

TECHNOLOGY DEVELOPMENT IN SUPPORT OF WIPP: A TRU STORY

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ABSTRACT

The National Transuranic (TRU) Waste Program (NTP), led by the U.S. Department of Energy's Carlsbad Area Office (CAO), reviews and consolidates TRU waste technology needs from across the DOE complex to provide a frame of reference for evaluating the urgency of resolving specific problems. Once TRU waste technology development programs are funded, the NTP participates in the review and evaluation of technology development activities to ensure that the solutions remain responsive to TRU waste management needs. This paper discusses the TRU waste technology development process and highlights the most pressing DOE complex-wide needs.

INTRODUCTION

TRU waste was created during the design, development, testing, and production of nuclear weapons for the nation's defense program. A fundamental component of the DOE's TRU waste management plan is the ultimate disposal of TRU waste at the Waste Isolation Pilot Plant (WIPP) located in Carlsbad, New Mexico. TRU waste is maintained in storage at DOE sites throughout the nation.

TRU means heavier than uranium, which is the heaviest naturally occurring element. Cleanup of weapons sites and dismantling thousands of weapons will generate more of the manmade waste. Most transuranic waste consists of contaminated laboratory items, tools, dried sludges, and other material from plutonium production facilities.

The term TRU waste means waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years (1).

In order to prepare TRU waste for ultimate disposal at WIPP, new technologies have been developed and are continuing to be developed. The NTP reviews and consolidates TRU waste technology needs from across the DOE complex to provide a frame of reference for evaluating the urgency of resolving specific problems.

TRU waste management needs can be specific to a single site or common among several sites. The NTP assesses waste management technology development needs on a case-by-case basis, prioritizes them according to NTP goals, and then aggressively solicits funding for their fulfillment. This approach also identifies the consequences of not fulfilling these needs (such as requirements in Site Treatment Plans and Consent Orders) and demonstrates how proposed

technology development projects will solve waste management problems. Once TRU waste Technology Development programs are funded, the NTP monitors and assesses these programs to ensure that the solutions remain responsive to the TRU waste management needs.

At first blush, it might seem that as the WIPP opens the need for technology development for transportation and disposal of TRU waste might subside. This is true for those technologies that were needed to demonstrate how the WIPP could safely operate. However, the initiatives currently funded or requested are focused on benefiting the program by reducing the cost of work necessary to send waste to WIPP and by making more waste available for disposal at WIPP. A significant fraction of the existing TRU waste inventory will eventually be packaged in standard waste boxes (SWB), for which few nondestructive assay (NDA) methods have been developed. For example, the Idaho National Engineering and Environmental Laboratory (INEEL), under NTP oversight, is currently developing and deploying such an NDA method. Once it is approved, any site can use it to characterize and ship waste to WIPP without repackaging it into standard drums.

BACKGROUND

As WIPP opens and TRU waste begins to be shipped, DOE sites across the country have stored TRU waste that must be characterized, repackaged, or treated if needed prior to shipping to WIPP for disposal. Total TRU contact-handled (CH) waste stored volumes prior to treatment and repackaging are reported as 104,400 m³. It is estimated that there is another 38,000 m³ of CH TRU waste that will be newly generated from decontamination and decommissioning (D&D) and environmental restoration (ER) efforts throughout the DOE complex, and still another 1,666 m³ of remote-handled (RH) TRU waste. All waste must be characterized to ensure that it is within WIPP waste acceptance criteria (WAC) and the TRUPACT-II and 72B shipping container requirements (2).

If the waste cannot be certified to meet shipping and disposal requirements, then it must be repackaged or treated. This will occur if it is suspected of nonconformance with respect to fissile material content or decay heat. Although this is a problem for all sites, it becomes a major effort for those sites with small quantities of contact- or remote-handled waste or with waste streams containing large, odd-shaped materials.

The DOE's Office of Science and Technology (EM-50) formed the Mixed Waste Characterization, Treatment, and Disposal Focus Area (MWFA) to develop and implement technologies necessary to meet the Department's commitments for characterization, treatment, transportation, and disposal of mixed waste (3). Over the past four years, the MWFA has funded TRU waste technology development activities to assist with various complex wide needs such as:

- Developing innovative nondestructive examination and assay techniques
- Improving waste handling techniques for significant waste streams.

The work of the MWFA is described in the MWFA Annual Plan (3).

The NTP works closely with the MWFA and the TRU Waste Steering Committee to ensure that TRU waste technology development activities most efficiently and effectively meet the needs of the various TRU waste sites. This close working relationship ensures that the money for technology development is spent to meet the most pressing needs. It also ensures that once the technology is developed it will be useful and deployable at the TRU waste sites. The NTP emphasizes working closely with the "end-users," thus the technology being developed can be tailored to effectively meet the needs and will be deployable.

THE TRU WASTE TECHNOLOGY DEVELOPMENT PROCESS

Several years ago, in an effort to involve each DOE site in technology development and deployment, Site Technology Coordinating Groups (STCG) were formed at the various DOE sites. These groups identify, quantify, and prioritize science and technology needs and opportunities that are required so that their site activities are performed safely and result in lower cost and/or accelerated schedules. These needs and opportunities are reviewed annually.

The NTP's mission is to integrate the national TRU waste system to assure that all TRU waste under the purview of the DOE is effectively and systematically managed from generation to disposal. The NTP's major objectives include the following:

- Establish an efficient management system that identifies and resolves complex-wide issues, analyzes alternative management strategies, and implements management strategies that optimize system effectiveness, minimize cost, and support high-level schedule objectives
- Establish a program to identify, characterize, treat, store, transport, and dispose of TRU waste that is not authorized for disposal at WIPP (so that it then becomes eligible for disposal at WIPP) (2).

The mission of the TRU Waste Steering Committee (TWSC) is to provide leadership, vision, and support in developing a systematic approach for managing the NTP. All DOE TRU waste sites are represented on the TWSC. The committee consists of DOE TRU waste managers from each of the sites. Thus, the end-users of any potential technology development are involved both at the end of the process of technology development and also at the beginning because they assist the STCGs with the preparation of need statements (4).

CAO's role is unique as it supports a CAO STCG and participates and directs the activities of the TWSC. Thus, CAO is able to involve technology development end-users from the beginning through the end of any technology development activity. This dual role allows CAO to:

- Work closely with all TRU waste sites
- Understand TRU waste technology development needs from the end-user's perspective
- Ensure that needs are effectively being translated into appropriate work
- Most importantly, to ensure that technology, once developed, is deployed.

THE CAO TRU WASTE TECHNOLOGY DEVELOPMENT STEPS

Step One: the first step in the process is to compile potential TRU waste technology development needs from the various TRU waste sites across the country. These needs are obtained from various sources, including STCG need statements, discussions with TWSC members, discussions with the MWFA, and other focus areas. The NTP as the national program is in close contact with each site through the TRU Waste Steering Committee members as well as regular discussions with TRU waste managers across the complex.

Step Two: once these needs have been compiled and defined as completely as possible the CAO NTP Technical Review Committee (TRC) reviews, categorizes, and subsequently prioritizes these needs.

The mission of the NTP TRC is to provide technical review, evaluation, and initial prioritization of TRU waste technology development and deployment proposals to ensure that TRU waste technology development and deployment activities can resolve present and future site TRU waste needs. The technical objectives of the NTP TRC are to:

- Ensure that the new and innovative technologies are developed to effectively meet site needs of characterizing, handling, and processing TRU waste for disposal at WIPP
- Match site needs with technology development activities to ensure that the National TRU waste management goals and objectives are implemented
- Review proposed activities to ensure proposals are technically sound, implementable, and follow sound scientific methods
- Provide link to emerging technology within the DOE complex and other technology developers at national laboratories and other research and development facilities
- Match new needs provided by individual sites to technology development being done, thus eliminating duplication of effort
- Participate in “go”-“no-go” decisions during technology development process.

Step Three: the TRC reviews the needs that have been submitted from the various sites and places them into the following groups or "bins":

- Technology development needs that are currently being done at some other site
- Technology development needs that need further definition
- Technology development needs that are a low priority and consequently will not go forward
- Technology development needs that have a priority to be funded.

The TRC then communicates directly with the individuals and groups that have submitted the needs to ensure that the groups of needs are further defined and evaluated as necessary.

Step Four: the next step in the process is for the TRC to develop within each grouping the technology development needs that should go forward for funding. At this point in the process the CAO NTP convenes groups of technical experts to review the work that is currently being funded and propose the specificity necessary to define the need and develop the most appropriate path forward for the technology development.

Step Five: after the needs have been carefully defined by the TRC and the technical experts from various DOE sites, they are then submitted to the TRU Waste Steering Committee for further review and validation. After the TRU Waste Steering Committee has validated the needs, the needs are submitted to EM 50 and other funding mechanisms, including EM Integration and the Accelerated Site Technology Deployment program for technology development funding.

Step Six: throughout the entire technology development process the NTP technology development efforts are reviewed carefully with the TWSC and the TRC to ensure that technology development activities are proceeding as expected. The entire process is user-driven in that end-users have significant roles (through both the TWSC and the convening of site TRU waste experts).

Figure 1 depicts the CAO/NTP Technology Development Process.

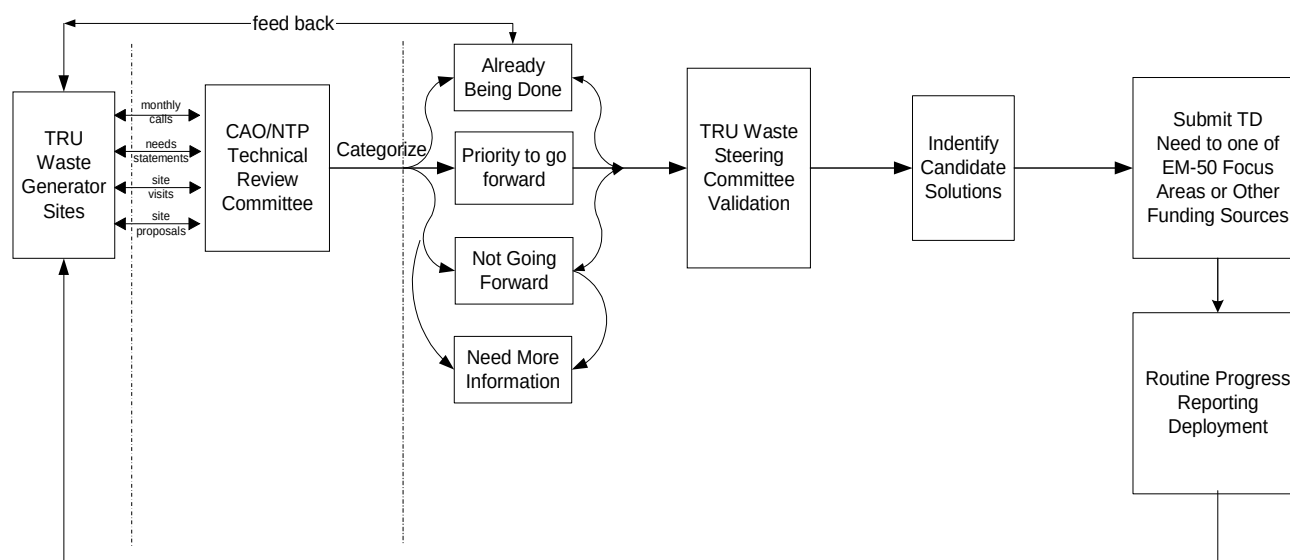


Figure 1: CAO/NTP Technology Development Process

GROUPINGS OF NEEDS

The needs that have been received from the TRU waste sites have been placed into categories. Each of these categories represents a number of needs. These grouping are further defined and the specificity needed to translate these needs into technology development activities is added by the convening of technical experts

The TRC has grouped the needs into the following categories:

Develop Drum Integrity Assessment Techniques

The problem is that a large number of retrievable waste drums (more than 509,000 barrels) have been subjected to various degrees of structural and containment integrity degradation during storage, due to metal corrosion and other chemical or physical processes. As required by the WIPP WAC, those drums must meet DOT Type A container integrity requirements. Waste drum integrity is currently evaluated by visual inspection and physical taping on the drums external surface. The current inspection methods are too subjective and have resulted in a conservative overpack rate of 12.5%. Also, the methods lack the capability to detect corrosion on drum inner surfaces. Therefore, objective container integrity criteria and measures must be developed in order to reduce the current practice conservatism.

Develop Transportation System for High-Wattage Waste

Radiolytic generation of flammable H₂ gas in waste containers is a safety concern for shipping TRU wastes, especially for those containing Pu-238 or a high activity fraction of Pu-239. The concentration of H₂ in a waste container must be assured to be below 5% in volume during transportation. This requirement is currently assured by imposing overly conservative thermal power limits, which have resulted in unnecessary rejection of many drums for shipment. To reduce this conservatism, a technique that can directly measure the actual rate of H₂ gas generation in an individual drum needs to be developed.

Most existing waste is retrievably stored in drums with no vents. According to the current waste characterization requirements, those waste drums must be vented to a predetermined time period as long as years to allow H₂ equilibration before they can be shipped to the WIPP. Similarly, waste drums must be equilibrated for 142-225 days prior to sampling in order to obtain representative gas samples. These long waiting time periods will create a serious interim storage problem and affect the throughput of the whole waste characterization process. It is expected that the actual waiting time periods for most drums are probably much shorter than those currently specified. To improve the efficiency of the waste characterization process, a technique that can directly determine headspace gas equilibration time for each individual drum is needed.

Currently 100% of waste drums are required to be sampled for headspace VOC analysis. In addition to its high cost, this requirement will potentially increase worker exposure to hazardous and radioactive materials. Therefore, there is a need to develop a rapid and convenient screening tool to determine whether VOCs are present in a significant quantity that may require further sampling and analysis. A measurement method is needed to determine the hydrogen gas generation rate so that drums that meet the criteria can be shipped and those that do not can be repackaged to meet the criteria. Actual measurement of hydrogen gas generation is needed rather than only calculations to predict gas generation rates. Accurate measurements will allow responsible decisions to be made regarding the need to repackage drums.

This group of needs also includes needs that require treatment of organic materials to remove the potential for hydrogen gas generation and increase the allowable isotopic loading within the transportation container.

Develop Capability to Assay WIPP-Specific Payload Containers

When equipment, such as glove boxes, mills, lathes, and large HEPA filters, is decommissioned, it is usually decontaminated as much as feasible, and, if it fits, is placed directly into a waste box. For defense-related TRU waste the only boxes accepted by WIPP are the TRUPACT-II standard waste boxes. WIPP requires that an assay, usually nondestructive assay (NDA), of the waste container be performed and that it meet the requirements of the Transuranic Waste Characterization Quality Assurance Program Plan (QAPP). Many sites have only a few boxes, which makes it impractical to purchase a separate box assay device, even if one were available. Without such a device, even if not mobile, large sites will not be able to dispose of a rather large inventory of boxed TRU waste in a timely manner.

Develop Capability to Support Sorting, Segregation, and Size Reduction Needs

A system is needed that will reduce the size of oversize, non-standard TRU waste boxes and their contents to fit into standard waste drums or boxes. The waste packages would then be characterized and shipped to WIPP. The system must be capable of reducing the size of irregularly shaped waste boxes and individual items within the boxes to enable everything to be packaged in standard waste containers acceptable to WIPP. Without such a system, large sites would not be able to conduct NDA of crated waste.

This group of needs also includes those needs for a modular glovebox or cell containment system to provide the capability to sort and repackage mixed and non-mixed drums of Pu-239 and Pu-238 waste, as well as small quantities of remote-handled waste. This modular system could become a major component of a larger facility that would provide the secondary containment, ventilation control, and support facilities required for operation. The system needs to include necessary equipment and capabilities to remotely open drums, remove contents for sorting and segregation, perform general assay, and repackaging contents into new drums or standard waste boxes.

Develop System to Support Sampling Waste Container Headspace Gas without Damaging the Vent

A non-destructive technique to analyze the headspace of TRU and TRU mixed (TRM) drummed waste for organic compounds is desired that will not destroy the integrity of the drum filter. Alternatively, a drum lid filter that does not have to be replaced after sampling would address the need. All drums of TRU and TRM waste to be disposed of at WIPP must have a headspace analysis for flammable volatile organic compounds (VOCs) according to the requirements of the WIPP WAC. Currently, after the headspace of a waste drum is sampled the filter must be replaced since the sampling process destroys the filter. In addition, there is potential to reduce worker exposure to ionizing radiation and hazardous constituents in the waste if an NDA technique is instituted.

Develop Techniques to Enable RH Waste Characterization, Packaging, Shipping, and Declassification

Near-term emphasis for the characterization, certification, and transportation of TRU waste to WIPP has been on CH waste. However, a significant quantity of remote-handled (RH) TRU waste is also planned for disposal at WIPP, with the remote-handling requirement coming from high concentrations of gamma-emitting fission products in the waste. This need is especially critical for some small-quantity sites that have difficulty funding the construction and certification of on-site facilities for the handling, characterization and certification for TRU waste for transport and disposal at WIPP. Mobile vendor teams are now undergoing certification. However, the near-term emphasis for mobile systems is also on CH waste. Some sites have near-term requirements for disposal of RH TRU waste, with large financial consequences if those requirements are not met.

One approach to the volume reduction of RH TRU materials is to decontaminate the items and concentrate the TRU materials in a much smaller volume. Decontamination techniques focusing

on radionuclides removal room for RH-TRU debris may allow re-categorization of the debris into non-TRU waste.

At present there are 3,600 cubic meters of RH-TRU debris in storage and an additional 23,000 m³ are forecast in the transuranic waste disposal inventory for WIPP. A volume reduction technology could reduce these quantities significantly. Selecting a volume reduction technology from existing technologies such as compaction, metal melting, and shredding and converting it to remote operation may require substantial development as well as regulatory review and/or approval.

CONCLUSIONS

The CAO NTP has developed a step-by-step process that:

- Starts with strong emphasis on end-user participation
 - Discussions with each DOE sites's TRU waste manager
 - Discussions with TRU Waste Steering Committee
 - Site visits
 - Conference calls
- Brings together and involves subject matter experts with common problems and the ability to identify innovative solutions
 - Technical exchanges
 - Technical review committee
- Clearly defines needs and problems with specificity so that technology development responds to "real" needs at "real" sites and thus is deployable and useful
 - Technical exchanges
 - Technical review committee
- Involves end-users throughout the technology development process not just at the end
 - Discussions with TRU Waste Steering Committee
 - Technical reviews and evaluation at decision points
- Supports deployment as a complex-wide activity
 - Technical review with the TRU Waste Steering Committee
 - Technical review with complex wide TRU waste managers

The CAO NTP goals of developing technology such that TRU waste can be characterized, certified, loaded, and shipped to WIPP is supported by the NTP's technology development process. WIPP is a critical step toward solving the nation's nuclear waste problem. WIPP is setting the standard for cost-effective, safe, and environmentally sound deep geologic disposal of defense-related radioactive waste. It is the benchmark for the disposal of other categories of nuclear waste. Current temporary storage facilities were never intended to provide permanent environmentally sound disposal. WIPP is essential to reducing risks to public health, workers, and the environment posed by wastes that are now stored at 10 major DOE sites and other

locations across the country. The nation must meet its responsibility to solve this problem so it won't be passed to future generations. As the nation's leader in TRU waste disposal, CAO takes the lead in developing innovative TRU technology development.

ACKNOWLEDGEMENT

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REFERENCES

1. U.S. CONGRESS, Public Law 102-579 102d Congress, "Waste Isolation Pilot Plant Land Withdrawal Act," October 1992.
2. U. S. DEPARTMENT OF ENERGY, "The National TRU Waste Management Plan," DOE/NTP 96-1204, Rev. 1, Carlsbad Area Office, December 1997.
3. U. S. DEPARTMENT OF ENERGY, "Mixed Waste Focus Area Annual Report," DOE/MWFA , 1997.
4. U. S. DEPARTMENT OF ENERGY, "National Transuranic Program Plan," DOE/NTP-94-1040, Carlsbad Area Office, October 1994.