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LOS ALAMOS NATIONAL LABORATORY NUCLEAR CRITICALITY SAFETY PIPELINE FOR EXPEDITED QUALIFICATION OF PERSONNEL

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ABSTRACT

The Los Alamos National Laboratory (LANL) Nuclear Criticality Safety (NCS) Pipeline is a method of accelerating the training and qualification of its next generation nuclear criticality safety professionals. An upper division university course in NCS will be offered at participating universities; students who perform well can participate in a summer internship in the LANL NCS Division the following summer focusing on NCS practices and facility specific training for qualification. Standout students may proceed with a criticality safety oriented research project worked during the senior academic year. The culmination of the pipeline is the hiring of students as full time personnel. This practice reduces the uncertainty around knowing whether the individual: (1) has the technical skills, knowledge, and abilities to succeed in criticality safety, (2) will be able to effectively integrate within the organization, and (3) is interested enough in the discipline to reduce potential retention issues.

This approach will address significant challenges in the NCS industry, including rising attrition rates over the next two decades, significant time and resources typically required to train qualified criticality safety professionals once hired, and the absence of available NCS-related academic coursework available at colleges and universities.

The university pipeline results in several benefits: (1) reduced training time and costs, (2) interested students will naturally self-sort and pursue the discipline at the university level, and (3) a pipeline of criticality safety candidates is readily available within the DOE Complex so that unexpected organizational or mission changes can be reacted to with increased agility.

Key Words: **Training, Qualification, University, Attrition, Criticality Safety**

1. INTRODUCTION

In collaboration with participating universities, Los Alamos National Laboratory's (LANL) Nuclear Safety Division (NCS) will offer an accelerated academic and experience-based program to attract, educate, and retain a workforce capable of fulfilling LANL's nuclear criticality safety mission. The Pipeline program was conceived to expedite recruiting and qualification of LANL's nuclear criticality safety professionals. LANL's current university partners are New Mexico State University (NMSU) and Texas A&M University (TAMU); additional universities are under consideration. This

partnership's short-term mission is to provide academic curricula, concurrent with professional experience gained under the guidance of a qualified mentor, to upper division undergraduate or graduate level students. The long-term mission is expediting the LANL qualification process and other requirements leading to a full-time Criticality Safety Analyst (CSA) position within LANL's Nuclear Criticality Safety (NCS) Division. LANL's staffing goal is 27 qualified CSAs and the Student Pipeline is a key initiative to meeting that goal. Additionally, the NCS Pipeline prepares participants with a solid skillset applicable to many other career paths at LANL or other institutions.

1. ISSUE DESCRIPTION

Three key issues are at the center of this initiative:

1. Attrition
2. Extended qualification period
3. Lack of relevant university coursework/curricula

Most senior criticality safety resources within the DOE complex are nearing retirement age. The industry-wide NCS discipline anticipates further attrition over the next two decades. According to a recent compensation study conducted by the NCS Division of the American Nuclear Society, the age of NCS professionals is heavily skewed towards individuals nearing the end of their career (29.4% with 31+ years and 23.5% with 21-30 years of professional experience). The impact of upcoming attrition is heightened by the time and resources typically required to train criticality safety professionals.

Locally, LANL's Nuclear Criticality Safety organization experienced significant staffing attrition from 2008-2012. Aggressive recruiting and retention efforts followed, resulting in gradual staffing increases over the next five years; the level has not yet stabilized at a rate necessary to fully support Laboratory operations.

Once hired, the new CSA progresses through a formal qualification program developed to 1) capture decades' worth of innovative and expert-based knowledge and practices, 2) address unique organizational and facility needs, and 3) comply with industry and nuclear operational requirements. The program is comprised of 10 competencies, including: nuclear theory; criticality safety calculation methods; critical experiments and data; hands-on experimental training; rules, standards, and guides; nuclear criticality safety evaluations; safety analysis and control; criticality accident alarm system (CAAS) and criticality detection systems (CDS); accountability practices; and facility knowledge. By definition, the qualification standard is comprehensive and complex, and while most LANL NCS new hires have either a BS or MS in nuclear engineering, the unique nature of the nuclear criticality safety discipline requires significant additional effort and time— an average of two years—to achieve qualification. A security clearance investigation, while often conducted concurrently, can take up to two years to complete. This additional ramp-up time is costly and often compounds the complexity of planning for and/or reacting to attrition.

Few university-level criticality safety courses are currently offered: Idaho State University offers a course that includes the principles of criticality safety (NE4446, *Nuclear Fuel Cycle Systems* [<http://coursecat.isu.edu/undergraduate/allcourses/ne/>]); the University of Tennessee periodically offers two NCS courses (NE421, *Introduction to Criticality Safety*, and NE543, *Special Topics in*

Nuclear Criticality Safety, including online lectures [<http://web.utk.edu/~rpevey/>]; and a graduate certificate is offered at University of Idaho- Idaho Falls (<https://www.uidaho.edu/idaho-falls/academic-programs/engr/ne-cert>). To our knowledge, there is no university or college in the United States that currently offers any degree in nuclear criticality safety.

Limited criticality safety academic programs often result in obscure perceptions of the nuclear criticality safety discipline. All too often, entry level CSAs realize the discipline is not a good fit and resign to pursue other interests, most often in the nuclear engineering fields predominantly covered in their academic coursework. By this point, significant time and effort has been invested by NCS in the potential CSA. Graduate or post-graduate degree opportunities consequently may also be lost.

2. PROGRAM ELEMENTS

2.1 University Coursework

NCS envisions a multi-tier implementation design with specific and measurable benefits at every level. The program design is built on best use of existing resources, such as leveraging the collective wisdom of on-staff SMEs as mentors for new staff and emerging talent. This program also requires redirecting traditional recruitment and retention strategies and funding to attract and engage the best and brightest to work on some of the most important science in the world.

The Student Pipeline Program begins with the development and delivery of an advanced level academic course customized for junior or senior level undergraduate students or graduate students. The course will include guest lectures, criticality safety problems, and an NCS evaluation development project. Successful course completion may progress to a LANL summer internship where the students learn about NCS practices and begin working on facility-specific training requirements leading to full qualification.

The obvious benefit is that students gain essential knowledge and experience; by design, an additional benefit is a shorter time frame required to complete the formal qualification—currently up to three years in some cases. This summer internship approach optimizes the student’s academic achievement and accelerates real-life skill development and application.

NCS will offer senior year/graduate program internships to those students who continuously demonstrate a strong aptitude for the NCS discipline. This internship will be conducted during the academic year under direction of LANL staff and university faculty. The combination of academic and professional experience further prepares the student for advanced academic study in graduate school and immediate career placement at LANL. Other employment requirements, such as security clearances, may be simultaneously completed to further alleviate time delays that typically occur when an employee is hired.

Due to the rigor of qualification requirements, the feasibility of awarding a university non-thesis graduate degree concurrent with the qualification is being evaluated.

Among the first students to complete a summer internship will be a graduate level student (GRA) knowledgeable of the academic curricula. The GRA, under the guidance of an NCS mentor, will

define LANL's needs for the initial fall 2017 course offering. The course may include lectures, practical criticality safety problems, and developing a criticality safety evaluation, all routinely completed by in-training staff at LANL. As the program matures, LANL senior CSAs may be considered as adjunct professors or affiliated faculty at the university, further enhancing the partnership. University faculty and NCS management will work jointly to monitor/measure progress, address emergent issues, and plan enduring gains and opportunities.

University faculty will be first-line offense by identifying strong candidates for the program and initiating discussion between the student, NCS management, and faculty. Decisions to begin the program will be carefully made based on all participant's interest and input; contingency plans for unforeseen circumstances will likewise be considered. The LANL internship scope may include (see Figure 1):

- paid summer internships
- paid work projects during the academic semester
- potential fellowship
- CSA positions upon successful completion of all requirements

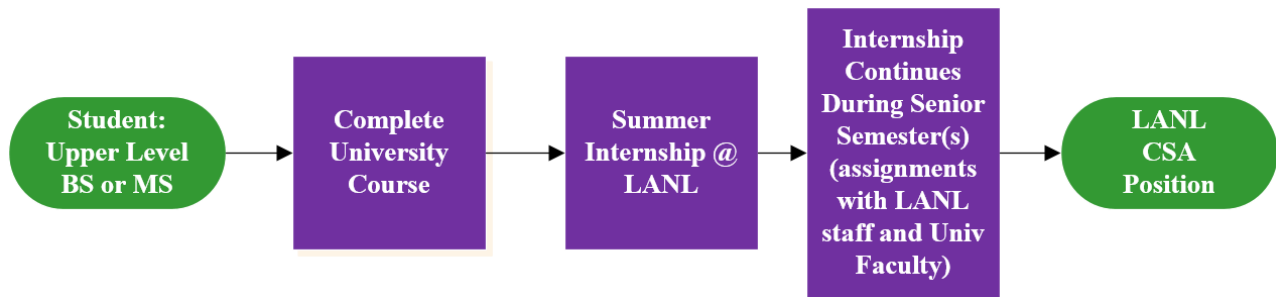


Figure 1. NCS Student Pipeline Process

2.2 Participation Requirements

To participate in this program, students must meet LANL employment requirements and be eligible for a DOE Q clearance; entry level criteria requires the student be upper-division undergraduate or graduate level in good standing with a minimum GPA of 3.0.

Continued eligibility for the program is based on satisfactory completion of requirements: successful completion of the university course is required to progress to the summer internship which is then required to be considered for the senior year internship.

2.3 Mentors

A program cornerstone is the mentor. The mentor's role is to provide oversight of the student's training experience, be a technical resource, and provide guided practice opportunities as the CSA in training develops real-time skills, comprehension, proficiency, and perspective. Mentoring will not replace, nor will it be used in lieu of, the formal training and qualification program or any of its parts.

Rather, it is an expert- and experience-based element of the entire training program that complements formal instruction to augment and enhance the qualification of the CSA.

The mentor will be a qualified CSA with appropriate technical and instructional experience and expertise; additional mentor requirements apply as defined by LANL policy. Mentor/student assignments will be made based on knowledge level, past training, experience, availability, commitment, and interpersonal skills. Beyond the formal requirements and expectations of mentors, program sponsors also believe that the mentor-mentee relationship will result in mutually beneficial relationships for all participants in the long term, creating a supportive environment for both professional and personal growth and development.

Creating an environment in which individuals are successful at the local level will inspire and support collective success at the global level. Once the program has matured and proven its value at LANL, other facilities may choose to implement a similar program and may benefit from the SME pool's expertise, lessons learned, and streamlined operational processes. LANL's CSA mentors will become leading practitioners in this area, positioned to assist others in this endeavor. An inherent byproduct will be that as they teach, mentors themselves will achieve greater understanding and proficiency in their given field. Peter F. Drucker put it this way, "No one learns as much about a subject as one who is forced to teach it."

2.4 LANL Tasks, Projects, and Deliverables

CSA core training requirements leading to qualification will be assigned to student interns. The requirements are defined in the site training document, called a Qualification Standard, and address technical criteria derived from ANSI/ANS-8.26-2007, *Criticality Safety Engineer Training and Qualification Program* and DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineer Training and Qualification*. The qualification standard also addresses Department of Energy nuclear facility requirements as defined in DOE Order 426.2, *Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*.

In addition to core training requirements, special projects will be assigned by NCS management based on the mentor's and student's specialized field, interest, and organizational needs (if a graduate degree is eventually awarded as part of this program, the special project may be considered for elective course credit in the degree curricula).

NCS management, the mentor, and the student will agree on deliverables, such as periodic progress meetings and reports, comprehensive final reports, peer presentation and presentations at technical conferences, professional society/committee memberships, and professional publications.

3. PROJECTED BENEFITS

This collaboration will benefit stakeholders in many short- and long-term ways.

Benefits to the students, include collaborative, cutting-edge, and progressive learning opportunities with experts in academia and industry; blended learning methods, e.g., classroom, laboratory, directed/supervised, mentored, self-driven; résumé building experiences and professional

development activities; internships that provide accelerated access to technical subject matter, organization/facility requirements, and DOE security requirements; and career opportunities at LANL.

Benefits to the University include minimal cost elective course for the university engineering department; increased access/collaboration with national laboratory; opportunities for students to obtain full-time employment via the program; fellowships; increased enrollment; and distinction.

Benefits to LANL include a partnership between LANL and the university to develop curricula relevant to the CS industry; internships that provide accelerated access to technical subject matter, organization/facility requirements, DOE security requirements; significantly reduced post-program training time (if any) for new hire CSAs; and a recruitment tool for vital new talent.

Benefits to the DOE complex include a sustainable educational resource; a hiring pipeline program that has the potential to be expanded to all sites; LANL mentors who can serve as advisors in other site implementations; and creation of a shared pool of SMEs across the complex.

4. CONCLUSION

Attrition has a tremendous negative impact on the continuity and success of any organization; it has been especially impactful at LANL's NCS Division over the last decade. Within the next five years, the thinning of the NCS workforce will further impair its ability to meet national nuclear mission. It is imperative that an accelerated method for accessing hire-ready students, able to hit the ground running at work, be rapidly devised. This plan is LANL's approach for cultivating a new resource in a shorter amount of time than previously possible. It is capable of repetition and replication at similar facilities throughout the complex who share the same general raw materials and can benefit from NCS representatives to advise in implementation, essentially serving as mentors for the new group of program sponsors (a "Johnny Appleseed" model).

Once launched, program sponsors fully anticipate expansion to other universities and potential implementation throughout the DOE complex. Positive impact has yet to be fully defined and may suggest further growth opportunities.

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