US DOE Office of Environmental Management Office of Waste Processing Fiscal Year 2010 Program Plan for Technology Development - 10508

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ABSTRACT

This paper describes the Fiscal Year 2010 (FY2010) Technology Development Program for the Office of Waste Processing, within the U.S. Department of Energy (DOE) Environmental Management (EM) Office of Technology Innovation & Development. The Waste Processing portion of the EM Office of Technology Innovation & Development mission was formalized in 2007 with the release of the DOE-EM Engineering and Technology Roadmap and encompassed technology development and maturation related to the treatment and disposition of high level waste (HLW); the disposition of Challenging Materials (CM); the handling and disposition of DOE Spent Nuclear Fuels (SNF); and the transportation and disposal of low-level waste (LLW) and transuranic waste (TRU). A large majority of these wastes and associated facilities are unique to the DOE, meaning many of the programs to treat these materials are "first-of-a-kind" and unprecedented in scope and complexity. As a result, the technologies required to disposition these wastes must be developed from basic principles, or require significant re-engineering to adapt to EM's specific applications. The Office of Waste Processing technology development program is focused on technology that enables the reduction of risk and uncertainty for handling and disposing of these materials throughout the DOE Complex.

This paper will describe the key Waste Processing program needs originating from the EM Engineering & Technology Roadmap, along with the early evolution of the program and management processes. Technology development strategies and approaches will also be described, along with an overview of major program initiatives for FY2010 that resulted from a formal review by the National Academy of Sciences. Finally, an overview of the key aspects of a reshaped Waste Processing program management and execution strategy for FY2010 will be provided.

INTRODUCTION

The Office of Environmental Management's Technology Development and Deployment (TDD) Program has been focused on establishing multi-year technology plans to support strategic initiatives outlined in a 2008 DOE-EM Engineering & Technology Roadmap [1]. The Roadmap identified six program areas; one of which was Waste Processing with five strategic initiatives. Two additional program areas/strategic initiatives (Spent Nuclear Fuel and Challenging Materials) were later incorporated into the Waste Processing program area. The thrust of the Roadmap and the subsequent program plans were to develop and mature technologies to reduce the risk and uncertainty in the processing of DOE high- and low-level and transuranic wastes, challenging materials, and spent nuclear fuel.

By 2008, the Office of Technology Innovation & Development – formerly the Office of Engineering and Technology, had provided prioritized tasks and funding to multiple DOE sites in support of the Waste Processing TDD program. Funding to the program had shown slight increases since 2006, but was anticipated for more dramatic increases in 2009 as the program continued to expand the breadth of the technologies under investigation. At its peak in 2009, the Waste Processing program was simultaneously executing fifteen projects with over twenty participants representing the Department, national laboratories, directed institutions, universities and commercial industry.

In 2009, the Office received multiple inputs and detailed guidance from reviews of the Waste Processing program by the National Academy of Sciences (NAS), a DOE formed Tank Waste System Integrated Project Team, and several national experts through a series of External Technical Reviews. The Department responded to the numerous inputs, notably the NAS review, through a reshaping of the program for FY2010 to more cleanly align with the highest priorities of the Department. This resulted in a refreshed program management approach and structure, and a re-grouping of the various technical work activities.

EVOLUTION OF THE WASTE PROCESSING TDD PROGRAM

Although the EM Office of Waste Processing has always invested in technology development efforts, the program began a reemergence with increased formality in 2006. The technical program, the organizational structure, and the investment by the Department evolved during the early years of the program into a formalized team of technology experts that spanned the waste processing complex, a broad but flexible portfolio of technical solutions and an ever increasing budget.

The Initiative Development Team

Beginning in 2007, EM Office of Waste Processing leadership organized into a formal structure of Initiative Development Teams (IDT) centered on each of the five Waste Processing strategic initiatives outlined in the Roadmap [2]. Technology optimization areas, or sub-elements, within the strategic initiatives were characterized by a work breakdown structure (WBS) that extended down to project and task levels. This original IDT arrangement by strategic initiatives (with the 2008 addition of Spent Nuclear Fuel and Challenging Materials initiatives) is shown in Figure 1 (see page 3).

The IDT was assigned responsibility for the management and interface of the relevant projects and tasks supporting the strategic initiatives and optimization areas. The individual IDT was led by EM Office of Waste Processing staff members. The individual IDT also included national laboratory, university, and commercial partners based on the particular focus of the IDT. The IDT and WBS arrangement facilitated prioritization of work scope within the full Waste Processing program, as well as, the development of multi-year plans that were comprised of short-, mid- and long-term technology solutions to the waste processing needs around the DOE Complex. Out-year prioritization methodologies varied from 2008 to 2010 (Congentus Framework for prioritizing FY2008 and FY2009, and Pair-Wise Comparison for 2010), but

always included discriminators for reducing risk (environmental and safety, and programmatic), and lifecycle impacts to the waste processing mission.

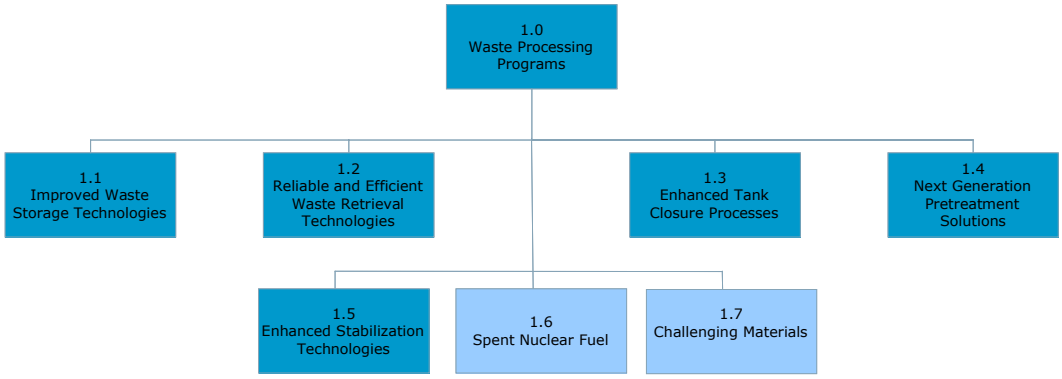

Fig. 1 – FY2008 Work Breakdown Structure and Initiative Development Teams formed the core structure to plan and manage the Waste Processing program technical portfolios (Spent Nuclear Fuel and Challenging Materials were added to the Waste Processing program in 2009).

Budgets and Funding

In 2009, the Waste Processing IDT had developed comprehensive technical portfolios of projects and tasks in each of the strategic initiatives based on the risk – reward approach of developing and maturing near-, mid-, and long-term technologies for baseline insertion. The Waste Processing balanced portfolios of technical tasks supported proposals of approximately $70 million in FY2010 (representing about twice the technology funding available in FY2009). The Office of Waste Processing had continually increased the investment in the development and maturation of technologies to address waste processing needs and by FY2010 had secured a $50 million budget to develop these needs technologies, an increase of almost three times the amount committed in 2006. The chart in Figure 2 demonstrates the Department's increasing financial commitment towards technologies to address the Department's needs in waste processing technologies.

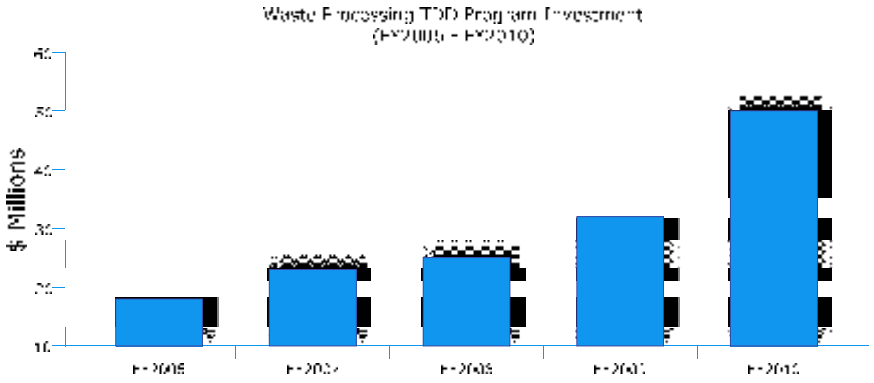

Fig. 2. The Department's FY2010 financial commitment to technologies to address waste processing technology needs has increased to almost three times the budget in FY2006.

THE 2009 NATIONAL ACADEMY OF SCIENCE REVIEW

In conjunction with the development of the Engineering and Technology Roadmap, the Department of Energy commissioned a study by the National Academy of Sciences (NAS) to identify; (1) waste processing science and technology gaps, (2) the expertise and infrastructure at the national laboratories needed to address the higher priority challenges, and (3) strategic opportunities to leverage research and development with other organizations. The study, released in a 2009 report [3], validated the EM technology roadmap approach and derived gaps ("…shortfall in available knowledge or technology that could prevent EM from accomplishing a cleanup task…") that could be bridged through research and development (R&D).

The NAS Waste Processing Gaps

The NAS report outlined and prioritized six technical program gaps for the Waste Processing program area that associated closely with the portfolios outlined within the original WBS developed from the Roadmap. The report also prioritized the gaps, which mimicked the portfolio prioritization and general funding breakdown developed from within the IDT for FY2010. The NAS listed technology gaps in waste left after tank cleanout and vitrification capacity, as the highest priorities, followed by the three medium priority gaps in technologies to address low activity (or secondary) waste streams, pilot-scale testing with quality simulants or actual wastes, and significant increases in the volume of high-level waste to be processed within the baseline vitrification process. A third, low priority gap, was identified in the lack of disposition paths for a number of wastes and nuclear materials.

The first and highest priority gap identified by the NAS report (colloquially, WP-1) suggested that waste may be left in tanks (and bins) after cleanout, particularly where internal obstructions (e.g. cooling coils) may prevent maximum coverage using conventional or commercial tools. A second high priority gap (WP-4), offered that increases in vitrification capacity may be needed to meet EM schedule commitments.

The three medium priority gaps identified by the NAS included: WP-2, where low activity streams from tank waste processing could contain substantial amounts of radionuclides without technologies demonstrated and deployed to remove or separate the radionculides. WP-3, also an NAS medium priority, described new facility designs, processes and operations reliance on pilot-testing with simulants rather than actual wastes where simulant representation of waste can be particularly challenging given the wide range of waste characteristics. The third NAS medium priority gap, WP-5 depicts increases in the disposal volumes of high-level waste based on the baseline tank waste vitrification process throughput (melting glass and glass loading). The last and only low priority gap identified by the NAS for Waste Processing was the lack of disposition paths for the large variety of other wastes and nuclear materials within the Complex (e.g. Idaho calcine, spent fuels, K-Basin sludge, etc.).

Upon review, the NAS technology gaps were able to be addressed by the extensive FY2010 Waste Processing program portfolio. At the most basic level, the original Roadmap optimization areas and projected on-going and proposed projects and tasks were capable of responding to the

gaps. A simplified mapping of the NAS gaps to the original breakdown of the Waste Processing program is shown in Figure 3.

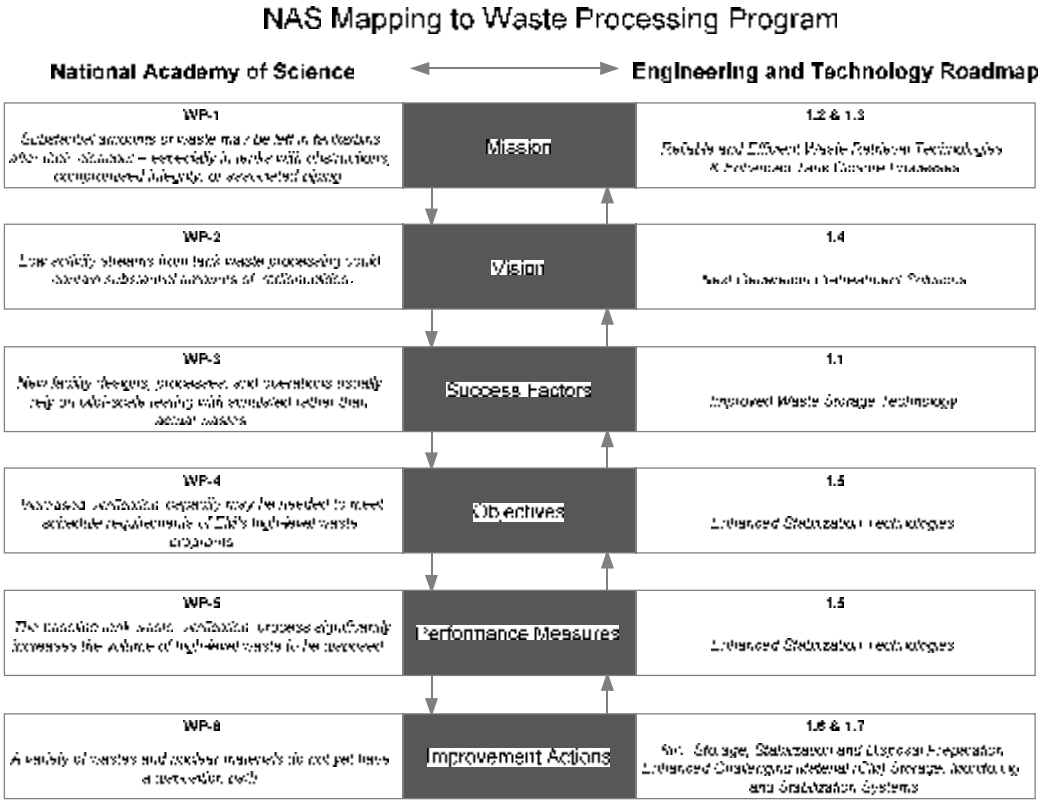

Fig. 3. Science and technology gaps reported by the National Academy of Sciences are easily mapped to the original Waste Processing strategic initiatives.

RESHAPING THE WASTE PROCESSING TECHNOLOGY PROGRAM FOR FY2010

Although the NAS report described significant technology challenges to the DOE cleanup mission, the Waste Processing program IDT was in a position to respond to the gaps through transformational projects and tasks outlined for the Waste Processing program portfolio in FY2010. However, despite inferred NAS validation of the elements of the Waste Processing program; adjustments to the organizational structure of the program (i.e. the IDT structure) and select initiatives were needed to more cleanly align the program with highest priorities of the Department. This "reshaping" of the Waste Processing program was put in place in early FY2010 and addresses not only the NAS gaps, but also adjusts for departmental goals and priorities, and departmental business changes (EM reorganization, upper-level EM management emphasis, FY2010 funding levels, and program budget management).

The result of the reshaping of the FY2010 occurred in three principle areas of the program; changes to the organization of the technical program to align with the NAS gaps, a shift to strictly transformational waste processing technology solutions, and technical program management structure changes with elevated Department leadership. Transformational technologies are those that will result in significant life cycle cost and schedule savings.

FY2010 Technical Reorganization to Focus on the NAS Waste Processing Gaps

The technical organization of the Waste Processing program in FY2010 was reshaped around the five highest priority gaps outlined in the 2009 NAS report with an emphasis on transformational solutions to address the gaps. The Waste Processing program addresses the highest priority NAS gaps through multiple projects and tasks, mostly of the transformational nature described previously. Thus, the FY2010 Waste Processing program would de-emphasize the original Roadmap WBS structure in favor of increased attention on the recommendations of the NAS report. Table 1 describes the general technology approach employed by the Waste Processing program to specifically address the NAS Waste Processing gaps.

Table I. FY2010 Waste Processing Program Transformational Approaches to Address the NAS Technology Gaps.

NAS Challenge	Priority	Waste Processing Program Approach
WP-1 *Substantial amounts of waste may be left in tanks/bins after their cleanout – especially in tanks with obstructions, compromised integrity, or associated piping.*	HIGH	• Develop Alternative Chemical Cleaning Techniques • Develop High-Throughput Waste Reduction Technologies • Develop Sludge Differential Settling Technologies • Improve Long-Term Performance Evaluation of Cementitious Materials and Waste Forms
WP-2 *Low activity streams from tank waste processing could contain substantial amounts of radionuclides.*	MEDIUM	• Deliver At-tank/In-tank Treatment Solutions to Accelerate Salt and Sludge Processing • Develop Approaches for Managing Technetium Issues • Develop Advanced Separation Technologies to address Key Waste Constituents (Na, Al, S) • Develop In-Situ Tank Characterization Technologies
WP-3 *New facility designs, processes and operations rely on pilot-testing with simulants rather than actual wastes.*	MEDIUM	• Develop Advanced Multi-Phase Mixing and Suspension Methods • Develop Simulants to Enable Design Verification
WP-4 *Increased vitrification capacity may be needed to meet schedule requirements of EM's high-level waste programs.*	HIGH	• Develop Next-Generation Melters • Develop Advanced Process Understanding and Predictive Tools for Melter Cold Cap Chemistry
WP-5 *The baseline tank waste vitrification process significantly increases the volumes of HLW to be disposed.*	MEDIUM	• Develop Advanced Glass Formulations to Increase Waste Loading and Melt Rate • Develop Alternative Treatment and Disposal Processes using Advanced Waste Forms
WP-6 *A variety of wastes and nuclear materials do not have a disposal path.*	LOW	none

Emphasis on Transformational Solutions in FY2010

The waste processing program will focus on transformational solutions as follows.

NAS gap WP-1 declares that waste may be left in tanks/bins after cleanout especially where tank internals are complicated by obstructions. The technical gap is addressed through four transformational approaches within the reshaped Waste Processing program. Development of alternative chemical cleaning techniques that could be expected improve the efficiency of tank waste removal while reducing secondary waste demands would dramatically improve waste processing and tank closure schedules. Development of higher throughput waste reduction technologies that could provide tank and waste consolidation options would address increased demands for wastes to be processed through waste disposition facilities (e.g. the Waste Treatment Plant at the Hanford Site.) Also addressing the NAS WP-1 gap is the development of sludge differential settling technologies that would allow more robust blending of the highly variable wastes at the waste tanks to meet the increased demands to feed the waste disposition processes. Finally, improved long-term performance evaluations of cementitious material and waste forms would have dramatic impacts on the near surface disposal of low level radioactive material. Improved understanding and reduced uncertainty of long term performance will facilitate and streamline the regulatory process and result in performance based waste management, treatment and landfill designs, and programmatic decision making.

The second NAS technical gap, WP-2, describes low-activity streams from processing tank waste that could contain substantial amounts of radionuclides. This gap is addressed within the FY2010 Waste Processing program through transformational solutions designed around pretreatment technologies at or, in the waste tanks that, is successful, actually accelerate the processing the waste by avoiding certain steps in the overall process flow sheet. The Waste Processing program also addresses this gap through development of technical approaches to managing technetium in the waste streams either by removing it, or retaining it in lower activity streams. The WP-2 gap is also addressed by transformational approaches that would attempt to selectively separate key waste constituents, such as, sodium, aluminum and sulfur that typically limit waste processing throughput (i.e. limited glass system tolerance). In-tank characterization is the final transformational approach in WP-2. This approach, which has merit in addressing other NAS gaps, would develop technologies and techniques for in tank radionuclide characterization of waste, potentially avoiding high-cost, lengthy laboratory analysis where it might not be critical.

The third NAS technical gap (WP-3) addressed by approaches in the FY2010 Waste Processing program is the reliance on pilot-scale testing with simulants rather than real wastes. The FY2010 Waste Processing program approaches this gap through development of advanced multi-phase mixing and suspension models and development of simulants to enable design verification. The mixing and suspension models would be expected to increase predictive capabilities to optimize treatment facility throughput with increased solids loading, rheological and chemical process flexibility and reduced conservatism in flows sheets. The transformational simulant development would attempt to integrate actual waste data in simulant development to reduce risk of basic data errors for new technologies while improving process flow sheet accuracy.

The fourth NAS Gap, WP-4 suggests increased vitrification capacity may be needed to meet high-level waste schedule requirements. The transformational Waste Processing program approach to this gap will develop next-generation melters and melter performance models. Robust melter models will reduce the occurrence of process upsets and optimize feed strategies. The models would also reduce the need for scaled melter testing and allow off-line process modification to be evaluated without disrupting throughput.

The fifth (WP-5), and final NAS gap addressed through transformational approaches in the Waste Processing program suggests that the baseline vitrification process would increase the volume of high-level waste for disposal and, therefore, alternatives to this are needed. Approaches to this gap include development of advanced glass formulations to increase waste loadings and melter rates, with the effect being more waste per volume and quicker production of the vitrified waste. The second approach to transformationally address WP-5 develops alternative treatment and disposal processes using advanced waste forms, allowing for less waste to be processed through the vitrification facilities.

Program Management Structure Changes for the FY2010 Waste Processing Program

In response to the significant shift of the technical program to only transformational technology solutions sorted by the NAS waste processing gaps, the Department reshaped the management structure of the program for FY2010 to provide more integrated and concise communications and development of technical approaches. The Integrated Tank Waste Technology Development & Deployment Team structure was instituted in late-November 2009.

The new structure for FY2010 takes advantage of the experience of the laboratory leads and Department leads which are divided into sub-teams reporting to the Director of the Office of Waste Processing. The teams are broken down into four areas, generally representing NAS Gaps WP-1, WP-2, WP-3 and WP-4/5. Once fully staffed in FY2010, the sub-teams will include representatives from site contractors, industry, and university partners. The structure will also allow peer reviews on an as-needed basis using experts from around the Complex, DOE field offices, national laboratories and universities to review and validate program approaches if necessary. The initial organizational structure changes were in-place in early FY2010, with the full sub-team and program review team staffing expected to be in place by mid-fiscal year. Figure 4 (see page 9) shows the new organizational structure for the FY2010 Waste Processing program.

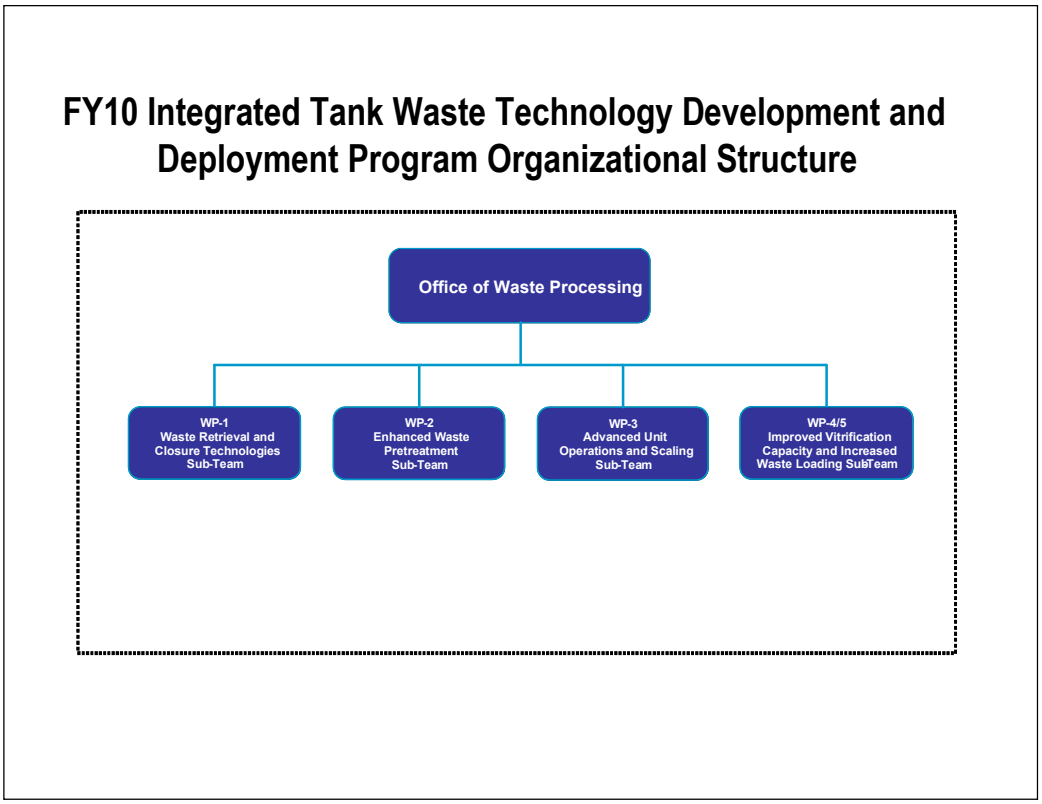

Fig. 4. The Waste Processing program management and organizational structure changed in FY2010 to reflect the technical areas addressing NAS gaps and increased stakeholder involvement.

CONCLUSION

The Waste Processing technology development and deployment program has continued to mature (fiscally and technically) since starting development of the Department's Engineering & Technology Roadmap in 2007. The Department and the Waste Processing program are positioned to transition to a more versatile and integrated program in FY2010 by;

1) Adopting the structure of the NAS Waste Processing technical gaps for technical and management organization,
2) Developing transformational technology approaches to address the NAS gaps, and,
3) Providing an integrated program to develop and deploy transformational approaches needed for the EM tank waste system.

REFERENCES

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