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Mixed Waste Focus Area
Department of Energy Technology Development Needs Identification and Prioritization

1. INTRODUCTION

The Assistant Secretary for the Office of Environmental Management (EM) at the United States Department of Energy (DOE) initiated a new approach in August of 1993 to environmental research and technology development[1]. The key features of this new approach included establishment of five "focus areas" and three "crosscutting technology" programs, which overlap the boundaries of the focus areas. The five focus areas include the Contaminant Plumes Containment and Remediation; Mixed Waste Characterization, Treatment, and Disposal; High-Level Waste Tank Remediation, Landfill Stabilization, and Decontamination and Decommissioning Focus Areas. The three crosscutting technologies programs include Characterization, Monitoring, and Sensor Technology; Efficient Separations and Processing; and Robotics. In addition, an Industrial Programs group has been established to support all of the focus areas and crosscutting programs. The major characteristic of the new approach is that aggressive teaming with the customers within EM, through the focus areas, is used to identify, develop, and implement needed technologies such that the major environmental management problems can be addressed, while cost-effectively expending the funding resources.

2. APPROACH OF THE MIXED WASTE FOCUS AREA

The DOE created the Mixed Waste Characterization, Treatment, and Disposal Focus Area (MWFA) to develop and facilitate implementation of technologies required to meet its commitments for treatment of mixed wastes under the Federal Facility Compliance Act (FFCA), and in accordance with the Land Disposal Restrictions (LDR) of the Resource Conservation and Recovery Act (RCRA). This includes mixed low-level wastes (MLLW) and mixed transuranic (MTRU) wastes. Mixed low-level waste are defined as wastes that contain both hazardous constituents, as identified by RCRA, and radioactive constituents, including alpha-emitting radionuclides below concentrations of 100 nanoCuries per gram. Mixed transuranic wastes contain RCRA contaminants and radioactive contaminants, including alpha-emitting radionuclides with concentrations above 100 nanoCuries per gram.

To accomplish this goal, the technology deficiencies must be identified and categorized, the deficiencies and needs must be prioritized, and a technical baseline must be established that integrates the requirements associated with these needs into the planned and ongoing environmental research and technology development activities supported by the MWFA. The following sections describe these steps.

2.1 Needs Identification and Categorization Process

To define the deficiencies or needs of the EM customers, the MWFA analyzed Proposed Site Treatment

Plans[2] (PSTPs), the *1995 Report of Hanford Site Land Disposal Restrictions for Mixed Waste*, April 1995 (DOE/RL-95-15)[3], as well as other applicable documents, and conducted site visits throughout the summer of 1995. Representatives from the Office of Waste Management (EM-30), the Office of Environmental Restoration (EM-40), and the Office of Facility Transition and Management (EM-60) at each site visited were requested to consult with the Focus Area to collaboratively define their technology needs. Personnel from these programs participated in the MWFA site visit as deemed appropriate by the respective sites.

2.1.1 Site Visit Process

The site visits had several specific purposes: 1) to identify the technology development needs for managing mixed wastes at the DOE sites; 2) to understand the regulatory status/situation at the sites; 3) to status the technology transfer and other privatization efforts at the sites; 4) to identify completed, ongoing, and planned technology development work being conducted by EM-30, 40, 50, and 60 at the sites; and 5) to identify potential matches between current capabilities and defined site technology needs (referred to hereafter as "quick wins").

2.1.1.1 Site Selection. The primary criteria for selecting the sites that the Focus Area would visit was the volume of mixed waste at the site. The data provided in the PSTPs, generated by the individual DOE sites, was analyzed according to waste type to determine the three sites that have the largest volumetric inventory for each category. The waste type categories, namely Wastewaters, Combustible Organics, Homogeneous Solids/Sludges/Soils, Debris/Solids, and Unique Wastes, are defined below.

As a result of this analysis, the following DOE facilities were identified for site visits: the Idaho National Engineering Laboratory (INEL), Savannah River Site (SRS), Hanford Reservation (Hanford), Oak Ridge Reservation (ORR), Ohio Sites (Ohio), Rocky Flats Environmental Technology Site (RFETS), and Albuquerque Sites (AL). The data generated for this evaluation is available upon request.

After the MWFA meetings were completed at the INEL during the month of May 1995, visits were scheduled for each of the identified sites through the contacts provided. The following is the final schedule for those site visits, after some interim revisions.

Savannah River	June 7-9, 1995	Ohio	July 13-14, 1995
Hanford	June 21-22, 1995	Rocky Flats	August 29-30, 1995
Oak Ridge	August 22-23, 1995	Albuquerque	August 1 - 3, 1995

The only site that ranked in the high that was not visited by the MWFA is the Portsmouth Gaseous Diffusion Plant at Piketon, OH. Although the Focus Area did not actually visit this facility, information was received during the Ohio (Fernald) site visit, because the personnel at these facilities have been working together to address similar problems. In addition, during the Oak Ridge Reservation visit, substantial information was received relative to the typical mixed waste streams associated with gaseous diffusion plants. Based on these premises, the MWFA has effectively addressed

the technology needs for approximately 82% of the DOE complex mixed waste inventory.

2.1.1.2 Site Visits. The specific purposes of the site visits were previously listed in this report. These included: 1) identify the technology development needs for managing mixed wastes at the DOE sites; 2) understand the regulatory status/situation at the sites; 3) status the technology transfer and other privatization efforts at the sites; 4) identify completed, ongoing, and planned technology development work being conducted by DOE EM-30, 40, 50, and 60; and 5) identify potential quick wins. This information was gathered to support the primary objective of the MWFA: to incorporate a systems analysis approach in developing an integrated strategy, or technical baseline, for directing mixed waste related technology development activities that will ensure that the EM-30, 40, and 60 customer needs are being met, and that the MWFA program is operating as cost-effectively as possible, while reducing the non-RCRA compliant DOE mixed waste inventory as quickly as practical.

The site visit process is a key element in establishing the framework and defining the specific requirements that must be scheduled and tracked to successfully implement the technical baseline. For this reason, the site visit process was carefully developed to ensure that effective communications are established between the MWFA and the sites, that the required information is obtained from the sites, that the data gathered is well documented and concurred with by the customers, and that a flexible system involving traditional technology development as related to the identified needs, as well as potential quick wins, is being cost-effectively used to support the primary objective of the MWFA.

Prior to each site visit, MWFA support personnel, primarily the Technical Resource Team (TRT), reviewed the PSTPs and other applicable documents that were available to develop an initial assessment of the site's technology development needs. The purposes for doing this were to provide a starting point for discussions pertaining to the site technology development needs, and to gain feedback to determine how accurate the MWFA perception of the site specific situation was. The needs assessments were transmitted to the sites for their review prior to the MWFA visits.

During the MWFA site visits, answers to specific questions related to the sites' needs, capabilities, and program status were sought. These questions, referred to as "Standard Questions for Site Visits", were developed prior to the site visits. The purpose of identifying these standard questions was to ensure that the data required to establish a defensible technical baseline was collected to the greatest extent practical. These questions also greatly enhanced the productivity and efficiency of the MWFA visits. A copy of the Standard Questions for Site Visits is available upon request.

The information obtained through the site visits and the initial needs assessments will be incorporated into the technical baseline. Some needs will define specific technology gaps in the treatment systems identified for the waste types, while others will be general system needs. The technology development needs and potential quick wins identified provide the customer defined justification for the technical baseline.

2.1.2 Needs Categorization Process

As previously mentioned, the needs identified during the site visits were categorized by waste type, namely

Wastewaters, Combustible Organics, Homogeneous Solids/Sludges/Soils, Debris/Solids, and Unique Wastes. These waste types are defined as follows:

Wastewater waste streams, which comprise approximately 3% of the total DOE Complex mixed waste inventory, include liquids and slurries. Slurries are defined as liquids with a total suspended solids (TSS) content greater than 1% and less than 30%. Liquids and slurries defined as Waste Waters contain less than 1% total organic carbon (TOC).

Combustible Organic waste streams, which comprise approximately 1.5% of the total DOE Complex mixed waste inventory, include liquids and slurries containing greater than 1% TOC, and solids with a base structure that is primarily organic such that a maximum of approximately 20% by weight would remain as residue following incineration. Solids are defined, including sludges, as having greater than 30% TSS.

Homogeneous Solids/Sludges/Soil waste streams, which comprise approximately 48% of the total DOE Complex mixed waste inventory, include waste that is at least 50% by volume inorganic sludges, including water content. Sludges are defined as having a TSS greater than 30%. A sludge may be a mixture with a stabilization agent that has not properly solidified, or may be a mixture with absorbent materials. This category also includes inorganic particulate, paint waste, and salt waste.

Debris/Solid waste streams, which comprise approximately 46% of the total DOE Complex mixed waste inventory, include waste that is at least 50% by volume materials that meet the EPA LDR criteria for classification as debris (..."material exceeding a 60 mm particle size that is intended for disposal...") This category also includes waste that is estimated to be 50% by volume soil, including sand or silt, rock, or gravel which does not meet the EPA LDR criteria for debris.

Unique Wastes, which comprise approximately 1.5% of the total DOE Complex mixed waste inventory, generally include low volume waste streams such as elemental heavy metals, batteries, reactive metals, explosives, compressed gases, lab packs, and other miscellaneous wastes that present unique treatment problems and are not included in the previously defined categories. It also includes the Final Waste Form and Unknown/Other category wastes [Z and U series waste streams identified in the *DOE Waste Treatability Group Guidance*[4] document, (DOE/LLW-217), January 1995].

2.1.3 Waste Type Manager Selection Process

During the site visit process, the MWFA initiated an effort to identify individuals with a strong background in each waste type, to provide leadership in managing the waste streams in each waste category. These individuals serve as a necessary resource to ensure that the identified needs, as related to the established technical baseline, are met such that the waste types can be brought into compliance with the applicable regulations.

Waste Type Managers (WTMs) were selected from experienced leaders, proposed by the sites in the DOE Complex, through an open nomination process. The WTMs will use a systems analysis approach to develop the technical baseline that the MWFA will implement to meet the identified DOE complex mixed

waste needs.

Although the MWFA is an EM-50 program, the customers are EM-30 (primarily), EM-40, and EM-60 organizations throughout the DOE Complex. As previously stated, the mission of the Focus Area is to identify, develop, and implement technologies needed by the EM customers to allow treatment of the DOE mixed waste inventory. For this reason, the MWFA desired to identify lead individuals for each waste type with a broad experience base in the waste type, and an EM-30 or 40 background. The insight, complex-wide contacts, and knowledge that these individuals can provide are crucial if the Focus Area is to effectively address and resolve the customers needs.

In every case, the primary WTM selected has come from an EM-30 environment. In *almost* every case, the individual chosen to be the WTM for a given waste type is employed at the site that has the largest inventory of that waste type.

2.2 Needs Prioritization Process

The needs identified by the DOE Complex during the site visits were compiled and documented in the *Mixed Waste Focus Area Department of Energy Technology Development Needs Report* (Needs Report), November 1995 (INEL-95/0555)[5]. Several categories of needs and deficiencies are identified in the Needs Report. These deficiencies and technology gaps are broadly categorized as waste type specific and general, non-waste type specific needs. The waste type specific needs are further categorized as general and site specific needs. The non-waste type specific deficiencies and needs are grouped as waste characterization, container integrity, waste handling, treatment system, and programmatic needs. Over 70 specific needs were identified through the site visits and the information obtained from the PSTPs and other applicable documents. As previously stated, these deficiencies and gaps are included in the MWFA Needs Report. Consequently, they will not be included in their entirety in this document; however, each need listed in the Needs Report has a unique identifying number that can be used to reference specific deficiencies and technology gaps.

During October 1995, the WTMs, the TRT, and the Technical Support Team (TST) finalized and implemented a prioritization process to evaluate identified deficiencies and technology gaps related to treatment of the mixed waste in the DOE Complex. The purpose of this prioritization activity was to establish the FY1997 technical baseline for the MWFA. This baseline forms the foundation of the technology development activities that will be supported by the Focus Area. Comprehensive integration of the needs defined through the site visit process into the prioritization process was imperative to accomplish the mission of the MWFA.

2.2.1 Needs Integration Into the Prioritization Process

The WTMs, with support from the TRT and TST, developed an initial list of the technology gaps associated with the process flow diagrams that were defined for the respective waste types. These needs were identified based on the technologies included in the treatment trains associated with the treatment process flow diagrams developed by the WTMs. The treatment process flows were generated based on the

preferred treatment options identified by the sites in the PSTPs, in conjunction with the process flow diagrams that had been generated during development of the DOE Programmatic Environmental Impact Statement (PEIS). The primary resource documents for this data were the *Mixed Waste Treatment Model: Basis and Analysis*[6], September 1995 (LA-13041-MS), and *Analysis of Waste Treatment Requirements for DOE Mixed Wastes*[7], February 1995 (BCMusgrave Inc., Livermore, CA).

The technology gaps identified by the WTMs and TRT were then compared to the needs and deficiencies listed in the Needs Report, previously mentioned. Although over 70 needs were initially identified, only 30 were considered for evaluation in the MWFA Technical Baseline Prioritization Process. This reduction was due to several factors. Some of the needs were identified for more than one waste type, which resulted in duplications. These were combined into one overall need statement. Other needs identified were very site specific, and not generally applicable to a significant volume of waste within a waste type. These deficiencies were removed from consideration in this prioritization process. However, they will be considered on a case-by-case basis as potential "quick wins", as discussed below. Some of the remaining deficiencies listed in the Needs Report are clearly more applicable to other focus areas and/or crosscutting programs. A mechanism is being established to transmit this information to other programs and track the dispositions of these identified needs. Finally, some of the deficiencies included in the Needs Report were programmatic in nature or related to MWFA policy definition. These needs were not amenable to the prioritization process, since it was developed to perform evaluation of technical gaps and deficiencies.

2.2.2 Prioritization of the Needs

After the initial evaluation and disposition of the identified technology gaps and deficiencies, the remaining needs were generalized and rolled up into 30 deficiency categories. These 30 "needs" were then prioritized using a three-phase evaluation process. The first phase of the prioritization process included definition and prioritization of process flows. Phase two included identification and prioritization of the technology deficiencies and needs associated with these process flows. Phase three integrated the separate prioritization processes completed in the first two phases to develop a final prioritized list of needs associated with the defined process flows.

Both quantitative and qualitative criteria were used to evaluate the treatment process flows and technology deficiencies. The set of criteria used to prioritize process flows was not the same as the criteria used to prioritize the deficiencies. In addition, each criteria was weighted based its relative importance within the prioritization framework.

2.2.2.1 Phase I: Identification and Prioritization of Treatment Process Flows. The first step of the prioritization process used by the MWFA included identification and prioritization of the treatment process flows. This was accomplished by utilizing the analysis and evaluation previously performed by the DOE sites during the PSTP development process. In addition, the process flow diagrams developed in support of the Programmatic Environmental Impact Statement (PEIS) were used as reference. Based on these two sources, treatment process flows were developed for every mixed waste stream in the DOE inventory.

Based on the previously defined needs, the flow sheets were included in the prioritization only if a need

existed in that process flow. Based on this evaluation, 17 treatment process flows were prioritized. The evaluation was based on quantitative and qualitative criteria, with individual weightings. The criteria, weight, and scale of merit used to prioritize the treatment flow processes are presented in the table below.

Table 2.1 Treatment Process Flow Prioritization Criteria

Criteria	Weight	Scale of Merit
Volume of waste	14%	1,2,3,4,5 (based on defined quantity levels)
Number of customers	8%	1,2,3,4,5 (based on number of sites that have waste applicable to this process flow)
Number of waste streams	10%	1,2,3,4,5 (based on the number of waste streams in a waste type applicable to this process flow)
Maturity	25%	1,2,3,4,5 (based on the time to implement the technology)
Waste Hazard	8%	1,3,5 (based on relative hazard associated with current configuration of waste: RCRA storage, inadvertent spill, corrosive/reactive liquid or gas release)
Extent of DOE Commitment	20%	1,3,5 (based on DOE agreements relative to the process flow: Consent Order, DNFSB recommendation, or no formal agreement)
Potential Economic Savings	15%	1,3,5 (based on expected life-cycle cost relative to the cost of the baseline process flow, as identified in the PEIS)

2.2.2.2 Phase II: Prioritization of Technology Deficiencies and Needs. The needs that had been identified were evaluated to a different set of criteria in the second phase of the prioritization process. These included quantitative and qualitative criteria, as before, but the specific criteria were different. These are listed in the following table.

Table 2.2 Technology Deficiency Prioritization Criteria

Criteria	Weight	Scale of Merit
Number of process flows	14%	1,,3,,5 (based on the number of flow sheets for which the deficiency has been defined)
Number of gaps in the process flow	7%	1,2,3,4,5 (based on number of additional deficiencies in the process flow, where lowest number ranks highest)
Hazard addressed	9%	1,3,5 (based on the relative operating hazard i.e. ALARA, questionable safety margins, OSHA/DOE standards
Maturity	12.5%	1,3,5 (based on the amount of R&D required, ranging from applied R&D to adaptation of commercial technology)
Critical Path	25%	1,3,5 (based on relative importance of need to critical path for the process flow)
Functional Requirements	12.5%	1,3,5 (based on the relative level of development of the standards that will be satisfied due to resolution of the need)
DOE Commitments	20%	1,3,5 (based on DOE agreements relative to the process flow: Consent Order, DNFSB recommendation, or no formal agreement)

2.2.2.3 Phase III: Integration of Phase I and Phase II Prioritizations. The final, and most difficult, step of the MWFA Technical Baseline Prioritization Process involved combining the separate prioritizations of technology needs and treatment process flows into a single, integrated prioritization. Several methods for combining these independent prioritizations were considered. Some techniques were quantitative, such as multiplying technical deficiency scores by the applicable process flow scores. Other methods were qualitative, such as using a graphical approach to determine the highest frequency for combinations of high priority process flows and deficiencies.

The latter method was chosen because, since the prioritization of the deficiencies accounted for frequency of flow sheets that the need was applicable to, a legitimate method for mathematically determining a score

could not be identified that did not give double credit for applicability to multiple treatment process flows. Consequently, the final integrated prioritization was accomplished by constructing a matrix with the 17 prioritized process flows listed horizontally across the top and the 30 prioritized deficiencies listed vertically down the left side. The matrix was then quartered, with the upper left portion given highest priority, followed by the upper right portion, then the lower left portion, with the lowest priority section being the lower right portion. The deficiencies were then ranked according to their frequency within each quarter, and the priority of each quarter. This lead to a final, integrated prioritization for the deficiencies identified for the DOE mixed waste inventory.

2.3 Quick Wins Disposition

As previously stated, "quick wins", as well as identified needs with characteristics similar to quick wins, were not considered in the MWFA Technical Baseline Prioritization Process. This is because these activities are usually site specific and address small waste volume problems. A broad range of activities may be classified as quick wins, but these can generally be categorized into the following four areas.

1. Tasks that provide opportunities to transfer technologies between sites, resulting in expedited treatment schedules and/or reduced costs.

2. Tasks that provide for expedited treatment of actual mixed wastes through RCRA treatability studies, preferably eliminating the target waste stream at the treatment site.

3. Tasks that resolve regulatory issues, allowing expedited treatment of mixed waste.

4. Tasks that provide for more efficient utilization of existing equipment and capabilities within the DOE complex in treating mixed.

Presently, almost 30 quick win opportunities have been identified, and additional quick wins will most likely be defined as the WTMs continue to further analyze their respective waste streams. A modified form of the evaluation process and criteria utilized to prioritize the DOE Complex mixed waste needs will be used to prioritize the quick wins, as required. Prioritization of quick wins will generally be a continuous process, rather than a scheduled, concentrated effort like the needs prioritization process. A set funding level will be established specifically for addressing quick wins, and as the quick wins are prioritized, the available budget will determine the activities that are supported by the MWFA.

2.4. Implementation Into the Technical Baseline

One of the most important aspects of the entire site visit process is close coordination with the EM-30, 40, and 60 customers in identifying their priority needs and concerns. Dissemination of the data collected into the technical baseline is critical in providing an integrated systems approach to addressing the needs of the MWFA customers. Accordingly, the technical baseline, which will be managed by the waste type managers (WTMs), discussed below, and their support teams, will be evaluated semi-annually, and the supporting projects will be reviewed quarterly to ensure that the EM-30, 40, and 60 priority needs are

being met in the most timely and cost-effective manner.

The term "technical baseline" refers to the strategic plan that the MWFA will establish to resolve the needs identified by the DOE Complex during the site visit process. The technical baseline will consist of a set of technology development activities supported by the Focus Area that address the highest priority deficiencies related to management of the mixed waste inventory in the DOE Complex. Every activity included in the MWFA technical baseline will directly address a prioritized need, deficiency, or technology gap identified by the DOE EM customers.

The prioritized needs and technology deficiencies will be used by the WTMs as the major input into development of the MWFA technical baseline. This baseline will be an integrated strategy that incorporates sound engineering judgement, the site identified technology needs, and cost-effective planning to define the most efficient system for treating the DOE complex mixed waste. However, the MWFA does not have the resources to address every need or investigate every potential quick win that supports the technical baseline, in any given fiscal year. This is why the identified needs have been prioritized and the, quick wins will prioritized, such that the greatest affect is realized for the DOE complex.

The framework of the technical baseline will be the treatment process flows that have been developed for all of the waste types. The prioritized needs will be related to these process flows and directed calls for proposals will be issued to the DOE complex to address these needs. The technical task plans (TTPs) that are received in response to these calls will then have to be prioritized.

Prioritization of the individual TTPs that implement the technical baseline is a multiple tiered process. The priority of the TTP is based not only on the technical merits of the proposed work, but also on the priority of the "need" that it addresses. The priority of the "need", as previously defined, is based on the priority of the treatment process flow system or systems that it is associated with, as well as the priority of the deficiency itself. The MWFA TRT, in conjunction with the WTMs, is presently developing the prioritization system necessary evaluate TTPs, which will define the technology development activities that are supported by the MWFA.

Once the technology development work within the MWFA has been prioritized, the details of the technical baseline will be established. However, the DOE system is very dynamic and constantly changing. That is why, as previously stated, the technical baseline, which will be managed by the WTMs and their support teams, will be evaluated semi-annually, and the supporting projects will be reviewed quarterly to ensure that the EM-30, 40, and 60 priority needs are being met in the most timely and cost-effective manner. As the situation in the DOE complex mandates changes to the technical baseline, the WTMs will use subsequent directed calls for proposals to address new/different needs. The prioritization system developed will be used to evaluate the TTPs that are submitted in response to these directed calls to ensure that the work supported by the MWFA continues to be as efficient as possible.

3. CONCLUSION

The initial data developed by the MWFA, and presented in this report, is an excellent step toward defining, addressing, and resolving the needs of the EM-30, 40, and 60 customers in the DOE complex. The

information collected to date is recognized as the *beginning*, and substantial refinement of this compilation will be accomplished in the ensuing months. Consequently, this report is considered to be a "living" document that will be updated at least annually. As the technical baseline becomes more mature, it will be more fully defined in this report.

The quarterly and semi-annual reviews of the MWFA program, previously defined, will ensure that the customer needs are identified, addressed, and eventually resolved. In addition, these reviews will ensure that the strategy for accomplishing this is properly documented.

The use of directed calls for proposals, which is a departure from the historical approach of issuing general calls for proposals, is seen as one of the most useful tools that the MWFA will have. Technically specific calls for proposals will be issued that are directed at resolving particular customer needs. This process is so beneficial because it allows the MWFA to consistently make comparative evaluations of proposals, ensuring that the prioritization process produces the most efficient, cost-effective, timely decisions. The end result will be a technically defensible, documented baseline that is guaranteed to meet the EM-30, 40, and 60 needs, as they are defined at the time of evaluation.

4. REFERENCES

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