Current Status of the DOE/NNSA Nuclear Criticality Safety Program Hands-on Criticality Safety Training Courses

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Carlsbad, NM
Agenda

• Introduce the US Department of Energy/National Nuclear Security Administration (DOE/NNSA) Nuclear Criticality Safety Program (NCSP) and the Training and Education Project (T&EP)
• NCSP and T&EP Background
• Courses Offered
  – the 2-Week Hands-on course
  – the 1-Week Manager course
• Course Statistics
• Acknowledgements
NNSA Nuclear Criticality Safety Program

10 Year Mission & Vision

5 Year Plan

Work Tasks
US DOE NCSP T&E Element

• **T&E Mission**
  – Continue to identify, develop, and facilitate training needs and educational resources (including hands-on training with fissionable material systems) in areas where no suitable alternative exists.
  
  – Primary purpose of the T&E element is to maintain and enhance the technical abilities and knowledge of those who impact (Criticality Safety Engineers, Criticality Safety Officers, and managers) or are impacted directly by (operators and process supervisors) the practice of criticality safety.
  
  – Includes training and education of people entering the criticality safety discipline from related scientific fields and maintaining and enhancing competency levels of those already in the community.

• **T&E Vision**
  – Identify, develop, provide, and promote practical and excellent technical training and educational resources that help ensure competency in the art, science, and implementation of nuclear criticality safety and is adaptable and responsive to the needs of those responsible for developing, implementing, and maintaining criticality safety.
## Current Status of the DOE/NNSA Nuclear Criticality Safety Program

### Hands-on Criticality Safety Training Courses

#### US DOE NCSP T&E M&V

### Training and Education - Budget and Technical Priority Rankings (cont'd)

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Goals</th>
<th>5y</th>
<th>10y</th>
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<tbody>
<tr>
<td><strong>Personnel/Facilities (cont’d):</strong></td>
<td>Qualification guidance consistent with the ANSI/ANS-8.26 standard graded from entry level criticality safety engineers to requalification for experienced criticality safety engineers</td>
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<tr>
<td><strong>Provider of criticality safety training not readily available from other sources</strong></td>
<td>The existing and unique training provided by the NCSP, e.g., classroom and hands-on experiment training, and NCSET modules, remains a high priority</td>
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<td>A criticality simulator is available to demonstrate criticality physics fundamentals to process operators</td>
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<td>A criticality simulator is available to simulate plant/process conditions and simulate a walk-through, i.e., simulated facility could be staffed by role players (e.g., operators)</td>
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<td>A mobile (CAT III or IV material) criticality hands-on critical or near critical demonstration capability is available</td>
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<td>Tutorial on subcritical methods and benchmark interpretation for nuclear criticality safety users</td>
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<td>Tutorials on CAAS system placement evaluation needs and design options and considerations</td>
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<td>Tutorial on D&amp;D related to criticality safety</td>
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<td>Sustain a training course for managers, supervisors, criticality safety officers, or criticality safety representatives, and DOE facility representatives</td>
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<td>Develop an NCSET module on the use of criticality safety accident slide rule to support emergency response</td>
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<tr>
<td>Develop a mobile CAT I criticality hands-on critical or near critical demonstration capability</td>
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**Color Code**

- **High Priority**
- **Medium Priority**
- **Low Priority**
- **STRETCH**
General Course Objectives

• Course content is based on CSSG Response to Tasking 2009-03 and ANSI/ANS-8.26-2007, “Criticality Safety Engineer Training and Qualification Program”

• Provide a consistent level of Department of Energy (DOE) interpretation, understanding, awareness and applications regarding
  – DOE Orders, Guides, American National Standards Institute/American Nuclear Society (ANS/ANSI) standards, rules
  – Performance of NCS evaluations
  – Hazards analysis methods and implementation/maintenance of NCS controls including precision and uncertainty of Non-destructive Assay (NDA) and Destructive Assay (DA) requirements

• Ensure versatility for cleared and un-cleared students

• Provide experimental hands-on training addressing
  – Characteristics of neutron multiplying systems
  – Discussion of
    • Reactor dynamics
    • Implications for the safety of fissionable material operations
NCSP Training and Education Project Courses

Hands-On Course (2 weeks)
- Classroom Training NFO/NATM*
  - Week 1
  - Hands-On Training NCERC**
  - Hands-On Training Sandia
  - Week 2

Manager Course (1 week)
- NCERC
- Sandia

Special Courses (1 week)
- NCERC

* NFO/NATM – Nevada Field Office/National Atomic Testing Museum
** NCERC – National Criticality Experiments Research Center
2-Week Hands-on Course – Week 1
Classroom Portion

Focus: NCS Evaluation Development

- DOE Requirements and the DOE NCSP
- Process criticality accident lessons-learned
- NCS fundamentals
- ANSI/ANS-8 consensus standards
- Single unit and array hand calculation methods
- NCS evaluations and evaluation workshops
- Human factors and reliability principles for NCS evaluations
- NDA – interpretation and application of NDA methods and results to NCS evaluations
- Validation of Computational Methods
- Homework and quizzes assigned daily
- Students must pass the course with an overall grade of 80%
2-Week Hands-on Course – Week 2 Hands-On Portion

Focus: Hands-on with fissionable materials

- Overview of Sandia and NCERC facilities and assemblies
- Overview of the experiment procedures and methodology
- Neutron dynamics fundamentals and subcritical multiplication
- Nuclear instrumentation
- ANSI/ANS-1 *Conduct of Critical Experiments*
- Lessons learned from experiment criticality accidents
- Subcritical and critical experiments
  - NCERC – operations with Planet, Flattop, Godiva IV, BeRP Ball, Np-237 Sphere, and Training Assembly for Criticality Safety (TACS)
  - Sandia – Seven percent critical experiment (7uPCX), Annular Core Research Reactor (ACRR) burst
- Critical experiments and the International Criticality Safety Benchmark Evaluation Project (ICSBEP) handbook
- Students must pass the course with an overall grade of 80%
1-Week Manager Course

Focus: Understanding of the student’s role in an NCS Program

• DOE Requirements, national standards, and the DOE NCSP
• Overview of Sandia and NCERC facilities and assemblies
  – Overview of the experiment procedures and methodology
• Neutron dynamics fundamentals and subcritical multiplication
• Nuclear instrumentation; conduct of operations
• ANSI/ANS-1 & 8 consensus standards
• NCS Evaluations
• Lessons learned from criticality accidents
• Subcritical and critical experiments
  – NCERC – Ops with Planet, Flattop, Godiva IV, BeRP Ball, Np-237 Sphere, and Training Assembly for Criticality Safety (TACS)
  – Sandia – Seven percent critical experiment (7uPCX), Annular Core Research Reactor (ACRR) burst
• Students must pass the course with an overall grade of 80%
NCERC Hands-on Course

Device Assembly Facility/
National Criticality Experiments Research Center

BeRP Ball and Np-237 Sphere Demonstration

TACS Subcritical Assembly

Flattop Critical Assembly

Godiva Critical & Delayed/Prompt Supercritical Assembly

Planet Critical Assembly
Sandia Hands-on Course

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

- EX1: Approach to critical on fuel loading
- EX2: Approach to critical on moderator height
- EX3: Approach to critical on fuel separation
- EX4: Interior fuel rod removal

Annular Core Research Reactor (~$3 Prompt Supercritical Pulse)
Course Statistics
Student Attendance

333 Students Total

Fiscal Year

FY12 FY13 FY14 FY15 FY16 FY17

# of Students

0 24 23 23 11 14

2-Week Course Manager Course
Acknowledgements

Registration & Badging
- Becka Hudson (LLNL)
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Sandia
- Mary Ellen Ratzer (SNL)
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- John Miller (SNL)
- Kerstan Cole (SNL)
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NCERC
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- Jeff Lewis (NSTec)
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Are there any questions?