Subject: Radiation Protection Policy

Approval

Title	Name	Signature	Date
Laboratory Supervisor	Kelley E. Keenan		05-26-22
Quality Assurance Officer	Jim Sumner		05-26-22

Document Revision History

Effective Date	Revision number	Review Type	Evaluators	Revisions
05-01-12	0	Internal	Jim Sumner (ETS)	Original document
06-20-12	1	External (TVA) External (NC RMB RPS) Internal	William Rogers (TVA) Donald Snodgrass (TVA) Rick Sherrard (TVA) Randy Crowe Jim Sumner (ETS)	• Provided additional information on building security. • Open doorways to the toxicity laboratory will be chained to prevent employees from accidentally entering the laboratory while contaminated samples are being used. • Incubators containing tests using samples containing tritium should remain locked. • Provided additional guidance on receiving samples from facilities that have historical documentation that indicates tritium concentrations are at or near background levels. • Example tritium disposal to sanitary sewer calculation was revised to exclude clean rinse water. • Exhibit P9.1: Example Signs and Postings were added. • Exhibit P9.2: Tritium Sample Receipt and Tracking Log was added. • Exhibit P9.3: Floor Plan was added.
11-02-12	2	External (TVA) Internal	William Rogers (TVA) Donald Snodgrass (TVA) Rick Sherrard (TVA) Jim Sumner (ETS)	• Exhibit P9.2: Tritium Sample Receipt and Tracking Log was updated and how the tritium inventory is tracked in the laboratory was described in RECEIPT, USE AND DISPOSAL OF TRITIATED SAMPLES section of this policy.
10-01-17	3	Internal	Jim Sumner (ETS)	• Updated policy to NELAP format. • Removed requirements for ghost wipes and urine bioassays.
05-26-22	4	Internal	Jim Sumner (ETS)	• Corrected typographical errors during license renewal review. Provided additional guidance.
06-20-22	5	Internal External (NC RMB RPS)	Jim Sumner (ETS)	• Provided guidance on when wipe tests and bioassays are performed.

Scope and Application

The Radiation Protection Policy is procedures and information for the radiation worker who uses radioactive materials in a laboratory setting at Environmental Testing Solutions, Inc. (ETS). This policy also reflects the requirements of relevant federal and state regulations.

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This policy specifically contains ETS procedures for accepting discharge water samples from Nuclear Power Plants, which contain trace quantities of tritium. ETS has established a limit on the level of tritium contained in these samples to meet safe disposal requirements to the sanitary sewer. All samples must contain ≤ 0.001 µCi/mL tritium. Samples exceeding the ETS requirement will not be accepted and returned to the client. ETS does not accept samples containing other radioisotopes, apart from naturally occurring radioisotopes.

PREFACE

The Radiation Protection Policy is procedures and information for the radiation worker who uses radioactive materials in a laboratory setting at Environmental Testing Solutions, Inc. (ETS). This policy also reflects the requirements of relevant federal and state regulations.

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INTRODUCTION

The radiation protection program at ETS combines the best efforts of management, radiation safety staff and all its employees to ensure the safe use of radioactive materials.

ETS is licensed by the North Carolina Department of Health and Human Services (NC DHHS), Radiation Protection Section to possess and use radioisotopes. This license has been issued by NC DHHS due to established policies and procedures designed to ensure the accountability of radioactive materials, which will minimize the exposure of employees to radioactive materials.

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PERSONELL ROLES AND RESPONSIBILITIES

There are three roles in ETS radiation safety program:

- The Radiation Safety Officer
- The Authorized User
- The Radiation Worker

The roles and responsibilities of each are described below:

The Radiation Safety Officer:

- oversees the radiation safety program
- authorizes the use of radioactive materials
- reviews incidents involving radioactive materials
- sets policies for the use of sources of radiation
- gives general supervision to the implementation of those policies
- advise Authorized Users and Radiation Workers on radiation safety and regulatory compliance issues
- provides the following services:
  - training
  - personal monitoring
  - pregnancy counseling
  - laboratory radiation surveys
  - incident, spill and contamination management
  - radioactive waste management

Radiation Safety Officer at ETS:

Jim Sumner, Phone: (828) 350-9364, E-mail: Jim@etsnclab.com

The Authorized Users:

Authorized Users are management who are approved by the Radiation Safety Officer to use radioactive materials under specific conditions. Any employee using radioactive materials at Environmental Testing Solutions, Inc. is either an Authorized User or is a Radiation Worker using radioactive materials under an Authorized User's supervision.

Each Authorized User is responsible for:

- The health and safety of anyone using or affected by the use of radioactive materials under his or her direction or supervision.
- Personally attending training and ensuring that his/her employees, staff and visitors receive appropriate training.
- Ensuring that his/her employees comply with relevant regulations, policies and procedures.

Authorized Users at ETS:

Jim Sumner, Phone: (828) 350-9364, E-mail: Jim@etsnclab.com
Kelley E. Keenan, Phone: (828) 350-9364, E-mail: Kelley@etsnclab.com

The Radiation Worker:

A Radiation Worker is anyone who uses radioactive materials. The Radiation Worker's training, compliance with regulations and procedures, careful work habits and respect for the health and safety of fellow workers are an integral part of the radiation safety program.

Radiation Worker responsibilities include the following:

- Complete the radiation safety training.
- Be familiar with the isotopes in use; know their radiological, physical and chemical properties, methods of detection, and types of hazards presented by each one, and the specific precautions and handling requirements for each isotope.
- Be familiar with all the relevant procedures of the radiation safety program, including waste disposal procedures.
- Maintain appropriate inventory, disposal and survey records.
- Secure radioactive materials by making sure that radioactive materials are stored or are under immediate supervision within the laboratory.
- Inform coworkers and visitors to the work area about the presence of radioactive materials and of any precautions they should take.
- Know who to notify in any incident involving sources of radiation and how to handle spills and personal contamination.

TRITIUM (Hydrogen-3, H-3)

General:

Tritium is a very low energy beta emitter and even large amounts of this isotope pose no external dose hazard to persons exposed. The beta radiation cannot penetrate the outer protective dead layer of the skin of the body. The major concern for individuals working with this isotope is the possibility of an internal exposure. Such an exposure may occur if an individual contaminates bare skin, accidentally ingests the material, or breathes it in the form of a gas or vapor. The critical organ for a tritium uptake is the water of the whole body. Three to four hours after an intake of tritiated water, the radioactive material is uniformly distributed throughout the body fluids. A tritium intake may be easily detected by analyzing a urine sample.

Many tritium compounds readily migrate through gloves and skin. Data from accidents involving tritium indicate that 80% of the body exposure occurs through skin absorption. Tritium compounds should be handled with gloved hands, and in some cases, with double gloves. Change gloves often. Tritiated DNA precursors are considered more toxic than tritiated water. However, they are generally less volatile and do not normally present a significantly greater hazard.

Physical data:

Radiological half-life: 12.28 years
Emissions: beta particles with a maximum energy of 18.6 keV and an average energy of 5.7 keV
Maximum range in air: 4.7 mm in air, 6 mm in tissue

Fraction transmitted through the dead layer of the skin: none
Dose rate to the skin at 10 cm: none
Dose rate to epidermal basal cells from skin contamination of 1 mCi/cm2: none
Shielding: none needed

Safe drinking water limit: 20,000 pCi/L = 0.00002 µCi/mL
ETS sample receipt limit: ≤ 0.001 µCi/mL

Internal occupational limits (annual limits on intake as tritiated water):
Ingestion: 80 mCi which is equivalent to 5 rem

Detection:
Liquid scintillation counting is the preferred method for detecting H-3. Most Geiger-Muller (G-M) detectors will not detect the presence of H-3.

Precautions:
H-3 contamination cannot be detected with a G-M meter, and special precautions are needed to keep the work environment clean. The use of wipe tests, with a liquid scintillation counter, is the only way to ensure that a work space does not contain contamination.

USING TRITIATED SAMPLES SAFELY

In some cases, the practices described below are required by regulation or by license conditions but in all cases these practices represent good laboratory practices which will promote the safe use of radioactive materials. Additional good laboratory practices are described in the laboratory General Safety Policy (POLICY-P6).

Protective Clothing

Lab accidents often involve spills or splashes which can readily contaminate exposed wrists, legs and feet. For any work with contaminated samples:

- Double gloves
- Full-length lab coat (worn closed with sleeves rolled down)
- Close-toed shoes (do NOT wear sandals or other open-toed shoes)
- Safety glasses

Keep an extra set of clothing and shoes in the lab if clothing becomes contaminated.

Avoid using petroleum-based hand creams when wearing gloves because petroleum-based hand creams may increase glove permeability.

Food and Beverages

- Do not eat or drink in any room where contaminated samples are in use.
- Do not store food, beverages, or medicines in refrigerators or freezers where contaminated samples are used or stored.
- Do not store food, beverages, medicines, cosmetics, coffee cups, eating utensils, etc. on open surfaces near lab benches where contamination can be readily spread.
- Smoking is not allowed on ETS property.

Mouth Pipetting

Never mouth pipet any solutions.

Security

- Building should always remain locked.
- Security alarm must be armed during non-working hours.
- Supervise visitors in the lab.
- When visitors who are not accompanied by authorized lab personnel enter the lab, find out who they are and why they are there.
- When samples containing tritium are used in the toxicity laboratory, open doorways will be chained to prevent employees from accidentally entering the laboratory.
- Incubators containing tests using samples containing tritium should remain locked.

Signs and Labels

- A Tritium Safety Sheet will be posted in all laboratory areas where tritiated samples are actively being used. The signs will indicate the name of the facility that has submitted tritiated samples. For example postings, refer to Exhibit P9.1.

Monitoring:

- **Due to the low levels of tritium received by the laboratory, monitoring with ghost wipes is not required.** Geiger counters (survey meters) are not sensitive to tritium radiation and therefore wipe tests and a liquid scintillation counter are necessary to determine levels of contamination. Radiation badges are not issued to individuals using only tritium because the radiation emitted by tritium is not of sufficient strength to penetrate the badge.
- **Due to the low levels of tritium received by the laboratory, analyses of urine samples are not required.**

SPILL AND INCIDENT PROCEDURES

An accident may happen to even the most careful of workers and any worker may be called upon to assist in the case of a spill, a contamination incident, or an emergency. Be prepared and know how to respond before an incident happens.

The following procedures provide an overview of who to notify and how to respond to several different types of incidents.

Who To Notify

An incident can be readily handled by the laboratory and may include a spill of contaminated samples or an incident of personal contamination. In all cases, contact the Radiation Safety Officer or Authorized User of the incident.

In the event of a fire or serious injury:

- Call 911
- Begin evacuation procedures (POLICY-P6)

What to Do When a Spill Occurs

For skin and body contamination, wash skin using mild soap and warm water for 2-3 minutes. Do not abrade skin or use hot water.

For spills onto laboratory surfaces:

1. Start cleanup at the edge of the contaminated area and work inward.
2. Clean wet spills or contamination using absorbent paper towels.
3. Change paper towels frequently to avoid smearing contamination around.
4. Change gloves frequently and check for rips and tears.
5. Mild acids may be used as decon solutions (e.g. acetic acid).

A Serious Injury with Radioactive Contamination

Serious injury and life-or-death situations always take priority over radiological concerns. In all cases of physical injury, even minor injuries, medical attention and hospitalization take precedence over contamination concerns. There are no radiation sources at ETS that produce contamination and radiation exposure risks large enough to prevent first aid from being given.

1. Call 911. Public Safety responders are trained to provide first aid.
2. If possible, have someone meet emergency response personnel and escort them to the accident scene.
3. Remove contaminated items and clothing from the victim only if these actions will cause no further harm.
4. If time permits, attempt to provide an uncontaminated pathway for the emergency crew.
5. Have someone who can provide useful additional information accompany the victim to the emergency room.

RECEIPT, USE AND DISPOSAL OF TRITIATED SAMPLES

Documentation:

- Nuclear Power Plant sample locations which have no potential of receiving tritium contaminated waste streams are required by ETS to provide documentation that indicates that there is no potential of tritium contamination at the location were samples are submitted for testing (this may include facilities that have historical records where tritium levels have been documented to be at or near background levels).
- Nuclear Power Plant sample locations which have the potential of receiving tritium contaminated waste streams are required by ETS to:
    1. Provide test results of the tritium concentration (µCi/mL) contained in each sample submitted for testing. Documentation may be sent by fax or email but must be received before samples are accepted by our laboratory.
    2. Tritium concentrations must be ≤ 0.001 µCi/mL in each sample submitted. This may result in the termination of a toxicity test, if a sample containing ≤ 0.001 µCi/mL cannot be collected for completing a test (meeting hold times and renewal requirements).
- Our laboratory will not receive samples contaminated with other radioisotopes.

Sample Receipt:

1. Wear protective clothing as described in "Using Tritiated Sample Safely" above, when unpacking tritiated samples.
2. Follow laboratory Sample Receipt, Handling and Storage Procedures (SOP-G4).
3. Log samples into the Tritium Sample Receipt and Tracking Log. The tracking log is an excel spreadsheet which documents the date received, sample description, tritium concentration and volume received. The spreadsheet calculates the total tritium contained in the sample and the contribution to the tritium inventory in the laboratory (Exhibit P9.2). Once samples are disposed to the sanitary sewer, the date is entered into the log and that contribution is removed from the laboratory's tritium inventory. Tritium test results, supplied by the facility, are maintained in the tracking logbook.

Use of Tritiated Samples:

ETS standard operating procedures are used to perform the required testing of tritiated samples.

Sample Disposal:
All samples will be disposed down the sanitary sewer. Work areas, glassware and plasticware that come in contact with contaminated samples will be washed with soapy water or a weak acid (e.g. acetic acid). Waste generated from washing will be disposed down the sanitary sewer.
Below is a conservative estimate of tritium released to the sanitary sewer, based on the tritium concentration limit set by ETS for samples received in the laboratory (≤ 0.001 µCi/ml).

Monthly average concentration for release to sanitary sewer requirement:
≤ 1.0×10^{-2} µCi/ml or ≤ 0.01 µCi/ml for Tritium obtained from Table 3 of Appendix B to 10 CFR 20.1001-20.2401

Monthly average water use at the laboratory (obtained from water bill):
5 CCF/month = 14,158,424 mL/month
(low conservative estimate = 10,000,000 ml/month)

Monthly average volume of samples containing tritium:
10 gallons for 1 test = 37,854 mL
(high volume estimate = 50,000 ml)

Maximum concentration of tritium contained in samples:
0.001 µCi/mL

Highest estimated concentration released to sanitary sewer:
0.001 µCi/ml contained in 50,000 ml of sample disposed down sewer with dilution by 10,000,000 ml of clean water in a month

= (0.001 X 50,000)/10,000,000 = **0.000005 µCi/ml monthly average**

The maximum monthly average (0.000005 µCi/ml) is well below the requirement for release to the sanitary sewer (≤ 0.01 µCi/ml).

SURVEYS AND CONTAMINATION CONTROL

Due to the tritium levels received by ETS, surveys are not required. Guidance provided below describes how to perform surveys, if a spill of contaminated samples occurs.

Wipe surveys, using "wipes" counted on a liquid scintillation counter, are used to monitor possible laboratory contamination at ETS. Wipe tests are the most versatile and most sensitive method of detecting low-level contamination in the laboratory.

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Defining Contamination:
The Radiation Safety Officer may request wipe tests when a sample containing ≥ 0.001 µCi/mL tritium has spilled.

How to Perform a Wipe Test

1. Wipe tests are performed by an approved testing laboratory using sample kits provided. In general, a piece of filter paper (about 1" in diameter), Q-tip or other swab is used to perform the wipe test. Wipe the area being surveyed. If the area is very large, subdivide it into smaller areas and use several wipes to better pinpoint the location of contamination. For some surfaces, including skin and clothing, the wipe media should be moistened with water or other appropriate solvent. Identify the area that the wipe sample was collected on the Floor Plan (Exhibit P9.3) and attach to the chain-of-custody form supplied by the laboratory performing the analysis.
2. The wipes are then shipped to the approved laboratory for analysis. The sample activity is determined by dividing the sample count by the counter's efficiency for the isotope in question.

When to Perform Wipe Tests:
Laboratory personnel should conduct wipe tests on individual work areas (which may include floors, benchtops, experimental equipment, etc.) under the following conditions:

- if a sample containing ≥ 0.001 µCi/mL tritium has spilled and decontamination is required

Where to Perform Wipe Tests:
Wipe tests can be performed on areas where splashes or spills may have occurred and areas where a person could unknowingly transfer contamination. Typical survey locations include:

- Bench tops, including the edges
- Sinks where tritiated samples were disposed (sink basin, surrounding bench, faucet handles)
- Floors: at working areas, laboratory entrances and waste containers
- Communal equipment, such as pipettors, timers, incubators, centrifuges, water baths, etc.
- Clean areas (offices, desks, doorknobs, phones, computers)

When to Document Wipe Tests
Records of each wipe test are maintained in the laboratory files. Wipe tests should contain the following information:

- Name of person performing the wipe test
- Date
- Brief description of the area
- Follow-up action taken when contamination is found

PERSONAL MONITORING

Internal Monitoring

Radioactive materials can be taken up internally when volatile or other airborne radioactive materials are inhaled and when radioactive materials are absorbed through skin or ingested. Internal uptakes may occur when lab personnel unknowingly handle contaminated objects, when permeation occurs through highly contaminated gloves, or when spills occur. To determine the dose resulting from an intake, urine bioassays may be performed.

When are Bioassays Required?

Due to the tritium levels received by ETS, bioassays are not required. The Radiation Safety Officer may request bioassays when samples containing ≥ 0.001 µCi/mL tritium have spilled, and direct skin contact has occurred. Any worker can request a precautionary bioassay at any time.

Declared Pregnant Worker Program

Any radiation worker who is pregnant or believes that she may be pregnant should contact the Radiation Safety Officer. All inquiries will be kept in confidence. The Radiation Protection Officer will alter work activities for the pregnant employee so that she is no longer working with tritiated samples. This will minimize additional exposure.

Exhibits

Exhibit P9.1: Example Signs and Postings
Exhibit P9.2: Tritium Sample Receipt and Tracking Log
Exhibit P9.3: Floor Plan

Exhibit P9.1: Example Signs and Postings

Tritium LAB SAFETY

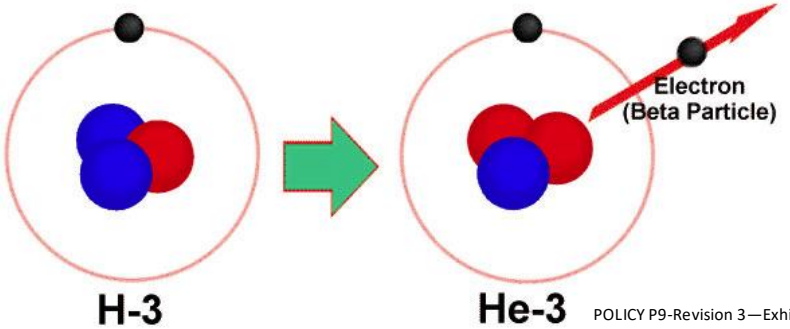
H-3 Tritium

Very Low Energy Beta Emitter
Half-Life: 12.28 Years
Maximum Energy: 19KeV (at 100%)
Maximum Range in Air: 1/6th inch
Annual Limits of Intake:
80 mCi (Ingestion/Inhalation)
Critical Organ: Whole Body
Bioassay: Urine

Detection: Wipe Test
Instrument:
Liquid Scintillation Counter
Shielding: None Required
PPE: Double Gloves, Lab Coat, Safety Glasses
Dosimetry: None Needed

Notes and Special Precautions

- **H-3 can NOT be detected with a portable survey meter. Surveys must be conducted using wipes and Liquid Scintillation Counting.**
- **Wipe tests required after studies using tritiated samples.**
- **Liquid Scintillation Counter efficiencies for H-3 = 60 -70%.**
- **Urine bioassays may be performed for some users; specifically if contamination or spills occur.**



CAUTION

Tritiated Samples in Use

Samples which may contain tritium include:

Sequoyah Nuclear Plant

Shearon Harris Plant

Watts Bar Nuclear Plant

Exhibit P9.2: Tritium Sample Receipt and Tracking Log

Tritium Sample Receipt and Tracking Log

Date received	Sample description	Tritium concentration (µCi/mL)	Volume received (mL)	Total tritium (µCi)	Contribution to Inventory (µCi)	Date diposed to sanitary sewer
08-09-17	Shearon Harris	0.00000484	4000	0.0194	0.0000	08-24-17
				0.0000	0.0000	
				0.0000	0.0000	
				0.0000	0.0000	
				0.0000	0.0000	
				0.0000	0.0000	
				0.0000	0.0000	
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				0.0000	0.0000	
		Limit (uCi)	100	Total Inventory	0.0000	

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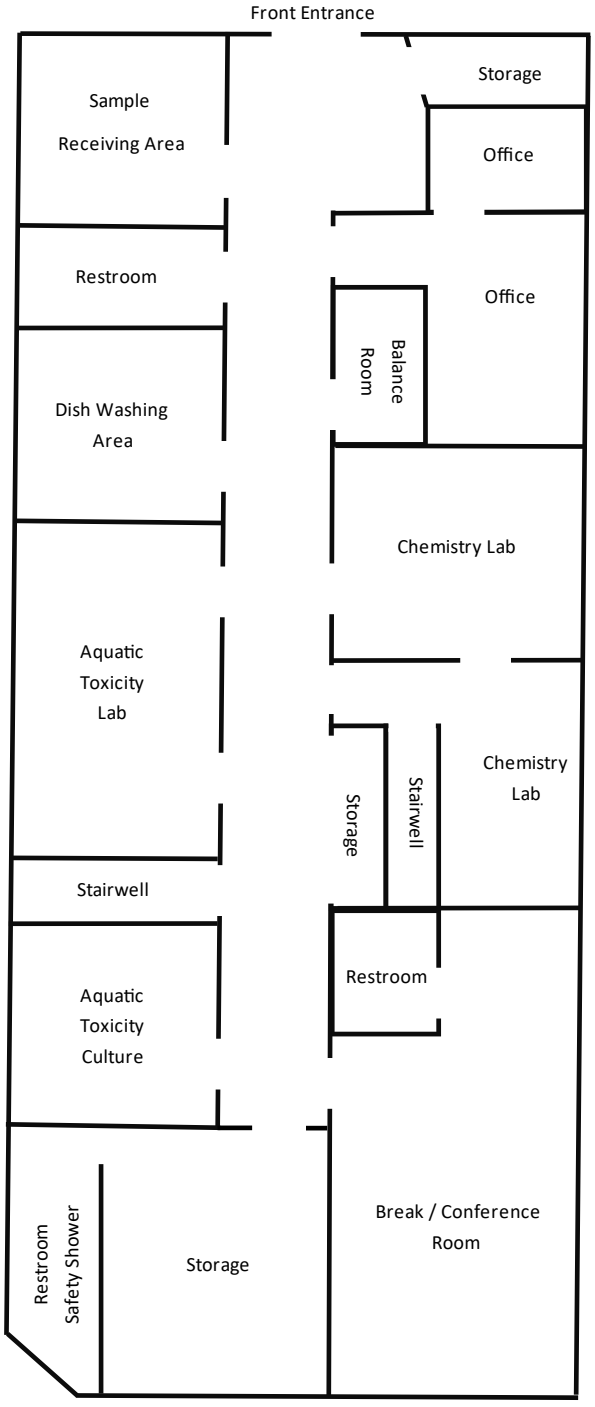
Exhibit P9.3: Floor Plan



POLICY P9-Revision 3 — Exhibit P9.3