EFCOG Best Practice #115

Best Practice Title: US DOE Nuclear Criticality Safety Program's Nuclear Criticality Safety Engineer "Hands-On" Subcritical and Critical Experiments Training and Education Course

Facilities: Los Alamos National Laboratory, Sandia National Laboratory, Nevada Nuclear Security Site

Point of Contact: Calvin M. Hopper, 865-576-8617, hoppercm@ornl.gov

Brief Description of Best Practice: The course is a comprehensive, two-contiguous week 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 and the training and education Mission and Vision of the US DOE Nuclear Criticality Safety Program (NCSP). The DOE NCSP nuclear criticality safety engineer (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 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.

Why the best practice was used: To proactively provide the Nuclear Criticality Safety Community tools needed to enhance the development of the Criticality Safety Engineers.

What are the benefits of the best practice: The course provides first hand live experience to the student on the principles used by the criticality safety practitioner. Additionally, the course provides DOE guidance in the interpretation and application of its federal rules, directives, standards, and guides with emphasis on preparing nuclear criticality safety evaluations that meet DOE standards. 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 fiscal year 2012; six times in fiscal year 2013; and eight times per fiscal year thereafter.

What problems/issues were associated with the best practice: The ability to provide criticality safety engineers with an environment that allows experience with actual physical parameters involved in developing criticality safety evaluations is invaluable to that engineer's career development. For this experience a location that can conduct criticality safety experiments is required. There are limited locations in the United States to gain that experience. A means to make the resources at those locations available to all practitioners is needed and has been developed by the US DOE Nuclear Safety Program. Further, involvement with key DOE sites in providing the criticality safety overview and criticality safety evaluation development will help standardize expectations across the complex.

How the success of the Best Practice was measured: The success of the Best Practice will be based on feedback from the sites concerning the value seen by the students in understanding the principles involved. Secondarily, the US DOE Nuclear Criticality Safety Program is constantly monitoring the quality of the criticality safety program at various sites, including knowledge of the engineers and the quality of their evaluations.

Description of process experience using the Best Practice: Similar hands on course have existed previously, initially at Los Alamos National Laboratory then at Livermore National Laboratory. The experiences at these locations were used in developing this current training and education course.

BELOW IS THE CURRENT FLYER CONCERNING DETAILS OF THE COURSE.

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

Facilities: 1st Week at Los Alamos National Laboratory (LANL) TA55/PF4 and Classroom
2nd Week at either:
Sandia National Laboratories (SNL)
Sandia Pulsed Reactor Facility Critical Experiments (SPRF/CX)
or:
Nevada Nuclear Security Site (NNSS) Device Assembly Facility (DAF)
National Critical Experiments Research Center (NCERC)

Points of Contact:

Program Coordinators:

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

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Course Content

The first week is for education of nuclear criticality safety fundamentals and standards and criticality safety evaluation development, and the second week is for hands-on subcritical and critical experiments training. Though there are two alternatives for the second week of hands-on subcritical and critical experiment training with very different experimental machines, the course has been designed to ensure that the same learning objectives are met regardless of where the second week of training occurs.

Los Alamos National Laboratory (classroom and facility tour)

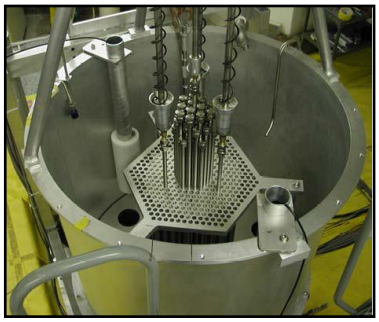
- Nuclear criticality safety history and fundamentals
- Time behavior of fissioning systems
- Process criticality safety accident discussion
- Hand calculation method discussion
- Evaluation team breakouts (in preparation for facility tour and process criticality safety evaluation assignments)
- Guidance in the preparation of DOE STD 3007 compliant nuclear criticality safety evaluations
- Overview of the ANSI/ANS 8 Series 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 for nuclear criticality safety purposes

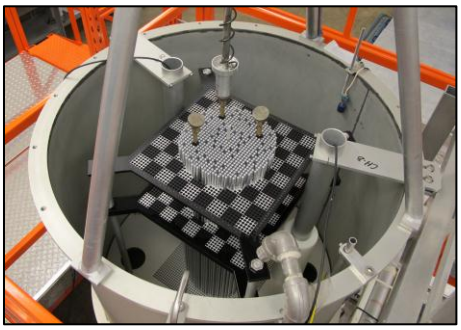
Classroom exercises in completing nuclear criticality safety evaluations are based on operations observed in the walk-around tours of the LANL TA-55/PF-4 plutonium facility shown here to the left.

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

- Fundamentals of criticality physics
- Critical-experiment accidents
- Critical-experiment design
- Critical-experiment execution
- Hands-on subcritical and critical experiments
- Analysis of experimental results
- Critical experiment benchmarking

The hands-on subcritical and critical experiments are performed in the SNL SPRF/CX lattice water tank shown below.





National Critical Experiments Research Center (hands-on subcritical and critical machines)

- Critical experiment accidents
- Experimental fission chain process
- 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

The hands-on subcritical and critical experiments are performed at the NCERC DAF of the NNSS shown below.

Various subcritical and critical experiment assembly machines exist at the NCERC. Critical assemblies used for this training include the Planet vertical lift assembly machine (seen below on the left), the Godiva IV fast burst reactor, the Flattop horizontal assembly machine, and the Training Assembly for Criticality Safety (TACS) vertical lift machine (shown below on the right) previously used at the Lawrence Livermore National Laboratory (LLNL) hands-on training courses.