

## The U.S. DOE-EM International Program – 17411

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### ABSTRACT

The U.S. Department of Energy (DOE) Office of Environmental Management (EM) has a mission to complete the safe clean-up of the environmental legacy resulting from six decades of weapons production and energy research. This effort is recognized as one of the largest and most diverse and technically complex environmental clean-up operations in the world. The overall strategy to address this challenge includes several components, one of which involves leveraging the expertise within the International community, when applicable. The opportunities related to international collaborations are an important component of the DOE EM strategy for the clean-up mission, providing excellent forums for EM to stay beneficially engaged with the international community and our global partners. EM has been supporting the clean-up mission of the Department through international collaborations for almost 20 years.

The EM International Program is sponsored by the DOE EM Office of the Chief of Staff (EM\_2.1), which directly supports the DOE-EM Office of Assistant Secretary (EM-1), in coordination with the entire EM organization. The primary objective of the EM International Program is to provide benefit to the Department in successful completion of the EM clean-up mission, through establishing strategic approaches for specific international collaboration initiatives that are focused on appropriate strategic program goals. The EM International Program strategy to support the EM mission includes many facets, but they can generally be grouped into two primary areas. First, the EM International Program maintains, establishes, and/or participates in international agreements such that appropriate mechanisms are available for conducting international collaborations with foreign government organizations, educational institutions and private industry to leverage resources and link international experience and expertise, in support of the EM mission and compliant with US foreign policy. Second, through coordination with the EM Office of Technology Development (EM-3.2), the EM International Program leverages these agreements to identify mutually beneficial opportunities to evaluate, test, and adapt technologies, capabilities, and expertise for application to EM mission needs. These activities directly support goals within the current DOE Strategic Plan 2014 – 2018, issued in April 2014.

Working with the Office of Technology Development, the EM International Program is developing a process for identifying and selecting collaborative international technology projects for Fiscal Year 2017 (FY17) that have high potential impact to

the EM mission. The technical scope of these activities is expected to span the entire EM mission, including tank waste and nuclear materials management; groundwater and soil remediation; deactivation and decommissioning; and radioactive waste disposal operations. Depending on budget availability, these collaborative activities are expected to be awarded by mid-FY17.

## **INTRODUCTION**

The mission of the DOE-EM Program, which is captured in *Goal 3, Strategic Objective 8* of the DOE Strategic Plan [1], is to complete the safe clean-up of radioactive and chemical waste resulting from the Manhattan Project and Cold War activities. As described in the DOE Strategic Plan, to accomplish this mission, the Department will leverage past experience, applying best practices and lessons learned; identify, develop, and deploy practical technological solutions derived from scientific research at the national laboratories; and look for innovative and sustainable practices that make clean-up more efficient. An important strategy that EM deploys to seek such innovative solutions is through a domestic and international network with other federal agencies, national laboratories, academia, foreign government agencies and institutions, and industry to collaboratively develop and deploy scientific and technological solutions in support of mission needs.

The EM International Program provides an important and complementary function within the overall EM program. In conjunction with EM senior management and Program Offices, we develop and implement strategies for effective interactions with the international community that are focused on areas related to the EM mission. Through these interactions, the EM International Program contributes to successfully completing the challenging clean-up mission, while ensuring compliance with U.S. policy. To that end, EM has been supporting the cleanup mission of the Department through international collaborations for almost 20 years.

## **MISSION**

The mission of the EM International Program is to provide benefit to the Department in successful completion of the EM clean-up mission, through establishing strategic approaches for specific international collaboration initiatives that are focused on applicable strategic program goals, and aligned with U.S. foreign policy.

## **VISION**

The vision of the EM International Program is to be an integral component of the overall DOE and EM strategies for mission success through leveraging international capabilities and expertise that offer benefit and assistance in addressing the challenges of the EM clean-up program.

## CHALLENGES AND OPPORTUNITIES

The challenges related to environmental clean-up resulting from nuclear energy and weapons production activities are not unique to the U.S. Common issues and challenges have been identified by many countries.

For example, safe and more cost-effective methods for processing and immobilization of radioactive waste continue to be areas of primary investment throughout the world. Whether dealing with high level waste (HLW), or spent nuclear fuel (SNF), processing and packaging of these materials for long term storage and eventual disposal represents significant technical challenges. Although processing systems are in operation, or under construction, in the U.S, France, Russia, Korea, Japan, and other countries, improvements to existing processes and/or new approaches are continually being sought with the intent of providing more cost-effective strategies. Additionally, better understanding of the long-term performance of the waste forms and packages produced by these processes are pursued to ensure that the systems implemented result in safe environmental conditions for future generations.

Similarly, many countries are actively investigating and/or developing geologic repositories for final disposition of the HLW and SNF inventories. As the global understanding of the environmental risk associated with these materials has grown, the international community has recognized that this issue is not specific to a given country or region, but rather a world challenge. As a result, there is an increasing interest and global influence in establishing and implementing international standards related to waste form/package, configuration, and overall system performance for disposition of these more challenging inventories. Due to the fact that nuclear power generation is growing throughout the world, ensuring safe, cost-effective, and reliable disposition of the resulting HLW and/or SNF is becoming increasingly important.

The U.S. also faces significant challenges in developing and deploying cost-effective technologies and strategies for conducting large scale environmental remediation (e.g., natural and modified natural attenuation techniques), for both surface and subsurface applications. A major area of emphasis is to develop a better understanding of the fate (i.e., complexation, biogeochemistry effects, etc.) and transport (i.e., rates, mechanisms, etc.) of key contaminants, such as carbon-14 ( $^{14}\text{C}$ ), technetium-99 ( $^{99}\text{Tc}$ ), and iodine-129 ( $^{129}\text{I}$ ). Developing a more comprehensive understanding of these characteristics will provide the technical bases for developing validated predictive modeling capabilities to support establishing more risk-informed alternatives to site closure and long term monitoring. Many others within the International community are addressing similar issues for their large environmental remediation projects.

Addressing the DOE clean-up challenges in a timely and cost-effective manner will require innovative and transformational technologies. Engagement with the international community is effective in providing exposure to global technological advances in areas related to the EM mission. Accordingly, EM must be positioned to

leverage existing agreements and other vehicles, or establish new ones where they do not exist, to enable effective international collaborative activities that support the EM mission. Additionally, these agreements must be structured such that they provide mutually beneficial exchanges, while compliant with U.S. foreign policy, and supportive of DOE energy and environmental policies.

As previously stated, much of the International community is facing similar challenges as the U.S. related to their environmental clean-up programs. With the recognized environmental impacts of global climate change, coupled with a struggling global economy, the importance and benefit of ongoing communication and technical exchange by the U.S. with the international community is essential to success in addressing the EM clean-up challenges. The EM International Program provides an effective framework for organizing and conducting this important dialogue, through the strategic objectives described later in this paper.

Opportunities to leverage key capabilities and expertise related to environmental clean-up have been continually and successfully exercised. Throughout the past two decades, EM has collaborated with numerous International partners in a variety of functional areas, including:

- Radioactive waste treatment, immobilization, and long term waste form performance;
- Management and disposition of plutonium, as well as other excess nuclear materials and challenging radioactive materials;
- Geologic disposal requirements, configurations, and geochemistry effects;
- Environmental remediation, fate and transport modeling and predictions, natural attenuation, and other environmental technologies and techniques;
- Deactivation and Decommissioning (D&D) technologies, including innovative decontamination characterization/assay techniques; and
- Other areas of similar challenges and interest related to management of complex clean-up-related projects.

These interactions have helped to establish a strong international network, in which EM is a recognized leader, and that will be essential in supporting current and future collaborations. While significant collaboration has been ongoing, we also recognize that technology development and deployment efforts within the international community have proceeded independently, and often there are innovative technologies, new approaches, and key lessons-learned that are applicable to U.S. challenges.

Through our international exchanges and participation, the EM program continually learns of potential solutions that are deployed or being investigated by other countries that may offer benefit to the EM clean-up mission. Recent examples from our United Kingdom partners include an innovative non-thermal destruction technology for treating radioactive organic waste streams and a 3-D sonar based technology that can map heel materials and obstructions in underground storage tanks. The EM International Program provides the opportunity to develop and/or maintain effective working relationships. Effective coordination and communication

with the appropriate EM Program Offices will position EM to leverage the global capabilities and expertise that are applicable to the EM clean-up challenges.

The EM International Program is positioned to recognize the appropriate international agreements and other alliances (i.e., Memorandums of Understanding, Statements of Intent, etc.) that have been established, or when new agreements are appropriate, while ensuring compliance with the DOE strategy and U.S. foreign policy. In this role, the EM International Program is a recognized element in an integrated EM strategy for completing the clean-up mission, providing the expertise in U.S. policy and knowledge-base to leverage or establish appropriate vehicles for international collaborations, as necessary.

## **INTERNATIONAL PROGRAM STRATEGIC OBJECTIVES**

The underlying principle of the EM International Program strategy is that all actions and engagements are aligned with U.S. policy and the DOE mission in supporting the successful completion of the EM clean-up program. Thus, all strategies and activities in which the EM International Program is engaged must establish and maintain an efficient framework for leveraging international opportunities to address the identified clean-up challenges, while providing clear organizational communications related to ongoing and planned strategic actions. The following strategic objectives, as described in the EM International Program 2015 – 2019 Strategic Plan [2], are founded on this principle and are focused to address the identified challenges and opportunities, as appropriate.

Strategic Objective 1: Ensure that collaborative projects and activities conducted under the auspices of the EM International Program are aligned with the priority need areas identified by the mission-specific program offices within EM, and appropriately augment technology projects conducted within the respective base programs.

Strategic Objective 2: Ensure that the EM organization is engaged with and well-represented to other DOE Program Offices, as appropriate, to support U.S. policy and the overall DOE strategy related to the EM mission.

Strategic Objective 3: Ensure that the EM organization is engaged with and well-represented to key federal agencies to support U.S. policy and the overall DOE strategy related to the EM mission.

Strategic Objective 4: Ensure that the EM organization, to include the mission-specific program offices within EM, is engaged with and well-represented on appropriate International organizations, committees, conferences, and partnering countries that can provide benefit to the EM mission.

Strategic Objective 5: Ensure that appropriate agreements, statements of intent, memoranda of understanding, and other alliances are maintained and/or established, as appropriate, and in accordance with U.S. policies, to maintain an effective network for international collaboration.

Specific performance goals, which are documented in the EM International Program Strategic Plan, have also been established to support achieving these important objectives.

## **MOVING FORWARD – INTERNATIONAL PROGRAM STRATEGIC ACTIONS**

The EM International Program performs several key strategic actions aimed at achieving the Strategic Objectives, which also support DOE policies on energy and the environment, as described in the DOE Strategic Plan, as well as U.S. foreign policy. We employ a multi-faceted approach to ensure that EM is actively engaged with and well represented throughout the International community for matters related to environmental cleanup. Key components include having visible and effective representation through the following activities:

- Establishing collaborative technology projects with International partners;
- Engaging with other DOE program offices;
- Engaging with other U.S. agencies and programs;
- Participating in multinational forums and agencies;
- Exercising and/or establishing collaborative international agreements; and
- Participating in key International conferences.

### **Establishing Collaborative Projects With International Partners**

In May 2014, the Secretary of Energy chartered the Secretary of Energy Advisory Board (SEAB) Task Force on Technology Development for EM. In the *Report of the Task Force on Technology Development for Environmental Management* [3], the SEAB Task Force identified a framework for identifying and prioritizing technology development for the EM program. Three strategic elements were recommended:

1. *An incremental technology development program* focused on improving the efficiency and effectiveness of existing cleanup processes.
2. *A high-impact technology development program* that pursues technologies that are outside the day-to-day program, that targets big challenges, and that hold the promise of breakthrough improvements.
3. *A fundamental research program* focused on developing new knowledge and capabilities that bear on the EM challenges, and are tailored to the EM mission.

The EM International Program works through the Office of Chief of Staff to leverage the entire EM organization to identify and select technical collaboration projects that are aligned with the SEAB recommended framework, and address the high priority technical challenges facing the EM mission and/or areas that offer potential significant improvement to baseline approaches. In this role, the EM International Program coordinates with the various EM program offices, leveraging existing opportunities that are aligned with US policy and the DOE mission, such that we can effectively engage counterparts from foreign governments, agencies, and organizations to:

- Identify areas of applicable technical expertise/technologies that are aligned with EM mission needs;

- Identify areas of mutual interest and benefit related to best management practices;
- Identify areas of mutual interest/opportunities within other DOE Program Offices for international collaborations; and
- Identify beneficial technical exchanges, workshops, conferences, committees, etc. in which to engage/support/participate.

Through the EM International Program, resources are provided, within the constraints of available funding, to support high priority collaborative projects and activities that have potential for significant benefit to the EM mission. Key technical program areas include:

- Tank waste (TW) and nuclear materials (NM) management and disposition;
- Soils and Groundwater (S&GW) remediation;
- Decontamination and Decommissioning (D&D) technologies, and
- Radioactive waste disposal (DISP) operations.

New opportunities continue to be identified for collaborations that represent important and effective international engagements.

*Existing and/or recent collaborative International partners* - EM has been working collaboratively with foreign governments, institutions, and universities throughout the past 20 years in a wide range of areas related to the EM mission. The technical focus and priorities continue to evolve as challenges are resolved and new challenges related to the EM mission, as well as global needs, are identified. Annually, around mid-fiscal year (FY), the International Program awards multiple collaborative projects for work scope spanning waste management, tank waste management, groundwater and soil remediation, D&D, disposal operations, and nuclear materials disposition initiatives. In FY2016, twelve collaborative projects were awarded that involve twelve different foreign organizations representing six countries in both the northern and southern hemispheres. These projects, which include both technical and non-technical activities, have opportunities for continuation into the next FY and beyond. The EM International Program is working with the Office of Technology Development (EM-3.2) to develop the process for soliciting and selecting the most beneficial projects for FY2017, which may be continuations of ongoing projects or new collaborations. Highlights of recent and ongoing collaborations in key technical areas are shown in Table I.

**TABLE I.** Recent and Ongoing Collaborations with International Partners

<b>AREA</b>	<b>TITLE</b>	<b>COUNTRY</b>	<b>FOREIGN ORG.</b>	<b>US ORGs.</b>
DISP	Performance prediction and accelerated aging evaluation of cementitious seals for borehole disposal of disused sealed radioactive cesium sources	Brazil.	Instituto de Pesquisas Energeticas e Nucleares (IPEN), Comissao Nacional de Energia Nuclear (CNEN)	SRNL
DISP	Swiss Cement-Encapsulated Solid Low-Level Waste Technology Collaboration	Switzerland	EPFL (École Polytechnique Fédérale de Lausanne)	PNNL
DISP	Treatment of Problematic/Orphan Wastes Using a Novel Technology from the UK	U.K.	Arvia Technology	NVE, MCL
S&GW	<sup>14</sup> C and <sup>99</sup> Tc Attenuation Based Strategies for Remediation and Waste Disposal Systems	U.K.	National Nuclear Laboratory	SRNL
S&GW	Technical Support and Collaboration on Fukushima Cleanup	Japan	Ministry of Education, Culture, Sports, Science and Technology (MEXT)	SRNL
TW	Correlating the Aging and Durability of Ancient Hillfort Glasses to the Predicted Long-Term Performance of Vitrified Waste	Sweden	Luleå University of Technology	PNNL
TW	Field Demonstration of Novel UK 3D SONAR Technology for Surveying and Mapping of Tank Sludges at Savannah River and Hanford	U.K.	FORTIS	NVE
TW	Test Bed demonstration of UK Snake Arm Robot Technology for Calcine Retrieval	U.K.	OC Robotics	NVE



AREA	TITLE	COUNTRY	FOREIGN ORG.	US ORGS.
TW	Glass leaching assessment for disposability: ILAW Durability and leaching test development	U.K.	Sheffield University	Vanderbilt University, PNNL
TW	In-Situ Three-Dimensional Mapping of Cold Cap Utilizing X-Ray Computed Tomography	Japan	Tokyo Institute of Technology	PNNL, INL
TW	In-Situ Monitoring of Cold Cap and Melts Utilizing X-Ray Computed Tomography and Ultrasound for Research and Development and Vitrification Facility Process Control	Japan	Tokyo Institute of Technology	PNNL
TW	Advance Decontamination of Radioactive Liquids Demonstration	Italy	WOW Technology SPA	White Technology Solutions, SRNL

### Engaging With DOE Program Offices

First and foremost, as a direct support function to the EM mission, the EM International Program supports the strategic goals and objectives of the Department within the International arena, by ensuring that EM Senior Management is informed, prepared, and well-represented during all international interactions. Through coordination with EM Senior Management, the EM International Program also engages with the Office of the Secretary of Energy, as well as the Office of the Deputy Secretary of Energy, to ensure that they are accurately informed and well-prepared regarding ongoing or future collaboration opportunities within the EM mission during their respective International activities.

Additionally, the EM International Program maintains close engagement with other DOE Program Offices that are responsible for missions that interface with EM's clean-up mission. This provides opportunities to leverage existing international programs and avoid duplication of efforts, thus enhancing EM's return on investment. The EM International Program coordinates with the senior management of these DOE Program Offices to ensure that they are accurately informed and well-prepared regarding the EM mission and areas that are germane to their respective international interactions. These preparations may include briefing materials, country papers, information regarding ongoing collaborations, etc., as appropriate. The following describes the current strategic actions with these key DOE Program Offices.

*National Nuclear Security Administration (NNSA)* [4] - Established by Congress in 2000, NNSA is a semi-autonomous agency within the U.S. DOE responsible for the

management and security of the nation's nuclear weapons, nuclear non-proliferation, and naval reactor programs. It also responds to nuclear and radiological emergencies in the United States and abroad. Additionally, NNSA federal agents provide safe and secure transportation of nuclear weapons and components and special nuclear materials along with other missions supporting the national security.

The NNSA and EM missions coincide in the areas of nonproliferation, particularly related to management and disposition of nuclear materials (e.g., plutonium), as well as environmental and waste management challenges associated with peaceful uses of nuclear technologies. A key area of strategic collaboration with NNSA is on the Joint Coordinating Committee under the U.S. – China Peaceful Uses for Nuclear Technology (PUNT) Agreement. This agreement, entered into in 1998, is a formal government-to-government mechanism established to support the civilian development of nuclear energy in both countries while addressing nuclear security, safety and proliferation risks. It identifies several areas of potential collaboration and technical exchange that are aligned with the EM mission, including radioactive and chemical waste management, spent fuel management, environmental remediation, and reactor facility D&D. Through coordination by the EM International Program, EM co-chairs the PUNT Working Group III: Environment and Waste Management with NNSA.

As part of the global interactions related to U.S. foreign and energy policies, the DOE provides workforce resources to support the Department's mission and strategic plan objectives and requirements in overseas assignments. The NNSA serves as the Executive Secretariat for the Overseas Presence Advisory Board (OPAB), which manages and coordinates the activities of the Department's overseas staff. Interaction with the OPAB is important to successful and effective communications and interactions with our International partners and other countries in which alliances are being established. The EM International Program represents EM on the OPAB, as well as its Working Capital Fund Working Group, to ensure that EM is well-represented and that the areas of interest to the EM mission are included in the OPAB planning and focus, as appropriate. As necessary, the EM International Program will work with OPAB in development of International Agreements that include areas of EM interest and equities (e.g., Japan).

*Office of Nuclear Energy (NE) [5]* - The primary mission of NE is to advance nuclear power as a resource capable of making major contributions in meeting our Nation's energy supply, environmental, and energy security needs. NE seeks to resolve technical, cost, safety, security and regulatory issues through research, development and demonstration. By focusing on the development of advanced nuclear technologies, NE supports the Administration's goals of providing domestic sources of secure energy, reducing greenhouse gases, and enhancing national security.

NE serves present and future U.S. energy needs by developing critical technologies for the future and helping to train tomorrow's workforce. The benefits of nuclear power as a safe, carbon-free, reliable and secure source of energy make it an

essential element in our Nation's energy and environmental future. A major area of interest related to sustainable nuclear energy is related to management and disposition of SNF, including legacy, newly generated, and future inventories. This is a key area of collaboration between EM, NE, and the international community.

Another key interaction between EM and NE is related to the International Framework for Nuclear Energy Cooperation (IFNEC). IFNEC was established at a meeting held in Accra, Ghana during June, 2010, at which the Partner countries of the Global Nuclear Energy Partnership (GNEP) formally agreed to transform the partnership to IFNEC and adopt a new Statement of Mission. IFNEC rotates the location of its meetings amongst the IFNEC countries. Among other things, it provides an opportunity for IFNEC countries to appreciate first-hand the vital role energy plays throughout the world and how nuclear energy is being used or considered. IFNEC consists of 63 countries and three international organizations representing every major geographical area globally and every major stage of economic and technical stage of development. It provides a forum for cooperation among participating states to explore mutually beneficial approaches to ensure that the use of nuclear energy for peaceful purposes proceeds in a manner that is efficient and meets the highest standards of safety, security and non-proliferation. Although the focus is on commercial nuclear power, the activities related to the back end of the fuel cycle, which includes R&D activities on advanced waste forms, SNF management, and processing technologies, are of particular interest to EM. Because of this, EM participates as an observer during the IFNEC expert meetings.

*Office of Science (SC)* [6] - SC is the single largest supporter of basic research in the physical sciences in the U.S., providing more than 40 percent of total funding for this vital area of national importance. It oversees – and is the principal federal funding agency of – the Nation's research programs in high-energy physics, nuclear physics, and fusion energy sciences. It also manages 10 world-class laboratories, which often are called the "crown jewels" of our national research infrastructure. The national laboratory system, created over a half-century ago, is the most comprehensive research system of its kind in the world.

In support of its mission, SC also oversees the construction and operation of some of the Nation's most advanced research and development (R&D) user facilities, located at national laboratories and universities. These include particle and nuclear physics accelerators, synchrotron light sources, neutron scattering facilities, supercomputers and high-speed computer networks.

EM actively taps into some of these unique resources and leverages ongoing R&D within SC to augment its technology development program, which also includes international collaborators. A prime example of ongoing leveraging is development of EM's Advanced Simulation Capability for Environmental Management (ASCEM). ASCEM is an integrated, modular, open-source toolset for advanced modeling and simulation that reduces uncertainties and risks associated with environmental remediation and closure programs. The high-speed and supercomputing platforms and expertise within SC will be key to validating algorithms and processing the data for predicting far-field fate and transport characteristics over geologic time periods.

Another example includes coordination on potentially transformational waste processing/remediation technologies.

Another key area of collaboration, which involves EM, NE, and SC, as well as the International community, is focused on investigation of the long-term performance of glass, as related to immobilization of HLW. Basic materials science research is needed to develop a more comprehensive understanding of the effects of the hydrogeological characteristics of specific subsurface environments and conditions on the chemical reactions and kinetics that occur as the glass interacts with its surroundings and degrades. This initiative will help develop an international consensus on the behavior and performance of glass waste forms over geological time periods. This will provide more representative predictive modeling for long term health and safety of the environment.

*Office of International Affairs (IA) [7]* - IA has the primary responsibility for coordinating the efforts of diverse elements in the Department to ensure a unified voice in our international energy policy. IA works closely with Departmental elements, other Federal agencies, national and international organizations and institutions, and the private sector to coordinate and align our international energy activities with our national energy policies. IA coordinates DOE international initiatives on clean energy, climate change, and technology exports.

As part of that role, IA negotiates and manages a variety of bilateral and multilateral agreements with other countries and international agencies for cooperation in R&D for energy, environmental, and technology cooperation. The EM International Program works with IA to leverage these various agreements and alliances, as appropriate, to support the EM mission through collaboration with International partners, in alignment with and support of U.S. energy policy. Through the EM International Program, multiple forums are supported to ensure that EM is well-represented in areas related to its mission. Examples of the EM International Program's involvement with IA include the following:

- Participating on the IA International Science & Technology (S&T) committee, providing technical expertise for review and scoring of S&T proposals;
- Representing EM in the Work for Others (WFO) program; and
- Serving as point-of-contact for the DOE Trade Coordination Strategy: Proposal to form a DOE Trade Coordination Committee.

### **Engaging With Other U.S. Federal Agencies And Programs**

The EM International Program also engages with other federal agencies and programs to foster EM involvement, as appropriate - prepare briefing materials, support EM involvement for specific international committees, working groups, programs, strategy meetings, etc.

EM will also strive to work with other U.S. agencies involved in energy, waste management, and other nuclear-related programs. By working closely with other government agencies, the International Program can be up to date on the latest policy and technological developments that have the potential to be leveraged to

address the time and high-cost of the clean-up mission. The following describes the current strategic actions with other key federal agencies and offices.

*Department of State (DOS)* [8] - The mission of the DOS is to “shape and sustain a peaceful, prosperous, just, and democratic world and foster conditions for stability and progress for the benefit of the American people and people everywhere”. A major component of that mission involves interaction with the international community on matters related to peaceful uses of nuclear technologies.

In recent years, the State Department activities on technical cooperation under the Joint Standing Committee on Nuclear Energy Cooperation (JSCNEC) and Joint Coordinating Meetings (JCM) on Science and Technology (S&T) have increased. The JSCNEC meeting includes a review of several joint projects between the United States and foreign nuclear research institutions. The JCM's focus more on science focused research. At these annual meetings, the DOE has been responsible for coordinating between the DOS, U.S. national laboratories, program offices, and other DOE participants and private entities, collecting updates on ongoing projects and identifying any new areas of collaboration. EM, NE, and NNSA also participate in DOS's organized JSCNECs and JCMs meetings held annually

Both the JSCNEC's and JCM's provide an important opportunity for the EM International Program to continue to broaden its understanding of environmental remediation and energy efforts in the international context. The meetings also enable senior EM personnel to share information and to gain lessons learned from environmental programs that are highly developed and assist in expanding the EM International Program. A number of countries with developed energy and environmental programs use the JSCNECs and JCMs as the formal bilateral cooperation channel between them and the United States where nuclear and science policy consultations, exchange of technical information, joint R&D activities, etc., transpire. Currently, EM participates in JSCNECs with Argentina and Korea, as well as the Joint Standing Committee on Civil Nuclear Cooperation with Taiwan.

The EM International Program also participates in the S&T Cooperation program within DOS, facilitating worldwide scientific exchanges, while providing protection of intellectual property rights. Other key roles that the EM International Program provides as part of the collaborative efforts with DOS include serving as EM's point-of-contact for requests for technical assistance by foreign governments as well as providing up-to-date information, communication, and engagement with DOE attachés in U.S. Embassies abroad in support of EM's international initiatives.

*White House* - The EM International Program engages with the White House in two key areas: the National Security Council (NSC) Civil Nuclear Team USA and the Office of Science and Technology Policy (OSTP) Fukushima Sharing Forum [9].

The NSC is the President's principal forum for considering national security and foreign policy matters with his senior national security advisors and cabinet officials. Since its inception under President Truman, the Council's function has been to advise and assist the President on national security and foreign policies.

The Council also serves as the President's principal arm for coordinating these policies among various government agencies. The EM International Program participates in the NSCs Civil Nuclear Team USA meetings, which provides a direct forum for information sharing related to global management and disposition strategies of disused nuclear facilities and materials.

Congress established the OSTP in 1976 with a broad mandate to advise the President and others within the Executive Office of the President on the effects of science and technology on domestic and international affairs. The 1976 Act also authorizes OSTP to lead interagency efforts to develop and implement sound science and technology policies and budgets, and to work with the private sector, state and local governments, the science and higher education communities, and other nations toward this end.

The mission of the OSTP includes the charge to provide the President and his senior staff with accurate, relevant, and timely scientific and technical advice on all matters of consequence. The primary example of this in which EM is engaged is the OSTP Fukushima Sharing Forum. Because of EM's joint leadership role with EPA on providing environmental remediation expertise to Japan related to the Fukushima accident, this is an ideal forum for EM to maintain and strengthen its global leadership in areas related to radioactive waste management, remediation, and disposition.

*Department of Commerce (DOC)* [10] - The DOC promotes job creation, economic growth, sustainable development and improved standards of living for all Americans by working in partnership with businesses, universities, communities and our nation's workers. The DOC's responsibilities involve multiple areas including trade, economic development, technology, entrepreneurship and business development, environmental stewardship, and statistical research and analysis. To drive U.S. competitiveness in the global marketplace, the DOC works to strengthen the international economic position of the U.S., facilitating global trade by opening up new markets for U.S. goods and services. The Commerce Department also provides effective management and monitoring of our nation's resources and assets to support both environmental and economic health.

The EM International Program is engaged with DOC in a variety of forums, providing the benefit of keeping apprised of available mechanisms and opportunities for international trade of technologies and expertise in areas related to the EM mission, and in compliance with U.S. export policy. As a result, the EM International Program provides the following functions:

- Representing EM at the Trade Promotion Coordinating Committee (TPCC);
- Participating on the Civil Nuclear Trade Working Group: Civil Nuclear Trade Policy Missions; and
- Participating on and contributing to the Environmental Trade Working Group (ETWG): Environmental Technologies Export Market Plans, Environmental Technologies "Top Export Prospects" Study.

## **Participating In Multinational Forums And Agencies**

The EM International Program provides benefit to the EM mission by promoting participation in multinational forums and agencies, such as the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA). We work with EM Senior Management and the various EM program offices to ensure that EM is well represented with these institutions, and participate in leadership roles, when feasible.

Establishing U.S. leadership world-wide through participation in these international organization forums positions EM to be cognizant of the most important ongoing international activities related to the EM mission, and the premier subject matter expertise in specific areas. These interactions allow EM to expand its role with multilateral international organizations in order to tap into the best science being used in the field. The following describes the current strategic actions with key multinational forums and agencies.

*International Atomic Energy Agency [11]* - Established in 1957 within the United Nations, and headquartered in Vienna, the IAEA is the world's center of cooperation in the nuclear field. The IAEA works with its 168 Member States, including the United States, and multiple partners world-wide, to promote safe, secure, and peaceful nuclear technologies.

EM's mission comprises disposition of radioactive waste and management of nuclear materials. Accordingly, the United States, along with 69 other countries/organizations, have pledged to support the objectives of the IAEA's Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) [11]. Opened for signature in September 1997 and entered into force in June 2001, the Joint Convention is the first legal instrument to directly address those issues on a global scale.

In May 2015, the fifth Review Meeting of Contracting Parties to the Joint Convention (JC) reaffirmed the importance of taking into account spent fuel and radioactive waste management from the very beginning of any nuclear activities. This was the first time that a U.S. representative was selected to serve as the president of the JC. While progress has been made, issues remain that EM may both aid in addressing and benefit from solving: (1) processing of legacy waste, (2) safety implications of longer storage of radioactive waste at the site of origin before disposition in a final repository, (3) the need for improved characterization and quality assurance of waste, and (4) assessment and demonstration of the safety of waste management activities and facilities. In addition, the need to establish a coherent policy for the disposal of all types of radioactive waste still remains. The JC is recognized as a key function within the IAEA. Membership in the JC was a key topic of the IAEA General Conference held in September 2016, with Director General Amano encouraging all Member States that have not done so to become Parties to the JC.

A recognized avenue for EM influence and benefit is participation in the IAEA “Network of Networks” established in September 2007 by the General Conference, the highest policymaking body of the IAEA composed of representatives of all Member States. Two established networks of interest to EM are the International Decommissioning Network (IDN) and the ENVIRONET for remediation of radiologically contaminated sites and remediation of soil and groundwater.

Among the activities of the networks, several offer clear opportunities for participation by EM as a “Member” organization (providing expertise and training capabilities) and for discovery by EM of innovative approaches to solving challenging remediation problems:

- Hosting of training courses, fellowships or scientific visits by Members;
- Providing suitably qualified and experienced individuals to support Participants (receive support from Members);
- Providing qualified peers for the Agency’s peer reviews and technical assistance;
- Providing expertise in the Agency’s program areas; and
- Supporting fellowships, exchanges, coaching and mentoring.

The EM International Program supports these areas by ensuring that EM is well represented and actively engaged, as appropriate. Specifically, the EM International Program serves as the primary point-of-contact for IAEA candidate nominations for participation in meetings related to the EM mission. Similarly, we participate in and provide the coordination for overall EM participation in the IAEA General Conference, identifying countries for bilateral meetings, preparing briefing materials, identifying any sensitivities, and providing input to the Secretary of Energy’s Statements and remarks that are germane to the EM mission.

*Nuclear Energy Agency (NEA)* [13] - The NEA is a specialized agency within the Organization for Economic Co-operation and Development (OECD), an intergovernmental organization of industrialized countries based in Paris, France. The mission of the NEA is to assist its member countries in maintaining and further developing, through international cooperation, the scientific, technological, and legal bases required for the safe, environmentally friendly, and economical use of nuclear energy for peaceful purposes.

The NEA consists of 31 countries, including the United States, in Europe, North America, and the Asia-Pacific regions. Together these nations represent approximately 90% of the world’s installed nuclear capacity. Nuclear power accounts for about one-fifth of the electricity produced in NEA member countries. The NEA works closely with the IAEA and with the European Commission in Brussels. Within the OECD, there is close coordination with the International Energy Agency and the Environment Directorate, as well as contacts with other directorates, as appropriate.

While EM’s mission is to clean up the legacy waste from nuclear weapons production rather than to develop nuclear energy for peaceful purposes, the interests of EM and of the NEA intersect in several areas, such as radiological



protection, public health, and nuclear science. The interests of EM and the NEA coincide particularly in radioactive waste management. The NEA seeks to assist its member countries in developing safe, sustainable, and societally acceptable strategies for the management of all types of radioactive materials, with particular emphasis on the management of long-lived waste and spent fuel, as well as decommissioning of disused nuclear facilities.

The EM mission could potentially benefit from the work of the NEA's Radioactive Waste Management Committee, which has the following objectives to:

- Foster a shared and broad-based understanding of the state of the art and emerging issues;
- Facilitate the elaboration of waste management strategies that respect societal requirements;
- Help to provide common bases to the national regulatory frameworks;
- Enable the management of radioactive waste and materials to benefit from progress of scientific and technical knowledge, e.g., through joint projects and specialist meetings;
- Contribute to knowledge consolidation and transfer, e.g., through the publication of technical reports, consensus statements and short flyers; and
- Help to advance best practices, e.g., by supporting international peer reviews.

Accordingly, the EM International Program functions as the point-of-contact for NEA candidate nominations for participation in meetings related to the EM mission, including participation on the Radioactive Waste Management Committee. This provides the necessary mechanism for effective collaboration in areas related to radioactive waste management with focus on UNF and HLW disposition.

Additionally, through the Committee's Working Party on Decommissioning and Dismantling (WPDD), EM remains engaged with and knowledgeable of the ongoing D&D practices and lessons-learned within the international community. The February 2016 annual meeting of the WPDD, titled the International Symposium on Preparation for Decommissioning, offered lessons-learned from around the world for participants related to all aspects of preparing for D&D, including characterization challenges and best practices, workforce transition issues, cost-effective waste management, and regulatory considerations.

### **Exercising And/Or Establishing International Collaborative Agreements And Other Alliances**

Agreements, Memorandums of Understanding (MOUs), Statements of Intent (SOIs) and other formal alliances constitute a comprehensive network that is necessary to establish collaborative projects, technical exchanges, and other interactions in support of developing effective international waste management strategies with international partners. The EM International Program applies expertise in identifying existing international agreements that are aligned with the scope of interest, such that efforts are not duplicated. However, where agreements do not exist, we will work with the appropriate Federal organizations, such as the State

Department and Department of Commerce, as well as other DOE Program Offices and/or Federal Agencies to modify existing or establish new agreements that support the scope, while in compliance with the DOE energy and environmental policies, as well as U.S. foreign policy. Table II provides a list of the current active agreements and other alliances between EM and our international partners.

**TABLE II.** Current Working Agreements, MOUs, SOIs, etc. between EM and International Partners

<b>COUNTRY</b>	<b>SIGNED DATE</b>	<b>TITLE</b>	<b>SIGNED BY</b>
China	1998	Agreement Between the Department of Energy of the United States of America and the State Development Planning Commission of the People's Republic of China on Cooperation Concerning Peaceful Uses of Nuclear Technologies (PUNT)	DOS and DOE
Hungary	2009	Memorandum of Understanding between the Department of Energy of the United States of America and the Public Agency for Radioactive Waste Management of the Republic of Hungary for Information Exchange Relating to Operation of Modular Vault Systems for Storage of Spent Nuclear Fuel	DOE EM
Germany	2011	Memorandum of Understanding between the Department of Energy of the United States of America and BUNDESMINISTERIUM FÜR WIRTSCHAFT UND TECHNOLOGIE for Cooperation in the Field of Geologic Disposal of Radioactive Waste	DOE NE and CBFO
Germany	2014	Statement of Intent between the Federal Ministry of Education and Research of the Federal Republic of Germany and the Ministry for Innovation, Science and Research of the State of North Rhine-Westphalia on behalf of the North Rhine-Westphalian State Government, the Department of Energy of the United State of America for the Proposed Use of Savannah River Site Facilities for Disposition of German Research Reactor Pebble Bed Fuel	DOE EM
France	2012	Memorandum of Understanding between the Department of Energy of the United States of America and the National Radioactive Waste Management Agency of France Concerning Cooperation in the Field of Radioactive Waste Management	DOE EM and NE

<b>COUNTRY</b>	<b>SIGNED DATE</b>	<b>TITLE</b>	<b>SIGNED BY</b>
United Kingdom	2007 (original SOI with UKNDA and DOE EM) 2012 (to include DOE NE) 2014 (to include UK's NNL)	Statement of Intent between the Department of Energy of the United States of America and the United Kingdom's Nuclear Decommissioning Authority for Exchange of Information concerning Management of Radioactive Waste	2007 DOE EM 2012 and 2014 DOE EM and NE 2014 DOE-EM and NE
United Kingdom	2014	Arrangement between the Office of Nuclear Regulation of Great Britain and the United States Department of Energy for the Exchange of Information and Co-operation in the Area of Nuclear Safety Matters	DOE EM
Russia	2012	Statement of Intent between the Department of Energy of the United States of America and the State Corporation for Atomic Energy "Rosatom" Concerning Collaboration in Innovative Technologies for Environmental Restoration and Radioactive Waste Management	DOE (Chu)
Canada <sup>1</sup>	2013	Statement of Intent between the United States Department of Energy and Atomic Energy of Canada Limited in the Field of Used Fuel and Radioactive Waste Management, Decommissioning and Environmental Restoration	DOE EM
Spain	2014	Memorandum of Understanding between the Department of Energy of the United States of America and the National Company of Radioactive Waste of Spain Concerning Cooperation in the Field of Used Nuclear Fuel and Radioactive Waste Management	DOE EM and NE

### Participating In Key International Conferences

The EM International Program participates with EM management in International Conferences that are aligned with U.S. policy and the overall DOE mission to both

<sup>1</sup> On November 3, 2014, AECL made the following announcement: "Atomic Energy of Canada Limited is advising you of an important milestone for Canada's premier nuclear science and technology organization. When business opened this morning, November 3, 2014 the experience, expertise and facilities you have long associated with Atomic Energy of Canada Limited (AECL) is now offered through a new organization – Canadian Nuclear Laboratories Limited (CNL), a wholly owned subsidiary of AECL." See related story at <http://www.world-nuclear-news.org/C-New-operator-for-AECL-laboratories-3110144.html>.

strengthen existing and foster new international relationships and partnerships. These International conferences provide the opportunity to promote the overall EM program to an international audience, at both programmatic and technology levels. Most importantly it allows EM to stay abreast of science and technology developments of other countries that may benefit the overall EM mission. International conferences allow the opportunity to obtain current technical information related to environmental technologies being developed and deployed in other countries, and to facilitate contact with potential subject matter experts that could assist EM in future technical reviews of environmental technologies. EM has been a supporter of various conferences at which EM management has been able to engage with international counterparts that have allowed the pursuit of research and development (R&D) collaboration. Important conferences that EM supports are the Waste Management Conference [14] held annually in Phoenix, Arizona and the American Society of Mechanical Engineers International Conference on Environmental Management and Radioactive Waste Management [15] held in various locations throughout Europe; as well as various topical meetings organized by the American Nuclear Society. The EM International Program in conjunction with the EM program offices will continue to identify key conferences focused on environmental remediation and radioactive waste management that allow EM to engage the technical skills and knowledge of foreign governments, industries, and universities to help identify transformational solutions that have the potential to assist with EM's clean-up mission.

## **CONCLUSION**

The EM International Program will continue to focus on identifying and leveraging international opportunities that can assist in reducing the cost and schedule of the EM cleanup mission; enhancing understanding of the processes related to environmental management; and accelerating and increasing innovative technology applications. This will be accomplished by enlisting international support and cooperation through participation in international organizations and developing and maintaining appropriate frameworks for bilateral and multilateral cooperation. Most importantly, the EM International Program will ensure the implementation of appropriate international agreements, providing an effective global network that can support completing the EM mission. Through the various strategic actions identified, the EM International Program will be positioned to identify and pursue global advances in technology that have the potential to reduce cost and optimize the efficiency of the Department's environmental cleanup responsibilities. Additionally, the EM International Program will be instrumental in obtaining and exchanging information on the global status of progress and policies in waste management. Finally, in its leadership role, the DOE EM can leverage these opportunities to assist other countries in adopting safe waste management and disposal practices that enhance international security, safety, and environmental integrity.

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