SAND 2022 xxxxxxx

Sandia National Laboratories

Operated for the United States Department of Energy
by National Technology and Engineering Solutions
of Sandia, LLC.
Albuquerque, New Mexico 87185-0101
Livermore, California 94551-0969

date: October 6, 2022

to: National Nuclear Security Administration
Office of International Nuclear Safeguards (NA-241)
Safeguards Human Capital Development Program

from: Christopher Faucett, Robert J. Finch

contact: Robert J. Finch
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM, USA
E-mail: rfinch@sandia.gov

subject: Knowledge Transfer and Training in Safeguards for Decommissioned Nuclear Facilities – Project Final Report for FY2022

Introduction

The International Atomic Energy Agency (IAEA) applies safeguards to nuclear facilities that are not operating, including those undergoing decommissioning, and the IAEA's effort in this area is both considerable and increasing. Specifically, the IAEA Department of Safeguards' Division of Concepts and Planning (SGCP-003: Safeguards Approaches) identified an R&D need to "Develop safeguards implementation guidelines for facilities under decommissioning and safeguards concepts for post-accident facilities under decommissioning"[1]. Nuclear facilities undergoing decommissioning are not exempt from safeguards agreements between the IAEA and Host State, and, accordingly, the requirement for verification of no diversion of nuclear material and detection of undeclared activities at decommissioned facilities remain even after facility shutdown. However, the effort required to meet safeguards objectives diminishes as nuclear material and essential equipment are removed during the decommissioning process which shifts the emphasis from verification of ever-diminishing fissile or source material inventories to verification of changes in facility design and equipment operability.

Despite developments of Gen. III+/IV nuclear technologies spurring a modern nuclear renaissance, nearly one-fourth of nuclear facilities safeguarded by the IAEA are non-operational.

[1] IAEA Department of Safeguards, "Research and Development Plan. Enhancing Capabilities for Nuclear Verification." STR-385, January 2018.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Identifying and meeting the challenges created by nuclear facility closures therefore presents an increasingly urgent mission for the IAEA. Safeguards experts with decommissioning expertise will be in demand; however, such experts with experience in both fields are uncommon. This HCD-funded project has helped to contribute expertise to these current and growing safeguards needs through education and training for an early-career international safeguards professional.

Personnel

This project supported the education of an early-career professional at Sandia who worked with a late-career safeguards professional at Sandia to learn about international nuclear safeguards applications to nuclear facilities undergoing decommissioning. The current project PI, Christopher Faucett. After 6 years of working in the *Severe Accident Analysis Department* (SNL Org. 8852) at SNL, Mr. Faucett recently accepted a position in SNL's *International Safeguards and Engagements Department* (SNL Org. 6832) where he supports safeguards engagements full-time. Mr. Faucett is a nuclear engineering PhD candidate at Texas A&M University, where he earned his BS and ME degrees, both in nuclear engineering. Mr. Faucett's coursework at TAMU has included both technical and policy-oriented safeguards topics provided by NSSPI faculty that provides a strong foundation for decommissioning-related work. Mr. Faucett's current safeguards portfolio includes leading technical work proliferation resistance analyses, supporting SNL engagements with X-energy, directing a team of safeguards analysts in integrated 3S studies of Gen. IV reactor designs, and, most recently, serving as the SNL POC for the NA-241 ARISE program.

Dr. Robert Finch, who served as mentor to the project PI, has been a staff member at Sandia since 2007, and originally worked on the License Application for the Yucca Mountain Repository. Since 2009, he has worked in Sandia's *Center for Global Security and Cooperation* as a technical specialist in safeguards, with an emphasis on geological repositories and spent fuel reprocessing, including containment and surveillance measures and design verification. Dr. Finch served on the IAEA's ASTOR expert group from 2009-2018, and currently contributes to the 10-year US-Korea Joint Fuel Cycle Studies Project as part of the Safeguards & Security Working Group examining safeguards for waste forms from electrochemical processing of spent nuclear fuel.

Activities

When this HCD work was funded, travel and attendance restrictions from the on-going COVID-19 pandemic were still in place. For this reason, this project primarily relied on internet-based courses and online learning e.g., the 2022 ESARDA training course. The activities in which Mr. Faucett participated are listed in the following section on Accomplishments. Additionally, multiple relevant publications were released regarding nuclear decommissioning and decommissioning safeguards. These publications are listed in the Resources section at the end of this report.

A key need identified during this effort was the need for specific decommissioning safeguards courses. While certain venues provided comprehensive training on nuclear facility decommissioning and international safeguards regimes, respectively, no training opportunities were identified that specifically addressed safeguards during decommissioning operations. The training opportunities Mr. Faucett took part in were invaluable. However, the availability of safeguards decommissioning training would have provided a more targeted learning environment as opposed to piecemeal training.

Accomplishments

Mr. Faucett completed the following activities during FY22.

1. ***20th edition of ESARDA Course on Nuclear Safeguards and Non-Proliferation.*** The basic aim of the ESARDA course is to stimulate student interests in safeguards. The course addresses aspects of the efforts to create a global nuclear non-proliferation system and how this system works in practice: the Treaty on Nonproliferation of Nuclear Weapons (NPT), safeguards technology, and export control. Also, regional settings, such as EURATOM Treaty, are presented and discussed. The course deals in particular with technical aspects and application of safeguards, that is, how to implement safeguards principles and methodologies within various nuclear facilities. The course provided an overview of inspections techniques, ranging from methods for neutron & gamma detection, design information verification, environmental sampling, and more.
2. ***International Safeguards for Facility Experts Workshop***. The International Safeguards for Facility Experts workshop is a 2-day event hosted by Y-12 and Pantex designed to give plant and facility experts an understanding of how their experience can apply to the international nuclear safeguards mission and to connect them with ways to support safeguards projects at their site. The workshop acts as both a learning and networking opportunity for safeguards professionals.
3. ***FY23 Concepts and Approaches Joint Proposal.*** Motivated by the IAEA's Safeguards R&D Priority P.5 ("to help prepare for new types of facilities and decommissioning"), Mr. Faucett and Dr. Finch assisted members of Y-12 and ORNL in preparing and submitting a Concepts and Approaches proposal for the FY23 annual NA-241 funding call. The scope of the proposed work includes developing guidance for the decommissioning of bulk handling facilities and investigating practical containment and surveillance measures for closed-down facilities.

Safeguards Impact:

Decommissioning presents distinct and shifting challenges to effectively implementing IAEA safeguards and meeting overarching safeguards objectives for non-operating nuclear facilities. Meeting these challenges will be an increasingly urgent mission for the IAEA as more and more nuclear facilities age and come offline around the world. Safeguards experts with decommissioning expertise will be in demand; however, experts with experience in both fields are uncommon. This project contributes to such expertise by combining Sandia's considerable expertise in decommissioning nuclear facilities with its extensive experience in international nuclear safeguards.

Resources (FY22)

- "Nuclear Decommissioning Case Studies: Safety, Environmental, and Security Rules, Volume Four", M. Laraia, April 2022, Academic Press.
- "Nuclear Decommissioning Case Studies: The People Side", M. Laraia, January 2022, Academic Press.
- H. Hale, K Hogue, J. Cooley, B McGinnis, M Cook, Identifying Efficiencies in Safeguards Implementation During the Post-Operational Life Cycle of a Facility. Y/PM-21-119. December 2021.
- "Nuclear Decommissioning Case Studies: Policies, Strategies, Planning and Knowledge Management", M. Laraia, June 2021, Academic Press.

- “Nuclear Decommissioning Case Studies: Volume One – Accidental Impacts on Workers, the Environment and Society”, M. Laraia, June 2021, Academic Press.
- H. Hale, K. Hogue, J. Cooley, “Recommendations for International Nuclear Safeguards Implementation Throughout the Post-Operational Facility Life Cycle,” Y-12 National Security Complex - Y/PM-20-109, 2020.