U.S. DEPARTMENT OF ENERGY (DOE)
NATIONAL NUCLEAR SECURITY ADMINISTRATION (NNSA)
DEFENSE NUCLEAR NONPROLIFERATION (DNN)

DNN Sentinel

DEFENSE BY OTHER MEANS

VOL. I, NO. 3

IN THIS ISSUE:

From the Deputy Administrator

As the last issue of the Sentinel went to press, the P5+1 and the Islamic Republic of Iran had just signed the Joint Comprehensive Plan of Action (JCPOA). Since then, we have marked Adoption Day, which occurred on October 18th, and are now focused on the actions necessary to be able to reach Implementation Day. As Secretary Moniz noted, "Adoption Day marks an important milestone in ensuring that Iran's nuclear program is exclusively peaceful in nature." (http://energy.gov/articles/statement-secretary-moniz-adoption-day-joint-comprehensive-plan-action)

The Department of Energy's nuclear experts at our national labs and beyond will lead the U.S. effort to work with our P5+1 partners and Iran to modernize the Arak reactor, eliminating a potential source of weapons-grade material. This is a key nonproliferation component of the agreement, which requires that Iran remove the current reactor core and fill it with concrete so it can never be used again in its current configuration. The redesign specified in the JCPOA will allow effective peaceful uses but not rapid accumulation of plutonium suitable for weapons and requires that the plutonium-bearing spent fuel be sent outside Iran, greatly complicating any Iranian attempts to make nuclear weapons from plutonium. The United States has substantial technical expertise and experience with reactor conversion, which we have used to reduce the use of highly enriched uranium in research reactors worldwide. As such, we expect to work closely with China and Iran on modernizing the reactor. (Joint statement of intent: http://energy.gov/articles/joint-statement-intent-concerning-arak-heavy-water-reactor-research-reactor-modernization)

Implementation Day is the next milestone on the JCPOA horizon and could come within the next 6 months if Iran fulfills all of its requirements and the IAEA is able to put the necessary transparency measures into

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http://nnsa.energy.gov/aboutus/ourprograms/nonproliferation-0

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Letter from the Deputy Administrator – *Continued*

place. We will keep you updated as we further define DOE's role in the implementation of the JCPOA.

Anne Harrington
Deputy Administrator
Defense Nuclear Nonproliferation

DNN Welcomes You to Our New Home

DNN celebrated the opening of our new location with a ribbon cutting ceremony on July 29, 2015. Pictured from left are DNN Principal Assistant Deputy Administrator David Huizenga, DOE Under Secretary for Nuclear Security and NNSA Administrator Lt. Gen. (Ret.) Frank Klotz, DNN Deputy Administrator Anne Harrington, and NNSA Principal Deputy Administrator Madelyn Creedon. The DNN offices are located at Portals III, 1201 Maryland Ave., 7th floor, S.W., Washington, DC 20024.

NNSA ▸ DNN QUICK LINKS

Follow the links below to learn more about recent NNSA and DNN activities.

Press Releases

NNSA Recovers Radiological Material from Mexico
http://nnsa.energy.gov/mediaroom/pressreleases/mexico-rad-recovery

United States and the Republic of Korea Sign Agreement for Civil Nuclear Cooperation
http://nnsa.energy.gov/mediaroom/pressreleases/rok-123

Blogs

NNSA Releases 2015 Enterprise Strategic Vision
http://nnsa.energy.gov/blog/nnsa-releases-2015-enterprise-strategic-vision

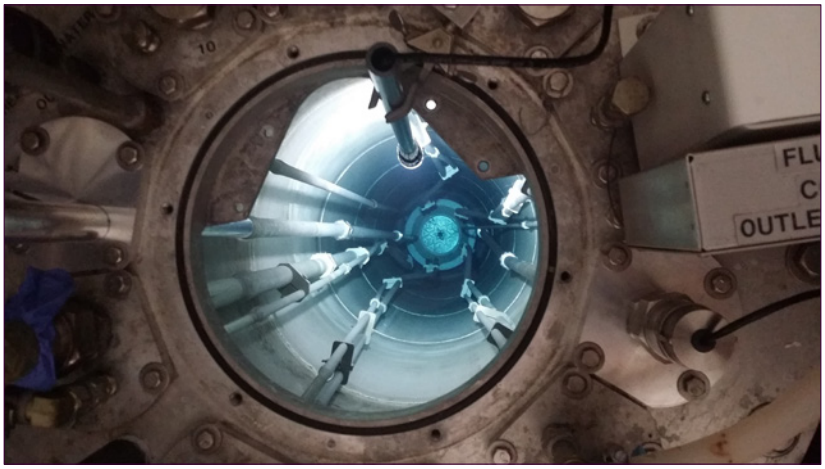
DOE/NNSA Visits Mumbai in Support of India's Global Center for Nuclear Energy Partnership
http://nnsa.energy.gov/blog/doennsa-visits-mumbai-support-india%E2%80%99s-global-center-nuclear-energy-partnership

NNSA Contributions to Nonproliferation and Arms Control Highlighted at Generation Prague 2015 Conference
http://nnsa.energy.gov/blog/nnsa-contributions-nonproliferation-and-arms-control-highlighted-generation-prague-2015

Jamaica SLOWPOKE Reactor Conversion and HEU Removal

By Jessica Jagmin Brookins

Following several years of international cooperation, Jamaica's "Safe Low-Power Kritical Experiment" (SLOWPOKE) research reactor has been successfully converted from using highly enriched uranium (HEU) fuel to low enriched uranium (LEU) fuel and the HEU has been returned to the United States. This makes the Caribbean region now completely free of HEU.



Jamaica's SLOWPOKE reactor achieved first criticality with the LEU fuel on September 30, 2015.

In 1984, the International Atomic Energy Agency (IAEA), Canada, Jamaica, and the United States arranged to provide nearly 1 kilogram of U.S.-origin HEU to fuel a newly built, Canadian designed, SLOWPOKE reactor at the International Center for Environmental and Nuclear Sciences (ICENS) at the University of West Indies in Kingston, Jamaica. The 32-year-old research reactor is used for neutron activation analysis, a method for determining which chemical elements comprise a material by bombarding the material with neutrons. This research has informed environmental, agricultural, and health related studies, as well as mineral exploration, and has contributed to increased food safety, food security, and water and air quality in Jamaica.

To ensure that this important research continues while minimizing the security risk posed by the presence of weapon-grade HEU, DNN's Office of Material Management and Minimization (M^3) Conversion and Removal programs worked in tandem to convert the reactor to operate on LEU fuel and return the HEU core to the United States in September 2015.

Although the Conversion and Removal programs frequently collaborate at the same facilities, it is rare for a conversion and removal to occur so close in time. Due to the radioactivity of the used fuel, it is often necessary to allow the material to "cool" so that it can be safely handled and transported. However, due to the SLOWPOKE HEU's limited radioactivity, the fuel was transported shortly after its removal from the reactor.

The École Polytechnique SLOWPOKE reactor in Montreal, which completed its conversion to LEU fuel in 1997, served as a model for the project. Canada Nuclear Laboratories (formerly Atomic Energy of Canada Limited) fabricated the LEU fuel under a contract with the Y-12 National Security Complex and also granted a one-time-use license for the intellectual property rights to replicate the unique tools needed to safely remove the HEU and insert the LEU core. Conversion of the core to LEU not only will maintain the same capabilities as the HEU core, but also will allow for longer full-power operation cycles and will have an overall longer lifetime than the HEU core. The core conversion is expected to permit reactor operations for another 30 to 40 years.

The conversion of the ICENS SLOWPOKE reactor marks the 94th conversion or shutdown as part of M^3's Conversion program. To date, M^3 has removed or confirmed the disposition of 5,366 kilograms of HEU, permanently eliminating the threat of this material being used in a weapon.

Read the NNSA press release to learn more about the SLOWPOKE reactor conversion and HEU removal from Jamaica: http://nnsa.energy.gov/mediaroom/pressreleases/nnsa-removes-u.s.-origin-heu-jamaica-makes-caribbean-heu-free.

Jessica Jagmin Brookins is a Nonproliferation Graduate Fellow in M^3 currently supporting HEU and plutonium removal projects in Asia. Ms. Jagmin Brookins holds a Master of Science in Foreign Service degree from Georgetown University.

Integrating Cyber Analysis and Nuclear Security

By Charles Nickerson

In the late 1990s, the city government of Lodz, Poland, initiated upgrades to its public tram system by installing a digital-based automatic control system. Each tram vehicle was outfitted with an infrared transmitter that communicated with control boxes located throughout the public transportation system. Ten years later, a 14-year-old train enthusiast noticed similarities between the operational parameters of the tram's infrared network and his television universal remote controller. After a few months of study and tweaking, he had developed a device that could match the amplitude and frequency of the emitters onboard the tram and establish a connection into the tram network. He successfully turned the city's rail lines into his personal train set, resulting in four derailments. Fortunately, there were no major injuries.

Digital technologies have greatly improved workforce productivity, accuracy, and reduced costs in every industrial sector—including the nuclear industry. Governments, companies, and individuals have adopted and deployed complex software and hardware solutions to maximize these digital benefits. However, these same solutions have spawned new vulnerabilities to the very systems that were designed to increase workforce efficiency and prevent proliferation. Cyberspace is a contested environment and the threat trend line is sloping ever higher toward more frequent and sophisticated attacks that attempt to inflict damage to our operations.

NNSA actively works with domestic and international partners to ensure that cyber considerations and cyber protection measures are a part of a robust and

IAEA Director General Yukiya Amano highlighted that "great strides in establishing improved designs and security measures to protect nuclear and radiological assets have been made. However, the adversary is adapting tactics and we must respond."

comprehensive nuclear security regime. In June 2015, a team of federal and laboratory staff from NNSA led by DNN Deputy Administrator Anne Harrington were key contributors and participants in a conference hosted by the International Atomic Energy Agency (IAEA): "Computer Security in a Nuclear World: Expert Discussion and Exchange." The conference focused on current challenges that Member States and individual facilities have in protecting assets from cyber-enabled adversaries.

Demonstrating the timeliness of this issue, the conference was attended by more than 800 participants and nearly 100 individual member states. The conference was opened by IAEA Director General Yukiya Amano, who stressed that industries outside the nuclear world are experiencing a shift in adversarial tactics that combine traditional theft and sabotage methods with cyber capabilities.

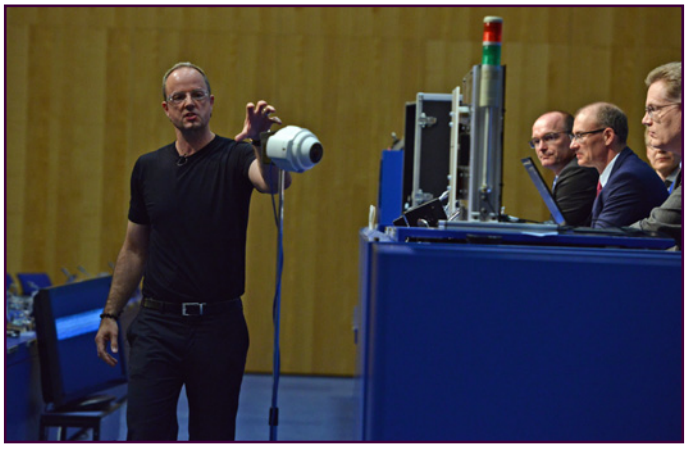
The consistent message from all Member States during the conference was that the cyber threat is an emerging capability within the existing design basis threat and that the instances of cyber attacks that produce a physical event in the nuclear industry will increase. Ms. Harrington concluded her plenary session remarks by stating, "The nuclear industry must respond to this security challenge by increasing resources and analysis to integrate the cyber discipline into our traditional nuclear security and nonproliferation programs." Following the plenary session opening remarks,

Integrating Cyber Analysis and Nuclear Security – *Continued*

Deputy Administrator Anne Harrington stated, "Costly, high profile security breaches against major energy and corporate infrastructures, such as the 2012 attack against Saudi Aramco that deleted data from three-quarters of the company's computers or the more recent attack against Korea Hydro and Nuclear Power, have demonstrated the seriousness and pervasiveness of the threat to everyone from facility operators to heads of State."

an international team led by NNSA personnel initiated the conference's technical discussions by demonstrating how an adversary could negatively impact nuclear power plant operations through cyber vulnerabilities. The demonstration scenario showed an adversary inserting code to manipulate the data used in a physical protection system and enable access to critical infrastructure areas. The demonstration served as the foundation from which technical experts discussed vulnerabilities and mitigation techniques for the remainder of the week.

Member States gave their unanimous support to the key conference finding that nuclear security must include cyber considerations; they are interconnected. Successful nuclear security programs and regimes are holistic in approach by



An international team led by NNSA personnel demonstrated how a cyber-enabled adversary could carry out traditional sabotage and theft scenarios.

analyzing material control, physical protection, safeguards, and other disciplines as an array within a single system. To be successful against today's adversary, the cyber discipline must be seamlessly integrated into the overall security program.

Charles Nickerson currently is overseeing the technical aspects of the Cyber Support Team, which works to enhance the security surrounding the critical digital assets that support DNN's nuclear nonproliferation efforts. He has developed security solutions and risk mitigation measures for nuclear and other supervisory control and data acquisition (SCADA) national security targets since 2003.

Radiation Detection System Commissioned in Romania

The radiation detection system at the Henri Coandă International Airport near Bucharest was commissioned in a ceremony July 22, 2015, led by U.S. Embassy Chargé d'Affaires Duane Butcher, Romanian Minister of Internal Affairs Gabriel Oprea, and other senior officials. The system is the latest result of the partnership of DOE/NNSA and the Romanian government to prevent illicit trafficking in nuclear and other radioactive material in Romania. DNN's Nuclear Smuggling Detection and Deterrence Program has worked together with Romania's General Inspectorate of Border Police to deploy multiple radiation detection systems that have scanned more than ten million vehicles, pedestrians, and shipping containers since 2010. Cooperation also has included joint trainings, practical exercises, and sustainability initiatives.

Read the NNSA press release to learn more about the radiation detection system installed near Bucharest: http://nnsa.energy.gov/mediaroom/pressreleases/nnsa-romania-launch-radiation-detection-system.

Administrator Leads NNSA Team at CTBT Science & Technology Conference

By Tim Evans

DOE Under Secretary for Nuclear Security and NNSA Administrator Lt. Gen. (Ret.) Frank Klotz was a featured speaker on June 22, 2015, in Vienna, Austria at the fifth Comprehensive-Nuclear-Test-Ban Treaty (CTBT) Science & Technology Conference (SnT15), during which over 1100 participants met to further enhance the strong relationship between the scientific and technological community and the Preparatory Commission for the CTBT Organization (CTBTO). Lt. Gen. Klotz's remarks focused on multilateral collaboration on nuclear explosion test monitoring and NNSA's extensive collaboration with the CTBTO Preparatory Commission in all aspects of the international monitoring and verification regime. Over 40 NNSA experts from 6 DOE National Laboratories (Los Alamos, Lawrence Livermore, Sandia, Pacific Northwest, Oak Ridge, and Idaho) and NNSA Headquarters attended SnT15 and presented on a wide range of topics, showing the depth of NNSA support for the CTBT effort.

DOE Under Secretary and NNSA Administrator Lt. Gen. (Ret.) Frank Klotz and Assistant Secretary of State Frank Rose hear about capabilities of the CTBTO International Monitoring System at the International Data Centre in Vienna, Austria.

DOE Under Secretary and NNSA Administrator Lt. Gen. (Ret.) Frank Klotz addressing a session at SnT15, discussing NNSA's support for multilateral collaboration on nuclear explosive test monitoring and verification. His remarks included the offer to "facilitate making [NNSA's] Nevada National Security Site available to future classes of OSI inspectors in order to enrich their training and experience."

Walt Dekin of Lawrence Livermore National Laboratory (left, with IDC Director Randy Bell, formerly of NNSA) won the Best Oral Presentation Award for "Understanding the Challenges of OSI Drilling to Safely Recover Relevant Radiological Samples from an Underground Nuclear Explosion." Mr. Dekin has extensive underground nuclear explosion monitoring experience and was a key Inspection Team leader at the 2014 large-scale OSI Integrated Field Exercise.

While in Vienna, Lt. Gen. Klotz also met with CTBTO Executive Secretary Lassina Zerbo and the Directors for the International Monitoring System (IMS), International Data Centre (IDC), and On-Site Inspection (OSI) Divisions; toured the IDC; and viewed radionuclide equipment at the Vienna International Centre. NNSA will continue to support the CTBT and contribute to the improvement of the CTBTO's nuclear explosion monitoring and verification capabilities.

Tim Evans is the Nuclear Testing Limitations Program Manager in DNN's Office of Nuclear Verification within the Office of Nonproliferation and Arms Control (NPAC). He has been with DOE for 24 years, with the past six in NPAC, managing NNSA's support for CTBT activities.

See related Tweets at
https://twitter.com/FrankKlotzNNSA/status/613374744021323778
https://twitter.com/ctbto_alerts/status/613242059634380805

INNOVATION: Developing a New Fuel to Enable Research Reactor Conversion

By Michael Itamura and Kristen Peters

The conversion of research reactors from highly enriched uranium (HEU) to low enriched uranium (LEU) fuel is a cornerstone of the United States' HEU minimization policy. Conversion achieves permanent threat reduction by decreasing the demand for HEU in civilian applications. The Reactor Conversion Program in DNN's Office of Material Management and Minimization (M^3) has successfully converted or verified the shutdown of 94 civilian HEU facilities worldwide. These facilities, most of which are standard research and test reactors, converted using existing LEU fuels developed in the 1980s and prior.

Many of the remaining HEU reactors around the world, however, require first-of-their-kind high density LEU fuels to be able to perform their scientific missions. In the United States, there are six so-called "high-performance research reactors" remaining, and the M^3 Reactor Conversion Program is working to develop a special high-density LEU fuel and associated commercial fabrication capability to convert these six reactors so they will be able to perform at a level equivalent to their current HEU performance without changing the geometry of the reactor core. The Europeans and Russians also are developing and testing new high-density fuels that will allow for the conversion of their HEU high performance research reactors.

The M^3 Reactor Conversion Program is leading a team of nine national laboratories and plants as well as industry participants to develop the new high-density fuel, establish a commercial-scale fabrication capability, and perform all the analyses needed to successfully convert the reactors using the new fuel. In order to meet reactor performance requirements, the new fuel needs to have upwards of 50 times the amount of uranium-238, compared to the current HEU fuel, to reduce the overall enrichment to 19.75%. As a result, the overall uranium density in the fuel needs to increase by a factor of five. One of the main technical challenges in developing this type of high-density fuel is fitting all of the additional uranium into the same volume and shape of the existing fuel elements. This fuel design also requires a new fabrication technology because it is manufactured using a single piece of enriched uranium metal (known as monolithic fuel meat) versus existing processes that use a powder compact.

Example of a high-density LEU fuel being rolled.

Because high-performance research reactors use much more HEU on an annual basis than standard research reactors, the HEU minimization benefits of converting reactors using new high-density fuels will be even greater than in the previous conversions. In fact, the conversion of the remaining high performance research reactors around the world will reduce the HEU in global civilian use and transit by almost ½ a metric ton annually—a huge threat reduction impact.

The M^3 Reactor Conversion Program has concluded over a dozen irradiation tests of this new high-density fuel and has confirmed that the fuel can operate safely in a variety of conditions. The next step of the program, currently underway, is to manufacture mini-plates that will undergo irradiation testing at the Advanced Test Reactor at the Idaho National Laboratory between 2017 and 2019 to evaluate multiple fuel fabrication concepts for the new high-density LEU fuel while also gathering additional irradiation data for the fuel qualification report that will be submitted to the Nuclear Regulatory Commission. Once the mini-plate tests and post-irradiation examination are completed, the M^3 Reactor Conversion Program will select a final fuel fabrication method. Using the selected fabrication method, several full-sized plate, element, tests, and demonstration tests will take place before the first U.S. high-performance research reactor is converted in 2025.

Michael Itamura is a contractor at Sandia National Laboratories currently assigned to M^3. He has supported the radiological security and reactor conversion programs of DNN since 2007. Dr. Itamura holds a B.S., M.S., and Ph.D. degrees in Mechanical Engineering from the University of California, Berkeley.

Kristen Peters is a former National Graduate Fellowship Program participant assigned to the M^3 Reactor Conversion Program. She holds her B.A. from Barnard College, Columbia University in Political Science and her Masters in Emergency and Disaster Management from Georgetown University.

LANL Scientist Recognized for Innovations in Sensing Nuclear Explosions from Space

By Meghan Wool

Dr. Eric Dors from Los Alamos National Laboratory (LANL) was one of nine recent recipients of the 2014 E. O. Lawrence Award for his work in national security and nonproliferation, research that was funded through DNN's Office of Research and Development. The award recognized Dr. Dors for his technical leadership of the Space and Atmospheric Burst Reporting System (SABRS), the next generation in satellite-based nuclear explosion sensing and detection. The system plays an essential role in fulfilling DOE's nonproliferation mission to monitor global nuclear detonations in support of the Limited Test Ban Treaty (LTBT). In order to improve upon previous generations of similar technology, the LANL team under Dr. Dors' direction reduced the weight, size, and complexity of the system, simplifying integration of SABRS onto host satellites. Their novel approach involved rethinking the entire layout and configuration of the system.

Dr. Dors acknowledges a number of factors that contributed to his personal success. While attending graduate school on a fellowship from NASA, he learned about preparing research proposals and project management. Then, early in his career, he was given a lot of responsibility, which provided him the opportunity to learn, make decisions, and grow. Dors expressed concern over the trend toward students more narrowly specializing in their fields while foregoing the type of "big picture" training that has helped his career. He feels graduate students should be in more holistic programs that develop their program management skills. "We need to find a way to give students a wider and larger perspective on how R&D is done and what it takes to pull all the different pieces together," he explains.

Dr. Dors has a deep commitment to developing the next generation of scientists and technical team members through training, coaching, and mentoring. As he explained, it takes years to "get people trained to do the things you need them to do. It's also very important for continuity of knowledge that there is no gap between the younger and the older generations so that the knowledge is passed along." Dr. Dors himself is part of that "continuity of knowledge" having had the opportunity to meet his predecessors who worked on legacy systems starting in the 1960s. He has great respect for the scientists who came before him, marveling at what they were able to accomplish without the advanced computing powers of today.

The **E. O. Lawrence Award** was established in 1959 to honor the memory of Dr. Ernest Orlando Lawrence, a 1939 Nobel Laureate in physics. Dr. Lawrence played a leading role in establishing the U.S. system of national laboratories. The award recognizes mid-career scientists and engineers in the United States who have advanced new research and scientific discovery. Learn more about E. O. Lawrence—the man and the award—at http://science.energy.gov/lawrence/.

Energy Secretary Dr. Ernest Moniz presented the E. O. Lawrence Award to Dr. Eric Dors at a ceremony held at DOE Headquarters in May 2015.

Looking to the future, Dr. Dors predicts a variety of challenges—the presence of more objects in space, new enemies, cyber threats, and budget constraints—will impact the development of new satellite detection and monitoring systems. Despite the challenges, however, the need to miniaturize and field these technologies will continue to grow.

Learn about all the exceptional U.S. scientists and engineers presented with an E. O. Lawrence Award awarded in May 2015: http://science.energy.gov/lawrence/award-laureates/2010s/2014-ceremony/.

Meghan Wool is a Leidos contractor supporting DNN's Office of Research & Development.

U.S., China, and IAEA Advance International HEU Minimization Efforts

By Brian Waud

In December 2015, a new low enriched uranium (LEU) core will be inserted into the Chinese Miniature Neutron Source Reactor (MNSR) at the Chinese Institute of Atomic Energy (CIAE), the final step in converting the reactor to LEU fuel. The conversion follows the discharge of the reactor's 93% highly enriched uranium (HEU) core and the receipt of an LEU operating license in September 2015. This MNSR will be the first converted through a joint effort of the United States, China, and the International Atomic Energy Agency (IAEA).

A number of Chinese designed MNSRs have been built around the world, including four in China (although only two in China are still operating) and one each in Ghana, Iran, Nigeria, Pakistan, and Syria. They are low-power (~30 kW) neutron source research reactors used primarily for neutron activation analysis (an analytical technique used for both qualitative and quantitative analysis of major, minor, trace, and rare elements), as well as for education and training. These reactors have cores consisting of less than 1 kilogram of HEU, enriched to 90% uranium-235 or greater.

Since 1978, various national and international activities have been underway to convert research and test reactors from the use of HEU fuel to LEU fuel. The MNSR community joined this international effort by establishing an IAEA Coordinated Research Project (CRP) in 2005 to harmonize various activities related to the conversion of MNSRs to LEU fuel. This first conversion in China serves as a test case for the remaining reactors; the MNSRs in Ghana, Nigeria, and Syria are already in various stages of conversion planning.

Through Argonne National Laboratory, the United States participated in the CRP by providing input to a generic conversion analysis, which will serve as the safety basis for future MNSR conversions. The CRP participants established that China, or other fuel fabricators, will be able to produce LEU cores for the MNSR reactors and that conversion of the MNSRs is feasible. The IAEA expects to publish the findings of the CRP in 2015 as a Technical Report entitled "Best Practice Analyses Supporting Conversion of Research Reactors from Highly Enriched Uranium Fuel to Low Enriched Uranium Fuel: The Case of Miniature Neutron Source Reactors."

Testing of the LEU core in the ZPTF at the CIAE.

LEU core inserted into the Chinese MNSR at the CIAE.

In 2008, CIAE, DOE/NNSA, and the IAEA agreed to build a zero power test facility (ZPTF) at CIAE to demonstrate the technology for implementing MNSR conversions. Testing the LEU fuel in the ZPTF successfully demonstrated that the fabricated LEU fuel meets the reactivity requirements of the MNSR facility without loss of performance capability. In fact, the LEU fuel may even provide some performance enhancements.

In addition to participating in the IAEA's CRP and supporting construction of the ZPTF, DNN's Office of Material Management and Minimization (M^3) provided technical and financial support to China to assist with the conversion of the CIAE prototype MNSR. M^3 helped by validating calculations and analysis used in the request for an operating license from the regulatory body, procuring the LEU core and testing it in the ZPTF, and procuring equipment necessary to remove HEU and insert LEU fuel.

The first successful MNSR conversion provides a baseline for the conversion of the remaining MNSRs. The LEU cores will be tested by China using the ZPTF to ensure that the design parameters and requirements are satisfactorily met. The next MNSR conversion, in Ghana, is planned to occur in 2016 and work is underway for additional MNSR conversions beyond that.

Brian Waud is the Project Manager for International Reactor Conversions in M^3. He has worked in varying nonproliferation roles at DOE since 2002, including serving five years at the IAEA as a Nuclear Security Officer.

DNN Expert Profile: Meet the NGFP Class of 2015

By Cornelia Brim and Maren Disney

After their first month on the job, several Fellows of the NNSA Graduate Fellowship Program (NGFP) assigned to DNN met with us to share their stories.

Why nonproliferation?

When asked what attracted them to nonproliferation work, Fellows cited a range of interests, from intellectual and science challenges to philosophical questions.

Tom Gray, who works in DNN's Front Office, spent 7 years in the U.S. Navy, some aboard a ballistic missile submarine, before coming to NGFP. "When I left the Navy, I wanted to experience the 'other' side of the issue [of nonproliferation] and I earned a master's degree in nonproliferation and terrorism studies," he said.

Kaitlin Oujo told us, "In contrast to work in other fields I've worked in (conflict resolution), nonproliferation takes a long view, staff members think about issues over the long-term. Where do we want to be in the next 10, 20, or 50 years? In other [U.S. Government-related] work I've done in the Middle East, staff members were responding to crises—elections in Egypt and ISIS gaining prominence—versus strategizing for the long-term." Oujo is assigned to DNN's Office of Global Material Security (GMS) in the Nuclear Smuggling Detection and Deterrence Program.

As an undergraduate student studying medical physics, Jessica Paul (now a PhD) was not aware of nonproliferation until she took a class that piqued her interest in nuclear engineering. She said, "Nonproliferation presents an opportunity to do important, impactful work." She thanks her insightful professors at the University of Florida and Georgia Tech for steering her into this field. Paul is assigned to DNN's Office of Research and Development (DNN R&D).

Some Fellows came into the field with first-hand experience with the challenges countries face in controlling their borders and maintaining a stable government.

"I've previously looked at nonproliferation through a China lens. When I worked for the U.S. Department of Energy (NNSA and the Office of Nuclear Energy) within the U.S. Embassy in Beijing, a mentor suggested I apply for the NGFP Fellowship," Jason Portner recalls. Portner is assigned to the Office of Nonproliferation and Arms Control (NPAC).

Part of the NGFP orientation at Pacific Northwest National Laboratory is a course in Social Styles, where participants explore how one's style—Driver, Expressive, Amiable, Analytic—can affect professional working relationships. (Clockwise) Andrew Cartas (upper left), Bonnie Canion, Chris McGuire, Ty Otto, Temica Stewart, and Dana Jesperson discuss style preferences and expectations.

The NNSA Graduate Fellowship Program is a full-time, salaried fellowship program that places graduate-level students interested in nuclear security careers in offices across NNSA. In June 2015, 15 Fellows joined DNN for one year. Read more about the program in the *DNN Sentinel,* Volume I, No. 2, page 10.

Of the NGFP Fellows currently assigned to DNN programs, 4 hold PhDs, and 11 hold masters degrees. Their expertise spans disciplines from science and engineering to nonproliferation, foreign policy, and international economics—and many have a "hybrid" background, meaning a mix of both technical and policy education. The Fellows are also world travelers, many of them having spent time studying or working in Europe, Russia, the Middle East, China, and Asia. Collectively, they are proficient in several foreign languages, including Arabic, Mandarin Chinese, French, German, Japanese, Russian, and Spanish.

For others, nonproliferation was a natural complement to academic studies in physics and nuclear engineering—and it was simply interesting. As Robert (Ty) Otto quipped, "What could be cooler than taking on the threat of nuclear destruction?" He is assigned to NPAC's Office of International Nuclear Safeguards.

What did you do during your first month at DNN?

While every Fellow's assignment is different, all agree that their first month was spent learning the lay of the nonproliferation landscape through reading and research, attending meetings, and becoming acquainted with coworkers.

Andrew Cartas, PhD, joked about receiving his "body weight in material to read." During his first month on the job, Cartas completed the "Issues in Missiles and Nuclear Nonproliferation" course at the James Martin Center for Nonproliferation Studies. Speakers included Tom Countryman, U.S. Assistant Secretary of State for International Security and Nonproliferation, who had just come back from Vienna and discussed negotiations with Iran for the Joint Comprehensive Plan of Action. "It was nice to have a behind-the-scenes perspective," Cartas said. He is assigned to DNN's Office of Materials Management and Minimization.

Bonnie Canion, who works for DNN R&D, said, "I had the opportunity to attend the conference, 'Generation Prague 2015: Bridging Divides, Defining the Future,' which happened to start right after the Joint Comprehensive Plan of Action in mid-July. Wendy Sherman, Undersecretary of State for Political Affairs and [lead U.S.] negotiator of the Iran deal, spoke to us and got a standing ovation."

Within GMS, Sarah Norris is helping with preparations for the International Atomic Energy Agency (IAEA) General Conference in September and for the Nuclear Security Summit in 2016.

Lance Garrison, PhD, supporting DNN R&D, is reviewing the entire portfolio and writing concise summaries of the research and development projects being performed. Garrison also attended the Generation Prague conference and is now acting as the "eyes and ears" of his office at a number of other conferences and meetings.

Tracey-Ann Wellington, PhD, who is assigned to NPAC's Office of Nuclear Export Controls said, "I've been working on understanding export licensing with a focus on missile technology." Wellington explained that her assignments have helped expose her to what the different DNN offices do and how they are engaged with each other.

Ben Briese, who is working in the GMS Nuclear Smuggling Detection and Deterrence Program, said, "I'm splitting my time between the implementation side and the sustainability side. For implementation, I've been working with country manager, Jared Carter (former NGFP Fellow, class of 2012). I support him on his work in Belarus, Moldova, and Croatia. I'll be traveling with him to Belarus supporting stakeholder meetings where we're reviewing the designs for a new set of radiation portal monitors we'll be installing there."

Most interesting task (so far) at DNN?

Only a month into their year-long assignments, Fellows had already begun their hands-on work, calling up their existing talents and strengths while acquiring new knowledge and experiencing nonproliferation work from a new perspective.

Elizabeth Lostracco, who works in the GMS Radiological Security Program, shared, "I did not know anything about isotopes, so learning about [isotopes and] non-isotopic alternate technologies is really fascinating. I love the mental challenge."

Cartas was asked to give his technical opinion on a highly debated paper on the validity of Russian means of plutonium disposal—with a 24-hour turnaround. Cartas said, "I was exposed to some of the elements in my background but I was forced to look at other research to make sure I was accurate. I could not speak off-the-cuff." Cartas delivered on the assignment and noted that it was an interesting opportunity to explore other points of view.

Cornelia Brim and Maren Disney are communications specialists at PNNL.

Read More

To see the full list of Fellows assigned to DNN and answers to more questions, read the *DNN Sentinel*, Vol. I, No. 3, Addendum online at http://nnsa.energy.gov/aboutus/ourprograms/nonproliferation-0.

Field Test of Automated System for the Verification of Uranium Cylinders

By Anagha Iyengar

DNN's Office of Nonproliferation and Arms Control (NPAC) has joined forces with several national laboratories, the International Atomic Energy Agency (IAEA), and Westinghouse to develop and evaluate a prototype system intended to improve nuclear safeguards at the front end of the fuel cycle. An Unattended Cylinder Verification Station (UCVS) would provide automated, independent verification of the declared relative enrichment, uranium-235 mass, and total uranium mass in cylinders used to store and transport uranium hexafluoride within and between nuclear facilities, such as uranium enrichment plants and fuel fabrication plants.

In April 2015, a UCVS prototype designed to preliminary requirements provided by the IAEA was installed at the Westinghouse nuclear fuel fabrication facility in Columbia, South Carolina. The UCVS prototype operates in an unattended fashion with operator involvement limited to placing a cylinder and waiting for the scan timer to elapse. The installation marked the beginning of long-term field testing of the integrated system that will include the assay of several hundred cylinders and a series of special scan sequences designed to address specific technical questions posed by the IAEA and others. Central to the field trial is a comparative evaluation of two candidate nondestructive assay methods, both of which were developed under NPAC and could improve the IAEA's ability to more fully and accurately measure the material in the cylinders.

NPAC's Office of International Nuclear Safeguards sponsored development of the UCVS field prototype in response to a request from the IAEA to the U.S. Support Program to IAEA Safeguards and the European Commission Support Program. The U.S. project team includes Pacific Northwest National Laboratory (PNNL), Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL), and Savannah River National Laboratory (SRNL).

In June 2015, representatives from DOE/NNSA, the IAEA, Euratom, several National Laboratories, and Westinghouse gathered at the fuel fabrication facility to assess the status of the field trial and accompanying analysis. For representatives from the IAEA and Euratom, the meeting provided the first opportunity to see the UCVS prototype in action and to hear feedback about the instrument from a facility operator.

UCVS field prototype in action at the Westinghouse fuel fabrication facility in South Carolina.

Analysis of the data is being performed offline by experts from PNNL, LANL, and ORNL. Preliminary findings were reported to the IAEA and Euratom in late September, and feedback from stakeholders will guide the final stage of the field trial and data analysis, expected to culminate in early 2016.

Why Automate Cylinder Measurements?

The ability of gaseous centrifuge enrichment plants (GCEPs) to change the isotopic concentration of uranium (i.e., enrichment levels) is a sensitive process and creates a proliferation concern. In recent years, the IAEA has pursued innovative techniques and an integrated suite of measures to verify that nuclear material at GCEPs is safeguarded at all stages in the process, including the cylinders used to store and transport uranium hexafluoride.

The IAEA's current methods for verifying the contents of these cylinders are time-consuming and labor-intensive. Since human and financial resources preclude continuous inspector presence at GCEPs, one set of improvements being explored is employing permanently installed, unattended instruments capable of performing routine and repetitive measurements that were previously performed by inspectors. By automating safeguards data collection, IAEA inspectors could focus scarce time and resources on detecting indications of undeclared activity.

Y-12 Hosts Japanese Delegation

The Y-12 National Security Complex recently hosted members of a U.S.–Japanese bilateral Nuclear Security Working Group (NSWG), which was established at the 2010 Nuclear Security Summit. The NSWG meets regularly at nuclear sites in Japan and the United States to share technology and methodologies that help secure our facilities, our nation, and the world. Y-12 offers its expertise in areas ranging from securing highly enriched uranium to training on safeguarding nuclear materials. The goal is to improve nuclear security practices worldwide.

Members of the Japanese delegation, led by Takashi Hatori (center), receive a briefing at the Alarm Response Training (ART) facility. ART courses prepare emergency responders for nuclear and radiological incidents.

Laura Holgate, leader of the U.S. delegation and National Security Council Senior Director for Weapons of Mass Destruction Terrorism and Threat Reduction, visits Y-12. “I’ve been well aware of the nonproliferation contributions by Y-12, but to see it in person is a real benefit to me,” she said.

At the Highly Enriched Uranium Materials Facility, Hatori is shown how to operate a uranium canister handling system.

DOE Under Secretary for Nuclear Security and NNSA Administrator Lt. Gen. (Ret.) Frank Klotz tours Y-12’s new ART facility in Oak Ridge and greets staff. See DNN Sentinel, Vol. I, No. 1, to learn about the opening of the new ART facility.

COUNTRY PROFILE: VIETNAM

Removing Materials from the Past and Preparing for a Secure Future

DNN has long been active throughout Southeast Asia, developing strong partnerships with regional actors to strengthen their indigenous nuclear security, safeguards, and nonproliferation practices. In Vietnam, DNN has established relationships with the Vietnam Agency for Radiation and Nuclear Safety (VARANS) and the Vietnam Atomic Energy Institute (VINATOM), the two main agencies under the Ministry of Science and Technology that are responsible for nuclear safety and security as well as the Vietnam Atomic Energy Commission.

Vietnam's nuclear history stretches back to the 1960s, when it began operating a Training Research Isotope General Atomics (TRIGA) research reactor on U.S.-origin enriched fuel. The United States removed the fuel on March 31, 1975, due to the unstable situation in the country. After the end of the Vietnam War, Vietnam restarted the reactor using Russian-origin highly enriched uranium (HEU) fuel.

In 2007, the reactor was partially converted to the use of LEU and all fresh HEU was returned to Russia. In 2011, the reactor was fully converted to LEU and the spent HEU was returned to Russia in 2013 after it had sufficiently cooled and could be transported safely. DNN assisted with both the reactor conversion and fuel returns. This trilateral effort with Vietnam and Russia made Vietnam the 11th location from which all HEU was removed as part of President Obama's effort to secure all vulnerable nuclear material around the world in four years.

Looking to the future, Vietnam is pursuing the development of a civilian nuclear power program. Current plans are to construct eight nuclear power reactors by 2030, with the first four to be built and financed by Russia and Japan.

The United States and Vietnam have had a legally binding, government-to-government Peaceful Uses of Nuclear Energy Agreement in place since October 2014. Known as a 123 Agreement, it allows licensing of U.S. exports of nuclear reactor and research information, material, technology, and equipment to Vietnam; however, no transfers have yet occurred under the agreement. DNN provided technical and policy support throughout the negotiations for the 123 Agreement and is in the process of negotiating an Administrative Arrangement (AA) to the Agreement. The AA is a non-legally binding document that will provide a framework for material tracking and accountancy. (See the FAQ article on page 16 to learn more about 123 Agreements.)

Vietnam's Nuclear History in Brief

1963 — Research reactor at Dalat Nuclear Research Center began operating

1982 — Joined the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) as a non-nuclear weapon state

1990 — Comprehensive Safeguards Agreement with the International Atomic Energy Agency (IAEA) entered into force

1996 — Signed the Comprehensive Nuclear Test Ban Treaty (CTBT)

2006 — Ratified the CTBT as an Annex-2 country

2011 — Approved plan to construct seven nuclear reactors

2012 — Concluded and ratified IAEA Additional Protocol

2014 — 123 Agreement between the United States and Vietnam went into effect

Country Profile: Vietnam – *Continued*

DNN's support of U.S.-Vietnam nuclear collaboration and cooperation covers many other areas in addition to conversions, removal, and policy negotiations.

Nuclear Security

DNN has supported physical protection and security of nuclear materials and facilities training events for Vietnamese participants since 2013. The training is presented in Vietnam and also at the regional Center of Excellence in Japan. Previous topics covered include INFCIRC 225/Rev. 5 implementation and foundations of physical protection. The most recent workshop, held in July 2015, covered contingency plan development.

Nuclear Smuggling Detection and Deterrence

To enhance Vietnam's ability to counter nuclear and radiological smuggling, DNN supported installation of a radiation detection system (RDS) at the Port of Cai Mep. In May 2014, Vietnam Customs began official operations of the RDS, and Vietnam is on track to assume long-term responsibility for operating and maintaining the system in 2016. An additional RDS installation is in the design stage for the Port of Cat Lai, with construction planned to start in 2016.

Radiological Security

DNN has cooperated with Vietnam in the area of radiological security for more than a decade. Current activities include providing security upgrades at sites that use or store high activity radiological sources, delivering training courses and workshops, and improving security at the Dalat Research Reactor. In all, DNN has provided security enhancements at 28 buildings in Vietnam and has worked with Vietnam on regulations development and training of inspectors. In May 2015, NNSA conducted a refresher training course that covered how to search for, recover, and secure orphaned radiological sources. Also in 2015, NNSA initiated a new project to help Vietnam develop a national response plan to a malicious incident involving radioactive materials.

Nuclear Safeguards

DNN subject matter experts conducting an equipment inventory check for handheld gamma-ray instruments at a Nuclear Safeguards Laboratory Development course for the Vietnam Agency for Radiation and Nuclear Safety (VARANS), held April 2015 in Hanoi.

DNN initiated safeguards engagement with Vietnam in 2007 to build its indigenous capacity to implement international safeguards. Cooperation primarily focused on assistance in the implementation of the Additional Protocol (AP), which Vietnam ratified in 2012, and consultation on safeguards-related legislation and regulations. In FY 2015, DNN expanded technical assistance to include the joint development and deployment of an information management system for nuclear material accounting and reporting in Vietnam. Future cooperation will include assistance in establishing a new safeguards laboratory, developing a strong national safeguards inspections capability, and creating a quality assurance/quality control program, as well as outreach to academic and other public stakeholders about Vietnam's safeguards reporting requirements under the AP.

Export Controls

DNN is collaborating with the General Department of Vietnam Customs to develop a Vietnamese version of DNN's Weapons of Mass Destruction Commodity Identification Training (WMD CIT). This effort will allow Vietnam Customs to train officials to recognize WMD-related commodities that may be transiting or transshipping through Vietnam. The expertise developed through this training will help Vietnamese Customs officers detect suspect shipments that could support an illicit WMD program. The Department of State provides funding for DNN's work in Vietnam, with technical expertise and training material provided by DNN.

FAQs: 123 Agreements for Peaceful Cooperation

U.S. firms cannot export nuclear material and equipment to just anyone. Before another country can receive exports of certain nuclear-related items from the United States, an Agreement for Peaceful Nuclear Cooperation or a "123 Agreement" must be in place with that country. The term "123" refers to Section 123 of the Atomic Energy Act of 1954, as amended. The agreement acts in conjunction with other nonproliferation tools, particularly the Nuclear Non-Proliferation Treaty, to establish the legal framework for significant nuclear cooperation between the United States and another country.

What types of exports require a 123 Agreement to be in place?

Nuclear material, equipment, and major components controlled by the U.S. Nuclear Regulatory Commission as outlined in Part 110 of Title 10 of the *Code of Federal Regulations*, including but not limited to, source material, special nuclear material, byproduct material, nuclear reactors, fuel cycle facilities, and specially designed or prepared equipment or components for such facilities.

Through what process does a 123 Agreement come to be in place?

Once the decision has been made to enter into negotiations on a new or renewed 123 Agreement, the Department of State has the lead for negotiating the agreement, with technical assistance from DOE and support from the Nuclear Regulatory Commission. Upon completion of negotiations, the Secretaries of State and Energy together must submit the proposed 123 Agreement and statutorily required supporting documentation to the President for review. The President then submits the package to Congress for a 90-day review period.

What is DNN's role in the process of negotiating and implementing 123 Agreements?

DNN is the office within DOE that provides statutorily required technical assistance to the Department of State in the negotiation of all 123 Agreements. DNN ensures that the proposed 123 Agreement complies with the terms of the Atomic Energy Act and aligns with the goals of the Secretary of Energy and Administration. DNN participates in all interagency meetings and Congressional briefings on any 123 Agreements in negotiation or under review and assists with all supporting documentation. Following entry into force, DNN leads the interagency on negotiating and implementing Administrative Arrangements to the 123 Agreements, which provide a framework for material accountancy and tracking for exchanges done pursuant to the agreement.

The Atomic Energy Act of 1954, signed into law by President Eisenhower, sets forth the conditions that are legally required to be in any 123 Agreement.

Does having a 123 Agreement in place with a specific country commit the United States to export certain items to that country?

No. The proposed agreement establishes the legal framework for nuclear cooperation to take place between U.S. entities and partner counties and companies. Each application to transfer nuclear materials, equipment, and technology is reviewed on a case-by-case basis by the U.S. Government and requires separate regulatory approval from the appropriate agency.

Besides opening the door to allow granting approval to export nuclear equipment and material to another country, what other functions are served by having a 123 Agreement?

A 123 Agreement allows for cooperation in technical exchanges, scientific research, and safeguards discussions. A 123 Agreement also can provide the basis for addressing any questions or disputes that could arise from the potential misuse or diversion of a licensed nuclear commodity.

Learn more and see the complete list of the States or groups of States with which the United States currently has entered into a 123 Agreement at: http://nnsa.energy.gov/aboutus/ourprograms/nonproliferation/treatiesagreements/123agreementsforpeacefulcooperation.