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International Safeguards Programs at Savannah River National Laboratory

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Abstract

Savannah River National Laboratory (SRNL) has a long history in nuclear fuel cycle activities that has led to contributions to international safeguards. SRNL is recognized as an international authority on plutonium assay by controlled-potential coulometry and has installed coulometers at the IAEA. SRNL staff also provides technical input and organizational support to the IAEA in the area of standard reference materials and characterization requirements that are critical for safeguards measurements. SRNL has supported safeguards technology development in various areas including environmental sampling, global cylinder monitoring and infrastructure development for testing. Specific projects have included establishment of a safeguards test bed at the H Canyon SRS chemical reprocessing facility, development and demonstration of a tamper-indicating continuous aerosol monitor for safeguarding bulk processing facilities, data splitting devices for joint-use equipment currently being tested in South Africa and assistance with the Unattended Cylinder Verification Station (UCVS) being tested at Westinghouse Electric Company's Columbia Fuel Fabrication Facility. SRNL also provides subject matter expert support to the National Nuclear Security Administration's (NNSA) Next Generation Safeguards Initiative (NGSI) and to the NNSA's Defense Nuclear Nonproliferation program in the areas of the IAEA's Additional Protocol, export control, destructive assay and non-destructive assay. This paper will provide a high-level overview of these SRNL programs that support the field of international safeguards and their recent progress.

Introduction

SRNL has supported a myriad of safeguards-relevant programs over time. Most recently, these efforts have focused on several diverse projects that span across a range of areas such as safeguards technology development, the cultivation of a future safeguards workforce, and increasing international safeguards outreach.

This paper will briefly describe each ongoing SRNL efforts systematically, and will provide next steps for the continued development of programs that support the field of international safeguards when feasible.

Collaboration with the IAEA on Plutonium Measurements using SRNL Coulometers

The R&D Engineering (RDE) and Analytical Laboratories (AL) organizations within the SRNL have been collaborating on international safeguard technology transfer and external technical support for over two decades. In 1994, scientists and engineers from AL & RDE began working with the International Atomic Energy Agency's (IAEA) Nuclear Material Laboratory (NML) in Seibersdorf, Austria and fabricated, tested, and installed an SRNL-designed controlled-potential coulometer at the Agency laboratory. In 1995, the SRNL Coulometer was installed by Joseph V. Cordaro and Michael K. Holland at the Agency's laboratory. In 1996, Cordaro and Holland returned to the laboratory in Seibersdorf to support the Agency's acceptance testing of the SRNL Coulometer using plutonium reference materials. Throughout this period, SRNL staff provided both training and on-going technical support to the Agency as they integrated the coulometric measurement capability into their safeguards measurement program.

Collaboration between the IAEA Agency Laboratory and the SRNL RDE and AL organizations has continued to mature and evolve. SRNL provides calibration and maintenance services for the SRNL Coulometer on an 18-24 month schedule. SRNL also provides training when the Agency rotates personnel responsible for coulometric measurements. The agency has used the SRNL Coulometer to independently verify plutonium primary and working standard solutions and to ensure the reliability of their preparation of plutonium solution used for large-size dry (LSD) spikes for isotope dilution using thermal ionization mass spectrometry.

In 2006, SRNL performed an upgrade to several peripheral components within the SRNL Coulometer. In 2010, a major upgrade to the design of the SRNL Coulometer was completed under a U. S. Support Program project. A new SRNL Coulometer was installed at the Agency's Laboratory in 2011.

At the request of the Agency, SRNL performed a major upgrade to the ISO 12183 standardized method for plutonium by coulometry, which was published by ISO in 2005. SRNL is now leading an effort to further upgrade the ISO 12183 standard based on lessons learned since 2005. SRNL has also investigated under the U. S. Support Program several areas of interest to the agency including: the minimum and optimum quantities of plutonium that could be measured using the SRNL Coulometer and still meet international target values; and the evaluation of method interference. In 2011, Holland attended an ESARDA Destructive Analysis Workshop in Seibersdorf that was hosted by the Agency. Holland presented information on coulometric measurements and the propagation of method uncertainty in accordance with the international standard JCGM 100, "Guide to the expression of uncertainty in measurement." SRNL was also requested by the Agency (as well as the Japan Atomic Energy Agency, JAEA) to support the planning for the production and characterization of LSD spikes for safeguard measurement at the Rokkasho Reprocessing Plant (RRP) and at the Japan Mixed Oxide Fuel Fabrication Plant (JMOX).

Collaboration with the JAEA on Plutonium Measurements using Coulometers

In 1998, scientists and engineers from AL & RDE began working with the Japan Atomic Energy Agency's (JAEA) Tokai Reprocessing Technology Development Center (TRTDC) Laboratory (TRTDC Lab) in Tokai-mura, Japan under the Joint NNSA&DOE/Japan Permanent Coordinating Group. Staff from the TRTDC Lab visited SRS and observed AL performing an in-house acceptance test of the SRNL Coulometers built for the TRTDC Lab. In 1999, Holland and Cordaro delivered two coulometers to the TRTDC Lab, provided training, and observed functionality testing. Since installation, Holland and Cordaro have collaborated with the TRTDC Lab to provide periodic calibration and maintenance services. Collaboration with JAEA included exchanging of technical and programmatic information on safeguards measurements and measurement control practices. All services were conducted in accordance with Program Action Sheets 5 (PAS-05).

In 2013, JAEA and SRNL closed PAS-05 and initiated PAS-28, which extended SRNL's involvement with TRTDC Lab. PAS-28 provided required technical and calibration services, but refocused efforts on human capital development and sustainability by JAEA in measurement expertise, instrument maintenance, and traceable component calibration. SRNL conducted support visits to JAEA under PAS-28 in 2014 and 2015. Plans exist to close PAS-28 in 2016.

In February 2016, Holland attended an LSD Spike certification meeting at the JNFL Tokyo Office where he presented information on: SRNL-JAEA collaboration history; SRNL-JAEA future plans and challenges; and the successful characterization of plutonium standard solution by the TRTDC Lab. A GUM uncertainty propagation prepared by Holland and Maria E. Morales-Arteaga, SRNL with support from TRTDC staff for the coulometric measurements performed by TRTDC Lab was included in this presentation. SRNL received funding for this GUM propagation from PAS-18, a collaboration directed by DOE's New Brunswick Laboratory (DOE-NBL) and JAEA's Plutonium Fuel Development Center Laboratory (PFDC Lab). The plutonium standard solution was prepared by the PFDC Lab for the purpose of producing additional LSD Spikes solutions for safeguards measurements by isotope dilution mass spectrometry. SRNL will likely be involved in supporting the upcoming characterization of the next plutonium standard solution for producing LSD Spikes, and may be requested to supply a new SRNL Coulometer for installation at a different plutonium laboratory in Japan, assuming that the TRTDC Lab continues to progress with scheduled facility decommissioning activities.

A more detailed presentation on the application of SRNL Coulometers at the TRTDC Laboratory and the SRNL-JAEA collaboration efforts is included in the proceeding of the 27th Annual INMM Conference. Refer to the paper entitled "Application of controlled-potential coulometry as a primary method for the characterization of plutonium nitrate solutions being used for large-size dry spikes reference materials; collaboration between JAEA and SRNL" by Holland, Cordaro, and Morales-Arteaga from the SRNL and M. Yamamato, T. Kuno, and N. Surugaya from the TRTDC Lab.

Coulometers Supplied to Other National and International Laboratories

SRNL Coulometers have also been supplied for safeguards and material characterization purposes to: the DOE-NBL in Argonne, IL; the Mayak Laboratory in Russia; and the RRP in Japan. The NBL has discontinued plutonium measurement activities and excess coulometry instrumentation will be returned to SRNL. The Mayak Laboratory used their past experiences with coulometry including the SRNL Coulometer to design and fabricate their own controlled-potential coulometers, which has many similarities compared with the 2016 and 2010 versions of the SRNL Coulometer along with other quality design features. The RRP has placed their SRNL Coulometers in long-term storage and is using the analytical capabilities at the JAEA's PFDC Lab and the TRTDC Lab to prepare and characterize LSD spikes. An SRNL Coulometer is being used by Los Alamos National Laboratory for plutonium assay and concentration measurements to support their defense program and nuclear material accountability functions.

IAEA NWAL – SRNL Qualification Status

The SRNL-AL was invited in 2012 by the IAEA to pursue a qualification under the Agency's Network of Analytical Laboratories to perform plutonium isotopic abundance measurements on samples of nuclear material. The SRNL/AL has capabilities for plutonium and uranium isotopic abundance using thermal ionization mass spectrometry (TIMS) that meet the international target values for measurement uncertainty. SRNL performed these isotopic abundance measurements in accordance with ASTM 1625 (classical TIMS analysis), and agreed to expand capabilities to include measuring Pu in accordance with ASTM 1672 (isotopic abundance using total evaporation). SRNL participated in the IAEA's 2013

Nuclear Material Round Robin (2013 RORO) performance exercise, which included both uranium and plutonium on loaded filaments. SRNL later participated in the IAEA's 2015 Nuclear Material Round Robin performance exercise, which provided test samples as dried nitrates of U, Pu, and mixed U/Pu. Later in 2016, the Agency will provide SRNL with the final set of NWAL nuclear material qualification test materials, which will include three dried nitrate materials of Pu and mixed U/Pu. The implementation of TIMS total evaporation and the measurement of performance test materials from the round robin exercises were performed by an analytical project team that included Maureen A. Bernard, Rebecca B. Thomas, Kattathu J. Mathew and Michael K. Holland. SRNL anticipates they will provide the IAEA with future network laboratory services and is interested in expanding their NWAL qualification to uranium and plutonium concentration measurements by TIMS and plutonium concentration measurement by controlled-potential coulometry.

Reference Materials

Needs within the nuclear industry for standard (or certified) reference materials have received increasing attention in the last several years for a variety of reasons. These include increasing amounts of reference materials being consumed; increasing difficulties in producing and characterizing reference materials encountered in the United States and other countries; and identification of new reference materials that are needed to support changing needs such as major remediation projects and mixed oxide fuel production. Because of these challenges, there is a growing need for individual sites to properly develop, characterize, and utilize working reference materials to reduce the demand on standard reference materials.

Savannah River National Laboratory (SRNL) is providing key assistance to the International Atomic Energy Agency (IAEA) and the international community to improve the current situation with respect to the proper use of working reference materials, as well as in supporting longer-range efforts to improve availability of standard reference materials. The following is an overview of SRNL contributions in these areas, as well as in the vital area of international consensus standards such as guides in the areas of reference materials, statistical applications, and quality assurance, as well as test methods used for safeguards and other measurements.

Reference Materials – Assistance to the IAEA

SRNL supported the IAEA and the international community in efforts to address the lack of adequate standard reference materials. In June 2013, ASTM International sponsored a two-day workshop on analytical developments in the nuclear fuel cycle in Avignon, France. This workshop, with Michael Brisson of SRNL as presiding officer, included a session on reference materials. Following that workshop, in September 2014, the IAEA hosted a Technical meeting on Reference Materials for Destructive Analysis in the Nuclear Fuel Cycle. Michael Brisson of SRNL assisted the IAEA in organizing the meeting, and served as meeting chairman.

One of the outcomes from the September 2014 IAEA Technical Meeting was identification of a need to assist laboratories in making better use of working reference materials where appropriate, to reduce the over-utilization of standard reference materials for daily laboratory activities. A specific recommendation from the Technical Meeting was to revise ASTM C1128, *Standard Guide for Preparation of Working Reference Materials for Use in Analysis of Nuclear Fuel Cycle Materials*, to provide more detailed guidance on preparation, characterization, packaging, and utilization of these materials. This revision is currently in progress utilizing a team of subject matter experts led by Brisson. An initial draft of the revised document was slated for review at the June 2016 meeting of ASTM International Subcommittee C26.08 on Quality Assurance, Statistical Applications, and Reference Materials, in Vienna, Austria. In addition to committee meetings, a second workshop on Analytical Developments, Reference Materials, and Statistical Applications in the Nuclear Fuel Cycle was organized by a Brisson-led team and featured ten presentations related to production, characterization, and use of reference materials.

SRNL also has analytical capabilities and subject matter expertise to support reference material characterization activities. These include thermal ionization mass spectrometry, isotope dilution mass spectrometry, uranium assay by Davies-Gray, inductively coupled plasma mass spectrometry, and other analysis methods.

International Standards

In addition to ASTM C1128 described above, Subcommittee C26.08 developed several other guides that are pertinent to quality assurance and laboratory analysis within the nuclear fuel cycle. These are listed in Table 1. ASTM C1009 has been revised to add cross-references to ISO/IEC 17025, update references and terminology, and add information regarding quality improvement. Further revisions to ASTM C1009 are planned to improve alignment with ISO/IEC 17025. ASTM C1068 was revised to add a fit-for-purpose checklist to evaluate measurement methods intended for safeguards or nuclear safety applications. SRNL led both of these efforts.

ASTM International Subcommittee C26.05 on Methods of Test currently has 77 active standards and eight proposed new standards. As 30% of the membership is from outside the United States, these standards are truly international in scope. The corresponding ISO working group (ISO/TC 85/SC 5/WG 1) has a similar number of standards.

Table 1. Standards under jurisdiction of ASTM International Committee C26.08

Standard No.	Title	Date of Last Revision
C1009	Standard Guide for Establishing and Maintaining a Quality Assurance Program for Analytical Laboratories Within the Nuclear Industry	2013
C1068	Standard Guide for Qualification of Measurement Methods by a Laboratory Within the Nuclear Industry	2015
C1128	Standard Guide for Preparation of Working Reference Materials for Use in Analysis of Nuclear Fuel Cycle Materials (revision now in progress)	2015
C1156	Standard Guide for Establishing Calibration for a Measurement Method Used to Analyze Nuclear Fuel Cycle Materials	2011
C1188	Standard Guide for Establishing a Quality Assurance Program for Uranium Conversion Facilities	2011
C1210	Standard Guide for Establishing a Measurement System Quality Control Program for Analytical Chemistry Laboratories Within the Nuclear Industry	2012
C1215	Standard Guide for Preparing and Interpreting Precision and Bias Statements in Test Method Standards Used in the Nuclear Industry	2012
C1297	Standard Guide for Qualification of Laboratory Analysts for the Analysis of Nuclear Fuel Cycle Materials	2011

SRNL is very actively involved in supporting the international community in the areas of nuclear reference materials and in development and maintenance of international standards. While much has been accomplished, there is more to be done, and SRNL intends to continue its support of these activities.

H Canyon Test Bed

The H-Canyon Safeguards Test Bed (HCSTB) utilizes the H-Canyon Processing Facility, located on the DOE Savannah River Site, to demonstrate novel safeguards applicable technologies in a relevant operating environment. H-Canyon is the only operational, full-scale aqueous nuclear processing facility in the United States and therefore represents a one of a kind domestic testing environment. As an operational facility, it provides a location for testing technologies and provides researchers with opportunities to move their technologies from the laboratory into a real-world environment. A major milestone in technology development is to identify suitable locations where equipment and/or techniques can be tested in simulated or operational facilities to ensure that they can perform as expected and withstand true environments. This test bed allows for the demonstration of emerging and proven technologies that have potential application for IAEA safeguards use.

The HCSTB project was initiated in 2011, as a response to NNSA's Next Generation Safeguards Initiative (NGSI) Program Plan FY2009-FY2013. In this report a need was identified for suitable locations to perform full-scale testing and demonstration of novel safeguards technologies in an operational setting. Such facilities in the United States are limited, and H Canyon represents the sole full-scale operational facility in the U.S. to perform field testing on the back end of the nuclear fuel cycle.

The NNSA Office of Nonproliferation and Arms Control funded the first safeguards field trial demonstration at H Canyon in March of 2013. A Plutonium-Uranium Monitoring and Acquisition System (PUMAS) developed by researchers at Argonne National Laboratory (ANL) was installed in-line with an H Canyon air-lift sampler in the Canyon sample aisle. The system was tested on plutonium process solution and was proven to give real time process monitoring of Pu concentration. The system is now permanently installed in H Canyon and routinely used for process monitoring. An additional PUMAS system, developed for solutions with a low concentration of Pu, was installed in the H Canyon sample aisle in 2015. Field testing of a High Resolution X-ray instrument (hiRX), developed at Los Alamos National Laboratory (LANL), was recently completed in F/H Analytical Laboratory. This is the laboratory that receives and tests H Canyon samples for process control and MC&A. The hiRX is designed to generate plutonium and uranium concentrations and was evaluated with H Canyon samples containing various amounts of Pu/U.

TRI-ACE

Researchers at Savannah River National Laboratory (SRNL) and Oak Ridge National Laboratory (ORNL) have developed a tamper resistant/tamper indicating aerosol contaminant extractor (TRI-ACE) to be used for unattended environmental sampling in support of safeguards applications. Environmental sampling has become a key component of International Atomic Energy Agency (IAEA) safeguards approaches by supporting conclusions concerning the absence of undeclared nuclear material or nuclear activities in a State. Swipe sampling is the most commonly used method for the collection of environmental samples from bulk handling facilities. However, augmenting swipe samples with an air monitoring system, which could continuously draw samples from the environment of bulk handling facilities, could improve the possibility of the detection of undeclared activities. Continuous, unattended sampling offers the possibility to collect airborne materials before they settle on surfaces which can be decontaminated, taken into existing duct work, filtered by plant ventilation, or escape via alternate pathways (i.e. drains, doors). The TRI-ACE system would allow for such collection in a manner that ensures sample integrity.

The TRI-ACE prototype, which was completed in early 2013, has many features which could indicate possible tampering events that may have occurred during unattended collection. Some of these features include a particle counter, air flow monitor, proximity detectors, temperature and humidity detectors, accelerometers, etc. All of these components can be used to establish normal, baseline facility operating parameters and then send out an alert when conditions deviate from normal.

The TRI-ACE has undergone extensive laboratory testing and was deployed on a field trial at the Paducah Gaseous Diffusion Plant in 2013. During this exercise the TRI-ACE underwent side-by-side testing with a standard Aerosol Contaminant Extractor (ACE) system (i.e., no tamper indicating components present) to identify any differences in collection efficiency that may be caused by the tamper resistant enclosure. Additional tests were included as a red team (ORNL, Paducah)/blue team (SRNL) exercise to test reasonable attempts to spoof the TRI-ACE system and assess the effectiveness of the tamper indicating components. During field testing several items were identified to improve the effectiveness of the device. These improvements were incorporated into the TRI-ACE0 in 2014. The TRI-ACE project with NA-241 concluded with a demonstration of the device's capabilities at IAEA headquarters in Vienna, Austria in 2015.

Joint-Use Sensors Interface (JUSI) Devices

SRNL has developed two Joint-Use Sensor Interface (JUSI) devices in recent years: the Authenticated Sensor Interface Device and the Coincidence Counter Signal Splitter.

Authenticated Sensor Interface Device (ASID)

The ASID was specifically designed as an interface to the Wohwa Accountancy Scale as a demonstration project for potential joint-use monitoring of nuclear accountancy scales. The design, however, allows for future enhancements that will permit it to interface to multiple sensor platforms ranging from all forms of digital communications to analog sensor inputs. The ASID was conceptualized as a modular device so that interface modules could be changed out to provide various sensor interfaces to match the given application. At the core of the ASID are embedded micro-controllers that permit this versatility. It accepts, then splits the signal and, conceptually, uniquely authenticates and encrypts a data stream to each party in a joint-use scenario. The ASID also provides data diode functionality on each output to ensure isolation of each party thus ensuring that no party can manipulate the sensor input or the data stream that is being transmitted to the other party. The ASID is a very adaptable, one size fits all (through modularity) solution to many joint-use technological challenges. Additional information on these and other features are available upon request or in previous INMM publications.

Coincidence Counter Signal Splitter (C2S2)

The C2S2 is specifically designed for a joint-use application for the simultaneous collection of nuclear measurement data from the High Activity – Active Well Coincidence Counter (HA-AWCC) at the Pelindaba Facility in South Africa. The C2S2 accurately splits the output pulse train from the HA-AWCC and provides each party, in this case the facility operator and the IAEA, an identical pulse train to their shift register for measurement and analysis. For this joint-use application the C2S2 will be used in attended mode so no tamper indicating features have been designed in. Data diode and power protection features, however, have been implemented in the circuitry. Further development will be required for this device to be implemented in an unattended application. Demonstration and use of the C2S2 could be a considerable step forward by demonstrating that coincidence counter signals can be simultaneously collected by independent shift registers, and thus provide the Agency a considerable cost savings through a reduction in the number of days inspectors are required to be at a given facility.

Seals

SRNL is currently developing two innovative seals: the Hydra Seal, and the Ceramic Seal.

Hydra Seal

Savannah River National Laboratory (SRNL) is developing a new loop seal called the Hydra tamper indicating seal. The Hydra Seal is a single-use loop seal with advanced authentication features that are created during seal application and can be verified in-situ. The Hydra Seal was originally conceived by the Savannah River National Laboratory (SRNL), Pacific Northwest National Laboratory (PNNL), the UK's Atomic Weapon Establishment (AWE) and Milagro Consulting, with most of the development performed by SRNL. The seal has a cubic shape with sides approximately 1.25" long. The external part of the seal is clear plastic, which allows the tamper indicating and authenticating features to be visible to both the monitoring and host parties. As part of the seal development, SRNL is developing a seal reader that assists with seal application and obtains reference and verification images of the seals for authentication and verification. It is envisioned that the Hydra Seal could be used in many applications where a robust low-cost passive seal is required. A vulnerability assessment of the seal design is currently being performed by Argonne National Laboratory and a field test of the seal is currently being performed in the K-Area Material Storage (KAMS) facility at the Savannah River Site (SRS).

Ceramic Seal

The Ceramic Seal project is research into the next generation technologies to advance Containment and Surveillance, in particular advancing security and improving efficiency. The Ceramic Seal is a small form factor loop seal with advanced tamper-indication including a frangible seal body, tamper planes, external tamper-indicating coatings, and electronic monitoring of the seal body integrity. It improves efficiency through a self-securing wire and in-situ verification with a handheld reader. Sandia National Laboratories (SNL) and Savannah River National Laboratory (SRNL), under sponsorship from the U.S. National Nuclear Security Administration (NNSA) Office of Defense Nuclear Nonproliferation Research and Development (DNN R&D), have previously designed and are now fabricating and testing Ceramic Seals. Tests are underway at both SNL and SRNL, with different types of tests occurring at each facility.

Chain of Custody:

Mapping and Evaluation of Technologies for Maintaining Chain of Custody during a Nuclear Weapons Monitored Dismantlement

During fiscal year 2015, Savannah River National Laboratory (SRNL) led a team of Arms Control subject matter experts in a Chain of Custody (CoC) Technology Mapping and Evaluation project. The team was comprised of experts from Lawrence Livermore National Laboratory, National Nuclear Security Administration, Oak Ridge National Laboratory, Pacific Northwest National Laboratory, Pantex, Sandia National Laboratories, and Savannah River National Laboratory. Experts from the Atomic Weapons

Establishment of the United Kingdom also contributed. The primary task of the project was to develop and evaluate chain of custody regimes for monitoring a notional nuclear warhead dismantlement given three technology constraint cases: using only equipment approved for use in the START and New START Treaties, using equipment that is currently fieldable, and using equipment that is expected to be fieldable within the next 5 years.

General frameworks for both the dismantlement process and the chain of custody process were developed. Equipment and procedures were integrated into these frameworks to develop a monitoring regime for each constraint case. The project team attempted to optimize the regime for each constraint case given the limited tool kits permitted, and given the need to balance verification requirements with issues of certification, cost, and operational impact. Each regime was assessed against specific criteria. The assessment criteria were developed by the team with input from other experts in the Arms Control community. Regime strengths, weaknesses and gaps were identified to inform the development of each subsequent regime. The gaps identified are used to inform decisions by the Office of Nuclear Verification in the National Nuclear Security Administration on future technology development needs.

International Nuclear Safeguards and Engagement Program

As part of the NGSI program, NNSA has the International Nuclear Safeguards Engagement Program (INSEP) to work with international partners to support and enhance nuclear safeguards implementation at all stages of civilian nuclear develop. These collaborations aim to improve the effectiveness and efficiency of safeguards throughout the nuclear fuel cycle and support the nonproliferation regime by helping partners develop nuclear infrastructure that emphasizes safeguards. SRNL's support of the former SRS fuel cycle facilities has enabled us to support INSEP partnership's around the world. Our subject matter experts have participated in workshops on implementation of safeguards laboratories, development of the State System of Accounting and Control (SSAC), implementation of IAEA INFCIRC/540 (Model Protocol Additional To The Agreement(s) Between State(s) and the IAEA, commonly referred to as the Additional Protocol (AP)).

SRNL technical staff has provided hands-on training on NDA equipment such as the HM-5, Inspector 1000 and ISOCS systems for plant staff in Algeria and Kazakhstan in order to develop the operators' capabilities with their safeguards instrumentation which enable the state authority responsible for safeguards implementation to better fulfill their responsibilities. As mentioned earlier in this paper we have provided technical experts to IAEA meetings with members states related to development of reference materials for destructive assay measurement required for safeguards purposes. SRNL's expertise in equipment subject to international export controls enables us to support INSEP as they work with partners to prepare the state declarations requirement by the AP. One aspect of an AP declaration is reporting of on manufacturing of a specific list of fifteen types of equipment related to uranium enrichment, reactor operations, and reprocessing of spent fuel. Our long history of support of SRS plutonium production reactors and chemical reprocessing facilities has enabled our staff to help train foreign partners in identification of industry sectors that have the ability to manufacture the equipment and how to conduct outreach to those sectors to inform the enterprises of their responsibilities. Another aspect of an AP declaration is reporting on the export of a list of identified equipment related to fuel cycle activities. For many years SRNL has been conducting training of partner's in how to recognize equipment specified in the AP and how to implement an export licensing system what would aid with the fulfillment of the AP export reporting requirement.

INSEP has invested significant financial and technical sources in assisting in development of a state's SSAC. In recent years, SRNL has supported workshops for partners related to sustaining an SSAC. This involves training partners in area such as development and maintaining procedures that provide data required by the SSAC, training programs necessary to staff who obtain and provide data requirement by the SSAC including operations, laboratory and oversight staff, and programs for the maintenance and calibration of equipment required for safeguards purposes.

Human Capital Development

A critical aspect of the Next Generation Safeguards Initiative (NGSI) is to propagate safeguards expertise through the promotion of safeguards awareness to upcoming professionals. SRNL welcomes several summer interns annually for this purpose, allowing for professional growth and hands-on experience with safeguards-related work in the DOE complex. In 2015, SRNL's two NGSI interns and one returning NGSI Post-Masters worked on a variety of safeguards projects, including policy analysis of the Additional Protocol and Joint Comprehensive Plan of Action. In the summer of 2016, two NGSI-related Post-Docs and four interns (one returning) will begin assisting on new safeguards-related projects. The previously returning NGSI Post-Masters, J. Rizzi, transitioned to a full-time position at SRNL and will continue to support safeguards-related projects and programs.

Beyond the internship and post-doctoral framework, SRNL also works to ensure graduates in a variety of disciplines have an international nuclear safeguards background or at least a familiarity with key safeguards concepts and approaches. SRNL has coordinated with multiple universities, including the University of South Carolina, the Georgia Institute of Technology, and Clemson University in order to establish safeguards courses within regularly offered curricula. These courses feature lectures crafted and delivered by SRNL personnel, and can include on-site visits to SRNL. During workshops, faculty and students are given facility-centric tours and also attend safeguards workshops hosted by SRNL's subject-relevant SMEs. Most recently, a group of 28 individuals attended the Clemson Safeguards Workshop in early June, 2016. Presentations on broad safeguards topics such as the nuclear nonproliferation regime and the Additional Protocol came alongside demonstrations of SRNL-designed safeguards-related equipment, such as the aforementioned ceramic seals and coincidence counter signal splitter. These outreach endeavors help ensure the next generation of professionals have a working knowledge of safeguards. Additional University Engagement efforts continue.

Unattended Cylinder Verification Stations

SRNL supported the deployment and testing on the Unattended Cylinder Verification Station (UCVS) at Westinghouse Fuel Fabrication Facility (WFFF). The device was jointly designed by staff at Pacific Northwest National Lab, Los Alamos National Lab and Oak Ridge National lab. The device is intended to collect signatures of UF_6 cylinders used for safeguards verification purposes at UF_6 processing facilities.

References

1. M. K. Holland, J. V. Cordaro, M. E. Morales-Arteaga, M. Yamamato, T. Kuno, and N. Surugaya, "Application of controlled-potential coulometry as a primary method for the characterization of plutonium nitrate solutions being used for large-size dry spikes reference materials; collaboration between JAEA and SRNL," proceeding of the 27th Annual INMM Conference, Atlanta, GA, USA, July 2016.