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Use of a Web Site to Enhance Criticality Safety Training

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1. Introduction

Currently, a website dedicated to enhancing communication and dissemination of criticality safety information is sponsored by the U.S. Department of Energy (DOE) Nuclear Criticality Safety Program (NCSP). This website was developed as part of the DOE response to the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 97-2, which reflected the need to make criticality safety information available to a wide audience. The website is the focal point for DOE nuclear criticality safety (NCS) activities, resources and references, including hyperlinks to other sites actively involved in the collection and dissemination of criticality safety information. The website is maintained by the Lawrence Livermore National Laboratory (LLNL) under auspices of the NCSP management.

One area of the website contains a series of Nuclear Criticality Safety Engineer Training (NCSET) modules. During the past few years, many users worldwide have accessed the NCSET section of the NCSP website and have downloaded the training modules as an aid for their training programs. This trend was remarkable in that it points out a continuing need of the criticality safety community across the globe.

It has long been recognized that training of criticality safety professionals is a continuing process involving both knowledge-based training and experience-based operations floor training. As more of the experienced criticality safety professionals reach retirement age, the opportunities for mentoring programs are reduced. It is essential that some method be provided to assist the training of young criticality safety professionals to replenish this limited human expert resource to support on-going and future nuclear operations.

The main objective of this paper is to present the features of the NCSP website, including its mission, contents, and most importantly its use for the dissemination of training modules to the criticality safety community. We will discuss lessons learned and several ideas for future development in the area of web-based training for criticality safety professionals. Our effort is intended to stimulate a discussion of ideas and solicit participation in the development of the next generation of a web-based criticality training site that can be used to assist the training of newcomers to this important safety discipline.

2. Main Features of the Website

Before venturing into a discussion of various training ideas, it is beneficial to summarize the main features of the website and the experience we have learned during last few years regarding the training module development and the needs of the criticality safety community. The current website is built upon a frame-based navigational scheme. The website contents were organized under sixteen menu buttons for ease of navigation. The data were structured into several categories: general website information (i.e., home page, website mission, DOE NCSP plan, and registration); general guidance for new users (i.e., basic NCS information, DOE Orders and Regulations); technical information (i.e., training and conferences, databases and references, NCS codes and data, NCSET, and website archives); major stakeholders and organizations (i.e., DOE NCS groups, DNFSB Actions, other resources, and high level links); and the user feedback page (i.e., a message board). The website provides a "one-stop" center where a user can also link to other key NCS websites. This approach offers several advantages including unnecessary duplication of information and allowing a user to access up-to-date information from various websites.

Among the features included in the NCSP website are general help for new criticality safety practitioners, a discussion of computational methods and resources, a collection of bibliographic references, and a collection of various technical and organizational information to help newcomers in this field. This website has been online since 1998. Currently, the website provides two bibliographic databases (i.e., the LLNL database and the Hanford database) with a data search engine to facilitate utilization of the databases. The two databases in combination have more than 10,000 bibliographical references including brief abstracts of journal articles,technical reports, criticality experiments, and other relevant criticality safety information from the last forty years.

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3. A Web-based Training Program

Early in the development of the website, it was recognized that, in addition to enhancing communication and information dissemination, training should be a major emphasis to help the newcomers to criticality safety. New graduates from universities generally need substantial mentoring to gain insights into the subtleties of the field and to acquire job-related experience. This is particularly evident in the field of criticality safety, partially due to the academic orientation of nuclear engineering curricula at most universities.

During last few years, substantial effort was spent towards development of the NCSET modules. The modules currently available, or to be posted soon, are listed below:

Module 1: Introductory Nuclear Criticality Physics
Module 2: Neutron Interactions
Module 3: The Fission Chain Reaction
Module 4: Neutron Scattering and Moderation
Module 5: Criticality Safety Limits
Module 6: Introduction to Diffusion Theory
Module 7: Introduction to the Monte Carlo Method
Module 8: Hand Calculation Methods-Part 1
Module 9: Hand Calculation Methods-Part 2 (coming soon)
Module 10: Criticality Safety in Material Processing Operations-Part 1
Module 11: Criticality Safety in Material Processing Operations-Part 2
Module 12: Development of Nuclear Criticality Safety Evaluations

Development of these training modules was a result of the effort of many members of the NCS community. Some of the training modules were developed from existing training materials used at various DOE sites that deal with handling of fissionable materials. Generally speaking, the training modules are aimed at the practical application of neutron physics with the goal of developing the necessary skills required to support facility design and nuclear facility operations in the area of criticality safety.

As mentioned earlier, the response from the criticality safety community to the NCSP website is truly remarkable. The training module section and the bibliographic database section are the most frequently accessed sections of the website by users worldwide. Furthermore, there have been and continue to be substantial downloads of the NCSET modules. This activity is beyond our initial expectations and truly represents the need of individual NCS practitioner to obtain training materials for their use.

The first eleven modules are similar in form to chapters of a textbook and many have exercises with answers included. Recognizing the trend towards interactive web-based training, Module 12 (Development of NCS Evaluations) was written in the form of a web page that can be viewed through any internet browser. The tutorial parts of the module contain internal links that take the reader to specific sections of an actual NCS evaluation to demonstrate how the principles are put into practices. After reading the appropriate section of the example, another link returns the reader to the point from which the tutorial section was left. Figure 1 shows an example that contains the description of the facility being evaluated and the link that returns the reader to the training section of the module.

We expect that future modules will continue to use this form, and incorporate even more interactive features that take advantage of the developments in computer training technology.

4. The Next Stage of Development

With the rapid progress of the internet information age, a web-based training option offers many advantages. It will allow new criticality safety engineers to train at their own pace, and provide refresher courses for more experienced people. When such a training program is made available on an easily accessible website that integrates the features described above, it can also provide a forum for criticality safety professionals to share their experiences and suggest improvements. Use of such an interactive site offers a great opportunity for cooperation among the diverse organizations interested in criticality safety, both domestically and internationally.

As we assessed the status of available NCS training materials and the need to offer more "operations-based" support training, it was quite obvious that text-based training modules, although easy to write and implement on the web site, have their limitations. First of all, a text-based training module is not the best approach to train people new to the area of criticality safety. A user needs to read through the text just like reading a textbook without the benefit of a teacher. Because of this, the NCSET section of the web site notes that the modules are generally intended to be used as part of a training program conducted by the appropriate training staff.

Furthermore, completely text-based training materials are more suitable for teaching basic theory and rule-based methodologies. Without pictures or diagrams, it is harder for a student to comprehend the relevant information related to a real work situation such as a workstation, process equipment, or a storage array. Most of the NCSET modules contain

2.1 Facility Description

Building X is a multi-purpose laboratory and office building. Among the many projects in progress is a long-standing study of pyro-metallurgical processes. One such project is centered in the A-Wing laboratories, and in particular room A-1. Electrorefining operations are conducted in an inert-atmosphere glove box that has been used for many years of research using depleted uranium material and will be extended to U(20) materials. Material is passed into the glove box through a small air lock and processed by laboratory personnel at numerous glove ports around the box.

The floor area of the glove box is approximately 2.4 m wide and 4.9 m long (8 ft x 16 ft). A cooling plenum is attached to one end through which a limited amount (approximately 12 gal) of a water/glycol solution circulates through a heat exchanger. In addition to the coolant, only small quantities of lubricants and cleaning solutions are present in the glove box.

Return to Module

Figure 1. Excerpt from Training Module Showing Return Hyperlink

diagrams and photos to help the students, but static images do not take advantage of current technology.

Our experience in classroom teaching on the fundamentals of criticality safety demonstrated time and again the effectiveness of using models and video clips to better portray a physical situation, and most of all to keep students interested in the subject. This is particularly relevant given that a web-based training course is centered on the interaction of a student's visual span with the information portrayed on a monitor screen.

The use of multimedia presentations offers great advantages when compared with static or text-based training modules. For example, a training module with criticality alarm sounds within a simulated criticality event description will produce a much greater impression on the student than simply reading a description of the alarm. Playing a videotape of a classroom teaching session is far superior to having a student read a text. Next to actual hands-on training, a video clip to show an experimental set up with its associated fissile material configuration is the preferred method of presentation. Similarly, a videotape by experts in the NCS field can convey more than simple words in a text. Projects at Los Alamos National Laboratory and Oak Ridge National Laboratory have included videotaped interviews with pioneers in the field, and we expect to incorporate clips from these sessions into future NCSET modules.

In addition to multimedia content, development of more interactive modules with immediate feedback is planned. A student would be asked to select an answer to a question that would test the level of understanding of the subject matter. Such an interactive mode is a good way to break the boredom of simple text reading or standard examinations. It also forces the student to process what he or she learns in real time by answering questions embedded in a training module.

All of these training ideas are not new. As a matter of fact, web-based training modules are currently widely used in many institutions. However, the development of such multi-media training modules for NCS training will need the contribution of many criticality safety professionals. Although quite challenging, such an undertaking is definitely worthwhile considering the collective recognition of such a need by the whole criticality safety community and is certainly attainable by calling on the vision and resources of NCS professionals willing to contribute to the effort of training future NCS engineers. The NCSP website is a good example of one such collective effort.

5. Concluding Remarks

Establishment of the NCSP website represents one attempt by the NCS community to meet the need to enhance communication and disseminate NCS

information to a wider audience. With the aging work force in this important technical field, there is a common recognition of the need to capture the corporate knowledge of these people and provide an easily accessible, web-based training opportunity to those people just entering the field of criticality safety.

A multimedia-based site can provide a wide range of possibilities for criticality safety training. Training modules could range from simple text-based material, similar to the NCSET modules, to interactive web-based training classes, to video lecture series. For example, the Los Alamos National Laboratory video series of interviews with pioneers of criticality safety could easily be incorporated into training modules. Obviously, the development of such a program depends largely upon the need and participation of experts who share the same vision and enthusiasm of training the next generation of criticality safety engineers.

The NCSP website is just one example of the potential benefits that web-based training can offer. You are encouraged to browse the NCSP website at http://ncsp.llnl.gov. We solicit your ideas in the training of future NCS engineers and welcome your participation with us in developing future multimedia training modules.