QAM-S-101

Laboratory Safety

Revision 13

Approval:

_____ 9-17-20

Laboratory Manager Date

_____ 9/17/20

RSO Date

Effective date: 9-26-20

Renewal date: _____ Initials: _____

Texas Institute for Applied Environmental Research

1. Applicability and Purpose

This procedure applies to all operations, activities and personnel in the laboratory(s) at the Texas Institute for Applied Environmental Research (TIAER), Tarleton State University, Stephenville, Texas. **Safety is the responsibility of each staff member, intern or student worker in the TIAER Lab**. The purpose of this procedure is to help ensure a safe working environment for laboratory personnel through training, hazard communication, exposure monitoring, and corrective actions. Laboratory safety involves chemical safety, fire safety, electrical safety, hazardous waste, radiological and other safety issues. **The Tarleton Risk Management website and Laboratory Safety Program are the focus of TIAER Lab personnel questions and concerns about general safety**. The Laboratory Manager (LM) is responsible for the initial safety tour at TIAER and compliance with this QAM. The TIAER Radiation Safety Officer (RSO) is responsible for radiation safety training, monitoring and record keeping. All other safety training is the responsibility of Tarleton and the Texas A&M System.

2. Definitions

2.1. ALARA- As Low As Reasonably Achievable, the goal of all staff with respect to radiation exposure.

2.2. Absorbed Dose- The energy imparted by ionizing radiation per unit mass of irradiated material.

2.3. Activity- Rate of disintegration, transformation, or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

2.4. Background radiation- Radiation from cosmic sources; naturally occurring radioactive materials, including global fallout as it exists in the environment from the testing of nuclear explosive devices. "Background radiation" does not include radiation from source, byproduct, or special nuclear materials, or devices regulated by the NRC or DHS. The average United States annual radiation exposure from natural sources is about 310 millirem (3.1 millisieverts or mSv).

2.5. Becquerel (Bq)- 1 pCi= 37 mBq (amount)

2.6. CPM- Counts per minute. Most radiation detectors display the number of events detected per unit of time. This can be converted to a measure of activity in dpm by dividing by the detection efficiency.

2.7. Curie (Ci)- A unit of activity. 3.7 x 10^{10} nuclear transformations per second, 3.7 x 10^{10} becquerels, or 2.22x10^{12} nuclear transformations per minute. The term nuclear transformations is often replaced by the term disintegrations.
2.8. DPM- Disintegrations per minute. A measure of activity based on the curie.
2.9. Dosimeter- a device used to measure radiation exposure. Dosimeters may be specific to body areas, such as hands, but are normally worn on the chest as a whole body device.
2.10. OSL- optically stimulated luminescent dosimeter
2.11. PPE-Personnel Protective Equipment, including gloves, facemasks, sleeves, etc.
2.12. REM- Roentgen Equivalent Man, a measure of absorbed dose to humans based on type of radiation
2.13. Radiation area- An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.
2.14. SDS- Safety Data Sheet- a detailed information bulletin prepared by the manufacturer or importer of a chemical that describes the physical and chemical properties, physical and health hazards, routes of exposure, precautions for safe handling and use, emergency and first-aid procedures, and control measures.
2.15. Sievert (Sv)- 1 mrem=10 µSv (dose)
2.16. TLD- thermoluminescent dosimeter
2.17. More safety definitions are found in QAM-R-100, “TIAER Radiochemistry Program”.

3. Equipment, Reagents and Standards

3.1. Various equipment and safety related chemicals are found in each specific Standard Operating Procedure. Refer to each SOP individually for these and PPE.
3.2. Safety glasses- required for anyone entering the laboratories
3.3. Ludlum Model 3 Survey Meter with pancake probe (QAM-RI-101, “Operation and Calibration of the Ludlum Model 3 Survey Meter”)

3.4. Ludlum Model 2350-1 Data Logger with NaI detector (QAM-RI-102, "Operation and Calibration of the Ludlum Model 2350-1 Data Logger")
3.5. Swipe cloth and petri dishes (SOP-RC-111, "Swipe Testing for Surface Contamination")
3.6. Spill cleanup kits with neutralizing agents
3.7. Dosimetry and personnel monitoring equipment

4. Procedure

4.1. Hazards: Examples of common hazards include the following:
4.1.1. Chemical hazards: Toxins, corrosives, flammables, and reactives
4.1.2. Biological hazards: Microbes, animals, plants, and genetically modified agents
4.1.3. Radiation hazards: Ionizing and nonionizing radiation
4.1.4. Physical hazards: Heating devices, cooling liquids, noise, projectiles, fire, cold, etc.
4.1.5. Electrical hazards: Fire and shock
4.1.6. Mechanical hazards: Moving machinery
4.1.7. Airborne hazardous materials: Vapors, dust, etc.
4.1.8. Ergonomic factors: Standing, repetitive motion

4.2 General Safe Laboratory Practices
4.2.1 Know the chemicals and hazards in your laboratory.
4.2.2 Know what to do in an emergency situation.
4.2.3 Know how to read and interpret SDSs.
4.2.4 Wear personal protective equipment, as appropriate. Full face shields and appropriate gloves are required for handling concentrated acids, liquid nitrogen and other materials that are extremely harmful.
4.2.5 Follow safe practices for working with chemicals.
4.2.6 Nothing in the lab is for human consumption.
4.2.7 Designate microwave ovens and other heating devices exclusively for food or laboratory operations, not both. Ensure ovens are clearly labeled to indicate their function.
4.2.8 Do not wear contact lenses around chemicals, fumes, dust particles, or other hazardous materials. Contact lenses are never be worn by personnel in the laboratory due to the possibility of fusion of the lenses to the eyeball from fumes or vapors in the atmosphere.

4.2.9 Protect unattended operations from utility failures and other potential problems that could lead to overheating or other hazardous events.

4.2.10 Avoid working alone in a laboratory.

4.2.11 Avoid producing aerosols. Work in a hood when handling airborne particulates or fumes.

4.2.12 Use extreme care when working with needles, blades, and glass.

4.2.13 Do not eat, drink, or use tobacco products in the laboratory. Food or drink is allowed only in designated office areas, not in the laboratory where analyses are performed or chemicals are stored.

4.2.14 Never make contact with a pipet using your mouth.

4.2.15 Clean contaminated equipment, personnel and areas as soon as possible. In the event of an acid, base, mercury, radioactive material or any other hazardous spill, avoid contaminating equipment and work areas any further. Clean non radioactive, hazardous spills immediately with an appropriate spill kit and dispose of waste properly. Decontamination for radioactivity is considered successful if not above 2x background upon surveying or less than 1000 dpm on swipes, but this may be radionuclide specific. Refer to SOP-RC-111, "Swipe Testing for Surface Contamination" for performing swipe testing procedures and QAM-R-100, "TIAER Laboratory Radiochemistry Program" for further information on frisking, decontamination and documentation of swipes and surveys. These procedures are always done under the supervision of the RSO.

4.2.16 Further, for radioactive spills:

4.2.16.1 Remain calm and use your training.

4.2.16.2 Notify persons in the area of the spill. Do not allow others to enter except authorized response personnel.

4.2.16.3 Notify the RSO and LM

4.2.16.4 Survey the area and any affected persons.

4.2.16.5 Where possible, cover the area and await direction from the RSO at a safe distance for ALARA.

4.2.17 If the RSO or LM are not immediately available, and any personnel survey indicates a dose rate above 20 mrem/hr at a 1 meter distance, personnel are to remove affected clothing or

PPE and resurvey. If personnel are still contaminated above this level, they will wash affected areas with mild soap and water until levels reduce.

4.2.18 Surface radiation decontamination: Dish detergent, window cleaner, vinegar, bubble bath, waterless hand cleaner, or oven cleaner are all suitable for cleaning items. Spill clean up kits may be available for certain material spills. Some particulate contamination may be cleaned with wet paper towels best.

4.2.19 Skin radiation decontamination: Carefully remove contaminated clothing. When cleaning skin, rinse generously, use mild soaps, and take care to not abrade the surface. Simply soaking skin in a mild detergent solution, vinegar, or bubble bath may remove most contamination.

4.2.20 Do not allow children in the laboratory except when accompanied by an adult employee. It is a violation of state law for a child to be unattended in a place that presents a risk of harm. Children are never allowed in Radiation Areas.

4.2.21 Keep laboratory doors closed.

4.2.22 Decontaminate all affected equipment after use.

4.2.23 Avoid using dry ice in enclosed areas. (Dry ice can produce elevated carbon dioxide levels.)

4.2.24 Dry ice mixed with isopropanol or ethanol may cause frost bite.

4.2.25 Hallways, corridors, and exit ways must be kept clear. Do not relocate (even temporarily) laboratory equipment to these areas.

4.2.26 Never underestimate the hazards associated with a laboratory. If you are unsure about what you are doing, get assistance.

4.2.27 Radioactive sources, materials and sample should always be stored securely. Sources not in use should be stored in a lead container or shield (for gamma and high energy beta radiation).

4.3 Personnel and PPE

4.3.1 Protective eyeglasses are worn at all times by anyone entering the laboratory, including visitors and non-laboratory personnel. At present, regular eyeglasses are considered sufficient for

routine labwork not involving strong acids, caustics and other dangerous chemicals.

4.3.2 Faceshields, goggles, gloves, labcoats, aprons and other protective equipment are worn as appropriate by the analyst or worker performing specific laboratory functions. Examples are: nitrile gloves are worn for handling organic solvents, thermal gloves are worn for hot or cold applications.

4.3.3 Personnel working in the laboratory wear sufficient leg covering and closed-toed shoes. Sandals are not allowed.

4.3.4 All personnel should think "**Safety**" at all times and in all functions.

4.3.5 All accidents or injuries, no matter how minor, are ***immediately*** reported to the LM or his/her designee. All radioactive spills require notification of the RSO.

4.3.6 No unauthorized experiments or maintenance are performed.

4.3.7 Horseplay in the laboratory is strictly prohibited. Personnel maintain a professional attitude when working in the laboratory

4.3.8 Radiation monitoring badges are worn by personnel who work with radioactive materials. Dose monitoring records are maintained by the RSO. Any monitoring worker has the right to review his/her exposure history. Badges may be OSL, TLD or Pocket Dosimeters, as deemed appropriate by the RSO. Dosimetry is not left near radioactive sources unless attached to the worker. Workers are not allowed to take dosimetry home. Lost or damaged dosimetry requires immediate notification to the RSO and initiation of a Corrective Action Report.

4.4 Chemical and Radioactive storage and use

4.4.1 Concentrated acids are stored in an acid storage cabinet or under a vent hood when not in immediate use. Strong bases are also stored separately and never be placed in glass containers.

4.4.2 All solvent extractions and acid digestions are performed in a vent hood to prevent fume release and minimize exposure.

4.4.3 Flammable materials are stored in a flammable storage cabinet or under a vent hood when not in immediate use.

4.4.4 All chemical, reagent and standard containers are clearly labeled, at a minimum, for contents, receipt or preparation date, SOP number (if appropriate) and the initials of the person

labeling them. Radioactive materials, sources and samples are labeled with special cyan and magenta labels “Caution-Radioactive Material” or equivalent designation.

4.4.5 Chemicals and radioactive materials are segregated by reactivity and storage requirements. Additionally, waste is segregated by solid, liquid and half-life of above or below 90 days. (See QAM-Q-101, “Disposal of Laboratory Waste”)

4.4.6 Gas cylinders remain capped when not in use and are secured to a stable stand or wall mount at all times, except when being moved or changed. Cylinders are labeled as "Full", "In Use", or "Empty". Flammable gases are stored separately from oxidant gases. Liquid nitrogen or argon are allowed to vent by special devices to avoid excessive pressure build up.

4.4.7 A Chemical Inventory Log (Q-102-1) is maintained by the Laboratory Manager in an Access file on a computer. Any time a chemical container is received, it is given a unique identifier in accordance with QAM-Q-102, “Material Acceptance Criteria”. When the container is opened, emptied or disposed of, the action is recorded in this log.

4.5 Physical Facilities in the Laboratory

4.5.1 Aisles, walkways and exits should remain clear. Access to safety showers, eyewashes and fire extinguishers remain open at all times.

4.5.2 Housekeeping and cleanliness should be ongoing at all times. All spills and messes should be cleaned up after every analysis.

4.5.3 Fire blankets, fire extinguishers, first aid kits, safety showers and eyewash stations are considered emergency equipment and not used for daily procedures or personal applications routinely.

4.5.4 If water or power is interrupted to the laboratory for any period of time, analytical functions and chemical functions cease and the laboratory workstations are evacuated. This is because safety capacities such as the safety shower and eyewash will not be available. If power is available, analysts may continue with paperwork or at computer workstations, but no chemical analyses are allowed without water availability.

4.5.5 Radiation areas are labeled in cyan and magenta colors as “Caution-Radiation Area” if the dose rate is 5 mrem/hr at 30 cm

from the source or surface of any material in the area. Radiation areas has exit screening prodecures for control of contamination. Refer to QAM-R-100, "TIAER Laboratory Radiochemistry Program" and RI-101, "Operation and Calibration of the Ludlum Model 3 Survey Meter" for screening.

4.6 Waste Disposal

4.6.1 Broken, chipped or cracked glassware is disposed of properly and not used. Broken glass is stored and disposed of in a special, unbreachable container.

4.6.2 Hazardous waste is disposed of and stored in proper containers in accordance with QAM-W-101, "Disposal of Laboratory Waste". Radwaste requires special precautions and segregation.

4.7 Documentation and Inspections

4.7.1 Safety inspections are performed on at least an annual basis by Tarleton State University and monthly by the TIAER RSO.

4.7.2 The Tarleton Risk Management Department provides the local Fire Department or authorities with an updated chemical inventory list and map of chemical storage locations within the laboratory. The Laboratory Manager provides Tarleton with an updated Chemical Inventory Log (Q-102-1) annually. Tarleton and the Texas A&M System periodically conduct safety and chemical hygiene inspections, and are responsible for fire extinguisher and general facilities maintenance.

4.7.3 A copy of the Tarleton Hazard Communication Program remains updated and online at the Tarleton website. A copy is given to all new employees to read. A current version of the chemical inventory list is available in the laboratory.

4.7.4 SDSs are not required for common household items used in the laboratory for the purposes of cleaning or other such use if the product conforms to labeling requirements under routine consumer product regulations.

4.7.5 Each analyst is trained in the handling of each chemical or piece of equipment prior to use. He/she reads the Safety Data Sheet and understand the hazards and precautions associated with each chemical prior to handling.

4.7.6 New employees are given a safety tour and are required to sign a sheet verifying that they have been shown the locations of listed safety equipment (Attachment 1, S-101-1), that they will read SDSs prior to working with chemicals, and have read the Tarleton Laboratory Safety Program. This does not constitute a verification that the employee has been trained in the areas or equipment shown during the tour. Individual training is performed and documented prior to use of the equipment.

4.7.7 New employees, and all employees annually, are given Radiation Safety Training (attachment 7.2 of QAM-R-100, "TIAER Laboratory Radiochemistry Program"). Only the RSO can authorize personnel to work in Radiation Areas.

4.7.8 Radiation safety inspections and monitoring are performed by the RSO or designee. These include, at a minimum, monthly swipe testing of work areas and surfaces for contamination, personnel and area dose monitoring, and review of records for material and sample receipt related to radioactive materials. Inspections are recorded on the Radiation Safety and Survey Logbook (or E-log), attachment 2.

5. Quality Control and Safety Aspects

5.1. All laboratory operations are performed in accordance with this procedure and QAM-Q-101, "Laboratory Quality Control". TIAER management is responsible for providing a safe working environment for all personnel. The Laboratory Manager is responsible for ensuring employee safety training annually as required by Tarleton, the Safety Tour (Attachment 1, S-101-1), chemical inventory (Q-102-1), and the stocking and upkeep of safety equipment. The RSO is responsible for laboratory radiation inspections (Attachment 2, S-101-2), dosimetry issuance and exposure records (Dosimetry Logbook, Attachment 3, S-101-3) and Radiation Safety Training of workers.

5.2. Lab Safety and Hazard Communications training is available online through the Tarleton Risk Management website. New employees and students who complete the online training will submit documentation of completion to Tarleton Risk Management within 30 days of completion. Other safety programs are available through Tarleton. TIAER Lab's Radiation Training is included as attachment 2 of QAM-R-100, "TIAER Laboratory Radiochemistry Program." Personnel are required to complete this annually, under the RSO, and document with a Personnel Training Form (Q-107-1).

5.3. The RSO is responsible for updating the LM on a periodic basis for non-fixed radioisotope usage and amounts for the Chemical Inventory (Q-102-1). Individuals using isotopes are required to log usage in the Standard Log (Q-102-2) for prepared standards and in Personal Logs (A-102) for spike amounts.

5.4. The RSO is responsible for compliance with the safety aspects of QAM-R-100, "TIAER Laboratory Radiochemistry Program". Other special considerations and emergency procedures are also found in the same program procedure.

5.5. Every employee is responsible for identifying risks, hazards, and unsafe situations or practices and for taking steps to control or report them. The employee who recognizes an unsafe condition notifies the LM immediately. Every employee always consider safety the top priority in any activity or project undertaken. It is the responsibility of the employee to notify the LM of any change in health, including pregnancy, that may require special precautions.

5.6. The LM and RSO are responsible to ensure a safe working environment in the lab through inspections and for maintaining Material Safety Data Sheets, employee exposure monitoring records and safety training records. Tarleton provides employees copies of the Hazard Communication Program, bloodborne pathogens, and other training and analyzes accidents and injuries for prevention and control. Tarleton also conducts occasional safety meetings for training and discussion of employee concerns, as well as fire drills, fire extinguisher training and evacuation exercises as necessary.

5.7. Certain individual clients and/or projects may require specific health and safety plans for use by TIAER Lab personnel. These are reviewed or written by the LM and RSO. In any case, no aspect of this QAM section is negated, but additional precautions may be added for the specific case required. Ex.- a site safety plan for a sampling/analysis project off site.

6. References

6.1. Handbook for Analytical Quality Control in Water and Wastewater Laboratories, USEPA EMSL, Cincinnati, OH, March 1979.

6.2. Standard Methods for the Examination of Water and Wastewater, latest online edition (EPA approved), ed. by Arnold E. Greenberg, et al., APHA, AWWA, Washington, D.C.

6.3. Employee Training Guide, Texas Hazard Communication Act, Texas Department of Health, Austin, Texas.
6.4. Tarleton State University Risk Management, http://www.tarleton.edu/safety/
6.5. National Environmental Laboratory Accreditation Conference (NELAC) TNI standard, The NELAC Institute, 2016.
6.6. Stanford University Radiation Safety Manual, January 2015.
6.7. University of Wisconsin-Milwaukee, Radiation Safety Program.
6.8. QAM-R-100, “TIAER Laboratory Radiochemistry Program”.

7. Attachments

7.1. TIAER Lab Safety Tour, S-101-1
7.2. Radiation Safety and Survey Logbook, S-101-2
7.3. Dosimetry Log, S-101-3
7.4. Personnel Screening Log

Attachment 1

TIAER Laboratory Safety Tour
Employee Safety Orientation Training

Date: _____

Employee: _____

Conducted by: _____

Eye Wash_____ Safety Shower_____ Exits_____

Radioactive Material Storage _____ Waste Storage _____

Fire Extinguisher_____ Flammable Storage_____

Safety Data Sheets location_____

First Aid Kit_____ Fire Blanket_____

I have been shown the location of the above items as listed. I will read and understand all Material Safety Data Sheets for chemicals prior to using them. I have read the Tarleton Laboratory Safety Program and Hazardous Communication Plan. I will not undertake any task or procedure without first being trained and documented as such. I will immediately notify the Laboratory Manager of any safety hazard I discover, any injury I receive, and any change in health which may affect my work status or ability to work safely.

Signed: _____

Laboratory Manager: _____

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Attachment 2
Radiation Safety and Survey Logbook

Building/Room #: _____ ***Date:*** _____ ***Performed by:*** _____

Contamination Survey (dpm) - Working surfaces and floor areas are smear tested for removable radioactive contamination in a random fashion. An area of approximately 100 cm^2 is covered by each swipe. Results are reported as net (background corrected) disintegrations per minute (dpm) on the description below. Area Survey (mrem/hr) – Radiation dose rates are measured at work areas and storage areas. The readings are reported as millirems per hour (mrem/h) on the description below. Except where noted readings are for beta and/or gamma radiation at 1 foot. Known sources of external radiation are noted on the description. Other items are noted.

Area description/sketch with swipe results:

Area Survey: (Instrument Used)

Manufacturer: _____Model: _____TIAER ID:_____
Date Calibrated: _____ Background: _____

Contamination Survey: (Instrument Used)

Manufacturer: Model: TIAER ID:
Surveyor's Name:

Inspection Check

General Lab Deficiencies	*(circle):*		
a. Personnel wearing dosimetry and PPE?	N/A	Yes	No
b. Radwaste containers labeled and segregated?	N/A	Yes	No
c. Radwaste in the general trash baskets?	N/A	Yes	No
d. Are isotopes, samples and sources secured?	N/A	Yes	No
e. Work areas and containers labeled?	N/A	Yes	No
f. Are records and logs updated and accurate?	N/A	Yes	No
g. Food or drink found in undesignated areas?	N/A	Yes	No

Comments:

_____

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Attachment 3
Dosimetry Logbook
(example)

TIAER ID	Serial #	Type	Manufacturer	Model	Calibrated by
Green	OB 297915	Pocket	Ludlum	AT-138	Ludlum
		Cal Date	*Cal Due Date*		
		4/14/17	8/14/17		

Date issued	initial reading	Issued to	Return date	final reading	Total exposure
7/13/17	0	Doe, Jane	8/27/17	0.2 mrem	0.2 mrem

Personal Exposure Records (confidential)

Name (Last, First)	Title	Gender (M,F)	Date of Birth	Accumulated Lifetime Dose as of (date)	Comments
Doe, Jane	Tech	F	8/13/65	4.5 mrem (7/30/15)	OSL records online at Landauer

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Attachment 4
Example Personnel Screening Log (RadScreening E-log)

Radiation Protection							
Ingress/Egress							
						(Y/N)	
Date	Time	Location	Personnel	Instrument	Measurement	Cleared	Other/Comments
		Mobile Lab					
		Mobile Lab					
		Mobile Lab					
		Mobile Lab					

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