



U.S. DEPARTMENT OF
ENERGY

OFFICE OF
**ENVIRONMENTAL
MANAGEMENT**

The DOE-EM International Program

*Supporting the EM Clean-up Mission through Focused
International Collaborations*

April 2018

- The challenges related to clean-up resulting from nuclear energy and weapons production activities are *not* unique to the U.S.
- EM has made significant progress, but much is left to be done.
- Opportunities exist to leverage key capabilities and expertise in areas of similar interest with **international partners** to address/resolve EM issues.
- ***The EM International Program helps implement and maintain the framework to enable and support beneficial interactions.***

- Processing/immobilization of radioactive waste
- Packaging of HLW, SNF and other nuclear materials for long term storage/disposal
- Geologic repository development
- More effective D&D technologies
- Cost-effective, large-scale environmental remediation





OFFICE OF TECHNOLOGY INNOVATION & DEVELOPMENT

International Program Strategic Plan 2010 - 2015

JULY 2010



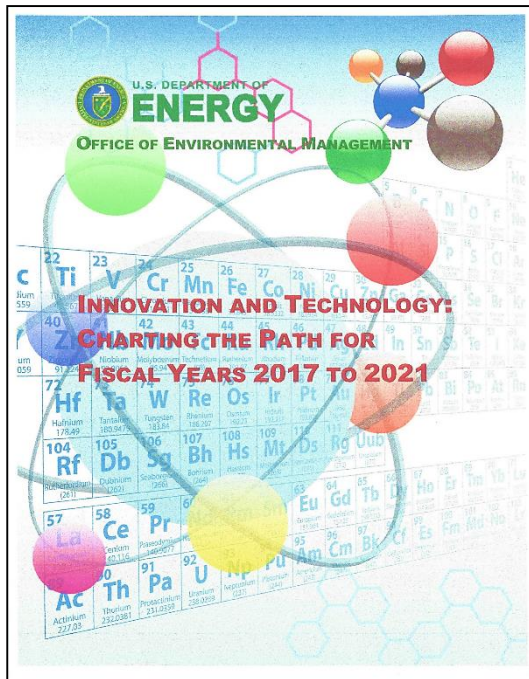
EM INTERNATIONAL PROGRAM

Strategic Plan *Moving Forward* 2015 - 2020

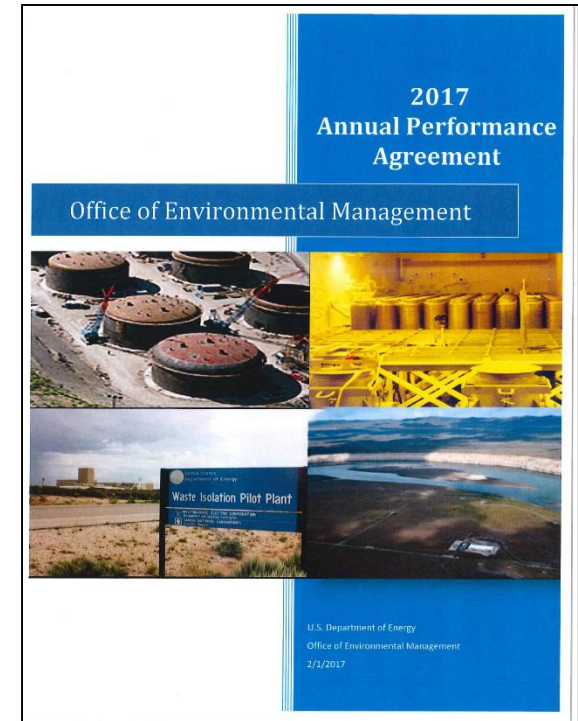
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- The EM International Program activities are conducted in accordance with an approved Strategic Plan.
- Specific initiatives are determined annually based on EM priorities and U.S. policy.
- In general, strategic activities fall within the following areas:
 - Establishing collaborative technology projects between with international partners.
 - Establishing appropriate international agreements to enable collaborations.
 - Engaging with DOE program offices and other U.S. agencies/programs.
 - Participating in multinational forums, agencies, and international conferences.

- The EM International Program works closely with EM senior management and EM site representatives to ensure activities are aligned with current mission needs and goals.



- Collaborative technology projects and key technical exchanges are coordinated through the Office of Technology Development (EM-3.2), with support from National Laboratories and U.S. industry, as appropriate.



- Collaborative Technology Projects span the EM mission areas and engage many collaborators.

- Historically, the EM International Program has awarded select technology projects annually.
- Generally about 12 projects – either new or continuation from the prior year – were awarded.
- Total budget has averaged about \$3M, with portions allocated to each participant, as described in the approved project plan.
- Projects are performed in collaboration with international entities and National Labs, as well as academia and U.S. industry.



1. Tank Waste Management and Disposition

- Innovative Immobilization Technologies.
- Novel Glass and Ceramic Waste Forms.
- Glass Product Qualification.
- Sludge Mapping in Tanks for Retrieval.



2. Soils and Groundwater Remediation

- Containment Fate and Transport Mechanisms.
- Mercury Remediation.
- Performance Assessment (PA) Modeling.



3. Decontamination and Decommissioning

- In Situ Decommissioning Techniques.
- Advanced Surface Decontamination Techniques.
- Graphite Reactor Decommissioning.



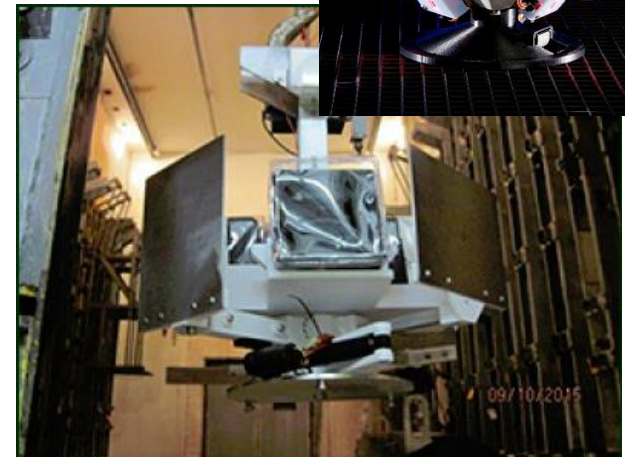
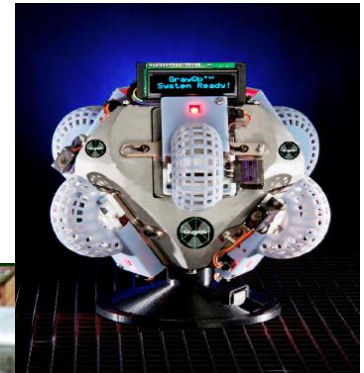
4. Nuclear Materials Management and Disposition

- Plutonium and SNF Management.
- SNF Retrieval.
- SNF and HLW Disposal Systems.
- SNF Processing and Packaging.



- GrayQb™ Radiation Mapping Device

- The GrayQb™ was developed by SRNL, but data from a broad variety of deployment conditions were needed.
- EM collaborated with the Canadian Nuclear Laboratory to demonstrate the device at the Chalk River Laboratories during 2015, in sub-zero temperatures.
- Data developed during that testing led to design improvements, paving the way for deployment for EM D&D activities.
- The GrayQb™ device was recently demonstrated at the Hanford Plutonium Reclamation Facility
- Additional GrayQb™ demonstrations planned: SRS Plutonium Experimental and Plutonium Fuel Form Facilities, D&D of the Portsmouth GDP cascades.

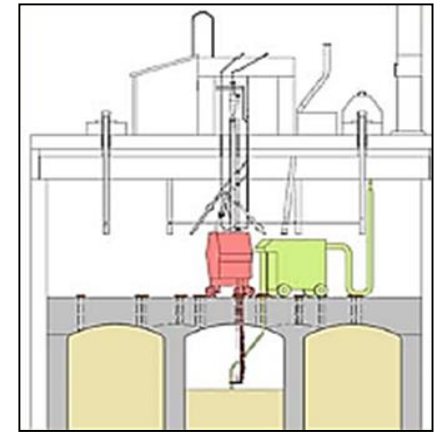


GrayQb™ hangs from a crane inside the Hanford Plutonium Reclamation Facility canyon (Reference *DOE EM Innovation and Technology: Charting the Path for Fiscal Years 2017 to 2021*)

- Robotic “Snake Arm” Demonstration
 - A UK-developed robot and laser system was demonstrated to effectively size reduce metallic and concrete objects in hazardous, confined spaces.
 - Leveraged UK technologies and EM robotics testbed at Portsmouth site to conduct the demonstration (bottom left photos).
 - The technology will allow for safer and more cost-effective targeted D&D.
- Potential additional application at Idaho Site (bottom right)
 - Retrieval of the HLW calcine stored in binsets
 - “Snake Arm” robot coupled with a retrieval head.



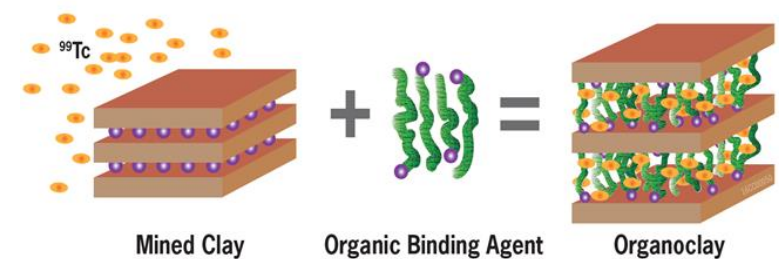
Reference: EM Website article, *EM*, *Contractors Collaborate of U.K. “Snake Arm” Robot Demonstration*, <https://www.energy.gov/em/articles/em-contractors-collaborate-uk-snake-arm-robot-demonstration>.



Conceptual design for Calcine Retrieval Snake Arm (Reference FY16 Factsheet *Demonstration of UK Snake Arm Robotic Technology for Calcine Retrieval*)

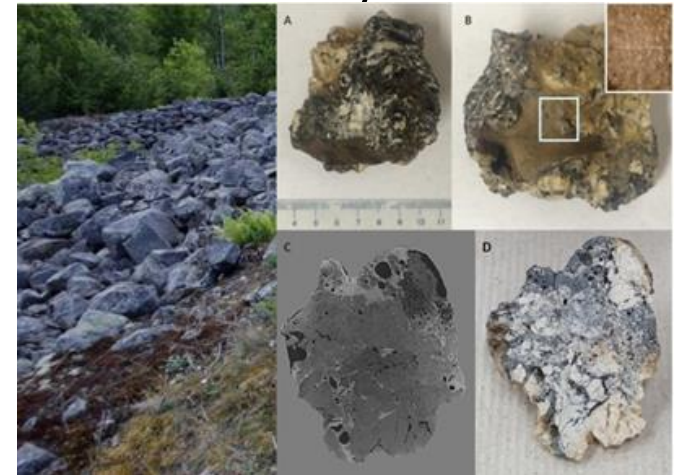
- ^{14}C and ^{99}Tc Attenuation-Based Remediation
 - EM collaborated with UK NNL and SRNL to develop attenuation-based strategies for ^{14}C and ^{99}Tc *in situ* management.
 - Installed field demonstration of sorbent (organo-clay) within the SRS F-Area Tc plume. Preliminary results are very promising.
 - Technology can be deployed without significantly changing the natural environment.
 - Organo-clays had near complete $\text{Tc}^{\text{VII}}\text{O}_4^-$ removal from groundwater.

- Successful demonstration and deployment of the technology will help address an intractable problem for DOE, reducing the risk associated with ^{14}C and ^{99}Tc contaminant plumes



Mined clays were modified with organic binding agents to create organo-clays that have an extraordinarily high affinity for ^{99}Tc . (Reference FY16 Factsheet, *^{14}C and ^{99}Tc Attenuation-Bas4d Strategies for Environmental Remediation*)

- Correlating Aging and Durability of Ancient Glasses to Predicted Long Term Performance of Vitrified Waste
 - An international team, including the Swedish Lulea University of Technology, PNNL, Washington State University, NIST, and the Smithsonian Institute, is studying ancient Broborg hillfort glasses to correlate observed durability with predictive models currently used for Hanford LAW.
 - ✓ Samples have been analyzed by the International team using a range of techniques to determine the internal structure and chemical composition
 - ✓ These studies will also be used to determine the melting process, which is key to the validation process.
 - Results will establish the effectiveness of current test methods, and potentially lead to improved waste loadings and/or expanded operational envelopes.



Vitrified samples from Broborg hillfort glass analyzed by x-ray computed tomography (Reference: FY16 Factsheet, *Correlating Aging and Durability of Ancient Glasses to Predicted Long Term Performance of Vitrified Waste*)

The EM International Program establishes, maintains, or leverages existing international agreements to enable the collaborative activities.



Presently, EM has active relationships with key countries, encompassing Europe, Asia, and North America, through the combined partnerships represented under the various active agreements.

- As demonstrated by the successful Technology Projects, International Agreements with **United Kingdom** entities have resulted in significant direct benefit to EM.
- ***Nuclear Decommissioning Authority (NDA) and National Nuclear Laboratory (NNL)***
 - SOI for Exchange of Information Concerning Management of Radioactive Waste
 - Amended: September, 2015 in Washington, DC
 - Extended: March 8th, 2017 in Phoenix, AZ
- ***Office for Nuclear Regulation (ONR)***
 - Arrangement for the Exchange of Information and Cooperation in the area of Nuclear Safety Matters
 - Signed: March 2014 in Washington D.C.
- ***UK Atomic Energy Authority (AEA)***
 - SOI for the Exchange of Information Concerning Remote Handling/Robotic Systems Deployed in Hazardous Environments
 - Signed: March 6th, 2017 in Phoenix, AZ

- Advances due to the bilateral agreement between UK NDA, UK NNL and DOE have allowed both parties to benefit in the following topical areas:
 - Waste Processing
 - Nuclear Material Disposition
 - Decommissioning and Decontamination

- Discussions are ongoing related to other non-technical areas, examples include:
 - Acquisition and Contract Management
 - Safeguards, Security and Emergency Preparedness



- The EM relationship with Japan, initiated in 2009, dramatically increased as a result of the Fukushima Daiichi accident in 2011. The interactions with Japan have leveraged DOE-developed expertise and resulted in significant benefit to the National Laboratories and U.S. Industry.
 - The U.S.-Japan Bilateral Commission on Civil Nuclear Cooperation (BLC) established in 2012 strengthened U.S support to Fukushima recovery.
 - ✓ Co-chaired by S-2 and the Japanese Deputy Foreign Minister
 - ✓ Provides the mechanism for comprehensive, senior-level dialogue on the safe and secure use of civil nuclear energy, including the response to the accident.
 - EM participation, including multiple National Laboratories, is through the BLC Decommissioning and Environmental Management Working Group.
 - ✓ Co-chaired by EM, EPA, and Japan's Ministry of Economy, Trade, and Industry (METI).
 - ✓ DOE National Laboratories provide support to the Japanese Government and TEPCO on strategies for long-term containment and cleanup of radioactive waste, as well as eventual D&D of the damaged reactors.
 - ✓ **This also identified opportunities for U.S industry to engage in the clean-up actions.**

- Fukushima support activities between National Laboratories, Universities, and Japanese entities are mutually beneficial.
 - In 2013, SRNL signed a contract with TEPCO to provide task-specific technical support for onsite remediation efforts. PNNL is also a key participant. INL and LBNL also engaged.
 - ✓ Provide advisory support to the Japan Atomic Energy Agency (JAEA) through its Collaborative Laboratories for Advanced Decommissioning Science (CLADS) program.
 - ✓ Collaborate on R&D projects with JAEA, Japanese universities, International Research Institute for Nuclear Decommissioning (IRID), etc.
 - ✓ Engage in strategic issues with METI, Ministry of Education, Culture, Sports, Science, and Technology (MEXT), and the Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF).
 - In 2016, DOE-NE and EM collaborated with Japanese entities to leverage the NE University Program (NEUP) to establish Joint US/Japan Sponsored Research, with Japan cost-sharing all of the R&D projects.



- EM, NE, and the EPA use the ***U.S. DOE Environmental Management National Laboratory Network***
 - Key purpose is to coordinate support from the National Laboratories in response to Japanese requests.
 - DOE and the National Laboratories continue to be actively involved with the Japanese Government and technical organizations on issues of mutual concern:
 - ✓ Fukushima reactor facilities D&D
 - ✓ Spent fuel storage and management
 - ✓ Site remediation, and
 - ✓ Waste management and disposal.
 - Japanese counterparts in the Network include METI, MEXT, NDF, JAEA, and TEPCO.



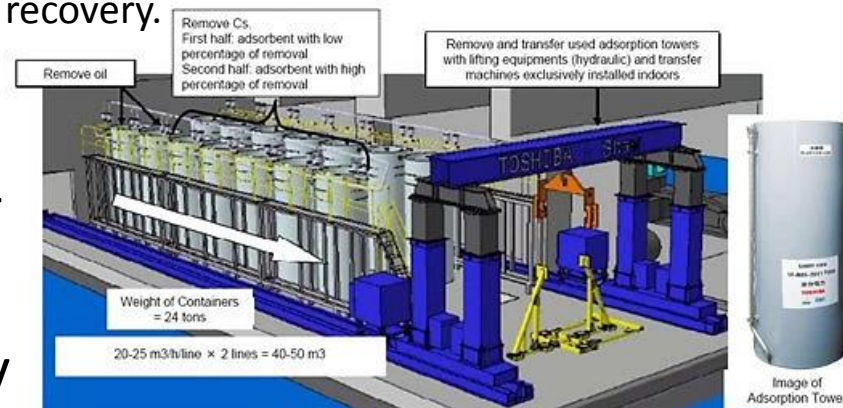
経済産業省
Ministry of Economy, Trade and Industry



文部科学省
MEXT
MINISTRY OF EDUCATION,
CULTURE, SPORTS,
SCIENCE AND TECHNOLOGY-JAPAN



- A key benefit of EM engagement with the Fukushima recovery has been the resulting opportunities for U.S. industry
 - Early and continued involvement has provided in-depth understanding of issues.
 - U.S. DOC, with support from EM, has teamed up with the Japanese Government to conduct *Japan-U.S. Decommissioning and Remediation/Fukushima Recovery Forum* events.
 - ✓ Facilitate efforts by U.S. and Japanese companies to explore opportunities to partner in work related to Fukushima recovery.
 - ✓ Four forums completed since 2013.
 - U.S. companies have been involved in clean-up of contaminated water
- New opportunities may offer potential benefit for U.S. industry related to D&D of Japanese reactors (damaged and other).



SARRY System developed by Shaw and AVANTECH to remove Cs-137 from contaminated water using ion exchange media originally developed by Texas A&M and ORNL.

- Engagement with other DOE offices, Federal Agencies and Programs on international matters is necessary for effective use of resources while maximizing opportunities. Key examples include:

- **DOE-NE:** Japan/Fukushima Recovery through INERI and NEUP cooperation
- **DOE-SC:** International Community/Long Term Glass Performance
- **NNSA:**
 - ✓ China/Joint Coordinated Committee on Peaceful Uses for Nuclear Technology (PUNT) – EM co- chairs the PUNT Working Group III: Environment and Waste Management with NNSA
 - ✓ Overseas Presence Advisory Board (OPAB) – NNSA is Executive Secretariat and the EM International Program represents EM.
- **DOC:** Working together to identify opportunities for U.S. industry in Japan
- **Others:** DOE Office of International Affairs State Department, White House: Leverage existing agreements and ensure international activities are aligned with U.S. foreign policy.



U.S. officials, including EM International Program staff, participated in the 8th US-China PUNT Joint Coordinated Committee



IAEA

International Atomic Energy Agency

- International Atomic Energy Agency (IAEA) – Vienna, Austria
 - Participation on the IAEA’s Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention[JC]).
 - Provides global leadership opportunities:
 - ✓ May 2015: 5th Organizational Meeting of the Parties to the JC selected a U.S. representative to serve as the president for first time (former EM-1).
 - ✓ May 2018: 6th Review Organizational Meeting of the Parties to the JC. Doug Tonkay (right), director of the EM Office of Waste Disposal, was selected in 2017 to serve as vice president to the JC.
- Nuclear Energy Agency (NEA) – Paris, France
 - Participation on the Radioactive Waste Management Committee (RWMC).
 - ✓ This provides mechanism for effective collaboration in areas related to radioactive waste management with focus on UNF and HLW disposition.
 - ✓ RWMC Working Party on Decommissioning and Dismantling (WPDD), provides opportunity to be engaged with and knowledgeable of the ongoing D&D practices and lessons-learned within the international community.



- The EM International Program will continue to support the EM clean-up mission and U.S. foreign policy by:
 - Identifying key collaborative activities among international partners, national laboratories, and industry to support development of high-impact technologies and best practices to address EM mission needs
 - Establishing key international relationships and partnerships (i.e., Agreements, SOIs, MOUs) that lead to successful R&D collaborations
 - Promoting EM technology needs through engagement in leading forums:
 - ✓ International activities of other DOE Offices (e.g., NNSA, NE, SC)
 - ✓ International activities of other federal agencies (e.g., DOS JSNEC/JCMs, DOC, White House OSTP Fukushima)
 - ✓ International Agencies (e.g., IAEA, NEA)
 - Leveraging international engagement, through National Laboratory involvement, to identify opportunities for U.S. industry, as appropriate.



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