# **Tritium Bioassay Protocol**

**Summary/Purpose:** The Tritium Bioassay Protocol Policy details procedures and requirements to document and analyze potential exposures when operations involve specific amounts of Tritiated Materials.

### **Tritium Bioassay Protocol**

Approved Users requesting to work with hydrogen-3 (tritium) in milliCurie or greater quantities, as well as other personnel in the immediate area, must take special care to prevent the release of tritium to the environment and to prevent its accidental ingestion or inhalation.

All personnel working within the approved lab must first submit a preliminary background bioassay and an individual's urine must be evaluated for tritium content, no earlier than 24 hours and no later than 72 hours, after the use or potential exposure to any tritium levels meeting or exceeding those given in Table 1.1.

This document outlines the steps to complete an accurate bioassay for tritium intake.

## When is a Bioassay Required?

**Table 1.1** A tritium (H-3) bioassay is required, when any of the activity levels or concentrations given in the table below are met or exceeded.

Processes	HTO (tritiated water and forms other than those in the right-hand column)	HT or T2 Gas(contained in sealed process vessels)	Nucleotide Precursors	HTO (mixed with more than 10 kg of inert H <sub>2</sub> O or other inert substances)
In open room or bench, (with possible escape of tritium from process vessels)	0.1 Curies (3.7 GBq)	100 Curies (3700 GBq)	0.01Curies (370 MBq)	0.01Curies (370 MBq)
Carried out within a fume hood of adequate design, face velocity, and performance reliability (With possible escape of tritium)	1 Curie	1000 Curies	0.1Curies(3.7	0.1Curies
	(37 GBq)	(37,000 GBq)	GBq)	(3.7 GBq)
Carried out within gloveboxes, (ordinarily closed, but with possible	10 Curies	10,000 Curies	1 Curie	1 Curie
	(370 GBq)	(370 TBq)	(37 GBq)	(37 GBq)

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release of tritium from		
process and occasional		
exposure to contaminated		
box and box leakage)		

### How much Tritium is allowed to be present in my body?

The Annual Limit on Intake (ALI) by ingestion or inhalation of tritium (H-3) is 3 x 10E9 Bq (~80 mCi) of Tritiated water. (Reference: ICRP 30)

**Table 1.2** Uptake limit concentration of hydrogen-3 in urine.

Criteria	Limit	
Weekly Limit for Whole Body Uptake	2 x 10-3 μCi / ml	
Permit Holder Investigation Level	6 x 10-4 μCi / ml	
Radiation Safety Notification Level	2 x 10-4 μCi / ml	

#### **General Precautions**

- All procedures involving milliCurie quantities of tritium (where the tritium compound is
  or could become volatile) must be conducted in a properly operating chemical fume
  hood.
  - o This includes:
  - Opening of packages;
  - o Dilution of stock solutions; and
  - o Chemical procedures.

#### How do I perform a Tritium Bioassay?

- Each individual requiring a bioassay shall collect, handle, and count their own samples.
- If an LSC is not available, you may submit a sample and a partially completed report to Laboratory Services.
- This shall be done by collecting all of the urine in a single urination-void, withdrawing a 1-10 ml sample (5 ml preferred) and discarding the remainder.

### **Sample Preparation**

- No specific sample preparation is required.
- Low potassium glass or plastic vials should be used to minimize background counts.
- An adequate amount of scintillation cocktail should be added and the sample should be shaken well.
- The sample vials should be allowed to dark adapt in the scintillation counter for one hour prior to counting to minimize fluorescence.

<sup>\*</sup> Individuals handling tritium compounds shall wear a lab coat and protective gloves.

### Why can't I use a Geiger counter?

- Portable survey instruments are inappropriate for monitoring the weak (18.6 keV max.) beta particle emitted by hydrogen-3.
- A liquid scintillation counter is adequate for counting contamination wipes and bioassay samples. This counter should be calibrated on an annual basis using National Institute of Standards and Technology (NIST) traceable standards.

#### How do I calculate the tritium concentration?

### **Formula for Determining Concentration**

The concentration of tritium in the sample in units of  $\mu Ci$  / ml can be calculated using the following formula:

Concentration =  $[C_s - C_b]/[(2.22 \times 10^6) \times V]$ 

where:  $C_s = Gross$  sample counts per minute

 $C_b = Background counts per minute$ 

E = Counting efficiency for tritium

V = Volume of sample

 $2.22 \times 10^6 = DPM per \mu Ci$ 

### Formula for Determining Minimum Detectable Activity (MDA)

The minimum detectable activity for the counter in units of  $\mu \text{Ci}$  / ml can be calculated using the following formula:

 $MDA = [2.71 + 4.65(R_b T)^{1/2}] / [(2.22 \times 10^6) E V T]$ 

where:  $R_b = Background$  count rate

T = Counting time

E = Counting efficiency for tritium

V = Volume of sample

 $2.22 \times 10^6 = DPM \text{ per } \mu\text{Ci}$ 

\* The calculated MDA must be lower than the limits on uptake or the effluent limits or the counting procedure is not valid.

**Records Retention** Use the Tritium Bioassay Worksheet (DHS-28) to comply with records retention requirements.

The **original** copy of Form DHS-28 must be submitted to Laboratory Services.

#### **Using Program Forms and Worksheets**

The forms and worksheets used with his document provide the basis for an individual to document the surveys and assessments performed.

All of the worksheets describe the policy that must be met for radiation safety surveys.

Form DHS-28 includes the minimum amount of information necessary to provide traceability and repeatability of the measurements, if needed.