Standard Operating Procedure

Use of Uranium ($^{238}U_{92}$) and Thorium ($^{232}Th_{90}$)

Facility: QMC central facility, Dept. of Physics, Physics Bldg., Rm 1357 & 1358

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Scope: This SOP details appropriate safety procedures for the use of radioactive material in the QMC central facility, restricted to those users approved by UMD Department of Environmental Safety (DES).

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Introduction:

Uranium ($^{238}U_{92}$) and Thorium ($^{232}Th_{90}$) are radioactive isotopes. Handling U- and Th- based materials involves 'Chemical', 'Biological', and 'Radiological' Hazards.

Toxicology:

Uranium ($^{238}U_{92}$): Flammable in dust form, react with moist air and water. Soluble uranium compounds are deposited in the kidney, liver, and bone where they cause damage. Insoluble uranium compounds affect lungs and its inhalation leads to osteosarcoma and lung cancer.

Thorium ($^{232}Th_{90}$): Flammable, decay products are toxic by ingestion and inhalation. Thorium is attracted to the bones, lungs, lymphatic glands and parenchymatous tissues. Thorium remains in the body for a long time and is known to cause changes to blood forming, nervous and reticule-endothelial systems, and functional and structural damage to lung and bone tissue.

Exposure Control:

Uranium (radioactivity ~ 0.334 μCi/g) emits Gamma & X-rays radiation of average energy 0.1438 and 0.1857 Mev producing a dose rate of 0.021 mSv/h at 1 m distances from the source. It emits Alpha particle of average energy 4.174 Mev and Beta radiation.

Thorium (radioactivity ~ 0.11 μCi/g) emits Gamma & X-rays radiation of average energy 0.059 Mev producing a dose rate of 0.0185 mSv/h at 1 m distances from the source. It emits Alpha particle of average energy 4.010 Mev and Beta radiation.

Annual Limit on Intake (ALIs): The ALIs are the annual intakes of a given radionuclide by "Reference Man" which would result in either (1) a committed effective dose equivalent of 5 rems (stochastic ALI) or (2) a committed dose equivalent of 50 rems to an organ or tissue (non-stochastic ALI). The ALI for U-238 is 10 μCi (ingestion), 0.04 μCi (inhalation). The ALI for Th-232 is 70 μCi (ingestion), 0.001 μCi (inhalation) **.**

In a typical experiment at QMC, small quantities of U-238 and Th-232 not exceeding 0.1g will be used. Therefore, a 0.1 g sample provides for 33 nCi U-238 and 11 nCi Th-232. The quantities handled are orders of magnitude below the ALI for ingestion. Furthermore, the potential for ingestion is minimized by wearing proper PPE and performing surveys to detect contamination at very low levels. The action level for removable contamination is 20 dpm/100 cm2 (0.009 nCi/100 cm2). Similarly, the potential for inhalation is low. The experimental procedures do not provide generation of volatile radioactivity. Procedures include encapsulation of the material during crystal growth in furnace. Materials will be handled in a laboratory hood until their contamination potential is known; however, at no time will airborne radioactive material be produced. Bioassays are required when the potential for intake exceeds 1/10th ALI; bioassays are not required for this experiment.

Procedures:

I. Personal Protective Equipment (PPE):

- Use protective gloves for handling

- Minimize exposure to the material by procedural planning

- Use proper shielding to surround the material (mainly alpha emitter - plastic containers)

- Maintain safe distance from the material

- Use of PPE (Glass, Lab coat, no open toe shoes)

- Wash hands after use

- Discard any radioactive waste using procedures noted in section VD and VI.

- For emergencies, lab is also equipped with fire extinguisher, eye wash/shower station and first aid kit.

II. Emergency Response Procedures:

The following actions, including remediation, will be carried out.

Personal Decontamination Techniques

- Wash well with soap and water and monitor skin
- Do Not abrade skin, only blot dry
- Decontamination of clothing and surfaces are covered under operating and emergency procedures

Spill and Leak Control

- Alert everyone in the area
- Confine the problem or emergency (includes the use of absorbent material)
- Clear area
- Summon Aid

Emergency Protective Equipment, Minimum Requirements

- Gloves
- Footwear Covers
- Safety Glasses
- Outer layer or easily removed protective clothing

III. **Type and Location of Hoods to be used with Radioactive Material:**
Work Bench and Fume Hood (checked within the last year for adequate flow by DES) with proper radiation area sign.

IV. Radiation Detection Equipment:

- Survey meter / GM (Geiger-Muller) counter with valid calibration.

Alpha detector: Liquid Scintillation Counter (LSC) within the vial, Located at Animal Science Building under PI Dr. Tom Porter, Animal Science), TRI CRAB Liquid Scintillation Analyzer, Maker-PACKARD; Model No. 2200CA

V. Method and Frequency of Monitoring your work area:

A. The storage site will be surveyed during the storage period. Survey will be done before and after every use, otherwise monthly when materials are not taken out from the storage.

B. An initial survey will be conducted with GM counter for gamma and beta radiation and with an air proportional detector for alpha radiation.

C. A wipe test will be conducted and the results will be posted in the wipe log book in the units of Disintegrations per Minute (DPM).

DPM = CPM /efficiency of detector [=100% for both U^{238} and Th^{232} on LSC]

D. Work bench top surface areas will be wiped with one inch discs of filter paper or Para film, and the area per wipe will cover approximately 100 cm^2. These wipes will be placed in a vial containing standard scintillation cocktail and counted in a Liquid Scintillation Counter. If any reading exceeds 20 dpm/100 cm^2, (1000 for ^3H) that area will be considered contaminated and will be cleaned. Since the action level is so low, one hand-held alpha scintillator detector (will be borrowed from radiation safety) will be used. This detector has a large active area and will provide for better Minimal Detectable

Activity. This will be followed up with wipe tests in order to ensure this low action level for alpha contamination is not exceeded on surfaces. The RSO (Radiation Safety Officer) will be notified of a contamination condition.

E. A self-survey of user's body and hands will be performed after each use with hand-held meter.

F. A log book will be maintained with all survey results.

VI. Type of Security to avoid loss or theft of radioactive material:

Raw materials, synthesized compounds, and the generated radioactive waste will be stored in a locked cabinet labeled for radioactive material storage. The radioactive waste will be picked up by DES upon request. The cabinet is situated in a controlled entry synthesis laboratory (1357 Physics) with monitored logging of entry/exit. A log book will also be maintained in the cabinet.