Comparison between the United States and United Kingdom Criticality Safety Personnel Training Program Guidance

Andrew R. Wysong

Lawrence Livermore National Laboratory, 7000 East Avenue, L-360, Livermore, CA 94550, wysong1@llnl.gov

David P. Heinrichs

Lawrence Livermore National Laboratory, 7000 East Avenue, L-198, Livermore, CA 94550, heinrichs1@llnl.gov

Nigel P. Tancock

Atomic Weapons Establishment, Aldermaston, Reading, Berkshire, RG7 4PR, UK, nigel.tancock@awe.co.uk

INTRODUCTION

The discipline of criticality safety (CS) has been developed in order to maintain safety in operations where significant amounts of fissionable material are to be manipulated. The operation is assessed by an individual or team of CS practitioners and an operational safety envelope is developed. The envelope can consist of limits on materials (i.e. fissionable mass, reflectors, moderators etc.), geometry (i.e. spacing, volume, etc.), and/or prescribed operating procedures which uphold a level of safety for personnel and equipment involved. The following paper is an overview of the similarities and differences in guidance on training programs for CS personnel at United States (US) and United Kingdom (UK) laboratories. This work was performed under the auspices of Joint Working Group 30 of the Mutual Defence Agreement between the United States and United Kingdom.

US CS TRAINING GUIDANCE

The US requirements for "Training and Qualification of Contractor Nuclear Criticality Safety Engineers" in the Department of Energy (DOE) complex are contained within the DOE Standard "Guidance for Nuclear Criticality Safety Engineer Training and Qualification." The guidance is provided to facilitate hiring and maintaining of trained and qualified CS staff within the DOE complex. Within DOE-STD-1135-99 there are ten sections defining the areas of training required to become qualified in the discipline of CS. These sections are:

1. Nuclear Theory
2. Calculational Methods
3. Critical Experiments and Data
4. Rules, Standards, and Guides
5. Nuclear Criticality Safety Evaluations
6. Safety Analysis and Control
7. Criticality Alarm Systems (CAS) and Criticality Detection Systems (CDS)
8. Accountability Practices
9. Hands on Experimental Training
10. Process/Facility Knowledge

In each of these sections a further breakdown of specific skill requirements is listed to further clarify the expectations of the DOE.

Another resource available for training guidance in the US is the national consensus standard ANSI/ANS-8.26-2007 which was created subsequently to DOE-STD-1135-99. The standard supplements the DOE document and provides useful reference material.

UK CS TRAINING GUIDANCE

The Office for Nuclear Regulation (ONR) provides no specific guidance on CS training programs; instead, the onus is on the licensee to demonstrate the adequacy of their arrangements. A guidance document used in many CS training programs is "The WPC Criticality Competence Framework." In the UK, the Working Party on Criticality (WPC) has existed for over 25 years and includes practitioners from regulatory bodies and industry. The papers of this committee are recognised by the ONR as providing a guide to current industry good practice. The WPC created the criticality competence framework in response to several issues in the UK nuclear CS community including: attrition of many senior CS professionals, decline in number of organisations that were once major contributors to the profession, and increase in number of small firms involved in CS assessment.

The competence framework is divided into four major sections:

1. Criticality Background Knowledge
2. Criticality Safety Management
3. Criticality Assessment Methods
4. Criticality Safety Assessment Methodologies

In each section specific skills and associated key knowledge/experiences are listed for use as a guide to

creation of training programs which encompass all important areas of CS.

COMPARISON OF TRAINING REQUIREMENTS

The comparison was performed by generating eight main subject areas important to CS Training:

1. Academic
2. Experimental
3. Assessment Methodology
4. Assessment Analysis
5. Rules, Standards, Guides
6. Alarms, Accidents, Response
7. Process/Facility Knowledge
8. Special Concerns

Each of the eight main subject areas included a list of topics which were further divided into areas of key knowledge/experience important to CS. The entire comparison matrix is too extensive to duplicate in full in the format of this paper. However, the significant results from the comparison are discussed in the following sections.

UNIQUE GUIDANCE SUBJECTS

The US and UK guidance on CS training includes a number of key knowledge/experience subjects that are unique to either country. A small number of disparities in the CS training guidance can be attributed to the different US and UK regulatory systems. For example, UK regulatory expectations place a strong emphasis on subjects such as Optioneering and ALARP.

Many differences in the CS training guidance cannot be attributed to the regulatory systems. These subjects are listed below:

UK: Implications of Controls, Nuclear Data, Engineering Drawings, Reactor Physics, Reactor Kinetics and Transients, Fissile Assay Methods, Waste and Long Term Disposal, Burn-Up Credit, MOX

US: Hands-On Training, Container Labelling & Postings

While the US and UK guidance on CS training may not specifically call out the above subjects, this does not prevent many of the respective facilities from covering the topic in their training programs. It is reasonable to expect that facilities will tailor their training requirements according to the nature of the operations performed. For example, criticality assessors from some UK facilities routinely attend the Training Assembly for Criticality Safety Hands-On course offered in the US. And in many US CS programs, MOX, Long Term Disposal, and other facility specific disciplines are included as general CS training. Several of the unique training subjects have been identified as best practice subject additions to training programs and are discussed further in the following section.

BEST PRACTICES

Training Subject Additions

There are a few training subjects unique to the UK or US that would increase the competency and efficiency of CS staff in both countries if included in CS training programs. Implications of Controls, Engineering Drawings, and Nuclear Data, currently unique to the UK training guidance, would add value in US training programs. The subject of Implications of Controls refers to the effects that a criticality control will have on operations and personnel working within the affected safety envelope. CS professionals may be incognizant of slowdowns in operations due to a criticality control because of the tendency to focus solely on safety. Additionally, ignoring implications of controls on interconnected processes can cause unforeseen negative impacts on safety outside the boundary of the specific operation being analyzed.

The understanding of engineering drawings allows for more efficient and accurate assumptions to be formulated in the fault identification process. Engineering drawings are commonly used in computer modelling and reactivity calculation where accuracy is a key factor in determining a credible safety argument.

A CS professional's ability to understand the validity, precision, and accuracy of nuclear data is another important component of the utilization of computer simulations for reactivity calculation. Without at least a fundamental grasp of the way nuclear data is measured and analyzed experimentally, as well as formatted and manipulated in reactivity calculation software, there is a possibility of a user relying on an erroneous result in a safety argument. Although the US training guidance does not specifically call out nuclear data, training material for this topic has been developed in the form of the Nuclear Criticality Safety Engineer Training Module 13, "Measurement and Development of Cross Section Sets."

The US training guidance subjects of Hands-On Training and Container Labelling & Postings would be beneficial inclusions in UK guidance. Hands-On training provides CS professionals a more concrete understanding of the main factors that affect reactivity. More significantly, it makes CS assessors mindful of the reality of operations involving nuclear material and the constraints and inconveniences encountered by operations staff.

Training on container labelling and postings allows CS professionals to develop effective operator aids which help operators maintain compliance with criticality safety controls. Although it is omitted from the UK guidance, facilities generally have some training to cover the specific procedures and format for labelling containers and creating postings. Nevertheless, it would be beneficial to formally include it in UK training guidance.

Increased Collaboration

Increased collaboration in the field of training will benefit both US and UK laboratories through access to larger and more diverse training materials and the benchmarking of both countries training guidance to their respective CS programs. A successful example is the US DOE Nuclear Criticality Safety Program Hands-On Training and Education Course, which provided UK CS professionals opportunity to gain Hands-On experience that does not exist domestically. This cooperation between the US and UK allows for cost sharing and increased awareness and knowledge in the international CS community. Other opportunities for shared training resources and lessons learned include the areas of new facility build, retrofitting of facilities, fabrication of weapons components, and assembly/disassembly of weapons.

Conclusion

The US and UK share many commonalities in training programs, however disparity does exist. Some of the differences are driven by the contrasting regulatory systems. However, there are several unique subject areas apparent in each nation's training guidance which have been identified as best practices for inclusion into CS training guidance in both the US and UK. Furthermore, opportunities exist for additional collaboration between the US and UK in the training of CS staff resulting in an increase of competency and efficiency for all involved personnel and programs.

REFERENCES

1. "Guidance for Nuclear Criticality Safety Engineer Training and Qualification," DOE-STD-1135-99, Department of Energy, Washington, DC, USA, September 1999.
2. "Criticality Safety Engineer Training and Qualification Program," ANSI/ANS-8.26-2007, American National Standard, American Nuclear Society, La Grange Park, IL, USA, June 20, 2007.
3. "Licence Condition Handbook," ONR, October 2011 (see LC10), http://www.hse.gov.uk/nuclear/silicon.pdf.
4. "Assessment of Licensees' Arrangements for Training and Assuring Personnel Competence", T/AST/027, HSE, September 22, 2010, http://www.hse.gov.uk/foi/internalops/nsd//tech_asst_guides/tast027.htm.
5. "The WPC Criticality Competence Framework," WPC/P243 Issue 1, Working Party on Criticality, UK, November 2008.
6. "Safety Assessment Principles for Nuclear Facilities," HSE, 2006, http://www.hse.gov.uk/nuclear/saps/index.htm.
7. "Measurement and Development of Cross Section Sets," NCSET Mod 13, Nuclear Criticality Safety Engineer Training, Nuclear Criticality Safety Program, Department of Energy, http://ncsp.llnl.gov/trainingMain.html.
8. "Nuclear Criticality Safety Program – Hands-On Training Course," Nuclear Criticality Safety Program, Department of Energy, http://ncsp.llnl.gov/classMain.html.