

## **Reducing Technical Risk in the Environmental Management Program--9463**

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### **ABSTRACT**

The goal of the Office of Engineering and Technology is to reduce the technical risk and uncertainty in the Environmental Management program. The office identifies and advances technologies, processes, and technical practices that improve the performance of Environmental Management projects over their entire lifecycle, from planning to disposal. Within this office is the Office of Waste Processing, the Office of Groundwater and Soil, and the Office of Decontamination and Decommissioning and Facility Engineering. Each of these offices 1) develops policy and guidance; 2) assesses projects and programs through technical reviews and oversight; 3) provides technical assistance and support to the Field and other HQ offices, and 4) implements the Technology, Development and Deployment Program. This paper describes the efforts underway to reduce technical risks, including the External Technical Reviews being led by the Office of Engineering and Technology. In addition, the paper addresses the efforts underway to identify the technology needs and gaps as well as the strategic plan/roadmap to address those needs.

### **INTRODUCTION**

The mission of the DOE-EM Office of Engineering & Technology (OET) is to identify vulnerabilities and to reduce the technical risk and uncertainty in EM projects. Risks are known issues that may prevent project success. Uncertainties are indefinite or unpredictable aspects of a project. Our vision is that the engineering and technology program will provide the engineering foundation, technical assistance, new approaches, and new technologies that contribute to significant reductions in risk (technical, environmental, safety, and health), cost, and schedule for completion of the EM mission. To fulfill that mission and realize that vision, OET takes several complementary approaches, including strategic planning, management, and engineering innovation; partnering with public and private research and development entities; and technology development.

### **STRATEGIC PLANNING AND MANAGEMENT INNOVATIONS**

In March 2008, OET published its Engineering and Technology Roadmap to guide our applied research and technology development/deployment efforts. This Roadmap identifies technology gaps and lays out a strategy for addressing them so as to minimize the risks and uncertainties that could stand between us and success. From the Roadmap come specific Five-Year Plans for the OET program areas: waste processing, groundwater and soil, and deactivation and decommissioning/ facility engineering. Critical, high-risk, high-payoff projects are selected for inclusion in the Five-Year Plans. Together, those tools enable OET to systematically address DOE's current and future environmental management needs.

OET also has instituted policies and guidance for implementation of engineering and technology "best practices" across the DOE Complex, some of which are described below.

### **ENGINEERING AND TECHNOLOGY "BEST PRACTICES"**

One way of meeting OET’s goal of reducing risks and uncertainties in the EM clean-up program is the development and promotion of “best practices.”

The OET has developed a set of tools to help assure the success of environmental projects by managing the technical issues that could prevent a project’s success – the “technical risks.” Those issues could include:

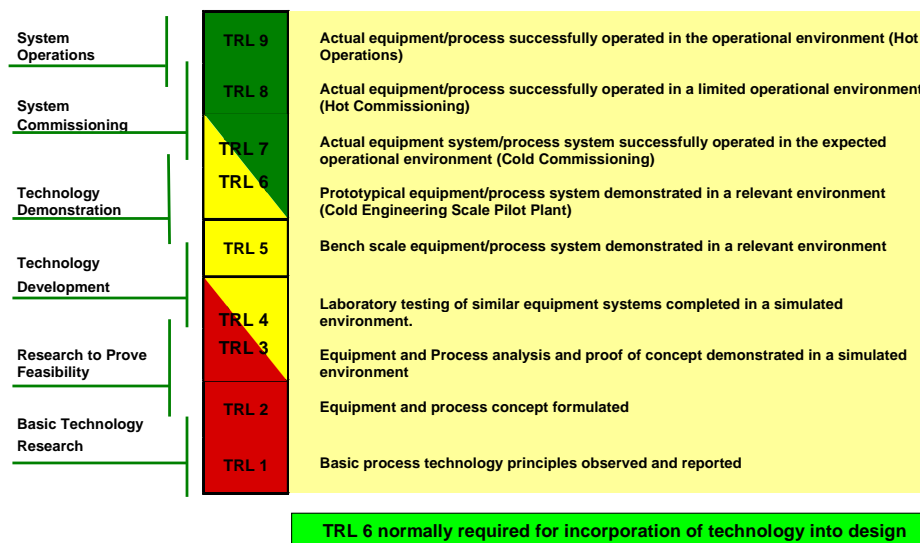
- no technology or engineering solution currently exists to accomplish a project task;
- a technology may exist, but is not yet mature enough to be used without additional development;
- a technical project risk requires additional focus and/or external review to mitigate risk; and
- a new technology may not yet be accepted by regulators.

To assist in the management of these technical risks, and thus increase the likelihood of successful implementation of environmental projects, DOE-EM’s Office of Engineering & Technology has developed the following processes: Technology Readiness Assessments (TRAs), External Technical Reviews (ETRs) and Technical Risk Rating (TRR).

### Technology Readiness Assessments

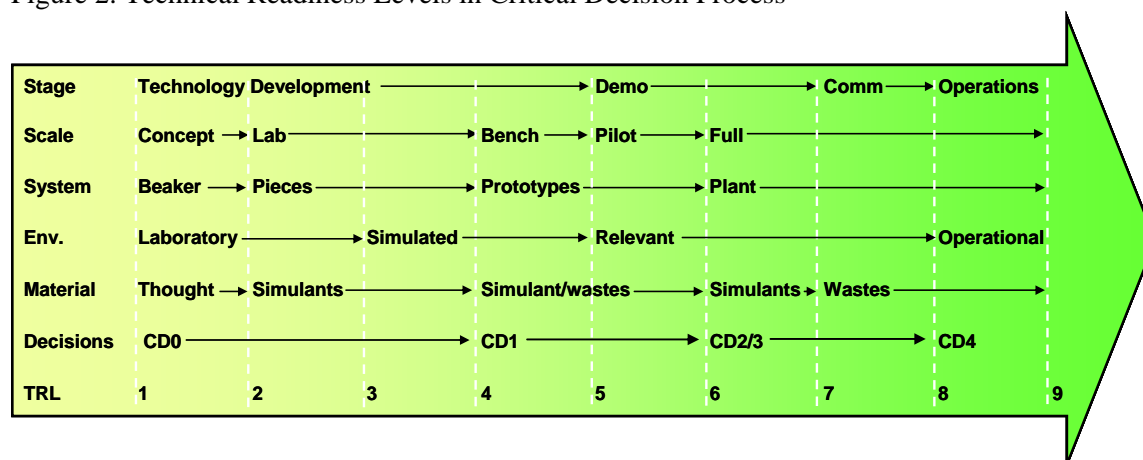
Technology Readiness Assessments are performed by DOE-EM personnel or outside subject matter experts to provide a snapshot in time of the maturity of technologies and their readiness for inclusion in the project. The results of a Technology Readiness Assessment assist DOE-EM in developing plans to mature the technologies and to make decisions related to technology insertion. Figure 1 defines the technology readiness levels.

Figure 1. Technology Readiness Level Scale



Following pilot programs at the Hanford and Savannah River Sites, DOE-EM issued a guide for performing Technology Readiness Assessments in March 2008 [1]. The DOE-EM Technology Readiness Assessment process is based on the process used by the Department of Defense. Figure 2 provides a representation of how technology readiness levels equate to maturity and DOE’s project management critical decision (CD) process. Based on DOE-EM’s experience with this process, other DOE and NNSA organizations are evaluating the DOE-EM Technology Readiness Assessment process for their own use.

Figure 2. Technical Readiness Levels in Critical Decision Process



Two examples of Technology Readiness Assessments are described briefly below:

- The Technology Readiness Assessment of the Hanford K Basins Sludge Treatment Project identified technologies that were not at the desired readiness levels. As the project team reviewed plans to mature the technologies, they decided to step back on the project execution timeline and evaluate different alternatives to meet technology gaps [2].
- A Technology Readiness Assessment of the U-233 Downblending and Disposition Project at Oak Ridge Site identified four critical technology elements whose current level of maturity should be further advanced prior to the start of final design efforts [3].

DOE-EM has conducted nine Technology Readiness Assessments:

- Hanford Waste Treatment and Immobilization Plant (WTP) Laboratory, Low Activity Waste (LAW) Facility and Balance of Facilities (BOF);
- Hanford WTP High-Level Waste (HLW) Facility;
- Hanford WTP Pre-Treatment (PT) Facility;
- Hanford Study of LAW Treatment Alternatives;
- Hanford K Basins Sludge Treatment Process;
- Savannah River Tank 48H Waste Treatment Technologies; and
- U-233 Downblending and Disposition Project at Oak Ridge.

### External Technical Reviews

The purpose of an External Technical Review is to reduce technical risk and uncertainty. External Technical Reviews use subject-matter experts from DOE-EM, the National Laboratories, academia, and industry - people who are independent of the project but knowledgeable in the subject area – to review the progress of major clean-up projects and provide pertinent information for DOE-EM to assess technical risk. The results of the reviews are used to develop strategies for reducing identified technical risks, and provide technical information needed to support critical project decisions. Technical risk reduction increases the probability of successful implementation of technical scope. DOE-EM in September 2008 issued a guide to standardize the review process. [4]

DOE-EM's Office of Engineering and Technology is leading the External Technical Review process and is working closely with Federal Project Directors to review such issues as technology development, systems integration, design, operations, maintenance, and nuclear safety. DOE-EM has completed several

successful reviews using expert engineers and scientists from private industry and academia over the last three years. External Technical Reviews have been completed to

- assess if operations at some sites have the same problems incurred at others (as was done in the Review of Landfills) [5];
- provide recommendations for technical issues (such as the mitigation and remediation of mercury contamination at the Y-12 Plant) [6]; and
- evaluate the basis for a selected technical approach prior to a key decision (as in the Review of the ARROW-Pak TRU Waste Container) [7].

Table I is a listing of the External Technical Reviews that have been completed during the last two fiscal years.<sup>1</sup> Additional external technical reviews will be conducted to support key project decisions and will be a mainstay of the DOE-EM program.

Table I. External Technical Reviews Completed in FY2006, FY2007, FY2008 and FY2009






External Technical Review	Site	Completed
		FY2006
Waste Treatment Plant Process Flowsheet	Office of River Protection	3/2006
Tank 48 Technical Path Forward	Savannah River	8/2006
Demonstration Bulk Vitrification System	Office of River Protection	9/2006
		FY2007
Salt Waste Processing Facility Design	Savannah River	11/2006
Hanford Remedial System for ZP-1/PW-1 Units	Richland	2/2007
Hanford Landfill - ERDF	Richland	6/2007
Caustic Recovery Technology Process	Office of River Protection	6/2007
Paducah C-400 Thermal Treatment	Paducah	8/2007
ARROW-PAK TRU Waste Container	Waste Isolation Pilot Project	8/2007
		FY2008
Idaho Landfill	Idaho	12/2007
Oak Ridge Landfill	Oak Ridge	2/2008
Portsmouth Landfill	Portsmouth	2/2008
Oak Ridge Y-12 Mercury Contamination	Oak Ridge	4/2008
Hanford Columbia River Projects	Richland	7/2008
Nevada Test Site Landfill	Nevada	7/2008
Supplemental Treatment of LAW	Office of River Protection	8/2008
Integrated Facility Disposition Project	Oak Ridge	8/2008
Paducah Landfill	Paducah	8/2008
Savannah River Landfill	Savannah River	8/2008
		FY2009
Plutonium Preparation Project	Savannah River	10/2008
Capabilities of Integrated Project Teams	All	12/2008 F
U-233 Downblending and Disposition Project	Oak Ridge	6/2009 F

### Technical Risk Rating Indicators

<sup>1</sup> Copies of External Technical Reviews and Technology Readiness Assessments may be found on the DOE Office of Engineering and Technology website – [www.em.doe.gov/Pages/TechAssistance.aspx](http://www.em.doe.gov/Pages/TechAssistance.aspx)

Technical Risk Ratings combine input from risk management plans, Technology Readiness Assessments, External Technical Reviews and other information into a tool for communicating between Federal Project Directors and DOE-EM management about technical risks. The Technical Risk Rating process was developed by DOE-EM's Office of Engineering & Technology and Savannah River National Laboratory. After a pilot in the spring of 2008, guidance [8] and training were provided to all of the DOE sites during the summer, so that each Federal Project Director could prepare Technical Risk Ratings for use during the quarterly project reviews at the end of CY 2008. The Technical Risk Ratings use a stoplight-themed graphic to promote communication of technical risk. For each of four criteria - Technology Maturity, Risk Urgency, Handling Difficulty, and Resolution Path — the stoplight provides visual representation of the level of concern. Red indicates an area that warrants heightened attention. Green indicates that the technical risks are manageable as planned. The objective is to bring pressing technical risks to the forefront, keeping the team and leadership informed and engaged such that the risk impacts are fully understood and they can be effectively managed.

Figure 3. Technical Risk Rating Indicators

-  Project technical risk(s) require heightened attention and may require Acquisition Executive decisions on direction or resource
-  Project technical risk(s) require additional focus and may require Acquisition Executive decisions on direction or resources.
-  Project technical risk(s) have concerns in several areas and may require additional focus by the Integrated Project Team.
-  Project technical risk(s) are manageable. Minor concern in selected areas, but additional focus not required.
-  Project technical risk(s) are manageable as planned

The criteria used to determine the Technical Risk Rating allow separate candid judgments on technical risk severity and handling that enables presentation of a more accurate status on technical risk to the project. Four criteria have been selected to comprise the Technical Risk Rating:

1. **Technology Maturity:** A measure of maturity/availability/existence of the technology needed to address the consequences of the risk. - “Are the needed technologies ready for deployment?”
2. **Risk Urgency:** A measure of the relative time in the project schedule when risk consequences are expected to occur and intervention is needed - “Are the impacts close, does the project have time to work the issues, is the critical path delayed?”
3. **Handling Difficulty:** A measure of the complexity and/or difficulty in developing and implementing a suitable solution to technical issues - “How difficult is it going to be to define and perform actions that will mitigate the risk(s)?”
4. **Resolution Path:** A measure of the progress made towards achieving expected results and reducing risk during implementation of the handling strategy - “Are the results from the risk handling actions mitigating the risk(s) as expected?”

The overall project Technical Risk Rating is determined by a qualitative assessment done by the Federal Project Director. The Federal Project Director bases this judgment on the individual criteria values and other input as appropriate. The final Rating is assigned based on Table II.

The initial use of the Technical Risk Rating in the latest Quarterly Project Reviews has resulted in:

- identification of specific technical risks of concern;
- increased and improved discussion of technical risks, and all risks in general;
- focused discussion on the resolution of technical risks; and
- identification of assistance for resolving the issues and roadblocks associated with mitigating the technical risk.

The technical risks identified during these reviews will be used to develop a risk “watch list” for DOE-EM management tracking. Additional technical support and independent reviews may be performed in the near future to assist resolution of the technical risks. Discussions with project managers working with DOE-EM indicate the Technical Risk Rating is applicable to government and industry projects.

Through the use of Technology Readiness Assessments, External Technical Reviews and the Technical Risk Ratings DOE-EM has put in place tools to assist in reducing the technical risks associated with its portfolio of projects. In the short period the tools have been in place, use of the tools has resulted in reductions in risks and increased attention to technical risks. Future plans include the continued use of the tools and the review of the results of the reviews to look for lessons learned that can be applied to other projects.

## **LEVERAGING HUMAN CAPITAL**

EM is becoming recognized as an organization with a world-class engineering and technology capability. That is due in part to OET's aggressive efforts to communicate and collaborate with public and private research and development entities. Current activities include:

- Integrated Project Team (IPT) Self Assessment – Technical Capabilities
- IPT External Assessment – Technical Capabilities
- Results from self and external assessments will feed into EM Human Capital Management Plan and Technical Qualifications Program
- Enhance technical capability at Headquarters through use of national laboratory intergovernmental personnel act assignments (IPA)
- Explore other human resource options, including Professional Development Corps, Florida International University Intern Program, International secondments, Vanderbilt training program, NRC grant program, etc.
- Benchmarking [Federal and private organizations; International – United Kingdom Nuclear Decommissioning Authority]
- Establishment of EM Corporate Boards [new Boards include HLW and QA]
- Finalization of EM Clean-up Technology Roadmap and strengthening of associated Communities of Practice.

### **Leveraging Research Investments among Federal Agencies**

Because advances in science can produce great strides in addressing clean-up needs, OET is bridging the gap between science and application in a variety of ways. Because many of EM's remaining clean-up problems are unique, highly complex, and technologically challenging, OET convened national laboratory scientists to work with them to investigate how basic fundamental scientific research can help to reduce risks and uncertainties in the current clean-up program. The scientific team concluded that basic research could provide: insight into fundamental mechanisms for current waste processing and disposal options; a path to develop alternative technologies should primary options fail; confidence that current models predicting long-term performance of different options are based upon best available science; and fundamental science discovery to enable transformational solutions to revolutionize current processes. OET leverages investments made within the Department by the Office of Science, Office of Nuclear Energy, National Nuclear Security Administration, and Office of Civilian and Radioactive Waste, especially in the areas of predicting high level waste performance and characterization of radiological waste. OET also leverages investments made by other federal agencies such as the Department of Defense (e.g., Strategic Environmental Research and Development Program), Department of Homeland Security (e.g., radiation detection) and National Institute of Standards and Technology in the Department of Commerce. OET continues to work cooperatively with the Nuclear Regulatory Commission on issues such as long term performance of cementitious materials.

### **Collaborating with Technical Experts Across the Globe**

OET is collaborating with the best technical experts from around the world to solve EM problems by reducing risk and accelerating clean-up with new technologies and methodologies. For example, OET is working cooperatively with the United Kingdom Nuclear Decommissioning Authority to conduct joint Technology Readiness Assessments to evaluate technologies being developed and implemented in the United Kingdom and with Russian and Ukrainian scientists and engineers to conduct research and technology development that address DOE clean-up challenges. OET also collaborates through exchanges of information on technical advances at international conferences.

## **Exchanging Technical Information and Lessons Learned among DOE Sites**

OET provides a critical role for sharing technical information and lessons learned among DOE sites and the virtual EM technical support community, which includes national laboratories, industry, and universities. Although each DOE site is unique, there are many similarities in terms of challenges to its cleanup programs that can benefit from technical exchanges. OET fills that key role by promoting communication from site to site via conference calls, email broadcasts, web-hosted information, and technical workshops. Each of OET's offices actively pursues technical information exchange using a variety of methods.

## **TECHNOLOGY DEVELOPMENT AND DEPLOYMENT**

Although major uncertainties/risks across the DOE complex still must be addressed through innovative technologies and approaches, much progress in the Environmental Management clean-up mission is expected over the next few years. Much progress has already been made. Technologies have been inserted to reduce risk through accelerated schedules, cost savings, reductions of worker risk, and solutions to intractable problems. For example, new technical approaches were instrumental in the completions at Fernald and Rocky Flats (e.g., silos waste retrieval and processing and silos grouting at Fernald and chemical decontamination of glove boxes and tanks at Rocky Flats). Technological solutions have made a difference in waste processing, soils and groundwater treatment, and deactivation and decommissioning. A few are described below.

### **Edible Oil Treatment Leads to Enhanced Attenuation for Chlorinated Solvents Need**

There are two fundamental challenges in reaching final closure for many DOE sites with contaminated soils and groundwater:

1. Transitioning from costly source treatments to passive (green) treatments and to acceptable end states
2. Developing regulatory support and acceptance to implement attenuation based remedies.

Technical developments are enabling transition from active, energy-intensive treatments to "green" treatments, minimizing our energy footprint on a national scale while also saving money.

Publicly available training is resulting in technical advancements in the public/private sectors. Researchers are hopeful that an enhanced attenuation approach will lead to effective groundwater clean-up with reduced energy use and impact to the environment. A full scale test of an enhanced attenuation remedy utilizing edible oil has been demonstrated at Savannah River Site's T-Area. Edible oils can reduce contaminant concentrations in two ways: stimulating microbiological degradation processes and reducing contaminant mobility by physical sequestration. Guidance for implementing attenuation-based remedies within regulatory frameworks is being developed with state and federal regulators.

### **Low – Temperature Caustic Leaching**

The mass of sludge in the SRS High-level waste (HLW) tanks is currently estimated to fill ~ 7,900 canisters when treated, which is more than previously estimated and likely will impact the Site Treatment Plan commitment to treat all HLW by 2028. In-tank, low-temperature caustic leaching to remove the aluminum in the sludge could significantly reduce the volume of waste required for vitrification.

Low-temperature caustic leaching was recently demonstrated at full scale in Tank 51 at SRS. Sixty-five per cent of the insoluble aluminum was removed. No new equipment was required, and dissolution was complete after 80 days. The aluminum-rich decant stream is staged for feed to the Salt Waste Processing Facility. The aluminum removed reduced the sludge volume by the equivalent of 100 canisters, reducing



the total life-cycle cost of the SRS HLW mission by an estimated \$100 million. This process is expected to reduce sludge mass by the equivalent of 900 canisters with a \$900 million life-cycle cost reduction.

### **D&D Toolbox**

207 facilities at the Oak Ridge Reservation and hundreds of facilities at other DOE sites awaiting D&D were erected in the mid 1940s and early 1950s to support the Manhattan Project and Cold War missions and are now structurally deteriorated and unsafe for workers to access for surveillance and maintenance and D&D A systems approach being used for highly contaminated, deteriorated structures that may be unsafe for prolonged worker access will deliver a “D&D Tool Box” with validated performance data on applicable D&D technologies that can be used on a wide variety of facilities and structures.

The “D&D Tool Box” consists of characterization, decontamination, and demolition technologies, including robotic systems and platforms that will provide alternative approaches to D&D The “D&D Tool Box” will provide reduced risk to workers, site personnel, and the environment while accelerating D&D and saving money. The technical approaches will be applicable across the DOE Complex

### **CONCLUSION**

The need for continued progress in DOE’s clean-up program as greater challenges are faced means an increasing need for engineering and technology solutions to address them. There is much to be done. The DOE-EM Office of Engineering and Technology is working to meet those challenges by providing solutions to reduce technical uncertainty, especially for first of a kind technologies; improving engineering and scientific capabilities; developing policy, strategies, and guidance for facility management and land redevelopment and for improvement of energy efficiency and conservation; and determining the investment level needed by EM to address the engineering and technology challenges of the future

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