US DOE Nuclear Criticality Safety Engineer Hands-On Subcritical and Critical Experiments Training and Education Course

Facilities: 1st Week at Los Alamos National Laboratory TA55/PF4 and Classroom

2nd Week at either

Sandia National Laboratories SPRF/CX

or

Nevada Nuclear Security Site Device Assembly Facility
National Critical Experiments Research Center

Cost: NONE

Points of Contact:

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Registration Request: http://ncsp.llnl.gov/classMain.html

Purpose of Presentation

The purpose of this presentation is to provide a description of the new US DOE Nuclear Criticality Safety Program (NCSP) Hands-On Subcritical and Critical Experiments Training and Education Course for Nuclear Criticality Safety Engineers (NCSE) in the DOE complex. The no-cost-to-student course is sponsored by the US DOE National Nuclear Security Administration (NNSA) NCSP and coordinated by the Oak Ridge National Laboratory (ORNL). The course replaces historic NCSE training programs held at Los Alamos National Laboratory (LANL) and then Lawrence Livermore National Laboratory (LLNL). The course is designed to provide the elements of training and education to NCSEs that are not typically available or provided by the employers of NCSEs and runs for two contiguous weeks at various US DOE facilities. The need for the course was identified by the NNSA to develop consistency in the understanding and application of nuclear data/experiments, national consensus standards, US DOE regulations, orders, standards, and guides as they apply to nuclear criticality safety programs in NNSA facilities, as well as the performance of nuclear criticality safety evaluations. Successful completion of the course by complete attendance, participation, and passing of examinations is a part of the qualification of NNSA personnel with nuclear criticality safety oversight responsibilities and provides a common basis of training for contractor NCSEs.

Brief Description of the Course

The basis of the course is derived from the American National Standards Institute/American Nuclear Society (ANSI/ANS) national standard ANSI/ANS-8.26-2007[1] and the training and education section of the Mission and Vision of the US DOE NCSP [2].

The DOE NCSP NCSE classroom education, facility training, and hands-on subcritical and critical experiments training provide education and training for entry-level NCSEs. The course content is limited in scope to provide education and training in subjects and facilities that cannot, or are not, readily provided by the NCSE's employer. This limitation avoids overlap with NCSE site-specific education and training. Additionally, the course provides DOE guidance in the interpretation and application of its federal rules, directives, standards, and guides with emphases on preparing nuclear criticality safety evaluations that meet DOE standards [3]. Upon the successful execution of repeated courses during 2012, the content and duration of the course will be modified to address additional DOE training needs for individuals (e.g., safety managers, supervisors, military personnel, etc.). The current education and hands-on training course will be provided four times in calendar year 2012 and subsequent years. It may be expanded to six to eight times per year if there is sufficient interest.

Course Content

The first week is devoted to education and facility training, and the second week provides hands-on subcritical and critical experiments training. Although the hands-on subcritical and critical experiments training is offered at two alternative sites using very different experimental machines, this portion of the course has been designed to ensure that the same learning objectives are met.

The following is an outlined description of the course contents.

Los Alamos National Laboratory (classroom and facility tour)

- Nuclear criticality safety history and fundamentals
- Time behavior of fissioning systems
- Process criticality safety accident discussion
- Hand calculation method discussion
- Evaluation team breakouts (in preparation for facility tour and process criticality safety evaluation assignments)
- Guidance in the preparation of DOE STD 3007 compliant nuclear criticality safety evaluations
- Overview of ANSI/ANS Series 8 Standards
- Instruction on interpreting and applying US DOE rules, directives, standards, and guides
- Hazards analysis role in the safety evaluation process
- Tour of TA-55/PF-4 plutonium process facility with specific walkdown in preparation of safety evaluation assignment
- Instruction about human factors and equipment reliability influence upon criticality safety
- Interpretation and application of nondestructive analysis methods and results to nuclear criticality safety

Classroom exercises in completing nuclear criticality safety evaluations are based on operations observed during the walk-around tours of the LANL TA-55/PF-4 plutonium facility shown in Figure 1.

Figure 1. TA-55 Plutonium Facility.

Sandia National Laboratories (SNL) (hands-on subcritical and critical water-moderated lattice experiments)

- Governing standard(s)
- Fundamentals of criticality physics
- Experimental methodology
- Critical experiment design and execution
- Reactor kinetics
- Critical experiment accidents
- Hands-on subcritical and critical experiments
- Fuel depletion/burnup
- Critical experiment benchmarking

The hands-on subcritical and critical experiments are performed in the SNL Sandia Pulsed Reactor Facility (SPRF) 7% Critical Experiment (7uPCX) lattice water tank shown in Figure 2.

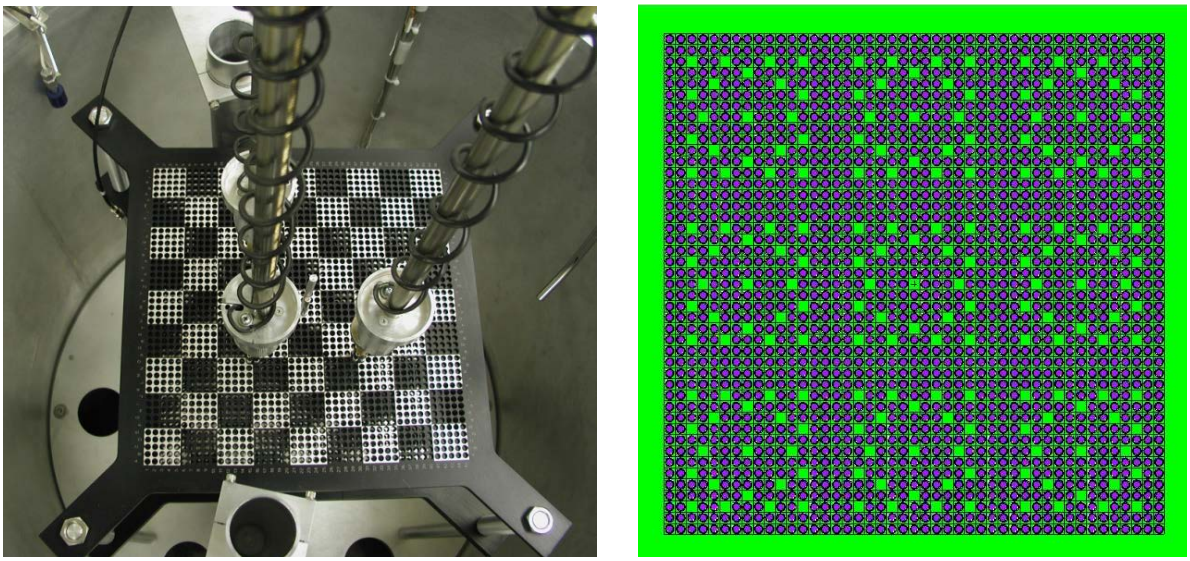

Figure 2. 7uPCX Experiment Water Tank.

Nevada National Security Site (NNSS) (hands-on subcritical and critical machines)

- Governing standard(s)
- Experimental methodology
- Definition of reactivity and multiplication related to the delayed and prompt critical states
- Neutron life cycle for thermal and fast neutron systems
- Point reactor kinetics model, in-hour equation
- Reactivity measurement methods, feedback
- Critical experiment accidents
- Hands-on experiments: Training Assembly for Criticality Safety (TACS), Planet, Flattop, BeRP ball, Godiva
- Critical experiment benchmarking

The hands-on subcritical and critical experiments are performed at the US DOE National Criticality Experiments Research Center (NCERC) contained within the Device Assembly Facility of the NNSS shown in Figure 3.

Figure 3. Device Assembly Facility.

Various subcritical and critical experiment assembly machines exist at the NCERC. They include the Planet vertical lift assembly machine (Figure 4), the Godiva IV fast burst reactor, the Flattop horizontal assembly machine, BeRP ball, and TACS vertical lift machine previously used at the recent LLNL hands-on training courses (Figure 5).

Figure 4. Planet Experiment Machine.

Figure 5. Training Assembly for Criticality Safety (TACS).

Registration

Registration requests to attend the course are made through the DOE NCSP website, http://ncsp.llnl.gov/classMain.html. The course is currently developed to accommodate security-cleared DOE staff, DOE contractors, NRC staff, NRC licensees, and uncleared US citizens. Provisions are planned to possibly accommodate certain foreign nationals.

Site and Facility Access

Depending on the hands-on course a student is attending, the access requirements are quite varied. They range from site-specific general employee training and introduction to radiation protection practices to DOE Radiation Worker II training and practical testing, as well as facility-specific emergency procedures. Upon approval to attend a particular course, the registered student will be given a list of prerequisites to be met in order to attend.

Summary

This most recent US evolution in classroom education and hands-on subcritical and critical experiments training provides a well-designed course that draws from the broad knowledge and experience of its developers from LANL, LLNL, SNL, and ORNL. It includes substantial upgrades in critical experiments machine capabilities and flexibility. It also consolidates education and facility training materials that marginally step outside a limited nuclear criticality safety technology domain.

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1. ANSI/ANS-8.26-2007, "Criticality Safety Engineer Training and Qualification Program," American Nuclear Society, 555 North Kensington Avenue, La Grange Park, Illinois 60526 USA.
2. The Mission and Vision of the United States Department of Energy Nuclear Criticality Safety Program for the Fiscal Years 2009–2018, National Nuclear Security Administration, http://ncsp.llnl.gov/NCSP-MV-COMPRESSED.pdf (March 2008).
3. DOE-STD-3007-2007, "DOE Standard Guidelines for Preparing Criticality Safety Evaluations at Department of Energy Nonreactor Nuclear Facilities" (February 2007).