ESH-RPO-BODA-01 Radiation Physics Staff Beam-On Dose Assessment Response

A. General Guidelines

The first Radiation Physics staff member who arrives at Site 39 Annex should initiate beam-on dose assessment procedures. Ideally, two Radiation Physics staff members and a Radiological Control Technician (RCT) should carry out these procedures. **Verify that all response personnel have not had a nuclear medicine procedure during the past month.** If possible, at least one of the responders should be of the same gender as the exposed individual. Security can be contacted to provide a person of the appropriate gender, but do not delay starting these procedures on this account. If enough personnel are available, an assigned Radiation Safety Officer (RSO) should go to the scene of the accident to gather information while counting continues at Site 39 Annex Beam-On Dose Assessment (BODA) room.

If more than one person has been exposed, follow the procedures for each person concurrently to the greatest extent possible. Most of the radioactivity produced in the person's body is short-lived, so the amount of radioactivity decreases rapidly with time. Therefore, **counting should begin as soon as possible after the exposure**. As many counts as possible should be completed within the first hour after the exposure. **However,** **if any of the exposed persons are seriously injured or display erythema (reddening of the skin), burns, or signs of radiation sickness such as nausea, vomiting, or diarrhea, medical treatment takes precedence over body counting measurements.** In this case, exposed persons should be sent to Delnor Hospital immediately. Fire Department personnel have been instructed to stop at the BODA facility to pick up the portable survey meter and clip board containing Portable Survey Instrument Measurements Form (R.P. #97). Notify hospital personnel that you suspect the person has been exposed to radiation.

Collect and save all materials eliminated from the person’s body to the extent possible. These will be analyzed for the presence of radioactivity. Bottles are in the personnel decontamination supply cabinet. Biohazard bags and vomit bags are located in Cabinet 1.

**No information regarding the dose assessment should be released until the assessment is complete.**

B. Initial Notification and Response Activities

1. Upon receiving notification of a Beam-On Exposure, the Radiation Physics staff member should fill out the Initial Response to Radiological Incident Form (R.P. Form #34). Note: Copies of all the necessary forms are contained in the BODA Forms binder.

2. Make sure that all exposed persons who are not seriously injured have been taken to Site 39 Annex. Call the Security Operations Center (SOC) at x4251 to communicate your estimated time of arrival at Site 39 Annex BODA room so that this information can be conveyed to the Incident Commander.

3. Confirm that the beam has been shut off to the affected beamline(s) by contacting the Main Control Room (x3721). If the beam has not been disabled, ask that it be shut off using critical devices leaving other magnets, collimators, etc., as they are. Ask that a hard copy be made of all relevant beam transport elements and that no repairs be made. The beam shall be shut down until the Chief Safety Officer/AD Head gives permission for it to be turned back on.

4. Using the Radiological Control Organization Emergency Call List provided at Site 39 Annex, contact another Radiation Physics staff member and an RCT to request help.

1. Upon arrival at Site 39 Annex BODA room, inform the Incident Commander via the SOC at x4251.

6. If Fire Fighters have already started body counting by the time you arrive, find out where they are in their procedures and if they have experienced any problems. **Verify that no first responders have had a nuclear medicine test during the past month.**

7. **If the exposed person has not arrived yet**, perform a source check on the portable survey meter and perform background and source checks for the Sodium Iodide (NaI(TI)) counter system. Complete BODA System Background and Source Checks (R.P. Form #66). Most likely, these measurements will be completed after body counting is finished. See Appendix B.

8. This procedure assumes that the exposed person may be wearing contaminated clothing and/or carrying radioactive personal items. **Provide the exposed person(s) with the following instructions:**

* Don't touch anything. Doors will be opened and closed for you
* Do not adjust your clothing; you might contaminate it
* Avoid touching your face or hair. Do not rub your eyes
* Remain in one place until you are instructed to move
* Additional instructions will be provided as body counting continues
* **Ask the exposed individual if he/she has received a nuclear medicine test within the past month**

9. **If there is more than one exposed individual**, instruct both people to enter the BODA room. Assist each person in completing all steps at STATION 1. See Section D.

# C. STATION 1: Getting Exposed Person Ready for Body Counting

1. Response personnel should don gloves to guard against contamination. Gloves are in the BODA supply CABINET 1. A person of the same gender should assist the exposed individual(s), as necessary, in removing their protective clothing that was donned at the scene of the accident. Call Security (x3414) if you need a person of the same gender present. Gloves should be discarded in the radioactive waste container.

2. Instruct the exposed person as follows:

* Avoid unnecessary movement
* Remove rings. Put them in a plastic bag and place the plastic bag in the aluminum can located in the restroom
* Don a pair of gloves
* Remove eyeglasses as applicable. Put them in a plastic bag and place the plastic bag in the box located in the restroom
* Remove watch, jewelry, coins, and all other metal objects. Put these items in a plastic bag and place the plastic bag in the aluminum can located in the restroom
* Remove dosimetry badge and self-reading pocket dosimeter and place in a plastic bag
* Remove ID badge and place in a plastic bag
* Remove gloves and put them in the radioactive waste container located in the restroom

3. Provide the exposed person with a fresh set of gloves, coveralls, and booties from CABINET 1. Instruct him/her to remove clothing down to his/her underwear and put on protective clothing.

4. Instruct the exposed person to put his/her clothes in the radioactive waste container located in the restroom. Close the restroom door.

1. After the exposed person has changed, instruct him/her to announce that they are ready to exit restroom. Open the restroom door.
2. Use a Sharpie to write exposed person’s Fermilab ID number/name on his/her coveralls.
3. Conduct a contamination survey of the individual. Refer to Site 39 Personnel Decontamination procedure (ESH-RPO-Decon-01), section 8.8 for instructions on conducting a contamination survey.

8. Record contamination survey results on a Body Chart (R.P. Form #72). Further decontamination can be conducted after body counting is finished if needed.

9. Repeat the above procedure for each exposed person.

D. Measurements for Multiple Exposed Persons

Follow procedures at STATION 2 and STATION 3 for exposed person 1 and exposed person 2 concurrently.

1. Only one exposed person should be in the room while taking counting data. Responder 1 should instruct exposed person 1 to leave the room and accompany him/her to transport vehicle.
2. Responder 1 should take portable survey meter and Portable Survey Meter Measurements Form (R.P. Form #97) located at STATION 2.
3. Responder 1 should follow instructions on RP Form #97 to collect and document portable survey meter measurements.
4. Responder 1 should continue taking measurements until notified that it is time to switch exposed persons (about 15 minutes).
5. Responder 2 should begin counting exposed person 2 at STATION 3.
6. Responder 2 should follow Computer System Measurements at STATION 3.
7. Each run consists of 5 1-minute counts. After 3 runs at STATION 3, switch exposed persons 1 and 2.
8. Staple and label 10-page packets as follows:

Person 1 Name/ID, Run #1

Person 1 Name/ID, Run #2

Person 1 Name/ID, Run #3

Person 2 Name/ID, Run #1

Person 2 Name/ID, Run #2

Person 2 Name/ID, Run #3

E. STATION 2: Portable Survey Meter Measurements

### 1. Turn the portable survey meter on and to the x1 scale and conduct a source check. The check source is attached to the instrument and the sticker adjacent to it will indicate the expected readings. Record the result on Dose Assessment Using Portable Survey Meter Measurements (R.P. Form #65).

2. If the Fire Department has already performed portable survey meter measurements, transfer their results to Dose Assessment Using Portable Survey Meter Measurements (R.P. Form #65).

3. If the Fire Department response personnel have **not** completed these measurements, do the following:

* + Place the probe, using the red dot for assistance, at the location of the body where the beam struck or, if not known, on the exposed individual’s midsection
	+ Press the small round gray switch on the top right of the meter face. This button starts counting for one-minute intervals. A red light will come on during counting and will shut off at the end of each one-minute count
	+ Record the number displayed in the scaler box on the instrument meter face for each one-minute count
	+ Record the number shown in the scaler display box on Portable Survey Meter Measurements Form (R.P. Form #97)
	+ Collect and record at least 3 one-minute count measurements

F. STATION 3: Sodium Iodide (NaI(TI)) Detector Computer System Measurements

1. Verify that the computer and printer are on.
2. Remove the Plexiglas block and place a fresh disposable sheet on the cot.

3. Instruct the exposed person to lay on the cot so that his/her midsection is lined up with the red arrow. Ask him/her to remain as still as possible during counting.

4. Double click on **MAESTRO™**.

5. Go to **SERVICES** menu, then use pull down menu to select **JOB CONTROL**.

6. Double click on **BODYCT**.

7. When **MAESTRO™** exits back to **WINDOWS™**, a run has been completed. Run # is each successive set of 5 one-minute counts for each person.

1. Each Run # has 10 printouts. Staple the 10-page packet together.
2. Write Run # and the exposed person’s name/Fermilab ID on report packet.
3. Repeat steps above for each exposed person. For multiple exposed persons, switch persons after every 3 Runs (15 minutes).
4. Remove and bag the disposable sheet from the cot for each person being counted. Place the disposable sheet in a rad waste container.
5. Collect a total of 3 runs per exposed individual.

G. Transport of Exposed Person to Delnor Hospital for Medical Evaluation

A high dose radiation exposure will result in some bone marrow damage. The degree of damage is related to the red and white blood cell counts of the individual measured over a period of time. Due to the possibility of blood changes and other radiation sickness effects, it is highly recommended that the exposed person to go to Delnor Hospital for medical evaluation. Note the exposed person cannot be forced to go to the hospital, but it should be highly encouraged.

1. If the exposed person gives permission to go to the hospital, arrange for Fire Department personnel to transport the exposed person to Delnor Hospital in an ambulance. Transportation can be arranged through the Incident Commander. One Radiation Physics staff member should go to Delnor Hospital to serve as a radiation safety subject matter expert.
2. Complete Medical History for Individual Involved in Radiological Incident (R.P. Form #94) and bring this completed form to Delnor Hospital.
3. Take a contamination wipe on the person’s ID badge and check the wipe with a frisker. If no contamination is present, return the ID badge to the exposed person.

1. Complete Description of Beam-On Exposure Incident (R.P. Form #95). If available, you could videotape or record the individual’s description.
2. Directions to Delnor Hospital: Take Wilson St. to Kirk Rd. Turn right on Kirk Rd. to go north to Fabyan Parkway. Turn left on Fabyan Parkway and travel west to Randall Rd. Turn right onto Randall going north. The hospital will be on the left side of the road about 2 miles north on Randall.



H. Post-Counting BODA Facility System Checks and Follow-up Activities

While one Radiation Physics staff member goes to the hospital, another Radiation Physics staff member should remain at the BODA facility to complete computer system checks and other follow-up activities.

1. Contact the SRSO to inform him/her of the actions taken and results of beam-on exposure response activities. Provide recommendations for further action such as bioassay, whole body counting, or transport to a local hospital.

2. Report the beam-on dose response event and provide documentation to the Fermilab Occupational Medical Office (FOMO). The event needs to be reported to the FOMO in all cases (with or without injury). If there is no injury, the event will be documented as “report only.” The FOMO will gather any other necessary information for Computerized Accident Incident Reporting System (CAIRS) reporting from the individual.

1. If there are any problems with the computer systems, record them in the logbook and refer to Appendix A, Operation of Computer Based Counting System, for help. Discuss these issues with other Radiation Physics staff members.
2. Complete Dose Assessment Using Portable Survey Meter Measurements (R.P. Form #65).
3. Complete Dose Assessment Using Sodium Iodide (NaI(TI)) Measurements (R.P. Form #69). This should be done after the first 5 measurements have been taken, if possible, and after at least 20 - 30 minutes of counting, as time permits. An interpretation for the printed report is shown in Appendix C, Operation of Computer Based Counting System. If the printer is non-functional, both of these calculations will have to wait until counting has stopped.
4. If not already completed, perform background and source checks of the NaI(TI) counter system. Complete BODA System Background and Source Checks (R.P. Form #66). See Appendix B.
5. Complete Emergency Processing of Dosimetry Badge (R.P. Form #92) to arrange for emergency processing of exposed person(s) dosimetry badge.
6. Survey each plastic bag containing personal items with the E140N Frisker.
7. If any E140N Frisker readings for a plastic bag exceed background (on contact), make arrangements for these items to be analyzed at the Radionuclide Analysis Facility (RAF).
8. Fill out Radionuclide Analysis Facility Chain of Custody (R.P. Form #33) for all of the items to be counted.
9. After RAF analysis is complete, make arrangements to return all personal items to the exposed person. ID badge should be returned to the exposed person as soon as possible. Ideally, wipe the person’s badge and if not contaminated, return it to the person during counting.
10. Verify with the RCT that the transport vehicle has been surveyed and decontaminated as necessary.
11. Survey and decontaminate the cot as necessary with a maslin cloth.
12. Use the maslin mop to decontaminate the floor where the person has walked. Count the mop using the E140N Frisker. Repeat this process as necessary.
13. Dispose of materials used to decontaminate the equipment as radioactive waste in the radioactive waste container.
14. Review and complete BODA Emergency Response Checklist for Radiation Physics Staff Members (R.P. Form #96) to ensure all activities have been completed.
15. Conduct a facility inventory and complete Beam-On Dose Assessment Inventory (R.P. Form #93). Give the inventory list to the Radiation Physics staff member who is responsible for BODA room so that supplies can be replenished.

**Appendix A**

# **Operation of Computer Based Counting System**

The dose assessment counting system utilizes a personal computer, a multi-channel analyzer and a software program called **MAESTRO™**. An 8" x 2" NaI(Tl) detector is located beneath the cot at STATION 3.

**Procedure**

1. Verify the SELECTOR switch (silver box on the table at STATION 3) is set to “COMPUTER” setting.

2. Verify that the computer and printer are on.

3. If the **WINDOWS™** operating system is not running, type at the DOS prompt:

 win <RETURN>

4. Double click the **MAESTRO™** icon.

5. Pull down the SERVICE menu. Select the JOB Control option.

1. Double click on **BODYCT**.

6. Record any problems encountered in the Body Counter Logbook. Notify the Radiation Physics member responsible for the BODA Facility. Refer to the section in this Appendix on Troubleshooting the Computer Based System.

**Interpretation of the Printout**

The report generated from the **MAESTRO™** program is shown below. For every one-minute count, two reports are generated on separate pages. Below is an example of the two-page reports that are generated for each one-minute count.

Detector # 1 ACQ 07-Jul-2018 at 14:39:39 RT = 60.0 LT = 59.9

 ESH-97661 MCB 129

 No sample description was entered

ROI # 1 RANGE: 42 = 98.99 keV to 1677 keV = 3952.41 keV

 AREA: Gross = 8066 Net = -85731 +/-5039

 CENTROID: 48.00 = 113.13 keV

 SHAPE: FWHM = 2.36 FW(1/5)M = 3.77

 ID: Th-227 at 113.16 keV

 Corrected Rate = 0.00 +/- 16172.20cA

Detector # 1 ACQ 07-Jul-2018 at 14:39:39 RT = 60.0 LT = 59.9

 ESH-97661 MCB 129

 No sample description was entered

ROI # 1 RANGE: 171 = 403.02 keV to 280 keV = 659.91 keV

 AREA: Gross = 752 Net = -275 +/- 132

 CENTROID: 219.00 = 516.15 keV

 SHAPE: FWHM = 44.78 FW(1/5)M = 46.19

 ID: Cs-138 at 516.74 keV

 Corrected Rate = 0.00 +/- 512.31 cA

The first page of the report provides the number of counts above 100 keV and the second page of the report provides the number of counts in the 511 keV peak.

* + - * Detector # 1 line provides the acquisition time and date. The two pages of reports will have the same acquisition time and date.

* + - * The ROI # 1 that reads RANGE: 42 = 98.99 keV to 1677 keV = 3952.41 keV is the total number of counts above 100 keV.
			* The ROI # 1 that reads RANGE: 171 = 403.02 keV to 280 keV = 659.91 keV is the total number of counts in the 511 keV peak.
			* Determine the number of counts above 100 keV and the number of counts in the 511 keV peak by reading the AREA: Gross = “ “ in each report.

In the example above, there are 8066 counts above 100 keV and 752 counts in the 511 keV peak. These numbers are used in the background and source check comparison using BODA System Background and Source Checks (R.P. Form #66).

**Examining the Spectra Using the Multi-Channel Analyzers**

A multichannel analyzer can be used to review a spectrum for better peak identification and background subtraction.

The software program MAESTROTM is interfaced with a multi-channel analyzer. The \*.job files save the spectra to the hard drive. These spectra can later be viewed using the MAESTROTM program. Then under the FILE menu, choose the RECALL option. The spectrum files will have the extension \*.chn and will be located in the c:\maestro\logbook directory. This should allow you to bring a spectrum on the screen. Directions for manipulating the file (changing the region of interest, comparing files, etc.) can be found in the User's Manual located near the computer.

Troubleshooting the Computer Based System

In any instance, make a note of the problem encountered and discuss it with other Radiation Physics members.

Problem 1: PRINTER DOES NOT WORK

1. Check to see if the printer has paper. If not, get the printer paper out of the supply cabinet at STATION 1 and load the printer.

3. Then, check to see that the paper is not jammed.

If the above does not work, skip the background check, the background count with the unexposed individual, and the source check. Continue counting by going to JOB Control window. Go to Other file and double click on NOPRINT. Rename files as prompted. After counting has been completed, save all files with the extensions .rpt and .chn. To do this, exit WINDOWS™ and type the following from the DOS prompt:

->copy c:\maestro\\*.rpt a:\\*.\*

->copy c:\maestro\\*.chn a:\\*.\*

Complete the dose assessment using the survey meter data. The dose assessment using the NaI(TI) measurements can be completed later.

Problem 2: COMPUTER DOES NOT COME ON

1. Check to see that the computer is on and that the monitor is on. Once they are turned on, follow the instructions provided in procedure.

2. If there is no response from the mouse or the keyboard, reboot the computer. If this is not successful, check to see that the cables are properly connected.

Problem 3: ERROR WHILE SAVING FILES

If an error is encountered while saving files, skip the background check, the background count with the unexposed individual, and the source check. Continue by going to JOB Control window. Go to Other file and double click on NOSAVE. Do not attempt to rename the files. The printouts should be sufficient to perform the dose estimate.

**Appendix B**

# **Maintenance of BODA Facility Whole Body Counter**

To ensure that the BODA Facility Whole Body Counter is operating properly, a background check and a source check are performed on a weekly basis by RAF staff.

**Procedure**

1. Source Check Count
	1. Obtain the 22Na check source, 22(0.1)5, from the small safe source in the RAF. The combination to this cabinet is available from RAF staff. Place the source on the cot, face-up, centered over the detector face.
	2. Within MAESTRO™, from the JOB control window, double click on Maintain file and then double click on SOURCE. *If the computer-based system is malfunctioning, contact the RAF Team Leader or the Radiation Physics member responsible for the BODA Facility.*
	3. Reports for the number of counts above the discriminator setting (>100 keV) and the number of counts in the 511 keV peak will print automatically.
	4. Remove the source from the cot.
	5. Check that the centroid energy of the 511 peak is within 50 keV of 511 keV. *If not, RAF staff must be contacted to perform a new energy calibration and re-create ROI files a511.roi and gross100.roi.*
	6. If the energy calibration is valid, a background check may be performed.
2. Background Check Count
	1. Within MAESTRO™, from the JOB control window, double click on Maintain file and then double click on BKG. Reports for the number of counts above the discriminator setting (>100 keV) and the number of counts in the 511 keV peak will print automatically.
3. QC Checks
	1. In the BODA\_CalChecks.xlsm spreadsheet, record the count date and time and the number of counts above the discriminator setting (> 100 keV) and the number of counts in the 511 keV peak for both the background and source counts in the BODA\_CalChecks.xlsm spreadsheet. Click the “Print” button at the top of the sheet.
	2. Check that the number of counts in the source 511 peak is greater than 3 times the number of counts in the background 511 peak*. If not, check that the calibration source is positioned correctly. If it is positioned correctly, the source activity may have reached an unusable level. In this case, a new 22Na check source must be obtained. Contact the Radiation Physics member responsible for the BODA Facility to make alternate arrangements for whole body counting until a new source is available.*
	3. Check that the background counts above the discriminator setting and in the 511 keV peak are within 30% of the last recorded background measurement. *If not, perform another background count. If it fails this test again, contact the RAF Team Leader, who will determine the cause and contact the Radiation Physics member responsible for the BODA Facility.*
	4. Check that the source decay-corrected counts above the discriminator setting and in the 511 keV peak are within 10% of their yearly averages. *If not, perform another background count. If it fails this test again, contact the RAF Team Leader, who will determine the cause and contact the Radiation Physics member responsible for the BODA Facility.*
4. Logbook Entry & Wrap-up
	1. Paste all printed results, spreadsheet results, QC failures and observations in the Body Counter logbook.
	2. Return the source to the RAF cabinet.