Thank you for joining the Baltimore-Washington Chapter of the Health Physics Society at the University of Maryland for a nuclear science merit badge program. Below please find some important information on what you can expect, how to prepare, and what you should bring. Updates to this document and our schedule are posted to our event website: https://bwchps.wildapricot.org/event-3520280.

- **Parking Directions Revised.** When you arrive, please park in Regents Drive Garage. Because no football game, there is free parking in parts of Regents Drive Garage this Saturday. Regents Drive garage has three parking areas: Lot RR, Lot B, and pay station spaces on roof. **Lot B and Lot RR are FREE this Saturday.** Pay station spaces on the roof require payment from 7 am – midnight seven days a week ($3/hour with no daily rate). You'll need your parking spot number when you pay at the kiosk near the elevators. You should not park in Zipcar spaces, service spaces, or meter spaces as these are not included in the free parking.

- After parking, walk to A. James Clark Hall (AJC) for registration and breakfast. See campus map on next page to help orient yourself.

- Registration is in Zupnik Forum lecture hall (AJC 1101). Please visit the registration table to check in and pay (if you haven’t already). Participants are split into 8 rotation groups (A1, A2, A3, A4 or B1, B2, B3, B4) to complete the merit badge activities. Groups A will start with the Classroom lecture and do activity rotations in the afternoon. Groups B will do the opposite. We did our best to keep parties and troops together. Please let us know if we made a mistake. **Scouts must stick with their “buddy” throughout the day.**

- Classroom sessions are in Zupnik Forum (ACJ 1101) and Activity rotation stations are in the Chemical & Nuclear Engineering Building which is just a short walk away (classrooms CHE 2116, 2118, 2140, and 2145).

- Breakfast and lunch will be in the Zupnik Forum (ACJ 1101)
  - Breakfast of coffee/hot chocolate, donuts/muffins, and fruit will be served starting at **8:30 am**. The merit badge program will start **promptly at 9:00 am.**
  - At **noon** we will have a lunch of pizza, salad, cookies, sodas/water.

- The requirements for the nuclear science merit badge and useful references can be found here: http://nuclearconnect.org/know-nuclear/talking-nuclear/boy-scouts-nuclear-science-merit-badge

- Scouts will complete activities 1, 2A, 3, 4B, 4D, 5A, 6C **during the event.** We recommend you complete activities **2B, 3B, 7, and 8 before arriving.** There will be opportunity for merit badge counselors to review and sign off on the pre-requisite activities at the event.

- For activity 2B, your atom models must be 3D. You may bring your models to the event (if they transport easily) or you may take photo(s) of the models and bring them to the event.

- Follow-up arrangements can be made with merit badge counselors to finish any requirements not complete at end of the day. Merit badge counselors have **Blue** name tags.

- We do not have special entertainment for the adults. You are welcome to sit in the Zupnik Forum or follow Scouts around.

**What to bring**

1. Closed toe walking shoes. No flip flops!
2. Pen/pencil and notebook. Be prepared to take some notes!
3. Print out merit badge worksheet (enclosed)
4. Bring your blue card. Must be signed in advance by your unit leader.
5. Bring your atom models or photos of atom models (or some combination of these).
6. Bring photo identification for reactor tour (minors exempt but should bring school ID if they have)
CAMPUS MAP

Registration located at
A. James Clark Hall
University of Maryland
8278 Paint Branch Dr
College Park, MD 20742

Google Directions to Regents Drive Parking Garage
TRIGA NUCLEAR REACTORS

Introduction

The Maryland University Training Reactor (MUTR) is a very early model 250 kW General Atomics low enrichment uranium TRIGA (Training, Research, Isotopes, General Atomics) reactor that was installed in 1970 as an upgrade from a 10 kW HEU Materials Testing Reactor previously installed in 1960. The UMD NRC license is #70 (Docket R-70). It is a major facility that supports teaching, research, and service for UMD as well as numerous outside collaborators.

Experimental Facilities

The MUTR is an open pool reactor with a maximum licensed, steady state, thermal power of 250 kW. The fuel is TRIGA-type stainless-steel-clad cylindrical fuel rods in which the enriched uranium is homogeneously mixed with a zirconium hydride neutron moderator. The MUTR is light water cooled and moderated, and the water also serves as a neutron reflector and biological shielding. The reactor contains five experimental facilities. The graphite filled thermal column provides an ex-core beam of thermal neutrons for experiments. Large samples, up to approximately 13.3 cm in diameter, can be placed adjacent to the core in either the beam tubes (two) or the through tube. The beam and through tubes can also provide ex-core gamma and neutron beams. Thermal flux levels in the through tube are $1.60 \times 10^9$ n/cm$^2$/sec coupled with a gamma dose rate of 2.1 rad/sec/kW. Finally, in-core irradiations of small samples (max. size of approx. 2.5 cm diameter by 5 cm length) can be performed using the pneumatic transfer system. This system is capable of providing thermal flux levels of $1.90 \times 10^{10}$ n/cm$^2$/sec coupled with a gamma dose rate of 2.1 rad/sec/kW. Reactor power is monitored through three in-core neutron detectors: a fission chamber, a compensated ion chamber (CIC) and an uncompensated ion chamber.
University of Maryland Nuclear Science Merit Badge Workshop - October 12, 2019
Classroom Session – Zupnik Forum (A. James Clark Hall Room 1101)

Requirement 1 a/b/c (Activity)

☐ a. Tell what radiation is

☐ b. Describe the hazards of radiation to humans, the environment, and wildlife.

Explain the difference between radiation exposure and contamination.
In your explanation, discuss the nature and magnitude of radiation risks to humans from nuclear power, medical radiation, and background radiation including radon.

Explain the ALARA principle and measures required by law to minimize these risks.

☐ c. Describe the radiation hazard symbol and explain where it should be used.

Tell why and how people must use radiation or radioactive materials carefully.

Requirement 2a (Activity)

☐ a. Tell the meaning of the following:

atom, nucleus, proton, neutron, electron, quark, isotope.

alpha particle, beta particle, gamma ray, X-ray; ionization, radioactivity, and radioisotope.

Requirement 2b (Pre-req Review)

Scouts or groups of scouts come up and explain / show their isotope models.

☐ b. Choose an element from the periodic table.

Construct 3-D models for the atoms of three isotopes of this element, showing neutrons, protons, and electrons. Use the three models to explain the difference between atomic number and mass number and the difference between the quark structure of a neutron and a proton.

Requirement 7 (Pre-req Review)

☐ Give an example of each of the following in relation to how energy from an atom can be used:

nuclear medicine, environmental applications, industrial applications, space exploration, and radiation therapy.

For each example, explain the application and its significance to nuclear science.

nuclear medicine, environmental applications, industrial applications, space exploration, and radiation therapy.
Station One – Cloud Chamber Lab
Chemical & Nuclear Engineering Building Room 2116

Requirement 4 b/d (Activity)

☐ b. Make a cloud chamber. (Use demo kit)
   Show how it can be used to see the tracks caused by radiation.
   Explain what is happening.

d. **Will be completed at station 3.**

Station Two – Survey Meter Lab
Chemical & Nuclear Engineering Building Room 2118

Requirement 5a (Activity)

☐ a. Using a radiation survey meter and a radioactive source, show how the counts-per-minute change as the source gets closer to, or farther from, the radiation detector.
   Place three different materials between the source and the detector, then explain any differences in the measurements per minute.
   Explain how time, distance, and shielding can reduce an individual’s radiation dose.

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Also review radiation, radiation hazard symbol, and ALARA using passageway displays – these were introduced in the classroom session as part of requirement 1.

Station Three – Reactor Tour
Chemical & Nuclear Engineering Building Room 2140

Requirement 4 b/d (Activity)

b. **Will be completed at station 1.**

d. Visit a place where radioisotopes are being used. Draw nuclear chain reaction in the reactor. Using a drawing, explain how and why they are used. Then discuss with your counselor the different kinds of radiation and how they can be used.

Requirement 6c. (Activity)

☐ c. Find out how many nuclear power plants exist in the United States.
   Locate the one nearest your home.
   Find out what percentage of electricity in the United States is generated by nuclear power plants, by coal, and by gas. Then discuss with your counselor how nuclear energy is used to produce electricity.
Station Four – Cyclotron Tour  
Chemical & Nuclear Engineering Building Room 2145

Requirement 3 (Activity)

☐ a. Visit the cyclotron and discuss how scientists at the University of Maryland are using it.

☐ b. (Pre-req review) Name three particle accelerators and describe several experiments that each accelerator performs.

Requirement 8 (Pre-req Review)

☐ Find out about three career opportunities in nuclear science that interest you. Pick one and find out the education, training, and experience required for this profession. Discuss this with your counselor and explain why this profession might interest you.