Technology Readiness Assessment of Department of Energy Waste Processing Facilities: Lessons Learned, Next Steps

D. Alexander
Department of Energy Office of River Protection
2440 Steven Blvd., Richland, WA 99352
K. Gerdes
Department of Energy, Office of Waste Processing, EM-21
19901 Germantown Rd., Germantown, MD, 20874-1290
L. Holton
Pacific Northwest National Laboratory
P.O. Box 999, Richland, WA, 99352
S. Krahn
Department of Energy, Office of Waste Processing, EM-21
1000 Independence Ave. S.W.
Washington DC 20585
H. Sutter
Consultant, Department of Energy, Office of Project Recovery
20442 Afternoon Ln., Germantown, MD, 20874

ABSTRACT

In an effort to improve its oversight of major waste treatment construction projects DOE has piloted a Technical Readiness Assessment/Technology Maturation Plan (TRA/TMP) process based on similar processes employed by the United States Department of Defense (DoD) and the National Aeronautics and Space Administration (NASA. DOE has carried out TRAs for the Hanford Waste Treatment and Immobilization Plant (WTP), for supplemental treatment technologies that may be employed to process Hanford low activity waste (LAW), for the removal of Hanford K-Basin waste, and for treatment technologies for Savannah River Site's tank 48.

This paper describes the TRA/TMP methodology and discusses the findings and lessons learned during its application. The paper also discusses the next steps in the technical assessment of DOE environmental projects.

INTRODUCTION

A TRA measures technology maturity using the Technology Readiness Level (TRL) scale that was pioneered by the NASA in the 1980s. The TRL scale ranges from 1 (basic principles observed) through 9 (total system used successfully in project operations). DoD and NASA normally require a TRL of 6 for incorporation of a technology into the detailed design process.

In 1999 the General Accounting Office recommended that the DoD adopt NASA's TRLs as a means of assessing technology maturity prior to transition. [1] In 2001, the Deputy Undersecretary of Defense for Science and Technology issued a memorandum that endorsed the use of TRLs in new major programs. Subsequently, the DoD developed detailed guidance for performing TRAs using TRLs in the 2003 "DoD Technology Readiness Assessment Deskbook" (updated in May 2005), hereafter referred to as "the Deskbook." [2] Recent legislation (2006) has specified that the DoD Milestone Decision Authority must certify to Congress that a technology has been demonstrated in a relevant environment (TRL 6) prior to transition of weapons system technologies to design or justify any waivers. TRL 6 is also used as the level required for technology insertion into design by NASA.

In March of 2007 the GAO recommended that DOE adopt the NASA/DoD methodology for evaluating technology maturity. [3] Language supporting the GAO recommendation was incorporated in the House version of the 2008 DOE-EM budget legislation.

TRA/TMP METHODOLOGY

TRAs provide a snapshot in time of the maturity of technology elements and their readiness for insertion into project design and execution. TMPs detail the strategy for developing immature technology elements to the point where they are ready for ready for project insertion. Together TRAs and TMPs are effective project management tools for reducing technical risk and avoiding cost increases and schedule delays.

The Technology Readiness Assessment (TRA)

> "A TRA is a systematic, metric-based process and accompanying report that assesses the maturity of certain technologies [called Critical Technology Elements (CTEs)] used in systems." [2]

The TRA provides an assessment of how far technology development has proceeded. It is conducted by personnel who are independent of the project team implementing the technical scope. It is a snapshot in time. It is not a pass/fail exercise, and contains no value judgment of the technology developers or the technology development program.

A TRA can:

- reveal the gap between a technology's current readiness level and the readiness level needed for successful inclusion in the project;
- identify at-risk technologies that need increased management attention or additional resources for technology development to initiate risk-reduction measures; and
- increase transparency of critical decisions by identifying key technologies that have been demonstrated to work or by highlighting still immature or unproven technologies that might result in high project risk.

Critical Technology Elements (CTEs)

The working definition of a CTE as defined in the Deskbook is given below and was used as a basis for identification of CTE's.

"A technology element is "critical" if the system being acquired depends on the technology element to meet operational requirements (with acceptable development, cost, and schedule and with acceptable production and operations costs) and if the technology element or its application is either new or novel. Said another way, an element that is new or novel or being used in a new or novel way is critical if it is necessary to achieve the successful development of a system, its acquisition, or its operational utility." [2]

The Deskbook provides the two sets of questions for use in the determination of CTEs given in Table I.

Table I. Questions used to Determine Critical Technology Elements [2]

First Set	Does the technology impact a functional requirement, mission schedule, or cost, and are end state requirements defined? 1. Does the technology directly impact a functional requirement of the process or facility? 2. Do limitations in the understanding of the technology result in a potential schedule risk, i.e., the technology may not be ready for insertion when required? 3. Do limitations in the understanding of the technology result in a potential cost risk, i.e., the technology may cause significant cost overruns? 4. Are there uncertainties in the definition of the end state requirements for this technology?
Second Set	Is the technology new, novel, modified or expected to operate at a performance level beyond its original design intention or demonstrated capability? 1. Is the technology (system) new or novel?

	2. Is the technology (system) modified? 3. Has the technology been repackaged so that a new relevant environment is realized? 4. Is the technology expected to operate in an environment and/or achieve a performance beyond its original design intention or demonstrated capability?

A system is determined to be a CTE if at least one question in each set can be answered yes.

Technology Readiness Levels (TRLs)

Technology Readiness Levels (TRLs) are measures used by DoD, NASA, other Federal Agencies, and many major companies to assess the maturity of evolving technologies prior to incorporating a technology into a system or subsystem. They were originally developed by NASA in the 1980's. The United States Air Force adopted the use of Technology Readiness Levels in the 1990's.

TRL definitions vary somewhat from agency to agency and within agencies depending on the types of technologies being assessed. The most common definitions are those used by DoD and NASA. DoD has definitions for hardware, software, manufacturing technology, and biomedical technology. [2] See the Deskbook for more information on DoD software, biomedical, and manufacturing TRLs.

For the DOE TRAs minor modifications were made in the DoD hardware definitions to make them more broadly applicable to EM projects such as the WTP that involve process chemistry. The definitions used by EM in its TRAs are given in Table II.

Table II. DOE Technology Readiness Level Definitions

TRL	**Description**
1. Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development (R&D). Example might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies.
3. Analytical and experimental critical function and/or characteristic proof of concept	Active research and development is initiated. This includes analytical studies and laboratory scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative. Components may be tested with simulants
4. Component and/or system validation in laboratory environment	Basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of 'ad hoc' hardware in a laboratory and testing with a range of simulants.
5. Laboratory scale, similar system validation in relevant environment	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high fidelity system in a simulated environment and/or with a range of real waste and simulants.
6. Engineering/pilot scale, similar (prototypical) system validation in a relevant environment.	Representative engineering scale model or prototype system, which is well beyond the lab scale tested for TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype with real waste and a range of simulants
7. Full scale, similar (prototypical) system demonstrated in a relevant	Prototype full scale system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment, Examples include testing the prototype in the field with a range of simulants

environment.	and/or real waste and cold commissioning.
8. Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with real waste in hot commissioning.
9. Actual system operated over the full range of expected conditions.	Actual operation of the technology in its final form, under the full range of operating conditions. Examples include using the actual system with the full range of wastes.

The testing requirements for the DOE TRLs are given in Table III.

Table III. WTP TRL Testing Requirements

TRL	**Scale of Testing**[a]	**Fidelity**[b]	**Environment**[c]
9	Full	Identical	Operational (Full Range)
8	Full	Identical	Operational (Limited Range)
7	Full	Similar	Relevant
6	Engineering/Pilot	Similar	Relevant
5	Lab	Similar	Relevant
4	Lab	Pieces	Simulated
3	Lab	Pieces	Simulated
2		Paper	
1		Paper	

[a] Full Scale = Full plant scale that matches final application
1/10 Full Scale < Engineering/Pilot Scale < Full Scale (Typical)
Lab Scale < 1/10 Full Scale (Typical)

[b] Identical System - configuration matches the final application in all respects.
Similar System - configuration matches the final application in almost all respects.
Pieces System - matches a piece or pieces of the final application.
Paper System - exists on paper (no hardware).

[c] Operational (Full Range) - Full range of actual waste
Operational (Limited Range) - Limited range of actual waste
Relevant - Range of simulants + limited range of actual waste
Simulated - Range of simulants

TRL Assessment Tools

A Technology Readiness Level Calculator was developed by the United States Air Force by Nolte. [4] This tool is standard set of questions implemented in Microsoft Excel™ that produces a graphical display of the TRLs achieved. With the assistance of Mr. Nolte, the Calculator was modified to make it more applicable to chemical processing systems by adding processing questions and modifying some of the original questions.

The Technology Maturation Plan (TMP)

The TMP is a strategic planning document that lays out the activities required to bring immature CTEs up to the desired TRL. It includes preliminary schedules and rough order of magnitude cost estimates that allow decision makers to determine the future course of technology development. Normally the TMP will be followed by detailed test plans (called Issue Resolution Plans at WTP) that provide more accurate cost and schedule information that can be incorporated into the project baseline

RELATIONSHIP OF TRAS AND TMPS, TO DOE CRITICAL DECISIONS

The TRA/ TMP process can be employed in a variety of situations requiring the determination of the state of technology development. In the realm of program and project management the TRA/TMP process can serve as one tool that can be employed in making the Critical Decisions required by DOE Order 413.3A [5]:

"The five Critical Decisions are major milestones approved by the Secretarial Acquisition Executive or Acquisition Executive that establish the mission need, recommended alternative, Acquisition Strategy, the Performance Baseline, and other essential elements required to ensure that the project meets applicable mission, design, security, and safety requirements. Each Critical Decision marks an increase in commitment of resources by the Department and requires successful completion of the preceding phase or Critical Decision." [5]

Definitions of the Critical Decisions and proposed TRL requirements for each CD are as follows.

CD-0, Approve Mission Need: Identification of a mission-related need and translation of this gap into functional requirements for filling the need. "The mission need is independent of a particular solution and should not be defined by equipment, facility, technological solution, or physical end item." [5] The focus for technology assessment at this CD would be on clear statements of the requirements of the input and the desired output of the process. For waste processing this would include full characterization of the waste as well as the requirements for processing and waste form. A technology requirements review would assess the adequacy of requirements definition and characterization information and determine any additional work necessary. If additional work is necessary, a plan would be developed detailing its scope and schedule.

CD-1, Alternative Selection and Cost Range: Identification of the preferred technological alternative, preparation of a conceptual design, and development of initial cost estimates. A TRA and a TMP would be required as part of the CD-1 approval process. Prior to CD-1 approval, all CTEs of the design should have reached at least TRL 4, and a TMP should have been prepared that details the strategies for bringing all CTEs to TRL 6.

CD-2, Performance Baseline: Completion of preliminary design and development of a performance baseline that contains a detailed scope, schedule, and cost estimate. A TRA would be required as part of the CD-2 process. Prior to CD-2 approval, all CTEs should have reached at least TRL 6. Attainment of TRL 6 means that the technology is ready for insertion into detailed design.

CD-3, Start of Construction: Completion of essentially all design and engineering and beginning of construction, implementation, procurement, or fabrication. A TRA would be required if there was significant technology modification as detailed design work progressed. If substantial modification of a technology occurred, a TRA must determine that the modified technology has attained TRL6 prior to its insertion into the detailed design and baseline.

CD-4, Start of Operations: Readiness to operate and/or maintain the system, facility, or capability. Successful completion of an Operational Readiness Review (ORR) corresponds to attainment of TRL 7/8.

EM APPLICATIONS OF THE TRA/TMP PROCESS

The Hanford Waste Treatment and Immobilization Plant (WTP)

The DOE River Protection Project (RPP) mission is to retrieve and treat the approximately 210 million liters (55 million gallons) of Hanford Site high-level, nuclear tank waste and close the tank farms to protect the Columbia River. DOE is building the Waste Treatment Plant (WTP), the largest radioactive chemical processing plant ever constructed, to treat the waste. The WTP is comprised of four major facilities: a Pretreatment (PT) Facility to separate the tank waste into high-level waste (HLW) and low-activity waste (LAW) process streams; a HLW Vitrification Facility to immobilize the HLW fraction; a LAW Vitrification Facility to immobilize the LAW fraction; and an Analytical Laboratory (LAB) to support the operations of all four treatment facilities. Additionally, there are the Balance of Facilities (BOF) operations that provide utilities and other support to the processing facilities. The WTP Project is DOE's largest capital construction project with an estimated cost of $12.3 billion, and a project completion date of November 2019.

In an effort to more effectively manage the technology risks associated with the WTP, the DOE conducted a TRA of the WTP facilities and developed a technology maturation plan (TMP) to ensure that all WTP technologies are ready to be incorporated into WTP detailed design. WTP TRAs were carried out in late 2006 and early 2007.

Hanford RPP Tank Waste Mission Completion Review

The WTP HLW vitrification facility is sized to process all of Hanford's high level tank waste, but the WTP LAW vitrification facility is sized to handle only about 50% of the LAW. The remaining LAW will be treated using one or more supplemental immobilization technologies. Supplemental pretreatment technologies may also be needed to feed the immobilization technologies and/or to support a treatment option that will bring the WTP LAW vitrification plant on line prior to the completion of the WTP PT facility.

The Hanford RPP Tank Waste Mission Completion Review was commissioned to assess the comparative advantages, disadvantages, and risks related to various LAW treatment scenarios and carried out in mid 2007. A TRA analysis was performed for each supplemental technology to provide objective information to support cost and schedule development.

Savannah River Site's Tank 48

Tank 48 is a 1.3 million gallon tank that contains 910,000 liters (240,000 gallons) of HLW as well as 21,800 kilograms (24 tons) of organic chemicals. The organic chemicals represent a safety hazard due to the potential formation of flammable benzene vapor. The safety hazard has required the isolation of Tank 48 from the rest of the SRS tank system, eliminating the possibility of using its badly needed remaining space to accommodate additional HLW. Destruction of the organic chemicals is a critical first step in returning tank 48 to service. The treatment process must be compatible with tank farm practices as well as SRS existing and planed HLW pretreatment and immobilization processes.

SRS is preparing to go forward with one of two competing treatment technologies, Fluidized Bed Steam Reforming or Wet Air Oxidation. DOE SRS conducted a TRA mid 2007 and is preparing a TMP analysis for each technology in order to support the technology selection and implementation process.

Hanford K-Basins

The Hanford K-Basins were used to store irradiated fuel prior to plutonium recovery. When processing at Hanford stopped, some fuel elements were allowed to remain in the K-Basins. Over time the fuel degraded. A recent effort to remove the fuel and drain K-Basins has succeeded in removing the major fuel pieces and related equipment leaving behind some sludge that must be removed prior to closing the basins. The DOE, Richland Operations Office (RL) is developing a Sludge Treatment Process (STP) for the retrieval, treatment and packaging of the sludge. The STP Project is comprised of seven major sub-systems: sludge containerization, retrieval, transfer, oxidation, assay, packaging, and drum handling.

RL conducted a TRA of STP technologies in mid-2007. A TMP is being finalized.

LESSONS LEARNED

1. Structure, Reproducibility, and Objectivity

The TRA process is structured and reproducible. The DoD Deskbook is an excellent guide, and the Calculator is a very simple method to ensure that major lines of enquiry are covered. The K-Basins TRA was carried out by personnel who had not participated in previous TRAs and with limited input from WTP TRA personnel. Nevertheless the resulting TRA closely matched the WTP TRA in form and results.

There is some subjectivity in the manner in which a project is broken down into technology elements that will be examined for potential CTEs. DoD recommends following the project work breakdown structure to get the starting list of technology elements. The WTP, supplemental treatment, and tank 48 TRAs started from a list of major processing systems, while the K-Basins TRA grouped similar processing systems and subsystems. The specific grouping of systems/subsystems into technology elements does not appear to matter as long as every system/subsystem is evaluated.

Once the list of technology elements is generated the determination of which ones are CTEs is straightforward using the two sets of questions found in the DoD Deskbook. The evaluation of each CTE using the calculator is also straightforward. The calculator questions covering hardware, programmatic, and manufacturing considerations were found to provide a fairly comprehensive set of lines of inquiry for key areas. One exception was that the Calculator questions did not cover all aspects of chemical processing. Although, some chemical processing questions were added to the Calculator and used for later TRAs, more work is needed in this area. It is probable that each type of project (e.g., D&D, groundwater treatment) will require additional questions suitable for the technology area being assessed.

2. Relevant Environment and Project Requirements

One of the temptations in technology development is to accept a technology that has worked well in another project as mature and ready for insertion without examining the differences in project requirements and relevant environments. Often these differences prove fatal to technology application.

Technologies must be tested in a “relevant environment” and meet project specific standards of performance. The specification of the relevant environment requires that the input to, and output from, the technology system/process be clearly defined. This means, for example, that the physical and chemical properties of the waste being treated must be thoroughly characterized including waste variability, and that the required characteristics of the treated waste be specified. It is also necessary to determine which waste properties are critical for the makeup of realistic simulants. If the wastes are variable, testing should be carried out on a complete range of wastes and simulants.

When competing supplemental treatment technologies were evaluated in the Hanford RPP Tank Waste Mission Completion Review, it was found that one of the reasons none of the technologies was rated mature was that the waste acceptance criteria for the product were not defined.

Clear definition of system/process requirements is critical. The WTP TRA/TMP process encountered a number of requirements that were overly restrictive. Trying to meet these, in some cases, virtually impossible requirements would have required major commitments of time and money for technology development. Reevaluation of the requirements led to much simpler and less costly technology solutions.

3. Mature All Technology Systems

Waste processing typically consists of a number of technology systems linked together. The tendency is to focus technology development on a core technology and ignore peripheral technologies. For example, Fluidized Bed Steam Reforming (FBSR) was assessed for treatment of Tank 48 waste. Most of the technology development work for this application had focused on the reactor (TRL 4) system. However, little attention had been paid to the product handling (TRL 3) system. Maturation of the product handling system does not appear to be difficult, but it clearly will require additional testing and development. Failure to mature peripheral systems could lead to major problems in process operation.

4. Assess Independently, Plan as a Team

The TRA assessment must be an independent assessment. The assessment team should consist of technology experts not connected to the project i.e., DOE and contractor personnel involved in the project should not be part of the TRA team. However, once the TRA is completed, the writing of the TMP and the next level of detailed technology development plans should be a combined DOE/contractor exercise. The responsibility for preparation of the TMPs for the WTP (completed), Tank 48 (in preparation), and K-Basins (in preparation) has fallen on the contractor with input from the DOE project office. ORP is using a Technology Steering Group consisting of high level DOE and Contractor personnel to oversee TMP and IRP development and implementation. This group has greatly improved the quality of the planning and the speed with which the TMP and IRPs are approved and implemented

5. Reduction of Project Risk

Project managers find the TRA/TMP process useful in assessing and managing project risk. It substantially reduces project risk by ensuring that technologies are mature before they are inserted into final design and major commitments of project scope, schedule and cost are made. This is, of course, the major point that the GAO made in its assessment of DoD and DOE projects. The WTP TRA determined that several key technologies were immature and not ready for inclusion in the final design. Completion of the work specified in the WTP TMP will raise all technologies to TRL 6 and greatly lower project risk. On the basis of the low level of technology maturity of key components and processes discovered in the K-Basins TRA, the project decided to step back and fully reevaluate its path forward.

6. Comparison of Competing Candidate Technologies

The Tank 48 and Hanford RPP Tank Waste Mission Completion Review TRA/TMPs were useful in distinguishing between competing candidate technologies. The TRA alone is usually not sufficient to compare technologies. The TMP is necessary to allow the comparison of the schedule, scope, and cost of maturing the technologies. It is possible for a less mature technology to require less time and money to attain TRL 6 than a more mature technology. It is even possible that a technology that is close to being mature will never become fully mature due to a fatal flaw.

The TRA/TMPs of competing technologies can also provide useful input to the decision on whether more than one technology should be matured. The Tank 48 TRA/TMP concluded that there was great likelihood that the lead technology could be successfully applied to the project and that the backup technology and could, if necessary, be rapidly matured. Thus, no further investment was necessary for the backup technology.

7. Setting Expectations

Setting up front expectations for technology maturity at various stages of a project is helpful to both project managers and technology developers. Technology developers seem to like having clear expectations for the nature and extent of testing required to mature the technology. The TMP provides a road map for work necessary prior to technology insertion into the detailed design. It ensures that tests and experiments will be both necessary and sufficient for technology maturation.

8. Communication

DOE and contractor personnel working on WTP and the K-Basins project have noticed that the TRA/TMP process, especially the use of TRL scale, provides a language and formalism that improves technical communication. The clear expectations and time spent on the development of the TMP also improves communication and fosters agreement on the path forward. Communication to DOE and Contractor higher level management and decision makers is also improved.

9. Documentation

The requirement that each answer to a calculator question be backed up by written documentation that was subsequently examined by the assessors ensured a reasonable degree of objectivity. Assessor "due diligence," document examination is vital to the process. It was not unusual for the assessors to determine that statements made during the Calculator Q/A sessions were not backed up by the documents specified. Occasionally TRLs determined during initial sessions had to be changed due to the lack of supporting documentation. Each TRA final report lists the Calculator questions, the yes/no answers and the supporting documentation for each answer.

10. Test a Prototypical System

All technology components must be tested, preferably in a complete, prototypical system. The WTP LAW melter offgas system was tested in prototypical configuration during melter development. This simplified assessment of offgas technology by allowing evaluation of the entire system as a single technology. If prototypical test results were not available, each offgas component would have had to be evaluated separately.

11. Flowsheet Evaluation is a Challenge

The WTP flowsheet consists of many technology systems and many interfaces. Although each system was assessed during the TRA, no useful way was found for assessment of the entire flowsheet as a unified whole to determine if project goals can be met. To some extent this is more a design question than a technology maturity question. Nevertheless, more thought and development needs to go into flowsheet evaluation

NEXT STEPS

DOE EM is still piloting the TRA/TMP process. The following next steps should be considered before the process can be implemented on an EM wide basis.

Determine Whether the Process is to be Required/Adopted by EM and/or DOE

The process requires significant project and DOE resources and may reach conclusions that severely impact project costs and schedules. NASA and DoD experience has been that unless the process is required, implementation will be spotty and uneven. As noted earlier, Congress may have decided the matter for DOE (as it has for DoD and NASA) in recent appropriation language

Develop Program Guidance for TRAs, TMPs, IRPs and Test Plans

EM is finalizing TRA/TMP program guidance. Publication of the initial version of the guidance is scheduled for March 2008.

Finalize Definitions and Embed Them in the Culture

Definitions of TRLs and the testing required to attain them must be finalized. Definitions and testing requirements for projects other than chemical waste processing, e.g., D&D and groundwater treatment, may have to be developed. Once finalized, the definitions and requirements must be embedded in EM's culture. This will require more than writing them into EM policy and procedures. They must become generally accepted as the way EM looks at technology development and does business.

Tie the TRA/TMP Process to DOE EM Project Management/Acquisition Strategy

As noted earlier, the process can become part of DOE EM project management by placing technology maturity requirements in the Critical Decision process. The technology maturity requirements suggested earlier in this paper may lengthen project technology development schedules and increase initial technology development costs. The

GAO argument and DoD, NASA, DOE and industrial experience is that these increases will be more than made up later in the project by limiting cost and schedule growth by decreasing project risk.

Connect the TRA/TMP Process to DOE EM Risk Evaluation Policy

The goal of the process is to identify technology risk and decrease it by requiring increased technology maturity prior to insertion in detailed design. The process must be harmonized with EM risk policy and practices.

Adapt DoD and NASA Materials to DOE EM Needs

The DoD Deskbook and the Calculator are aligned with the DoD project management and acquisition processes. Some Calculator questions must be modified to make them more relevant to DOE project management processes and the needs of specific technology applications such as waste processing, groundwater treatment, and D&D.

Disseminate Information on the TRA/TMP Process and Train Facilitators and Assessors

A wide range of EM and contractor personnel including project managers, contracts personnel, technology developers, technology assessors, and engineering personnel must become familiar with the TRA/TMP process and TRL requirements for the DOE project management and acquisition process. Training materials must be developed and training sessions held.

Continue to Wrestle With Chemical Process Flow

As noted in the lessons learned section of this paper, DOE is still searching for a methodology that will enable EM to assess the complete process flow.

CONCLUSION

The TRA/TMP process has already proven useful for technology evaluation for a number of DOE EM waste processing projects. Valuable lessons have been learned. EM is in the process of determining the scope of application of the process to additional EM projects.

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