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

DNN Sentinel

DEFENSE BY OTHER MEANS

Vol. III, No. 1

IN THIS ISSUE:

From the Acting Deputy Administrator

Since the last issue of the *DNN Sentinel*, many changes have occurred within the Department of Energy and NNSA's Office of Defense Nuclear Nonproliferation (DNN). However, the work that the DNN team is leading, the work of the extraordinarily brilliant men and women, continues at DOE and the national laboratories. We maintain, as evidenced by the FY 2018 budget request to Congress, strong support from Secretary Rick Perry for our mission and activities. I am confident that we will continue to demonstrate our ability to "go change the world," and we have been working hard with Secretary Perry and his team to keep our vital work on track.

One way that DNN meets our mission of enhancing U.S. national security by reducing the threat of nuclear and radiological terrorism and nuclear proliferation is by embracing interagency and interdisciplinary approaches to solving problems and making progress. The stories in this issue of the *Sentinel* highlight these partnerships—with local governments, international partners, academia, and civilian and military end-users of our innovations. In a time of transition, it is important to remember that our success depends on our ability to work diligently, together with our partners, to support national and global security.

Our mission is enduring and the news about world events reinforces the need for our constant vigilance and focus on addressing nuclear threats. I want to thank the entire DNN team for their support and continued hard work that makes our success and strengthening global nuclear security possible.

David Huizenga
Acting Deputy Administrator
Defense Nuclear Nonproliferation

DNN SENTINEL:
DEFENSE BY OTHER MEANS

VOL. III, NO. 1

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

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

Press Release

NNSA Spearheads International Effort to Convert Ghana Reactor to LEU Fuel

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Nuclear Security Training Center Opens in Kazakhstan

https://nnsa.energy.gov/mediaroom/pressreleases/nuclear-security-training-center-opens-kazakhstan

Blogs

NNSA and Turkey cooperate to combat nuclear smuggling

https://nnsa.energy.gov/blog/nnsa-and-turkey-cooperate-combat-nuclear-smuggling

U.S. and Poland host international nonproliferation workshop for law enforcement personnel

https://nnsa.energy.gov/blog/u.s.-and-poland-host-international-nonproliferation-workshop-law-enforcement-personnel

WSU program sponsored by NNSA leads to safeguards solutions

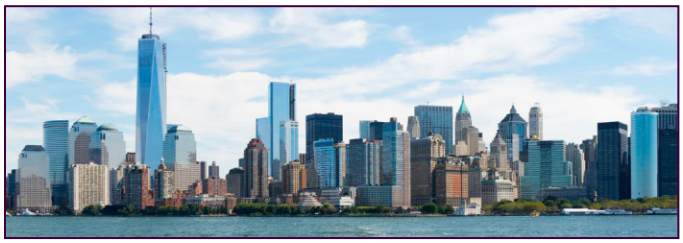
https://nnsa.energy.gov/blog/wsu-program-sponsored-nnsa-leads-safeguards-solutions

NNSA and PONI partnership grows next generation of nuclear security experts

https://nnsa.energy.gov/blog/nnsa-and-poni-partnership-grows-next-generation-nuclear-security-experts

NNSA and IAEA sponsor training on nuclear material accounting for international partners

https://nnsa.energy.gov/blog/nnsa-and-iaea-sponsor-training-nuclear-material-accounting-international-partners



Reducing Terrorism Risks in New York City by Replacing Medical Tools Using Radioactive Materials

By Lance Garrison

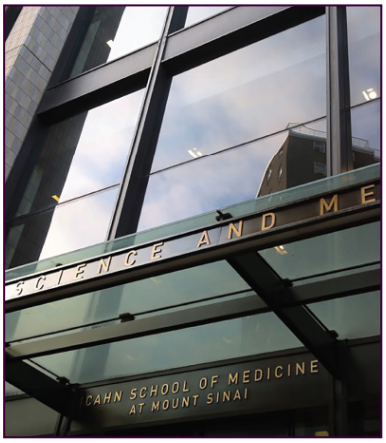
New York City is home to many *firsts* that have paved the path for America's development: the first U.S. capital from 1789 to 1790, the first U.S. pizzeria in 1905 (Lombardi's Pizza), the first commodity market (the New York Cotton Exchange), and the first steel wire suspension bridge (the Brooklyn Bridge), to name a few. Now, it is first in the field of radiological security: New York is leading the first city-wide initiative in the United States to replace cesium-137-based irradiators with alternatives that do not contain radioactive sources.

New York medical facilities and universities are partnering with DNN's Office of Radiological Security (ORS), the New York City Department of Health and Mental Hygiene, and the Nuclear Threat Initiative to replace the vast majority of the city's irradiators containing high-activity cesium-137 sources (around 4% of the U.S. cesium-137 irradiator inventory) over the next few years. Using alternative technologies, such as X-ray irradiators, eliminates the risk of cesium-137 sources being misused in acts of terrorism, such as a radiological dirty-bomb.

ORS is playing a pivotal role in this replacement effort through its Cesium Irradiator Replacement Project (CIRP). Through CIRP, qualified sites that choose to replace their cesium-137 based irradiators receive money toward the purchase of the new irradiator. In addition, ORS removes and disposes of the cesium-137 based irradiator through the Off-Site Source Recovery Project at no cost to the site, given the lack of commercial disposition options for these sources. (For an overview of CIRP, see *Cesium Irradiator Replacement Preserves Health Benefits, Promotes Radiological Safety* in the DNN *Sentinel* Vol. II No.1.)

Irradiators are primarily used by hospitals and blood banks to treat blood products prior to transfusion; and by medical researchers to perform biological studies. To ensure the change in technology does not negatively impact current or future patient health, ORS only partners with volunteers who are confident that the non-radioisotopic alternative technology, such as X-ray irradiators, will meet their current and future performance needs.

New York has a history as a national leader in radiological security. A terrorism target in the past, the city continues to be considered a major target now and for the foreseeable future. As a result, the New York Police Department (NYPD) has taken a proactive approach to security against terrorism, including radiological terrorism, earning recognition as one of the best law enforcement organizations dealing with radiological threats in the country. In addition to the CIRP initiative, New York City users of high-activity radioactive sources, the New York City Department of Health and Mental Hygiene, and the NYPD have partnered with ORS over the past eight years to increase the physical security of the sources and ensure that law enforcement is prepared to respond to any attempted theft or malicious use of the material.



"We recently decided to use X-ray instead of cesium irradiators in our new building. Mount Sinai is proactively looking at alternative technologies and will, hopefully, phase out all radioactive material as time goes by." — *Dr. Jacob Kamen, Mount Sinai Medical Center.*

ORS continues to work with other sites around the country to replace cesium-137 irradiators through CIRP and will use the New York City initiative as a model for engagement in other regions.

Lance Garrison manages the Domestic Alternative Technology Portfolio, including the Cesium Irradiator Replacement Project, in DNN's Office of Radiological Security. He previously served DNN's Office of Research and Development as a 2015 NNSA Graduate Fellow.

Joint Exercise with Army Tests Mobile Facilities to Package and Remove Nuclear Materials

For two months between April and June 2017, the DNN Office of Material Management and Minimization's (M^3) Emerging Threats program exercised two mobile facilities in support of a critical national security capability—to expeditiously package and safely remove nuclear materials in the event of an urgent need outside the United States. The exercise, named *Corvina Loco*, tested the Mobile Plutonium Facility (MPF) and Mobile Uranium Facility (MUF) at Naval Air Station Key West, Florida, to simulate operations in a subtropical climate. Each facility can be quickly deployed wherever the need should arise.

Birdseye view of the Mobile Plutonium Facility (left) and the Mobile Uranium Facility (right) as they were set up for the exercise.

Under DOE/NNSA leadership, personnel from the Savannah River National Laboratory (SRNL), Oak Ridge National Laboratory (ORNL), and Y-12 National Security Complex (Y-12) mustered at Naval Air Station Key West for the deployment and exercise of MPF and MUF. Transportable by air, land, and sea, the facilities comprise connected, self-contained, customized shipping containers that can be operated in austere environments with limited infrastructure. Each mobile facility has been carefully designed and optimized to handle specific nuclear materials safely and securely, while maintaining the capability for rapid global deployment.

Y-12 personnel perform material sampling procedures on simulated materials.

The genesis of the Emerging Threats program came after Y-12 teams were sent to Kazakhstan and Georgia in 1994 and 1998 to remove highly enriched uranium (HEU) on short notice and then again in 2004 and 2008, when Y-12 and ORNL teams were deployed to Iraq to remove tonnes of HEU and uranium oxide (yellowcake), along with thousands of radioactive sources. These events made clear to DOE/NNSA the need to have the right equipment and personnel trained and ready to quickly remove materials. SRNL designed and built the MPF, while teams from Y-12 and ORNL used their operational expertise from the previous removal efforts to develop the MUF. The resulting facilities allow experts to characterize, stabilize, and package plutonium, and uranium—including HEU, low-enriched, natural, and depleted uranium—in all forms.

Corvina Loco was notable as the first full-scale joint exercise with the U.S. Army's Nuclear Disablement Team. The MPF and MUF used surrogate materials to practice processing, packaging, verifying, and shipping activities during multiple exercise scenarios. To better simulate the circumstances

in which the facilities could be deployed, Army personnel delivered the "nuclear material" to the technical personnel, who then managed material movements within the MPF and MUF facilities. Once the MPF and MUF teams received material, technical personnel analyzed X-rays, reviewed non-destructive assay data, verified certain technical characteristics, and held pre-operations briefings, all while central operations centers monitored and controlled every aspect of the process.

environment, in Alaska to test a cold environment, and now on Key West to test a subtropical environment. Each preceding exercise introduced additional complexity, building up to this combined exercise with the U.S. Army. It was the culmination of months of hard work and coordination among SRNL, ORNL, and Y-12 personnel. Naval Air Station Key West provided incredible support as the hosts for the exercise.

ORNL's Shane Cromwell gives distinguished visitors a peek into the facility maintenance capabilities of the Mobile Uranium Facility (left). Alice Murray from SRNL talks about a potential course of action during a Mobile Plutonium Facility team meeting (right).

Y-12 personnel take a 'swipe' to test for external contamination on simulated materials.

The MPF and MUF are key components of NNSA's full spectrum of capabilities to respond to nuclear threats. The Emerging Threats program works with other organizations within NNSA, including verification, emergency response, and consequence management teams.

Corvina Loco follows in the tradition of testing in new environments and adjusting capabilities based on lessons learned. Previous exercises were held at Nevada National Security Site to test a desert

During *Corvina Loco*, MPF and MUF team members logged more than 18,000 training hours, while collecting nearly 40 pages of formal lessons learned and implementing countless informal improvements throughout the exercise. However, the biggest take-away by far was the value of increased coordination between the Army and NNSA's Emerging Threats Program.

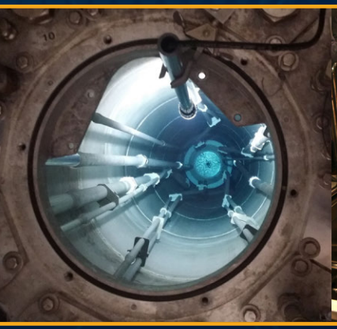
Corvina Loco demonstrated to all participating agencies that NNSA's MPF and MUF are ready to respond. The Emerging Threats team will continue to maintain proficiency by having small-scale exercises and trainings until the next mock deployment exercise. The next exercise will build on the lessons learned during *Corvina Loco* and will be fully integrated with the military in an international location.

Read the NNSA blog about *Corvina Loco* at https://nnsa.energy.gov/blog/doennsa-test-mobile-nuclear-facilities-army-during-national-security-exercise.

To learn more about the MPF, see *Operation Sputnik—First Remote Deployment of MPF* in the *DNN Sentinel, Vol II, No. 2*.

DNN FOCUS AND CAPABILITIES

The **Office of Defense Nuclear Nonproliferation** strengthens U.S. security by reducing global dangers posed by nuclear weapons, material, and technology.



DNN CAPABILITIES

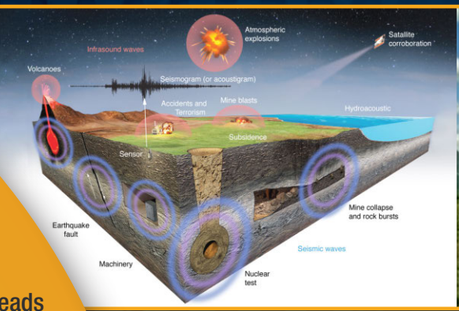
Minimize Nuclear and Radiological Materials

- Remove
- Dispose
- Reduce Demand

DNN FOCUS: NUCLEAR AND RADIOLOGICAL THREATS

Detect Proliferation

- Nuclear Explosions
- Materials and Warheads
- Material Production
- Weapons Development



Secure Nuclear Facilities and Radiological Materials

Counter Nuclear Ambitions

Counter Nuclear Smuggling

- Land Borders
- Seaport
- Airports
- Mobile

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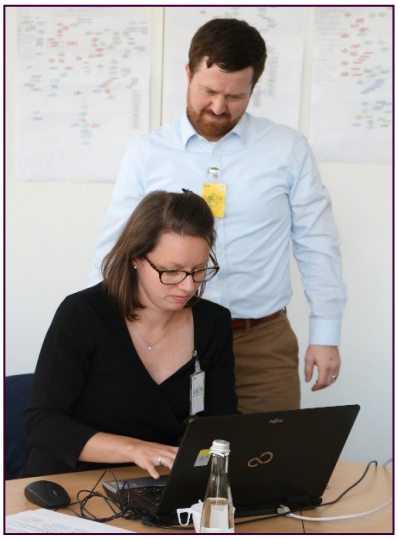
Improving Investigative Tools to Identify and Convict Nuclear Smugglers



The real-time pace of the exercise challenged participants to share nuclear forensics information throughout the fictitious nuclear smuggling scenario.

A critical component of an effective national nuclear detection architecture is a country's ability to coordinate interagency partners when investigating a nuclear smuggling seizure. Understanding jurisdictions and missions of all relevant agencies is critical when gathering nuclear trafficking evidence that can help identify suspects and lead to convictions.

To help partner countries Georgia, Ukraine, Azerbaijan, and Moldova identify good practice in interagency coordination, DNN hosted the Nuclear Forensic Scenario Exercise (NUFORSE) in Germany earlier this year. This tabletop simulation brought law enforcement, regulatory officials, and technical experts from each partner country together with facilitators from DNN's Office of Nuclear Smuggling Detection and Deterrence (NSDD) to discuss nuclear forensics activities within their own countries and identify areas for improved communication among agencies.

"Participants respond to realistic nuclear smuggling incident scenarios, which are introduced and unfold in real time over the course of the exercise," said Liz Dallas, NSDD exercise facilitator. "They must work together and share information with their interagency partners to be successful."

NSDD, the European Commission Joint Research Centre, and subject matter experts from Argonne, Lawrence Livermore, and Oak Ridge National Laboratories designed the exercise. Representatives from the State Department observed to gain insights for future development of nuclear forensics exercises.

On the final debriefing day, participants discussed applying what they learned to nuclear forensics work in their own countries as well as ways to improve sharing information across borders.

New Publication Sheds Light on Years of Experience in Monitoring the Earth for Nuclear Explosions

Los Alamos National Laboratory (LANL) has published a monograph, *Trends in Nuclear Explosion Monitoring Research & Development – A Physics Perspective*, (DOI:10.2172/1355758) that comprehensively collects research from 1993 to 2016. This overview is an incomparable resource for next-generation researchers working on the challenge of detecting nuclear explosions anywhere in the world. The document has prompted thoughtful consideration by DNN's Office of Research and Development of future research directions that can complement and supplement work already conducted or underway.

Dr. Monica Maceira, Associate Professor of Physics at the University of Tennessee stated, "Nuclear explosion monitoring is critical to our national and global security. Researchers have spent more than a half-century studying the science behind nuclear explosions and developing tools, techniques, and systems to monitor them. This monograph provides an in-depth look at the fruits of that labor and, in doing so, shows just how advanced and complex this field has become." The authors discuss trends in source physics, signal propagation, sensors, and signal analysis, highlighting recent publications that advanced the science and can motivate promising research and development efforts.

LANL produced the monograph in collaboration with Lawrence Livermore, Pacific Northwest, and Sandia National Laboratories and the Naval Research Laboratory.

Searching Cities for Terrorist Devices with Speed and Accuracy

A sample of the optimized urban search plan produced by OPTUS.

Scanning cities for radiological and nuclear (RN) devices requires an approach that includes both unique expertise and specialized technologies. In coordination with both NNSA end-users and other government agencies, DNN's Office of Research and Development has developed the Optimization Planning Tool for Urban Search (OPTUS). OPTUS improves both the efficiency and effectiveness of RN searches in urban environments by increasing the probability of finding dangerous materials while simultaneously reducing search time. The OPTUS tool works by creating a map along with "directions" that end users can use to navigate urban areas. Some of the tool's features include:

- Validated models of radiation transport and detection algorithms
- Efficient search patterns
- Ability to increase probability of detection if given a set period of time for search
- Building data that can cause false alarms
- Current traffic patterns and driving data
- Prior radiation background measurements
- Modification of threat specifications and available detection assets

The model combines these features to guide a more efficient search or increase confidence in the absence of a RN device in an urban area.

The OPTUS project began in April 2014 and is a collaboration between Lawrence Livermore, Lawrence Berkeley, and Oak Ridge National Laboratories along with the Remote Sensing Laboratory at Andrews Air Force Base.

COUNTRY PROFILE: ARGENTINA

HEU Free and Continuing to Lead

A significant milestone in nuclear security was achieved last year as a result of cooperation between the United States of America and Argentina. At the 2016 Nuclear Security Summit, Argentina announced the completion of a key Summit deliverable: the successful down-blending and disposition of its remaining highly enriched uranium (HEU), a goal on which the United States and Argentina jointly collaborated for many years. Upon successful completion of the down-blending, Argentina became the final country in South America to dispose of its HEU, making the entire continent free of HEU.

Over the course of many years of partnership between the U.S. Department of Energy's National Nuclear Security Administration (DOE/NNSA) and Argentina's National Atomic Energy Commission (CNEA), more than 40 kilograms of HEU were removed from Argentina. This left approximately four kilograms of HEU that could not return to the United States due to its form and composition. As a result, DOE/NNSA's Office of Material Management and Minimization (M^3), CNEA, the Y-12 National Security Complex, and Savannah River National Laboratory cooperated to down-blend Argentina's remaining HEU in-country. Despite technical and regulatory challenges, CNEA remained committed to down-blending its remaining HEU, and both sides collaborated extensively to find creative solutions.

Argentina was the first country in South America to use nuclear power, and today has three operating nuclear power plants with another under construction. Argentina also has five operational low-enriched uranium (LEU) research reactors, two of which were converted from HEU fuel to LEU fuel with U.S. support (in 1987 and 2008).

Argentina is a regional producer of molybdenum-99 (Mo-99). It uses LEU in the production of this important medical isotope. In fact, it was Argentina's conversion to using LEU for Mo-99 production in 2002 that helped move the country closer to eliminating HEU.

DNN has a long history of bilateral cooperation with the Republic of Argentina. In addition to CNEA, other partners include the Nuclear Regulatory Authority (ARN), Argentina's customs agency, and the Ministries of Foreign Affairs and Energy and Mining (MEM).

Nuclear and Radiological Security Cooperation

In 2015, the Argentine government established MEM, our newest organizational partner. MEM defines, organizes, coordinates, and streamlines all government activities related to energy, including nuclear and radiological security.

In October 2016, DNN and MEM signed a Memorandum of Understanding (MOU) that complements existing NNSA cooperation with Argentina and

Argentina's Nuclear History in Brief

- **1957** — Joined the International Atomic Energy Agency (IAEA)
- **1974** — First commercial power reactor began operating
- **1992** — Joined the Australia Group
- **1993** — Joined the Missile Technology Control Regime
- **1994** — Joined the Nuclear Suppliers Group
- **1995** — Acceded to the Nuclear Non-Proliferation Treaty as a non-nuclear weapons state
- **2008** — Converted last research reactor to use low-enriched uranium
- **2016** — Became free of highly enriched uranium

Country Profile: Argentina – *Continued*

facilitates further collaboration on nuclear and radiological security and nuclear forensics. Additionally, it allows for advanced discussions on the requirements, design, and development of a nuclear security support center, currently focused on training protective force personnel. MEM and DNN already have begun these efforts by conducting a training needs analysis.

Earlier this year, the two organizations partnered to conduct a nuclear forensics workshop, the first formal collaboration between the United States and Argentina on the subject. Additional activities conducted to date include protective force trainings and nuclear security culture workshops. Most recently, the sides met on the margins of the meeting of the U.S.-Argentina Joint Standing Committee on Energy Cooperation in August 2017 at Lawrence Livermore National Laboratory to take stock of the cooperation so far and plan for future collaboration.

Additionally, pilot site physical protection assessments and upgrades at civil sites with International Atomic Energy Agency (IAEA) Category 1 radioactive materials are scheduled to begin in early FY 2018. This will be coupled with material theft response training for Argentine law enforcement agencies and site security inspections training for ARN. In May 2017, DNN held a transportation security course for nuclear and radiological materials for representatives of ARN, CNEA, customs, federal law enforcement, the coast guard, and airport security.

In addition to the MOU and cooperation with MEM, DNN continues to collaborate with ARN. In May 2017, DNN held a transportation security course for nuclear and radiological materials for representatives of ARN, CNEA, customs, federal law enforcement, the coast guard, and airport security.

Export Control Cooperation

DNN's Office of Nonproliferation and Arms Control (NPAC), in cooperation with the U.S. Department of State's Export Control and Related Border Security Program (EXBS), has worked with the Government of Argentina for more than a decade, including longstanding collaboration on NPAC's Commodity Identification Training (CIT) Program. Formed in 2007, Argentina's CIT Working Group (Capacitación para la Identificación de Mercaderías Estratégicas Sujetas a Control, Spanish acronym CIME) represents 12 governmental agencies and serves as an instructor cadre for Argentine and regional CIT outreach, including cooperation with Chile and Peru.

NPAC's future collaborations will include export control technical exchanges in Argentina and across the region to share best practices on licensing, enterprise outreach, and enforcement implementation.

Nuclear Safeguards Engagement

In the area of nuclear safeguards, NPAC sponsored a workshop last year with ARN to consider technology approaches for containment and surveillance during and after the transfer of spent fuel from pools inside a facility to new dry storage silos. Representatives from ARN, the facility operators, the dry storage facility designer, and the Brazil-Argentina Agency for Nuclear Accounting and Control (ABACC) participated. The outcome was a list of technologies that could be considered for use during each phase of the spent fuel transfer.

A nuclear forensics workshop held in Argentina earlier this year is among the collaborative activities made possible through an MOU between DNN and Argentina's newly established Ministry of Energy and Mining (MEM).

In addition, NPAC has worked with ABACC for several years to develop software that can be used with the IAEA's neutron counter at Argentina's Atucha 1 power reactor spent fuel pools. In October 2016, NPAC worked with ABACC, the IAEA, ARN, and the facility operators to field test the software, which is planned for transfer to ABACC next year.

FAQs: Bilateral Physical Protection Visits

Nuclear technology has numerous beneficial uses, including in research, medicine, and commercial enterprises. If an international partner requests nuclear material from the United States to support its peaceful activities, the United States is legally required to determine that adequate physical security measures will be maintained for the nuclear material. The United States assesses whether physical security requirements are met by conducting periodic government-to-government consultations and physical protection visits to sites that hold, or are requesting to receive, U.S.-obligated nuclear material.

What provides the legal basis for the visits?

Section 123 of the 1954 Atomic Energy Act, as amended, requires that the United States ensure all U.S.-obligated nuclear material provided under an Agreement for Peaceful Nuclear Cooperation between the United States and a foreign partner (also called a "123 Agreement") has adequate physical protection. In addition, Nuclear Regulatory Commission (NRC) export regulations require that license reviews include NRC determinations on whether physical protection measures in recipient countries provide protection at least comparable to International Atomic Energy Agency (IAEA) recommendations outlined in the publication Information Circular 225/Revision 5 (INFCIRC/225/Rev.5).

What is meant by U.S.-obligated nuclear material?

"U.S.-obligated" refers to nuclear material that is located in another country and subject to a 123 Agreement. Obligations (sometimes referred to as "flags") are the terms and conditions that are applied by the supplying government to nuclear material when it is transferred. Obligations that are placed on nuclear material transferred by the United States often include that:

- the recipient will
  - use the material only for peaceful purposes;
  - provide adequate physical protection; and
  - apply IAEA or fallback safeguards, as appropriate;
- the recipient may not conduct the following without United States consent:
  - retransfers;
  - enrichment to and beyond 20%; and
  - alteration in form or content of nuclear material (e.g., reprocessing).

What is the purpose of physical protection visits?

The goals of the visits are to exchange information on good practices for physical protection and discuss the physical security measures for U.S.-obligated material to ensure that it is protected against potential theft and sabotage. If necessary, the team will recommend security enhancements that a foreign facility should consider implementing.

How does the U.S. Government define "adequate" physical security measures?

Physical security measures are deemed adequate if they provide a level of protection at least comparable to the current version of IAEA recommendations outlined in INFCIRC/225.

What is DNN's role?

Staff in DNN's Office of Nonproliferation and Arms Control (NPAC) lead the U.S. interagency team that conducts physical protection assessment visits. The mission of the U.S. team is to make and document a consensus decision regarding the adequacy of the physical security measures for U.S.-obligated nuclear material in a host country, based on a visit to that country and its relevant nuclear facilities, and considering all available information.

What other agencies participate in the visits?

The NRC, Department of State, and the Department of Defense's Defense Threat Reduction Agency all send representatives. Experts from DOE National Laboratories also are critical contributors to the teams.

How many visits are conducted each year?

NPAC conducts at least six site visits per year. Since 1974, the U.S. Government has conducted nearly 200 visits.

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