

## Dose Assessment Using NaI Measurements

### General Information:

The Beam-On Dose Assessment (BODA) Facility is responsible for assaying the short term activity produced when a particle beam strikes tissue. In addition to the estimate based on the modified Bicron Analyst measurements, an estimate should also be made utilizing the NaI(Tl) detector in the BODA Facility. Station 3 is equipped with a 8" X 2" NaI(Tl) detector and is capable of measuring the radiation emitted from the activation products in the body.

The dose equivalent calculation using the NaI(Tl) scintillation measurements is based on tests performed at Lawrence Berkeley Laboratory (LBL) using a tissue equivalent material and has an uncertainty of approximately a factor of 2. It is based on counts above a 100 keV threshold at 30 minutes post exposure as at this early time little interference was seen with the  $^{11}\text{C}$  decay. See RP Note #85 for further information.

1. If you can make (or have made) a measurement at 30 minutes post exposure, use Equation 1 to determine the dose in rem (see the attached worksheet). Otherwise use Equation 2 and calculate a dose for several of the first measurements, using the attached worksheet. See Section 5 of the main procedure for what further actions are warranted after the dose estimate has been obtained. The estimated accuracy of these calculations is about a factor of two.

### Equation 1 (30 minutes post exposure):

$$\text{Dose(rem)} = \left[ \frac{(\text{cpm exposed person on cot}) - (\text{cpm unexposed person on cot})}{422.4} \right] \quad (1)$$

cpm exposed person on cot: cpm above the 100 keV threshold at 30 minutes after the exposure

cpm unexposed person on cot: cpm above the 100 keV threshold  
(see Background and Calibration Sheet -- Appendix E)

If the count rate is not available for 30 minutes post-exposure, use equation (2) below which corrects for the  $^{11}\text{C}$  half-life as time passes. This should overestimate the dose as other longer half-life decays will start to contribute as time passes.

**Equation 2 (any time post exposure):**

$$\text{Dose(rem)} = \left[ \frac{(\text{cpm exposed person on cot}) - (\text{cpm unexposed person on cot})}{1172 * \exp\left(-\frac{\text{time since exposure (min)}}{20.3}\right)} \right] \quad (2)$$

2. If further counting is possible, then collect a minimum of 20-30 minutes of data using the NaI(Tl) detector at Station 3 in order to see how close the decay curve is to that of  $^{11}\text{C}$ . This will give you an estimate of the uncertainty introduced if you do not have a measurement at 30 minutes post exposure. The closer the half-life is to that of  $^{11}\text{C}$ , the more accurate the extrapolation and Equation 2 is at determining a dose.
  - a. From the printouts, graph the number of counts > 100 keV versus time since the exposure on semi-log paper. See Operation of the Counting Systems for the interpretation of the printouts, also posted on the wall by Station 3. Semi-log paper can be found on the back side of the dose assessment calculation sheet that follows or in the Supply Cabinet at Station 1.
  - b. Estimate a best-fit curve from the plot of the data.
  - c. Determine the half-life of the radionuclide. This will be indicated by the time it takes for the count rate to decrease by a factor of two. The half-life of  $^{11}\text{C}$  is 20.3 minutes.
  - d. From the graph, estimate the count rate at 30 minutes post-exposure and use Equation 1 to determine another dose estimate. This dose estimate may be more accurate than the one determined using Equation 2.

Name Exposed Individual: \_\_\_\_\_ ID#: \_\_\_\_\_

Time of Exposure: \_\_\_\_\_ AM/PM Date of Exposure: \_\_\_\_\_

Dose Estimate

By: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>
	NaI Reading (> 100 keV)	Reading Unexposed Person (Appendix B)	Net Counts Col A - Col B	Time of Measurement	Elapsed Time (min) Col D - Time of Exposure	Dose (rem)	Initials of Person Making Measurement
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
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14							
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22							
23							
24							
25							

Appendix F

DOSE ASSESSMENT USING NaI  
(Plot Counts Versus Time)

