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An Assessment of the SRNS Criticality Safety Summer Intern Program

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INTRODUCTION

Nuclear engineering, because of its nature, complexity, and the small number of practitioners in the world, is sometimes considered a niche filed of engineering employing concepts from nuclear physics, mechanical engineering, material science, and chemistry. Nuclear criticality safety (the practice of preventing an unsolicited nuclear excursion) is itself an even smaller niche field of nuclear engineering that involves both detailed knowledge of nuclear kinetics and an on-the-floor, in-the-field presence to observe and assess fissile material operations. The fundamental skill set to be a criticality safety engineer is rarely focused on in traditional nuclear engineering programs. The time to recruit, train, and develop an effective criticality safety engineer can be 3-5 years, which also coincides with the point at which retention becomes increasingly difficult for recent graduates. Currently, there are only a few hundred practicing criticality safety engineers across the U.S. to support all of the federal and commercial nuclear industry. Competition for experienced criticality safety engineers is high. Development and retention of competent, experienced criticality safety engineers is of key importance at nearly every facility that handles fissile materials.

Savannah River Nuclear Solutions, LLC (SRNS) boasts an impressive summer engineering internship program. Engineers of all disciplines are hired to be exposed to approximately 10 weeks of real-world work experience. The program regularly employs 100-150 interns, even during the COVID-19 pandemic of 2020. There is currently no cap on the number of interns as the positions are project driven. If a manager has a project in mind that an intern could support, that manager may request a summer intern. The interns are paid out of the internship program budget, incentivizing managers to host a summer intern. The interns are primarily rising seniors and rising juniors, but the program is open to any applicant who has completed at least one semester of an engineering curriculum, is a U.S. citizen, and has at least a 2.5 GPA. This incentivizes a large number of students to apply. Because the number of projects is exceeded by the number of applicants, the internship is competitive with typically more than 600 applicants per year.

Between 2017 and projected for 2023, the Criticality Safety Program (CSP), a division of the Nuclear and Criticality Safety Engineering Group, at SRNS has hosted 15 summer interns. The author served as mentor or co-mentor for 9 of those interns.

This paper serves as a critique of the CSP summer internship to date. The project types, class ranks, and demographics of the interns are discussed. Results of the program in terms of intern publications, career path decisions of the participants, and project completion are examined.

To date, the SRNS criticality safety program has hosted interns from South Carolina State University (SCSU), North Carolina State University (NCSU), Missouri University of Science and Technology (MUST), University of Michigan (UM), Rensselaer Polytechnic Institute (RPI), University of Tennessee Knoxville (UTK), University of Wisconsin-Madison (UW), and Texas A&M University (TAMU). The schools are listed in chronological order of when a student from that university first worked as an SRNS criticality safety intern during the 2017-2023 period.

PROGRAM GOALS

One may say there are four broad goals of the CSP internship program are described below.

Site wide, the program in general seeks to provide engineering students, primarily those at the undergraduate level, with real-world work experience. The experience is intended to help guide them in career decisions. It is expected that enough of those interns will return within the next 1 to 2 years as full time SRNS employees to make the program worthwhile for the company.

The CSP internship seeks to introduce rising nuclear engineers to the niche field of nuclear criticality safety. Many nuclear engineering majors do not realize that specializing in criticality safety is not only a career option, but a fulfilling, important, and lucrative one.

The CSP internship program seeks to use interns to address short length projects that are of interest to the program but which the full-time staff does not typically have time to address due to higher priorities. Projects vary in nature but include scoping studies, general facility support, advanced process analysis, and academic interest.

The CSP internship program also desires to serve as a pipeline for highly qualified and motivated engineers with an interest in criticality safety to join the group after graduation. The internship program has been called a two-month in-person interview.

INTERN DEMOGRAPHICS

To date, all CSP interns were undergraduate nuclear engineering majors at the time of their internship. Nine were men and six were women. All were traditional college students between the ages of 19 and 23. Two identified as minorities based on race. Table I lists the interns by project, year of the internship, class rank at the beginning of the internship, and university. The reader will note that a

numerical label is used rather than names to protect the privacy of the interns.

PROJECT OUTCOMES

All SRNS criticality safety interns

- participated in the program for at least 9 weeks during which time they directly interacted with their mentors and peers.
- participated in no fewer than two facility tours and directly observed fissile material operations
- interacted with engineers of other disciplines as well as facility operations and management.
- gained experience in working under Department of Energy regulations and standards
- gained familiarity with criticality safety methods, nuclear chemistry, and special nuclear material safety – subjects they said they would not otherwise encounter during their undergraduate education.

The intern projects listed in Table I are qualitatively evaluated for their impact to the facilities they supported.

Aspects of projects 1, 9, and 10 have been implemented by their respective facilities and operations. Aspects of projects 6, 7, 11, 12, 14 and 15 are being evaluated for their potential production use.

It should be noted that aspects of projects 3, 4, and 8 were intended as support for proposed site missions that were either not awarded or that the facility operation was ceased after the project date.

Additionally, the six projects marked with an asterisk in Table I were developed into summary papers that have been or will be presented at an ANS conference.

COVID IMPACTS

SRNS is proud of the fact that it did not suspend its internship program in the summer of 2020. In fact, the 2020 program had one of the highest number of applicants to date, possibly due to so many other companies suspending their programs.

The 2020 interns in the critical safety group worked on site, in-person with mentors up to 75% of their time and teleworked 25% of their time (1 day of a 4-10 schedule). Masking, social distancing, and limited occupancy of buildings were observed. The group rotated mentors so that the interns sat with a different co-mentor each day they were on site. Escorting was required due to work in a secure location. This maximized the intern interaction with mentors while minimizing building occupancy.

The 2021 interns in criticality safety observed a 50/50 in-person/telework schedule that essentially aligned with the schedule of their mentors. Project 7 was an exception in that it had two co-mentors that alternated days on site. The 2021 COVID restrictions included making and social distancing in communal areas, though building occupancy limits were relaxed.

In both 2020 and 2021 facility tours were continued though they had to be scheduled at least a week in advance due to occupancy restrictions.

CAREER DECISIONS

Table II lists the post-graduation career decisions of the interns who have graduated at the time of this writing. Two of the interns have left the field of nuclear engineering, one for physics and one for mechanical engineering. Three of the interns returned to SRNS as full-time employees. Three went on to graduate school. Two entered commercial nuclear power. The remainder are still in school at the time of this writing.

PROGRAM CRITIQUE

Return on SRNS Investment – Facility Support

- 60% (9/15) of the intern projects were or will potentially be incorporated into facility use

Return on SRNS Investment – Staffing

- 20% (3/15) of the interns returned as full-time employees upon graduation with their bachelor's degree. The number rises only to 30% if those who have yet to graduate are deducted. All three are currently still employed at SRNS.

Return on SRNS Investment – Professional Development

- 40% (6/15) of the intern projects have been or will be published in open literature

In terms of tangible benefits to the SRNS criticality safety group, the program has had modest success. To date, there have been only limited returns on investment in both usable work and staffing.

The internship program at this point cannot be relied on as a pipeline for new employees for the group. During the evaluation in this work period, the SRNS criticality safety group hired 18 engineers of which only 3 were past interns of the group.

In terms of student success, the program is judged to be successful and will be continued. The program has remained stable even during COVID, consistently provides real world work experience, and results in completed projects that nearly half of the time result in published papers. None of the interns or mentors reported having a negative experience.

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Table I. Intern Demographics

Intern	Project Description	Year	Academic Rank	University
1	Limiting Surface Density Calculations for the 9975 Package	2017	Junior	SCSU
2	Matching SCALE Calculations to Neutron Multiplication Readings	2018	Junior	NCSU
3	SCALE Validation Package for U-233 Processing	2019	Junior	MUST
4	Parameter Trending in SEPHIS*	2019	Junior	NCSU
5	Entry Level Tasks for Freshman Intern	2020	Freshman	UM
6	Reactivity of Reprocessing Impurities on HALEU Fuels*	2020	Junior	RPI
7	Increased H-Canyon Dissolver Loading*	2021	Junior	UTK
8	Critical Concentrations of U and Pu in Advanced Solvents *	2021	Junior	NCSU
9	SCALE Modeling for CritView ™	2021	Sophomore	NCSU
10	MCNP Modeling for CritView ™	2021	Sophomore	UW
11	Reevaluate U-235/Pu-239 fissile gram equivalencies for H-Canyon	2022	Sophomore	SCSU
12	PuF_6 Critical Calculations* / Fissile equivalencies for H-Canyon	2023	Junior	TAMU
13	H-Canyon sump critical configurations for LEU	2023	Junior	TAMU
14	Scope Creep on SRNS Validation Suite for SCALE 6.3*	2023	Junior	NCSU
15	Review Pu Storage Configurations for Criticality Safety	2023	Junior	TAMU

*Submitted or planned publication.

Table II. Intern Career Decisions

Intern	Career Decision
1	**Returned full time to SRNS, Criticality Safety Engineering**
2	**Returned full time to SRNS, Criticality Safety Engineering**
3	Graduate school at Michigan State pursuing Ph.D. in physics
4	**Returned full time to SRNS, Nuclear Safety Engineering**
5	Changed major to mechanical engineering, currently works for Siemens (Atlanta location)
6	Graduate school at RPI pursuing Ph.D. in nuclear engineering
7	Commercial nuclear, NextEra Energy at the St. Lucie Plant
8	Graduate school at Georgia Tech pursuing M.S. in health physics
9	Still in school at the time of this authoring
10	Commercial nuclear, Radiation Analysis at Westinghouse Electric Company
11	Still in school at the time of this authoring
12	Still in school at the time of this authoring
13	Still in school at the time of this authoring
14	Still in school at the time of this authoring
15	Still in school at the time of this authoring