation (e.g., place contaminated bench coverings in radioactive waste or seal contaminated items and store for decay).

4.3.5 Contamination in excess of the CNSC Surface Contamination Limit (refer to table 2 at the end of this procedure) shall be reported promptly to the Radiation Safety Officer, who will file a report with the CNSC.

4.3.6 Decommissioning (ensuring no contamination is present) is required for equipment or areas prior to service, renovation or use for non-radioactive work. Such decommissioning shall be recorded on a separate copy of the Weekly Contamination Monitoring Form.

4.4 Monitoring for Contamination

4.4.1 Wipe Test Method - The Wipe Test Method is required for contamination monitoring **at least weekly** when using isotopes other than P-32 unless the conditions of the Radioisotope User Permit specify otherwise.

a) Ensure the contamination level for the isotope and method of detection you are using is listed on the University Contamination Levels table at the end of this procedure. This table lists a range of counts corresponding to the University Contamination Level (**0.5 Bq/cm^2**) for a variety of isotopes. These ranges are based on the manufacturer's supplied efficiencies. If you are unable to count to DPM and the isotope you are using is not listed (or you prefer not to use Liquid Scintillation technique), you will need to propose a method of quantification to the Radiation Safety Officer (RSO) for approval. The RSO will supply a documented action level. Keep a copy of the RSO approval in your Radiation Safety Records binder and write the information onto your Weekly Contamination Monitoring form in the space provided for "Alternate Method".

b) Select an absorbent grade of filter paper with a diameter of about 5 centimeters (qualitative analytical grade is suitable) or another suitable material. Consider wetting the paper with water or 50% alcohol. Hold the moistened filter paper on the edge with thumb and index finger and rub lightly but firmly over the surface, using the pads of the other fingers to apply light pressure, try to obtain the contamination on centre of the paper. Wipe an area of approximately **100 cm^2**. *A zigzag pattern may be used to sample a large area.* Include a blank or background count using an unused wipe.

c) Allow the paper to dry (as required by capabilities of scintillation fluid), and add scintillation fluid (if you do not add scintillation fluid then you are using an Alternate Method that must be pre-approved by Environmental Health and Safety). Due to the activation of many scintillation fluids by exposure to light, it is recommended to store vials in the dark overnight after sealing and shaking them. This is usually enough time to allow chemiluminescence and ultraviolet activation to dissipate. Program instrument to report counts in DPM whenever available. Follow manufacturer's instruction count for the isotopes in use. Include a standard of known activity or calibrate with a standard if suggested by manufacturer. *RECOMMENDED: Count each sample for a minimum of 5 minutes.*

d) Obtain LSC results printout and maintain it in the Radiation Safety Records binder. Record the results in the contamination monitoring section of the HSMS. Compare results to the action level for isotope in use with the lowest counting efficiency. Decontaminate areas where contamination was found and re-monitor. Include details of action taken and the results of re-monitoring in the records. *Record highest and final readings.*

4.4.2 Direct Method - Direct monitoring is required **after each use** of more than 18.5 MBq of P-32. Accepted in lieu of Wipe Test for Weekly Monitoring for P-32 (and other nuclear substances only if specified on the Internal Nuclear Substance Permit) only if the meter and probe combination used has a sticker verifying the calibration of the unit and the sticker is dated less than one year old.

a) Before monitoring, follow manufacturer's operational checks (visual check, battery check, measure a check source i.e. source of known activity, if available).

b) Measure background with the meter set on slow.

c) Monitor areas with the meter, switched on "fast", by passing the detectors lowly (less than 2.5 cm per second) with the detector face towards the surface. Keep the distance between the detector and the surface as small as possible without touching. If contamination is detected, stop and obtain a measurement with the meter set on slow.

d) Record results in contamination monitoring records. Note maximum reading for locations monitored. Decontaminate areas where contamination was found and re-monitor. Include details of action taken and the results of re-monitoring in the records. *Remember to record highest and final readings.*

4.5 Calculating Contamination Level

For indirect monitoring – wipe tests
(Liquid scintillation and Gamma counting)

$$\textbf{Surface Contamination (Bq/cm}^2\textbf{)} = \frac{\textbf{Count}_m - \textbf{Count}_b}{\textbf{E}_c \textbf{ x E}_w \textbf{ x A x 60}}$$

$Count_m$ = measured counts/min (cpm) $Count_b$ = background counts/min (cpm)
E_c = Efficiency of counter E_w = Efficiency of wipe (10%) A = area wiped (100 cm^2)

TABLE 1: Memorial University Action Levels – counts per minute (cpm) corresponding to **0.5 Bq/cm^2** for standard radioisotopes used at MUN.

Method of Detection	Isotope	Manufacturers supplied counting efficiency (E_c)	Counts corresponding to 0.5 Bq/cm^2 [Net measurement (count – background)]
Wipe test (liquid scintillation counting)	H3	20-60%	60-180 cpm
	S35, C14	80-97%	240-290 cpm
	Cr51	35%	100 cpm
	I131	70%	210 cpm
	I125, Co57	78%	230 cpm
	P32, Na22, P33, Ca45, Sr90	~100%	300 cpm

Note: These values are for reference only. Use manufacturer supplied E_c to determine the exact value corresponding to 0.5 Bq/cm^2.

TABLE 2: CNSC Surface Contamination Limits – Reporting Levels

Class / Radioisotopes	Removable Contamination Limits	
	Radioisotope Areas	Other Areas
Class A: (all alpha emitters and their daughters) Co-60, Ir-192, Na-22, Na-24, Sb-124, Ta-182, Zn-65	3Bq/cm2	0.3 Bq/cm2
Class B: As-74, Au-198, Br-82, Co-58, F-18, Fe-59, Ga-67, Gd-153, Hg-206, I-131, In-111, In-114m, Nb-95, Rb-84, Rb-86, Sc-46, Se-75, Sm-153, Sn-113, Sn-123, Sr-85, Sr-90	30Bq/cm2	3Bq/cm2
Class C: Au-195m, **C-14, Ca-45**, Cd-109, Ce-144, Cl-36, Co-57, **Cr-51, H-3**, I-123, **I-125**, Ni-63, **P-32, P-33,** Re-186, Re-188, Ru-103, **S-35**, Sr-89, Tc-99m Tl-201, Y-90, Yb-169	300Bq/cm2	30Bq/cm2

A copy to be placed with Contamination Monitoring Records.

Appendix A: Contamination monitoring action limits – A summary

1. **"Dirty" wipe result –** any result exceeding **0.5 Bq/cm2**.

   Action = immediately clean/decontaminate and rewipe

2. **MUN "action" limit –** Isotope dependent (see table 2 above). Any result exceeding **0.3 Bq/cm2 (class A), 3 Bq/cm2 (class B) or 30 Bq/cm2 (class C).**

   Action = immediately clean/decontaminate and rewipe. **Notify the RSO** as soon as possible. The RSO will conduct an investigation to determine the root cause and prescribe corrective measures to prevent reoccurrences.

3. **CNSC "reporting" level -** Isotope and location dependent (see table 2 above).
   a. **For authorized radioisotope laboratories -** Any result exceeding **3 Bq/cm2 (class A), 30 Bq/cm2 (class B) or 300 Bq/cm2 (class C).**
   b. **For other (i.e. public access areas) -** Any result exceeding **0.3 Bq/cm2 (class A), 3 Bq/cm2 (class B) or 30 Bq/cm2 (class C).**

   Action = immediately clean/decontaminate and rewipe. **Notify the RSO** as soon as possible. The RSO will conduct an investigation to determine the root cause and prescribe corrective measures to prevent reoccurrences. The RSO will report the findings to the CNSC within the prescribed reporting period.