A. Purpose

Tritium (H-3) decays by emission of a low energy ($E_{\text{max}} = 0.013$ MeV) beta particle. Liquid scintillation counting is an effective means to assess tritium in liquids. However, many samples, particularly urine, are colored or otherwise contain suspended particles or chemicals that can block or otherwise interfere with production or collection of scintillation events caused by transit of the beta particles through the cocktail, making accurate estimation of the H-3 content problematic. This procedure outlines steps for preparing and counting tritium (H-3) urine bioassay, water, and other liquids using liquid scintillation counting (LSC). Samples will be counted twice – once without a known spike of H-3 and once with a known activity. This will allow for determination of the actual counting efficiency for each sample.

B. Applicability/scope

This procedure applies to all counting work done by LSC for H-3 in liquids at any campus.

C. Definitions

- CE – counting efficiency
- CEDE – Committed effective dose equivalent
- CPM – counts per minute
- DPM – disintegrations per minute
- LSC – liquid scintillation counting
- RAM – radioactive materials

D. Procedures

1. Gather the following supplies:
   - 20 ml LSC vials
   - Tritiated H-3 water standard vial – DO NOT remove the vial cap, use the septum. A concentration of about 0.1 to 0.2 uCi/ml is sufficient. Recommended vendor and item: Eckert & Ziegler Isotopes Products [H-3]H$_2$O standard (NIST traceable).
   - 1 or 3 ml syringe with attached needle
   - 1 ml pipettor and tips
   - 0.1 ml pipettor and tips
   - Miscellaneous materials for working with RAM – gloves, bench top paper, etc.
2. Prepare and count the samples

   a. Prepare the work area for using RAM. Un-tape the sample bottles if the samples are from Nevis. Record the sample identification numbers/information or label sample bottles as needed for later identification.

   b. Label the LSC vial with the appropriate identification information. Add 10 ml of scintillation cocktail to each vial. [NOTE: use LSC cocktail that is compatible with aqueous samples]

   c. Pipette 1 ml of sample into a 20 ml LSC vial. Repeat this step for all samples.

   d. Mix contents by swirling the vial for 5 seconds. Do not shake the vial or bubbles will be introduced to the fluid that may cause false counts.

   e. Prepare a blank background LSC vial with 10 ml of LSC cocktail and place in the first position of the first counter rack.

   f. Re-mix all samples using the swirl method. Wait 10 minutes before counting to allow bubbles to dissipate.

   g. Count the samples. Use a protocol that does not automatically subtract the background.

3. Spike the samples and count again

   a. Using the syringe through the septum, withdraw enough tritiated H-3 water standard so that 0.1 ml can be added to each sample. Dispense the water standard into a clean 20 ml LSC vial to temporarily hold the spike. DO NOT remove the standard vial cap but carefully push the syringe needle through the septum, invert the vial and withdraw the water.

   b. Pipette 0.1 ml of H-3 water standard into each sample vial. This will spike each sample with a known amount of H-3 so the counting efficiency of individual samples can be determined. The amount of H-3 spike should represent an activity that will overwhelm any activity in the sample (i.e., > 20-fold above expected counts)

   c. Mix the spike with each sample using the swirl method. Allow the samples to rest for 3 minutes and then swirl each sample again.

   d. Count all samples again using the same recipe as Step 2.g above.

   e. Review the count data. Re-count if there is any question as to the quality of the data.

4. Data analysis
Sample disintegrations per minute (DPM) should be calculated by subtracting the counts per minute (CPM) recorded in the H-3 channel for the first (blank background) vial from the CPM recorded in the same channel for the sample (net CPM). The counting efficiency (CE) is calculated by dividing the CPM of the sample with the spike (3.d. above) by the known DPM of the H-3 water standard for the spike volume. The activity in the sample is then calculated by dividing the net CPM by CE.

Copy the latest analysis spreadsheet and create a new spreadsheet file. The analysis spreadsheet is located on the shared drive at: P:\Radiation Safety\Dose Calcs Internal External Bioassay\Nevis. Re-name the sample identification in the spreadsheet as needed and input the pre- and post-spike CPM data. The H-3 water standard data is already supplied at the top right hand corner and does not need to be changed until a new water standard is purchased. The standard is decay-corrected automatically.

5. For urine data where committed effective dose equivalent (CEDE) is desired, input the person’s weight, in kg, and the CEDE will be displayed.

E. Emergency Contact

None.

F. Medical Surveillance

None.

G. Recordkeeping

Save all analysis spreadsheets on the shared drive. For any significant internal exposures (e.g. more than 5 mrem CED), report the dose to the Dosimetry Coordinator so the data may be added to the person’s permanent dose history.

H. Appendices

None.

I. Forms

None.

J. References

None.

K. Acknowledgements
None.