DOE/ID-10524

Volume 1

Revision 0

January 16, 1996

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**Mixed Waste Focus Area
Integrated Technical Baseline Report
Phase I - Volume 1**

Mixed Waste Focus Area

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**Mixed Waste Focus Area
Integrated Technical Baseline Report
Phase I**

Published January 1996

Idaho National Engineering Laboratory

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Idaho Falls, Idaho 83415**

**Prepared for the
U.S. Department of Energy**

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ABSTRACT

The Department of Energy (DOE) established the Mixed Waste Characterization, Treatment, and Disposal Focus Area (MWFA) to develop and facilitate implementation of technologies required to meet the Department's commitments for treatment of mixed low-level and transuranic wastes. The mission of the MWFA is to provide acceptable treatment systems, developed in partnership with users and with participation of stakeholders, tribal governments, and regulators, that are capable of treating DOE's mixed waste. These treatment systems include all necessary steps such as characterization, pretreatment, and disposal. To accomplish this mission, a technical baseline is being established that forms the basis for determining which technology development activities will be supported by the MWFA. The technical baseline is the prioritized list of deficiencies, and the resulting technology development activities needed to overcome these deficiencies. This document presents Phase I of the technical baseline development process, which resulted in the prioritized list of deficiencies that the MWFA will address. A summary of the data and the assumptions upon which this work was based is included, as well as information concerning the DOE Office of Environmental Management (EM) mixed waste technology development needs. The next phase in the technical baseline development process, Phase II, will result in the identification of technology development activities that will be conducted through the MWFA to resolve the identified deficiencies.

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EXECUTIVE SUMMARY

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. The key feature of this new approach included establishment of five "focus areas" and three "crosscutting" technology programs, which address issues that are common to multiple 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, the Industrial Programs Group has been established to support all focus areas and crosscutting programs. The major characteristic of the new approach is aggressive teaming with the customers within EM. This teaming approach 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.

The Mixed Waste Characterization, Treatment, and Disposal Focus Area (MWFA) was formed to develop and facilitate implementation of technologies required to meet the Department's commitments for characterization, treatment, and disposal of mixed low-level and transuranic wastes. The Idaho National Engineering Laboratory (INEL) has been identified as the Lead Organization for management of the MWFA. To successfully implement DOE's planned approach, the MWFA uses unique capabilities and expertise from across the DOE complex.

The mission of the MWFA is to provide acceptable treatment systems, developed in partnership with users and with participation of stakeholders, tribal governments, and regulators, that are capable of treating DOE's mixed waste. These treatment systems include the necessary associated steps such as waste characterization, pretreatment, and disposal. To accomplish this mission, this technical baseline is being established to form the basis for determining the specific technology development activities that will be supported by the MWFA. The technical baseline is the prioritized list of deficiencies, and the resulting technology development activities to resolve these deficiencies, that the MWFA will pursue. A deficiency represents some roadblock related to a technical aspect of characterization, treatment, or handling of mixed waste. The purpose of the technical baseline is to (a) provide strong technical justification for funded technology development, (b) tie technology development activities to customer needs, (c) systematically integrate technology development activities, and (d) develop technologies only when they are not commercially available.

The MWFA has categorized all mixed waste streams into five waste types. These five waste types, which are based upon waste characteristics that require similar treatment and waste management activities, are used as a basis to categorize the mixed waste technology development activities within the MWFA. The five MWFA waste types are (1) wastewaters, (2) combustible organics, (3) homogeneous solids and soils, (4) debris, and (5) unique wastes. To ensure that technology development activities are tied to customer needs, the MWFA recognized a need for strong customer input in the technical baseline development and implementation process. The MWFA has addressed this need by a strong teaming arrangement with the EM customer organizations. The Waste Type Manager (WTM) positions, which are key to developing and implementing the entire MWFA strategy, have been filled with individuals that are members of the MWFA's customer organizations (Office of Waste Management, EM-30; Office of Environmental Restoration, EM-40; and Office of Nuclear Material and Facility Stabilization, EM-60). These WTMs were selected from experienced leaders, proposed by the sites in the DOE complex,

through an open nomination process. The WTMs direct the development and demonstration of technologies that are responsive to customer needs and that achieve compliance with regulatory requirements for treating and disposing of the mixed waste within their respective waste type.

The technical baseline development process has been divided into two phases. Phase I of the process, which is documented in this report, included the development and prioritization of process flow diagrams, the identification and prioritization of the associated technology deficiencies, and the integration of these two prioritized lists. This phase resulted in the prioritized list of deficiencies that the MWFA will address. Phase II of the technical baseline development process will include an examination of current and proposed activities in light of the identified deficiencies. The second phase will result in the technical strategy which will include identification of the specific technology development activities that will be supported by the MWFA. As such, the technical baseline will form the basis for the fiscal year (FY)-1997 MWFA funding strategy.

Phase I of the technical baseline development process did not include tribal and stakeholder inputs. This input will be gained during several steps in the second phase of the technical baseline development process, including but not limited to, the identification of needs, the development of prioritization criteria, and proposal review and selection.

A detailed systematic approach, shown in Figure ES-1, was used to develop Phase I of the technical baseline. First, the current inventory of DOE mixed waste was analyzed and sorted into the five waste types and then further sorted by whether treatment for the waste currently existed (Waste Category A, treatment exists onsite; B, treatment exists offsite; or C, no treatment currently exists). Drawing upon the DOE sites' Proposed Site Treatment Plans (PSTPs) and previous studies where possible, treatment systems were identified for DOE's mixed waste. These treatment systems included all of the steps necessary to treat the waste, including characterization and pretreatment, treatment, off-gas systems, and final waste form. Varying levels of detail on these treatment systems were needed for different steps within Phase I of the technical baseline development process. The highest level treatment system, with the least detail, was documented in block diagrams. The next level of detail was provided in process flow diagrams. Additional detail was provided in treatment trains. The block diagrams, process flow diagrams, and treatment trains are shown in the appendices of this document.

Identification of DOE's mixed waste technology development needs is a key input to ensuring that the MWFA is addressing those needs. To define the needs of the EM customers, the MWFA analyzed PSTPs, as well as other applicable documents, and conducted site visits throughout the summer of 1995. The MWFA visited sites under the purview of the Albuquerque, Idaho, Oak Ridge, Ohio, Richland, Rocky Flats, and Savannah River Operations Offices.

Using the needs identified from the DOE sites and the expertise of the WTMs and the Technical Resource Team (TRT) (a team of technical experts from across the nation) mixed waste technology development deficiencies were identified within the various treatment system process flow diagrams. Separate prioritization criteria were prepared to prioritize the process flow diagrams and the individual deficiencies. These prioritization criteria were reviewed by experts across the DOE complex, and then were applied in the technical baseline development process to produce the prioritized list of technology deficiencies.

Figure ES-1. Technical baseline development process - Phase I.

Technical Recommendations

Through the process described in this report, the MWFA has identified and prioritized the technical deficiencies that exist for mixed waste management. The technical recommendations, which include the prioritized list of technology deficiency areas that will be supported by the MWFA, are shown in Table ES-1.

Table ES-1. Prioritized integrated list of mixed waste technology deficiencies.

Technology Deficiency	Description
1. Mercury stabilization	Mercury contaminated wastes require stabilization to control mercury solubility to meet Universal Treatment Standards (≤ 0.2 ppm).
2. Mercury amalgamation	Methods and equipment designs are required for amalgamating bulk non-recyclable mercury to meet Universal Treatment Standards (≤ 0.2 ppm)..
3. NDE/NDA-initial characterization	Nondestructive examination (NDE) and nondestructive assay (NDA) techniques and equipment are required to determine the nature of the waste matrix in drums and boxes, confirm the presence and concentration of RCRA regulated materials and radionuclides, and identify characteristics of concern for operational safety and process continuity.
4. Mercury separation/removal	New techniques must be developed to physically or chemically remove mercury from wastes as a pretreatment to simplify downstream operations.
5. Material handling	Methods and equipment designs are required that will provide for handling all types of DOE waste materials in all process steps without undue risk of exposure of operating personnel to radioactivity.
6. Sorting/segregation	Efficient separation of waste types, as well as segregating nonradioactive, or radioactive only (no RCRA regulated constituents) from mixed wastes is needed for safe, reliable, efficient processing.
7. Salt stabilization	Stabilization processes are required that increase waste loadings, improve durability, and/or reduce the volume increase typical of today's standard practices.
8. Ash stabilization	Stabilization processes are required for this ash that increase waste loadings, improve durability and/or reduce the volume increase typical of today's standard practices.
9. Mercury monitoring	Though mercury monitors are commercially available, it would be advantageous to develop real-time monitors requiring minimal consumables and low maintenance, with operating ranges covering the emission limits typical of incinerators.
10. Alpha monitoring	Though alpha monitors are commercially available, it would be advantageous to develop real-time monitors requiring minimal consumables and low maintenance, with operating ranges covering the emission limits typical of alpha material processing facilities.

Table ES-1. continued.

Technology Deficiency	Description
11. VOC monitoring	Process monitoring could be improved with real-time monitors requiring minimal consumables and low maintenance, which can identify specific contaminants in operating ranges covering the emission limits typical of hazardous waste treatment facilities.
12. Heavy metal monitoring	Process monitoring could be improved with real-time monitors requiring minimal consumables and low maintenance, which can identify specific metals in operating ranges covering the emission limits typical of hazardous waste incinerators.
13. Radionuclide distribution/partitioning	More complete information on the fractional distribution of radionuclides between the off-gas, the final waste form, and any secondary waste streams in high temperature mixed waste treatment processes is needed to support equipment design and process permitting.
14. Waste form performance	An objective, technically defensible evaluation of the long-term performance of advanced waste forms must be conducted to allow flexibility in siting and operating low-level waste (LLW) disposal facilities in a manner to best exploit the more durable, higher waste-loading forms.
15. HEPA filter improvements	A stronger, high-temperature, longer lived HEPA filter, that can survive a greater pressure drop, and that requires less frequent replacement, or that can be cleaned and reused, is needed.
16. Mercury filter	A potential enhancement to traditional offgas treatment design would be a selective mercury removal step, which removes essentially all of the mercury from the off-gas stream for separate treatment.
17. Molten product - decanting	Operating techniques and equipment design are required to facilitate decanting or transfer of molten materials from furnaces in an effective, reliable, and safe manner applicable to a radioactive environment.
18. Comparative analysis/aqueous	A comparative analysis on the efficacy, reliability, applicability, and maintainability of the many processes now being developed for destruction of organic contamination in wastewaters containing radionuclides must be done to select two or three processes for further development.
19. Aqueous organic nonthermal destruction	Destruction/removal of most regulated organic constituents expected to be found in wastewaters from mixed waste treatment should be demonstrated to reliably attain regulatory limits in a manner applicable to a radioactive environment.
20. Refractory performance	Improved refractories, or operating techniques better suited to the DOE-specific waste processing conditions, are required to increase long-term refractory reliability.
21. Nitrate removal	Methods are needed to destroy or remove residual nitrates in sludges and wastewaters.

Table ES-1. continued.

Technology Deficiency	Description
22. Fission product removal	Methods are needed for removal or significant reduction of the concentrations of fission products from mixed waste, especially process residues and sludges.
23. Internal drum pressure measurement	Methods are needed to measure internal drum pressure without penetrating the drums.
24. Container integrity measurement	Methods are needed to test the integrity of stored containers to identify any containers that may require particularly careful handling or overpack in preparation for management or processing of the contents.
25. Cyanide destruction	Methods are required to treat cyanide in the presence of interfering dissolved, suspended, and matrix materials.
26. Thermal desorption	Methods are required to minimize pretreatment to adequately prepare wastes for thermal desorption so the contaminants can escape, and to verify cleanup levels can be attained while maintaining radionuclide containment.
27. Evaporator design	Better designs are needed for evaporators for DOE waste-specific treatment plant streams.
28. Sludge washing	Sludge washing technologies should demonstrate reliable feed preparation and washing of contaminated process residues, sludges, and particulates to satisfy RCRA requirements.
29. Trace metal removal	Techniques are needed to meet wastewater discharge permit requirements (e.g. 0.001 mg/L cadmium, 0.003 mg/L lead, and 0.004 mg/L silver) while minimizing secondary waste generation.
30. Supercritical CO ₂	Techniques are needed to minimize pretreatment to adequately prepare the wastes for supercritical CO ₂ extraction so that the organics can be removed, and the wastes can be fed and removed from the supercritical environment while maintaining radionuclide containment.

Phase II of the technical baseline development process will result in the identification of specific technology development activities that will be supported by the MWFA to resolve the identified deficiencies. These specific technology development activities, developed with public and tribal input, will comprise the integrated technical baseline, for the FY-1997 MWFA funding strategy.

During this process, several issues and activities were identified that must be addressed to implement this funding strategy. These activities are described in Section, Issues and Assumptions, and Section, Path Forward, of this document. The technical baseline document, when both phases are completed, will be a living document. The document will be updated periodically to contain the most complete and accurate technical basis for MWFA activities.

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ACRONYMS

AMWTP	Advance Mixed Waste Treatment Project
CIF	Consolidated Incineration Facility
CPC	Chemical Parameter Categories
DOE	U. S. Department of Energy
EM	Environmental Management
EPA	U. S. Environmental Protection Agency
FFCA	Federal Facility Compliance Act
HEPA	high-efficiency particulate air
HLW	high-level waste
INEL	Idaho National Engineering Laboratory
IWPF	Idaho Waste Processing Facility
LANL	Los Alamos National Laboratory
LDR	Land Disposal Restriction
LLW	low-level waste
MLLW	mixed low-level waste
MPC	Matrix Parameter Categories
MTRU	mixed transuranic
MTU	mobile treatment unit
MWFA	Mixed Waste Focus Area
MWIR	Mixed Waste Inventory Report
NDA	nondestructive assay
NDE	nondestructive examination
ORNL	Oak Ridge National Laboratory
PCB	polychlorinated biphenyl
PEIS	Programmatic Environmental Impact Statement
PI	principal investigator
PSTP	Proposed Site Treatment Plan
R&D	research and development
RCRA	Resource Conservation and Recovery Act
RF	Rocky Flats
RPC	Radiological Parameter Categories
SRS	Savannah River Site
STP	Site Treatment Plan
TBD	to be determined
TCLP	Toxic Characteristic Leach Procedure
TRT	Technical Resource Team
TSP	Technical Support Program
TST	Technical Support Team
TTP	Technical Task Plan
TRU	transuranic
VOC	volatile organic compound
WAC	waste acceptance criteria
WIPP	Waste Isolation Pilot Plant

ACRONYMS continued

WTM	Waste Type Manager
WTT	Waste Type Team

Mixed Waste Focus Area Integrated Technical Baseline Report Phase I

1. MIXED WASTE FOCUS AREA TECHNICAL OVERVIEW

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 for environmental research and technology development. The key features of this new approach included establishment of five "focus areas" and three "crosscutting technology" programs, which address issues common to multiple 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 technology programs include Characterization, Monitoring, and Sensor Technology; Efficient Separations and Processing; and Robotics. In addition, the Industrial Programs Group has been established to support all of the focus areas and crosscutting programs. The major characteristic of the new approach is aggressive teaming with the customers within EM. This teaming approach is used to identify, develop, and implement needed technologies such that the major environmental management problems can be addressed, while cost-effectively expending the available resources.

The Mixed Waste Characterization, Treatment, and Disposal Focus Area (MWFA) was formed to develop and facilitate implementation of technologies required to meet the Department's commitments for treatment of mixed wastes, including mixed low-level waste (MLLW) and mixed transuranic (MTRU) waste under the Federal Facility Compliance Act (FFCA), and in accordance with the Land Disposal Restrictions (LDRs) of the Resource Conservation and Recovery Act (RCRA). The Idaho National Engineering Laboratory (INEL) has been identified as the Lead Organization for the technical management of the MWFA. To successfully implement the DOE's planned approach, the MWFA uses unique capabilities and expertise from across the DOE complex.

The mission of the MWFA is to provide acceptable treatment systems (including the associated steps from characterization through disposal), developed in partnership with EM users and with participation of stakeholders, tribal governments, and regulators, that are capable of treating DOE's mixed waste. To accomplish this mission, a technical baseline is being established for determining which technology development activities will be supported by the MWFA. The technical baseline is the prioritized list of deficiencies that the MWFA will support, along with the associated technology development activities. A deficiency represents a roadblock related to a technical aspect of characterization, treatment, or handling of mixed waste. The purpose of the technical baseline is to (a) provide strong technical justification for funded technology development, (b) tie technology development activities to customer needs, (c) systematically integrate technology development activities, and (d) develop technologies only when they are not commercially available. Resources available to the MWFA cannot support duplicative efforts at multiple sites, or repetitive demonstrations of essentially the same technology. The funding will be directed to provide the most progress overall in support of the requirements of the FFCA and the DOE-EM mission of responsible management and disposition of mixed wastes. The MWFA operating philosophy is to only fund tasks that have user endorsement.

To ensure that technology development activities are tied to customer needs, the MWFA recognized the necessity of strong customer input in the technical baseline development and

implementation process. The MWFA has addressed this need by a strong teaming arrangement with the EM customer organizations. The MWFA has categorized all mixed waste streams into five waste types. These five waste types are used to allocate the mixed waste technology development activities within the MWFA. The waste types are based on the treatability groups defined in the DOE Waste Treatability Guidance, DOE/LLW-217, which was generated as part of the FFCA process. The five MWFA waste types are (1) wastewaters, (2) combustible organics, (3) homogeneous solids and soils, (4) debris/solids, and (5) unique wastes.

Waste Type Managers (WTMs) were selected from across the DOE complex to direct the development and demonstration of technologies that are responsive to customer needs and achieve compliance with regulatory requirements for treating and disposing of the mixed waste within their respective waste type. The WTM positions have been filled with individuals that are members of the MWFA's customer organizations (EM-30, EM-40, and EM-60). These WTMs were selected from experienced leaders, proposed by the sites in the DOE complex, through an open nomination process. In May 1995, the MWFA solicited proposals from across the DOE complex for individuals to fill the five WTM positions. [Reference X, DOE Letter, Christine Bonzon to Distribution, "*Development and Implementation of Mixed Waste Focus Area Program* (OPE-R&D-95-427), May 23, 1995]. The criteria used to select the WTMs focused on strong EM-30 or EM-40 experience; an understanding of the technical, regulatory, and programmatic issues associated with that waste type; involvement in the FFCA process; and a tie to a DOE site with a large inventory in the particular waste type. As a result of this solicitation, the selected WTMs provide the customer link to ensure that the MWFA technology development activities support EM customer-identified needs.

The WTMs are listed in Table 1-1. Their resumes are included in Appendix A for reference.

Table 1-1. Waste Type Managers.

Waste Type	Waste Type Manager
Wastewaters	Cliff Brown Jr., Oak Ridge National Laboratory (ORNL)
Combustible Organics	Leon Borduin, Los Alamos National Laboratory (LANL) Dave Hutchins, DOE-Oak Ridge Operations Office
Inorganic Homogeneous Solids and Soils	Scott Anderson, Rocky Flats Environmental Technology Site (RFETS)
Debris	Mike Connolly, INEL Jim Blankenhorn, Savannah River Site (SRS), Deputy
Unique Wastes	Ron Nakaoka, LANL

To accomplish their activities, the WTMs are supported by Waste Type Teams (WTTs). The WTTs have not been fully formed to date. When complete, the WTTs will include technical support, regulatory support, tribal and stakeholder interface personnel, EM customer participation from the sites with significant waste volume in the particular waste type, and the principal investigators (PIs) from major technology development activities within the waste type.

The MWFA also recognizes the need for active involvement of tribes and stakeholders into our processes. The tribal and stakeholder interface personnel, which are members of the WTTs, act as a liaison between the activities ongoing within the WTTs and the various tribal and stakeholder groups.

The technical baseline development process has been divided into two phases. Phase I of the process, which is documented in this report, included the technical development and prioritization of process flow diagrams, the identification and prioritization of the associated technology deficiencies, and finally the integration of these two prioritized lists. This phase resulted in the prioritized list of deficiencies that the MWFA will address and support in future funding calls. Phase II will include an examination of current and proposed activities in light of the identified deficiencies. The second phase will result in the technical strategy, including the identification of specific technology development activities that will be supported by the MWFA. As such, the technical baseline will form the basis for the FY-1997 MWFA funding strategy.

Phase I of the technical baseline development process did not include tribal and stakeholder inputs. This input will be gained during several steps in the second phase of the technical baseline development process, including but not limited to, the identification of needs, the development of prioritization criteria, and proposal review and selection.

The MWFA has used the term "quick wins" to address a certain set of activities that will be addressed outside the technical baseline process. These quick wins can generally be categorized as tasks that: (a) provide for more efficient utilization of existing equipment and capabilities within the DOE complex in treating mixed waste, including transfer of technologies between sites, (b) provide for expedited treatment of mixed wastes through RCRA treatability studies, or (c) resolve regulatory issues, thus allowing for expedited treatment of mixed waste.

These activities were not addressed in the technical baseline development process because they are usually site specific and address small waste volume problems. However, they represent activities that could greatly benefit the DOE complex. A modified form of the evaluation process and of the criteria used by the MWFA in developing the technical baseline will be used to prioritize the quick wins, separate from this technical baseline line process. A set funding level will be established specifically for addressing quick wins. Many stakeholder and regulatory needs are driven by site- specific issues and will be addressed on a site by site.

2. TECHNICAL BASELINE DEVELOPMENT PROCESS

A detailed systematic approach, shown in Figure 2-1, was used to develop Phase I of the technical baseline. This figure is a graphical representation of the system of activities and interim products necessary to produce a defensible recommendation for funding of technologies to treat mixed wastes. Each box in the diagram represents an activity and arrows represent products, data, or documents used as inputs into or the products out of the activity. The center row of boxes shows the key activities of the WTM's, while the boxes on the top and bottom rows show inputs to these activities, as provided by the Technical Resource Team (TRT) and the Technical Support Team (TST). The TRT is a team of technical experts from across the nation. The TST is the technical support staff for the WTTs.

The first activity was to develop high-level treatment system diagrams for major groups of mixed waste (Box 1; Figure 2-1). These treatment systems were developed at three levels: block flow diagrams, process flow diagrams, and treatment trains. An example of each of these diagrams follows. Figure 2-2 is an example block diagram, showing the top level steps in each treatment system for the waste type. An example process flow diagram is shown in Figure 2-3. The process flow diagram illustrates the sequence of technologies needed to provide the necessary characterization, processing, and final preparation to allow disposal in compliance with applicable DOE, Environmental Protection

Figure 2-1. Technical baseline development process - Phase I.

Debris Waste

Figure 2-2. Example of treatment systems block diagram.

Debris, Thermal Process

PSTP Preferred Options

Category A

- WERF
- CIF
- TSCA

Category B

- WERF
- CIF
- TSCA
- DSSI
- Quadrex

Category C

- Commercial Thermal Treatment
- IWPF
- Mobile Chemical Treatment Project
- Mixed Waste Treatment Facility

Figure 2-3. Example of a treatment system process flow diagram.

Agency (EPA), and State requirements. Approximately four process flow diagrams were identified for each of the five waste types. Treatment trains show the next level of detail in the treatment system, as shown in the example in Figure 2-4. Several treatment trains were identified for each process flow diagram to further detail the treatment activities. The process flow diagrams and treatment trains for each waste type are included in Appendices B through F.

As Figure 2-1 indicates, two sets of input data were used to develop the process flow diagrams and treatment train. Based upon the waste stream data in the most recent Mixed Waste Inventory Report (MWIR), each of the DOE mixed waste streams was sorted into the five waste types (Box 2; Figure 2-1). Within the five waste types, the waste stream data were further divided into three categories (A, B, and C) that reflects whether wastes are destined for existing onsite treatment facilities (Category A), existing offsite treatment facilities (Category B), or for treatment facilities that do not yet exist (Category C). The detailed waste information is listed with the process flow diagrams and treatment trains in Appendices B through F. Appendix G provides information on the method used to obtain and use the waste data.

The second input into the process flow diagram and treatment train development activity was an evaluation of previous programs and studies (Box 3; Figure 2-1). Where possible, existing information was used rather than duplicating past work. The process flow diagrams were generated based on the preferred treatment options identified by the sites in the Proposed Site Treatment Plans (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 these data were the *Mixed Waste Treatment Model: Basis and Analysis*, September 1995 (LA-13041-MS), and *Analysis of Waste Treatment Requirements for DOE Mixed Waste*, February 1995 (BCMusgrave Inc., Livermore, CA).

Identification of DOE's mixed waste technology development needs is a key input to ensuring that the MWFA is addressing those needs (Box 4; Figure 2-1). Obtaining input into the EM customer needs was a major initiative for the MWFA during the summer of 1995. To define the needs of the EM customers (EM-30, EM-40, and EM-60), the MWFA analyzed PSTPs, as well as other applicable documents, and conducted site visits. The MWFA visited sites under the purview of the Albuquerque, Idaho, Oak Ridge, Ohio, Richland, Rocky Flats, and Savannah River Operations Offices. Information gained through the site visit process is included in Section 4, Site Assessments. Information on the needs of all sites, including those not visits, was obtained through review of the PSTPs.

Using the needs identified from the DOE sites and the expertise of the WTM's and the TRT, mixed waste technology development deficiencies were identified for the various process flow diagrams (Box 5; Figure 2-1). These deficiencies represent significant that must be overcome for DOE to treat mixed waste. Barriers that were determined to be strictly engineering adaptations of existing technologies, and not technology deficiencies, were generally not considered as technology development deficiencies in this process.

Separate prioritization criteria were prepared to prioritize the process flow diagrams and the individual deficiencies (Box 6; Figure 2-1). These prioritization criteria were reviewed by technical experts across the DOE complex, and then were applied in the technical baseline development process. The criteria form the basis for evaluation of mixed waste process flow diagrams and technology deficiencies. A strong emphasis was placed on collaboration with the DOE complex users in EM-30, EM-40, and EM-60. The MWFA operating philosophy is to only fund tasks that have user endorsement.

Debris, Thermal Process, Incineration Treatment Train, MWIR 5000

Figure 2-4. Example of a treatment train.

The process flow diagram prioritization criteria form the basis for ranking the treatment systems. The basic process flows (depicted in the process flow diagrams in Appendices B through F) provide treatment capability for virtually all of the DOE mixed waste inventory. The process flow diagram evaluation is broken up into primary, and where appropriate, secondary criteria. The primary process flow diagram criteria include the impact that the process flow diagram will have on DOE complex mixed waste treatment activities, the potential cost savings, the maturity of the process flow diagram, and DOE commitments associated with the process flow diagram. More detail on these primary criteria, and information on the secondary criteria, is included in Appendix H.

The technology deficiency criteria form the basis for ranking the deficiencies. This allows allocation of resources to resolving the most critical problems that prevent implementation of process flow diagrams. Deficiencies derived by analysis of the process flow diagrams were prioritized, based on the available factual information from the PSTPs and the sites; the experience and judgement of the WTM's; and the technical guidance from the TRT. The criteria for evaluating deficiencies were similar to those described above for process flow diagrams. Differences between the two sets of criteria were necessary to better define the priorities in technology improvement. The primary criteria for prioritization of the technology deficiencies included the impact that the technology deficiencies had on the treatment systems (e.g., the number of process flow diagrams that included that deficiency), consideration of whether the deficiency was a critical path issue for mixed waste treatment, the maturity of ongoing activities that could address the deficiency, the detail available on the functional requirements that the solution must meet, and DOE commitments. The details of the prioritization criteria are included in Appendix H.

The prioritization criteria were then applied to the identified process flow diagrams and to the list of technology deficiencies (Box 7; Figure 2-1). The individual work sheets that show the prioritization results are included in Appendix H. Several of the criteria are objective, such as the volume of waste designated to a particular process flow diagram, and are based upon available information on the waste and on the DOE site treatment plans. The subjective criteria, such as the potential cost savings, were applied using the experience and judgement of the WTM's and the technical guidance of the TRT. Upon completion of the prioritization of the process flow diagrams and the individual technology deficiencies, the two prioritized lists were integrated. This process resulted in a prioritized, integrated list of technology deficiencies, as described later in this report. The resulting prioritized list has been presented to DOE-ID at a formal review (Box 8; Figure 2-1).

3. TECHNICAL BASELINE RESULTS

The end deliverable from the technical baseline development process described above is the prioritized, integrated list of technology deficiencies. Three additional interim deliverables led to this final prioritized list of deficiencies. These deliverables are included below.

3.1 Process Flow Diagram Prioritization

The first step in the prioritization process was the process flow diagram prioritization. Figure 3-1 shows the summary of this prioritization effort. As described in Section 2, and in detail in Appendix H, a number of criteria were considered when ranking the process flow diagrams. A numerical value was assigned for each criteria, weighting factors were assigned, and the results totaled for each process flow

	Vol. of Waste	No. of Cust.	No. of Streams	Waste Hazard	Potential Savings	Time to Implement	DOE Commit.	SUBTOTALS
Debris Thermal Treatment	0.7	0.24	0.5	0.08	0.75	0.76	1	4.03
Elemental Mercury	0.28	0.4	0.2	0.32	0.45	1.25	1	3.9
Combustible Organic, Thermal	0.28	0.4	0.2	0.24	0.45	1.25	1	3.82
Waste Water, Direct Stabilization	0.28	0.16	0.1	0.32	0.45	1.25	1	3.56
Debris Non-Thermal	0.56	0.4	0.3	0.08	0.15	1	1	3.49
Sludge Thermal Treatment	0.56	0.08	0.4	0.16	0.45	0.76	1	3.41
Debris Stabilization	0.28	0.4	0.1	0.08	0.3	1.25	1	3.41
Lab Packs Stabilization	0.28	0.24	0.1	0.08	0.45	1.25	1	3.4
Unique Waste, Compressed Gases	0.28	0.16	0.1	0.4	0.45	1	1	3.39
Waste Water, Thermal	0.28	0.16	0.1	0.24	0.6	1	1	3.38
Lab Packs, Thermal Oxidation	0.28	0.32	0.2	0.08	0.45	1	1	3.33
Waste Water, Non-Thermal	0.28	0.4	0.3	0.32	0.3	0.5	1	3.1
Lab Packs, Chemical Oxidation	0.28	0.16	0.1	0.24	0.3	1	1	3.08
Sludge, Thermal Desorption	0.28	0.08	0.1	0.16	0.45	1	1	3.07
Debris, Thermal Desorption	0.28	0.24	0.1	0.08	0.45	0.76	1	2.91
Combustible Organic, Non-Thermal	0.28	0.24	0.2	0.24	0.15	0.76	1	2.87
Sludge, Extract/Oxidation	0.28	0.08	0.1	0.16	0.3	0.5	1	2.42

Figure 3-1. Process flow diagram prioritization diagram.

Figure 3-1 lists the process flow diagrams (in descending order of priority), the criteria, and the numeric values assigned to each process flow diagram

3.2 Deficiency Prioritization

The second step in the prioritization process was to prioritize the individual technology deficiencies that had been identified. Figure 3-2 shows the summary of the individual deficiency prioritization effort. A deficiency represents some roadblock related to a technical aspect of characterization, treatment, or handling, or disposal of mixed waste. As described in detail in Appendix H, a number of criteria were considered when prioritizing the individual deficiencies. As with the process flow diagrams, a numerical value was assigned to each criteria, weighting factors were assigned, and a numerical ranking was determined for each deficiency. Figure 3-2 lists the individual deficiencies (in descending order of priority), along with the criteria and the numeric values assigned to each deficiency.

3.3 Needs Matrix

Upon completion of the prioritization for both the process flow diagrams and the technology deficiencies, the two resulting prioritized lists were combined into one final set of prioritized, integrated deficiencies. Those deficiencies that affected the higher priority process flow diagrams rate higher than deficiencies affecting lower priority process flow diagrams. Figure 3-3 shows the needs matrix, which integrates the prioritized process flow diagrams and the prioritized technology deficiencies. Process flow diagrams are listed across the top of the matrix, starting with the highest priority process flow diagram (debris thermal treatment) at the left. Other process flow diagrams follow from left to right in descending order of priority. Deficiencies are listed on the left side of the figure, with the highest priority deficiency (Hg Amalgamation) at the top of the column and others following in descending order. An X on the matrix indicates which deficiencies are associated with each particular process flow diagram. This matrix was used to develop the final deliverable, which is the prioritized, integrated list of technology deficiencies.

3.4 Prioritized Integrated List of Technology Deficiencies

With the relative importance of process flow diagrams and technology deficiencies depicted in the needs matrix, a prioritized, integrated list of technology deficiencies was developed. This step integrated the two individually prioritized lists. The needs matrix was divided into quadrants. The upper left hand quadrant contains the highest priority process flow diagrams and the highest priority individual deficiencies. Similarly, the lower right hand quadrant contains the lowest priority process flow diagrams and lowest priority individual deficiencies. The other two quadrants contain a mix of high/low priority process flow diagrams and high/low priority individual deficiencies. The quadrants are not equal in size because the prioritization scores of several process flow diagrams were very similar. The quadrants were formed at logical break points between process flow diagrams and deficiencies, based upon the scores obtained through the prioritization process.

	No. of flowshts	No. of gaps	Hazards addressed	Critical Path	Maturity	Functional Req	DOE Commit.	SUBTOTALS
Hg Amalgamation	0.14	0.35	0.45	1.25	0.63	0.63	1	4.45
Hg Stabilization	0.7	0.35	0.45	0.25	0.63	0.63	1	4.01
Initial Char. (NDE,NDA)	0.42	0.35	0.45	1	0.25	0.38	1	3.85
Hg Remove/Extract	0.42	0.35	0.45	0.25	0.5	0.63	1	3.6
Desorption Eff.	0.14	0.07	0.09	0.75	0.63	0.63	1	3.31
Material Handling	0.42	0.14	0.45	0.75	0.38	0.38	0.6	3.12
CN Destruction	0.14	0.07	0.09	0.5	0.63	0.63	1	3.06
Sorting/Seg. Imp.	0.7	0.35	0.27	0.5	0.25	0.38	0.6	3.05
Radiation Partitioning	0.14	0.28	0.27	0.75	0.63	0.38	0.6	3.05
Ash Stabilization	0.42	0.07	0.27	0.75	0.5	0.63	0.2	2.84
Salt Stabil. (Cl,NO3)	0.7	0.28	0.27	0.25	0.5	0.63	0.2	2.83
Heavy Metal Monitor	0.42	0.07	0.18	0.25	0.5	0.38	1	2.8
Alpha Monitor	0.42	0.07	0.18	0.25	0.5	0.38	1	2.8
Hg Monitor	0.42	0.07	0.18	0.25	0.5	0.38	1	2.8
VOC Monitor	0.42	0.07	0.18	0.25	0.5	0.38	1	2.8
Aq/Org NTerm Destr	0.42	0.21	0.09	0.25	0.38	0.38	1	2.73
SCCO2 Eff	0.14	0.21	0.09	0.5	0.5	0.63	0.6	2.67
Fission Product Rem.	0.14	0.14	0.45	0.25	0.5	0.38	0.6	2.46
Was Form Per. U/TRU	0.7	0.35	0.45	0.25	0.13	0.13	0.2	2.21
Comparative Analysis	0.42	0.14	0.27	0.25	0.5	0.38	0.2	2.16
Internal Drum Press.	0.14	0.35	0.27	0.25	0.38	0.13	0.6	2.12
Improved HEPAs	0.42	0.07	0.18	0.25	0.5	0.38	0.2	2
Evapor. Design	0.14	0.07	0.09	0.25	0.63	0.13	0.6	1.91
Hg Filter	0.42	0.07	0.18	0.25	0.38	0.38	0.2	1.88
Nitrate Removal	0.14	0.28	0.09	0.25	0.5	0.38	0.2	1.84
Molten Prod. Decant	0.42	0.07	0.27	0.25	0.5	0.13	0.2	1.84
Refractory Perf.	0.14	0.07	0.09	0.25	0.63	0.38	0.2	1.76
Sludge Washing	0.14	0.07	0.09	0.25	0.38	0.63	0.2	1.76
Container Integrity	0.14	0.35	0.27	0.25	0.38	0.13	0.2	1.72
Trace Mtl Removal	0.14	0.07	0.09	0.25	0.5	0.13	0.2	1.38

Figure 3-2. Deficiency prioritization.

High

[illegible]

Starting with the upper left hand quadrant, deficiencies were studied with respect to how many times they appeared on the process flow diagrams (density), whether they appeared on high or low priority process flow diagrams, and then they were prioritized accordingly. For instance, Hg stabilization is shown as the Number 2 deficiency on the needs matrix; however, it appears as a need on five process flow diagrams in the first quadrant, and therefore was elevated to the Number 1 prioritized technology deficiency. Likewise, desorption efficiency, which appears as the Number 5 deficiency on the needs matrix, did not support any process flow diagrams in the first quadrant and was given a relatively low prioritized technology deficiency ranking of 26. This process is not an exact science and allows for some interpretation between final rankings. Where needed, the judgement of the WTM's was relied upon. The final prioritized, integrated list of technology deficiencies, with a brief explanation of each deficiency is shown in Table 3-1. A detailed list of the deficiencies is given in Appendix I.

Table 3-1. Prioritized integrated list of mixed waste technology deficiencies.

Technology deficiency	Description
1. Mercury stabilization	Toxic metal contaminants regulated under the Resource Conservation and Recovery Act (RCRA) contained in mixed wastes require removal or stabilization to control solubility under the conditions of the Toxic Characteristic Leach Procedure (TCLP) before the wastes can be disposed. Under RCRA, the "low mercury" contamination level, less than 260 ppm (>260 ppm requires retorting) requires stabilization to control mercury solubility to the Universal Treatment Standards (≤ 0.2 ppm). Verification of treatment, i.e. penetrating the entire matrix and stabilizing essentially all of the mercury in the system, is required.
2. Mercury amalgamation	Elemental mercury may be derived as a product of retorting high mercury (>260 ppm) wastes, or recovered from the offgas of a thermal treatment unit, in addition to the elemental mercury streams in the DOE mixed waste inventory. Radioactive mercury can probably not be completely purified and verified for recycle. Disposal of the mercury will require amalgamation to form a stable, insoluble product for disposal. Methods and equipment designs are required for amalgamating bulk non-recyclable mercury.
3. NDE/NDA-initial characterization	Nondestructive examination (NDE) and nondestructive assay (NDA) techniques and equipment are required for the initial characterization of many hazardous wastes and all other (tramp) materials in waste drums and boxes. Obtaining representative samples of these heterogeneous wastes and materials is made much more difficult in a radioactive environment, which escalates costs dramatically. It is necessary to determine the nature of the waste matrix in any package, confirm the presence and concentration of RCRA regulated materials and radionuclides, and identify characteristics of concern for operational safety and process continuity. This is to be accomplished noninvasively or with minimal penetration.

Table 3-1. continued.

Technology deficiency	Description
4. Mercury separation/removal	The presence of mercury complicates the design of offgas systems, stabilization of residuals, and monitoring of all effluents. It may be advantageous to remove the mercury as a pretreatment to simplify downstream operations. New techniques must be developed to physically or chemically remove the mercury for separate stabilization. Waste matrices from which mercury separation may be required include soil, all types of process residues or sludges and particulate materials, and debris. Processing methods must ensure adequate removal, and include measuring and monitoring methods to control and verify the process.
5. Material handling	Handling of DOE mixed waste must be accomplished safely in a radioactive environment, including containment for alpha contamination. Radioactive material containment limits access to the containers or wastes, and creates difficulties for opening of containers, removal of wastes, sorting, conditioning (feed preparation), and size reduction for feed to treatment. Many common industrial practices involving manual sorting, shredding, and conveying materials into and out of the process may not be possible due to the radioactive contamination of these wastes. Methods and equipment designs are required that will provide for handling all types of DOE waste materials in all process steps without undue risk of exposure of operating personnel to radioactivity.
6. Sorting/segregation	Mixed waste packages contain waste materials with many different matrices. It will often be necessary to sort or segregate materials such as debris from sludges, or different types of debris matrices, before the waste can be assigned to appropriate treatment. Efficient separation of nonradioactive, or radioactive only (no RCRA regulated constituents) from mixed wastes could produce substantial savings. Because these wastes are radioactive and may contain volatile hazardous materials, the sorting and segregation must be done with adequate containment to control potential releases.
7. Salt stabilization	Some existing mixed wastes, and various types of waste residues that will be produced in treatment of other mixed wastes, will be high in salt content, typically chlorides, nitrates, and hydroxide sludges. These salts can be very difficult and expensive to stabilize in glass or standard Portland cement-based grouts. Polymeric compounds may contain higher concentrations of some salts in the near term, but do not chemically bind the contaminants, and an organic matrix may be undesirable for some disposal scenarios. Stabilization processes are required that increase waste loadings, improve durability and/or reduce the volume increase typical of today's standard practices. Significantly improved matrices such as new grouts based on innovative chemistries, polymers, etc. will be required.
8. Ash stabilization	Ash is routinely produced at DOE facilities incinerating mixed wastes. The Universal Treatment Standards have made leach resistance requirements more stringent for some heavy metals. Stabilization processes are required for this ash that increase waste loadings, improve durability and/or reduce the volume increase typical of today's standard practices. Significantly improved matrices such as new grouts based on innovative chemistries, polymers, etc. will be required.

Table 3-1. continued.

Technology deficiency	Description
9. Mercury monitoring	Mercury is present in a wide variety of mixed waste matrices and at widely varying concentrations. Monitoring methods for mercury vapors are required to ensure that mercury is not being released, particularly from processes operating at elevated temperatures. Though mercury monitors are commercially available, it would be advantageous to develop real-time monitors requiring minimal consumables and low maintenance, with operating ranges covering the emission limits typical of incinerators.
10. Alpha monitoring	Processing of mixed wastes will require monitoring of wastes at all stages of handling to ensure that radioactivity, especially alpha radionuclides, are not being released, particularly with processes operating at elevated temperatures. Though alpha monitors are commercially available, it would be advantageous to develop real-time monitors requiring minimal consumables and low maintenance, with operating ranges covering the emission limits typical of alpha material processing facilities.
11. VOC monitoring	RCRA regulated volatile organic compounds (VOCs) are present in many mixed wastes. Because these contaminants are volatile, they are highly mobile, and will be released from newly opened packages and at any stage in processing that involves elevated temperatures. Monitoring of VOCs in the treatment facility effluent is necessary to ensure the facility is operating in accordance with environmental protection requirements. It would be advantageous to develop real-time monitors requiring minimal consumables and low maintenance, which can identify specific contaminants in operating ranges covering the emission limits typical of hazardous waste treatment facilities.
12. Heavy metal monitoring	RCRA regulated heavy metals are present in many mixed wastes. In high temperature processes some of these metals can be volatilized. Though most of these metals are readily captured, some may be carried through the offgas system as fine particles, or potentially as vapors as described above for mercury. It would be advantageous to develop real-time monitors requiring minimal consumables and low maintenance, which can identify specific metals in operating ranges covering the emission limits typical of hazardous waste incinerators.
13. Radionuclide distribution/partitioning	During mixed waste treatment processes, particularly thermal systems, the distribution and migration of radionuclides throughout the processing system must be understood to ensure adequate control. Only limited data exist to predict the fractional distribution of radionuclides between the offgas, the final waste form, and any secondary waste streams. More complete information on the radionuclide distribution in high temperature mixed waste treatment processes is needed to support equipment design and process permitting.

Table 3-1. continued.

Technology deficiency	Description
14. Waste form performance	The performance criteria for regulated hazardous constituents are generally established in State and EPA regulations, such as TCLP requirements. No such requirements have been finalized for radionuclides, so the increased durability of vitrified, slagged, or encapsulated waste forms has not been incorporated into disposal facility permitting or performance assessments. An objective, technically defensible evaluation of the long-term performance of advanced waste forms must be conducted. The evaluation must satisfy regulator and stakeholder concerns to allow flexibility in siting and operating low level waste disposal facilities to best exploit the more durable, higher waste-loading forms.
15. HEPA filter improvements	High-efficiency particulate air (HEPA) filters are a vital part of the environmental protection systems for any facility processing radioactive materials. Discarding these filters contributes significantly to the net waste produced from waste treatment operations. The filters are also a potential point for accidental breakthrough and release of radionuclides. A stronger, high-temperature, longer lived HEPA filter, that can survive a greater pressure drop, and that requires less frequent replacement, or that can be cleaned and reused, is needed. New filter designs should be designed to replace standard filters with minimal retrofit of existing systems.
16. Mercury filter	Mercury is present in a wide variety of mixed waste matrices and at widely varying concentrations. Mercury will be present in some wastes for which mercury treatment will not be indicated. At elevated temperatures in many waste treatment processes mercury will vaporize. Therefore the off-gas system for most, if not all, mixed waste treatment systems will require a step for mercury removal. Typically this step is a water quench, which condenses most volatiles, but creates a mixture in the blowdown stream that is difficult to treat. A potential enhancement to this traditional design would be a selective mercury removal step, which removes essentially all of the mercury from the off-gas stream for separate treatment. Candidate processes exist, but have not been demonstrated on mixed waste off-gas streams.
17. Molten product - decanting	Many treatment processes being developed for mixed wastes will operate with molten material. These processes require the transfer of a molten product from the furnace to another vessel for final handling/disposal. Usually separation of the molten material from untreated waste and perhaps a slag or metal phase is required. Operating techniques and equipment design are required to accomplish this decanting or transfer of molten phases in an effective, reliable, and safe manner applicable to a radioactive environment.
18. Comparative analysis/aqueous	A comparative analysis on the efficacy, reliability, applicability, and maintainability of the many processes now being developed for destruction of organic contamination in wastewaters containing radionuclides must be done to select two or three processes to be developed in Item 19 below.

Table 3-1. continued.

Technology deficiency	Description
19. Aqueous organic nonthermal destruction	Successful destruction/removal of regulated organic constituents in wastewater is necessary for many aqueous plant recycle streams, as well as mixed waste solutions currently being stored in the DOE inventory. Organic containing aqueous streams in treatment processes may contain dissolved and suspended solids along with any of a wide variety of organics. Of particular concern are halogenated and high molecular weight compounds. Several candidate technologies exist, but it remains to be demonstrated that any one or a combination can reliably treat all of the organic constituents expected to be present in mixed waste and be operated in a radioactive environment.
20. Refractory performance	Refractory lifetime is a limiting factor for operation of incinerators and most other thermal treatment processes. Refractories are degraded by acid and caustic conditions and thermal cycling, and sorb metals and radionuclides during operation. Replacement of refractories decreases operating time, adds to operating costs and personnel exposure, and generates a secondary mixed waste stream. Improved refractories, or operating techniques better suited to the DOE- specific processing conditions, are required for long-term processing success.
21. Nitrate removal	Most DOE chemical operations are conducted in nitrate based systems because of process simplicity and material compatibility. As a result, many of DOE mixed wastes contain nitrates. Nitrates are reactive oxidizers, which can cause complications in treatment processes and additional difficulties in waste stabilization processes. Methods are needed to destroy or remove residual nitrates from sludges and wastewaters.
22. Fission product removal	Some mixed wastes contain elevated levels of radionuclides requiring special handling and treatment. Techniques for selective removal of nuclides such as cesium, strontium, and tritium would simplify processing of the balance of the matrix. Methods are needed for removal or significant reduction of the concentrations of fission products from mixed waste, especially process residues and sludges.
23. Internal drum pressure measurement	The occurrence of internal drum pressure is a hazard to operating personnel and to process equipment. Methods are needed to measure internal drum pressure without penetrating the drums.
24. Container integrity measurement	Many DOE wastes have been stored for a significant time period. Some of the waste containers have suffered measurable degradation. Containers at or near failure due to stress and corrosion are a potential hazard to personnel and operating systems. Methods are needed to test the integrity of stored containers to identify any that may require particularly careful handling or overpack in preparation for managing or processing of the contents.
25. Cyanide destruction	Cyanide occurs in DOE wastes primarily from metal cleaning and processing operations. RCRA regulations require the destruction of cyanide anion when it is present. This is normally done in a simple one step aqueous oxidation reaction. Not all DOE wastes containing cyanides are amenable to treatment by this aqueous based reaction. Methods are required to treat cyanide in the presence of interfering dissolved, suspended, and matrix materials.

Table 3.1 continued.

Technology deficiency	Description
26. Thermal desorption	Thermal desorption of organic hazardous constituents and mercury from process residues, sludges, soils, and debris has been commercialized, and is now proposed for a number of mixed waste streams. Many of these wastes are physically and chemically complex materials. Methods are required to minimize pretreatment to adequately prepare the wastes so that the contaminants can escape, to provide thermal processing such that cleanup levels can be attained while maintaining radionuclide containment, and to verify LDR compliance.
27. Evaporator design	Processes for treatment of mixed wastes will generate many aqueous streams for recycle within the plant. Recycling and final cleaning of water for discharge usually involves one or more evaporation steps. Evaporators are subject to fouling and corrosion and use fairly large quantities of energy. Better designs are needed for evaporators for DOE waste-specific treatment plant streams.
28. Sludge washing	Sludge washing may be a key step in nonthermal treatment processes. This treatment is also potentially applicable to small quantities of waste. Organic removal requirements in RCRA regulations are generally well beyond that which has been demonstrated for any of the candidate processes. Alternative approaches are required, or methods are needed to enhance the performance of the candidate sludge washing technologies, to demonstrate feed preparation and washing of process residues, sludges, and particulates to RCRA requirements.
29. Trace metal removal	Some wastewater treatment facilities in the DOE complex are subject to new permitting requirements which mandate extremely low levels for some metals in effluents (e.g., 0.001 mg/L cadmium, 0.003 mg/L lead, and 0.004 mg/L silver). Standard water polishing ion-exchange resins are not sufficiently specific to avoid depletion by other ions in the wastes. Other techniques are needed to meet permit requirements while minimizing secondary waste generation.
30. Supercritical CO ₂	Supercritical CO ₂ extraction similar to that commercially practiced for a variety of standard applications has been proposed for treatment of a number of mixed waste streams in lieu of thermal processing. Many of these wastes are physically and chemically complex materials. Methods are needed to enhance the effectiveness of supercritical CO ₂ for removal of organics from process residues, sludges and particulates, soils, and debris (especially more complex pieces of debris). Techniques to minimize pretreatment to adequately prepare the wastes so that the organics can be removed, and the wastes can be fed and removed from the supercritical environment while maintaining radionuclide containment are required. Compliance with LDR must also be verified.

4. DOE SITE ASSESSMENTS

The primary mission of the MWFA is to ensure that the needs of the EM-30, 40, and 60 customers are addressed by the technology development activities supported by the MWFA. To define the deficiencies or needs of the EM customers, the MWFA analyzed PSTPs, the *1995 Report of Hanford Site Land Disposal Restrictions for Mixed Waste*, April 1995 (DOE/RL-95-15), as well as other applicable documents, and conducted site visits throughout the summer of 1995.

4.1 Needs Integration into the Technical Baseline Development Process

The MWFA visited sites under the purview of Albuquerque, Idaho, Oak Ridge, Rocky Flats, Richland, and Savannah River Operations Offices. Information on sites that were not visited was obtained through review of the PSTPs. Representatives from EM-30, EM-40, and EM-60 at each Operations Office visited were consulted to define their technology needs. These needs were then integrated into the MWFA technical baseline development process.

4.2 Individual Site Assessments

Figures 4-1 through 4-7 show the applicability of the technical baseline process to the seven DOE Operations Offices that were visited by the MWFA. Each of the seven figures shows the needs matrix, which was described in Section 2, individualized for the DOE Operations Office being addressed. For each of the seven Operations Offices, the top two or three process flow diagrams are shaded. The figures also indicate the volume of waste that will be treated by the top process flow diagrams.

4.3 Integration of Site-Identified Needs Into the Technical Baseline Development 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 Complex Needs Report* (Needs Report), December 1995 (INEL-95/0555). Several categories of needs and deficiencies are identified in the Needs Report. These deficiencies 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 are included in Section 3 of the 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 will be used in Appendix J of this report, along with a brief description, to reference specific deficiencies.

As discussed in Section 2 of this report, the WTM's, with support from the TRT and the TST, developed an initial list of the technology deficiencies associated with the process flow diagrams that were defined for the respective waste types. The technology deficiencies identified by the WTM's and TRT were then compared to the needs and deficiencies listed in the Needs Report. Although over 70

		Highest Priority ←								Process Flow →								Lowest Priority	
		Debris Thermal Treatment	Elemental Mercury	Comb. Organic Thermal	Waste Water, Direct Stabilization	Debris Non-Thermal	Sludge Thermal Treatment	Debris Stabilization	Lab Packs Stabilization	Unique Waste, Compressed Gases	Waste Water, Thermal	Lab Packs Thermal Oxidation	Waste Water Non-Thermal	Lab Packs, Chemical Oxidation	Sludge, Thermal Desorption	Debris, Thermal Desorption	Combustible Organic, Non-Thermal	Sludge, Extract/ Oxidation	
Highest Priority ↑	1	Hg Amalgamation		x			x				x								
	2	Hg Stabilization	x	x	X		x	x			x		x			X	x	x	
	3	Initial Char. (NDE/NTA)	x		X		x	x	X						x	X		x	
	4	Hg Remove/Extract		x			x						x				x	x	
	5	Desorption Eff.													x	X			
	6	Material Handling	x				x						x		x	X	x		
	7	CN Destruction											x						
	8	Sorting/Seg. Imp.	x				x	x	X	x	x		x		x	x	X		
	9	Radiation Partitioning	x													x	X		
	10	Ash Stabilization	x		X			x				x	x				X		
	11	Salt Stabl. (Cl,NO ₃)	x		X	x	x	x		x		x	x	x		x	X	x	x
	12	Heavy Metal Monitor	x		X			x				x	x						
	13	Alpha Monitor	x		X		x	x				x	x			x	X		
	14	Hg Monitor	x	x	X			x				x	x			x	X		
	15	VOC Monitor	x		X			x				x	x			x	X	x	
Deficiency Prioritization ↓	16	Aq/Org N-Therm Destr				x							x	x			x		
	17	SC CO ₂ Extraction																x	
	18	Fission Product Rem.				x							x						
	19	Was Form Per. U/TRU	x			x	x	x	X	x		x	x	x	x	x	X	x	x
	20	Comparative Analysis					x						x	x			x		
	21	Internal Drum Press.					x						x						
	22	Improved HEPAs	x		X			x				x	x			x	X		
	23	Evapor. Design												x					
	24	Hg Filter	x		X			x				x	x				X		
	25	Nitrate Removal				x				x				x					
	26	Molten Prod. Decant	x		X			x				x	x						
	27	Refractory Perf.	x					x											
	28	Sludge Washing												x				x	
	29	Container Integrity					x												
	30	Trace Mtl Removal												x					
		42.5 m ³ 0.02% of complex volume				126.5 m ³ 0.07% of complex volume								64.1 m ³ 0.04% of complex volume					

42.5 m³
0.02% of complex volume

126.5 m³
0.07% of complex volume

64.1 m³
0.04% of complex volume

Figure 4-1. Albuquerque needs matrix.

		Highest Priority ←						Process Flow						→ Lowest Priority					
		Debris Thermal Treatment	Elemental Mercury	Comb. Organic Thermal	Waste Water, Direct Stabilization	Debris Non-Thermal	Sludge Thermal Treatment	Debris Stabilization	Lab Packs Stabilization	Unique Waste, Compressed Gases	Waste Water, Thermal	Lab Packs Thermal Oxidation	Waste Water Non-Thermal	Lab Packs, Chemical Oxidation	Sludge, Thermal Desorption	Debris, Thermal Desorption	Combustible Organic, Non-Thermal	Sludge, Extract/ Oxidation	
Highest Priority	1	Hg Amalgamation	X				X				X								
	2	Hg Stabilization	X	X	X	X	X				X		X			X	X	X	
	3	Initial Char. (NDE,NDA)	X		X		X	X							X	X		X	
	4	Hg Remove/Extract	X	X			X						X				X	X	
	5	Desorption Eff.	X												X	X			
	6	Material Handling	X				X						X		X		X		
	7	CN Destruction	X										X						
	8	Sorting/Seg. Imp.	X				X	X	X	X			X		X	X			
	9	Radiation Partitioning	X												X	X			
	10	Ash Stabilization	X		X			X				X	X				X		
	11	Salt Stabl. (Cl,NO3)	X		X	X	X		X		X	X	X		X	X	X	X	
	12	Heavy Metal Monitor	X		X		X				X	X							
	13	Alpha Monitor	X		X		X				X	X			X	X			
	14	Hg Monitor	X	X	X		X				X	X			X	X			
	15	VOC Monitor	X		X		X				X	X			X	X	X		
	16	Aq/Org N-Therm Destr	X				X						X	X			X		
	17	SC CO2 Extraction	X															X	
	18	Fission Product Rem.	X			X							X						
	19	Was Form Per. U/TRU	X			X	X	X	X	X		X	X	X	X	X	X	X	
	20	Comparative Analysis	X				X						X	X			X		
Lowest Priority	21	Internal Drum Press.	X			X							X						
	22	Improved HEPAs	X		X		X				X	X			X	X			
	23	Evapor. Design	X										X						
	24	Hg Filter	X		X		X				X	X				X			
	25	Nitrate Removal	X			X			X				X						
	26	Molten Prod. Decant	X		X		X				X	X							
	27	Refractory Perf.	X																
	28	Sludge Washing	X										X				X		
	29	Container Integrity	X				X												
	30	Trace Mtl Removal	X										X						

51,383.1 m3

29.33% of complex volume

9,532.0 m3

5.44% of complex volume

51,383.1 m³
29.33% of complex volume

9,532.0 m³
5.44% of complex volume

Figure 4-2. Idaho needs matrix.

		Process Flow																	
		Highest Priority								Lowest Priority									
Highest Priority		Debris Thermal Treatment	Elemental Mercury	Comb. Organic Thermal	Waste Water, Direct Stabilization	Debris Non-Thermal	Sludge Thermal Treatment	Debris Stabilization	Lab Packs Stabilization	Unique Waste, Compressed Gases	Waste Water, Thermal	Lab Packs Thermal Oxidation	Waste Water Non-Thermal	Lab Packs, Chemical Oxidation	Sludge, Thermal Desorption	Debris, Thermal Desorption	Combustible Organic, Non-Thermal	Sludge, Extract/ Oxidation	Lowest Priority
1	Hg Amalgamation		x				x				x								
2	Hg Stabilization	x	x	x		X	x				x		x			x	x	x	
3	Initial Char. (NDE/NDT)	x		x		X	x	x							x	x		x	
4	Hg Remove/Extract		x			X							x				x	x	
5	Desorption Eff.														x	x			
6	Material Handling	x				X						x		x		x	x		
7	CN Destruction												x						
8	Sorting/Seg. Imp.	x				X	x	x	x	x		x		x	x	x			
9	Radiation Partitioning	x													x	x			
10	Ash Stabilization	x		x			x				x	x				x			
11	Salt Stabli. (Cl,NO ₃)	x		x	X	X	x		x		x	x	x		x	x	x	x	
12	Heavy Metal Monitor	x		x			x				x	x							
13	Alpha Monitor	x		x		X	x				x	x			x	x			
14	Hg Monitor	x	x	x			x				x	x			x	x			
15	VOC Monitor	x		x			x				x	x			x	x	x		
16	Aq/Org N-Therm Destr					X							x	x			x		
17	SC CO ₂ Extraction																	x	
18	Fission Product Rem.				X								x						
19	Was Form Per. U/TRU	x			X	X	x	x	x		x	x	x	x	x	x	x	x	
20	Comparative Analysis				X	X							x	x			x		
21	Internal Drum Press.					X							x						
22	Improved HEPAs	x		x			x				x	x			x	x			
23	Evapor. Design												x						
24	Hg Filter	x		x			x				x	x				x			
25	Nitrate Removal				X				x				x						
26	Molten Prod. Decant	x		x			x				x	x							
27	Refractory Perf.	x					x												
28	Sludge Washing												x				x		
29	Container Integrity					X													
30	Trace Mil Removal												x						

2,771.2 m³
1.59% of complex volume
1,512.4 m³
0.86% of complex volume

Figure 4-3. Oak Ridge needs matrix.

		Highest Priority									Process Flow									Lowest Priority			
		Debris Thermal Treatment	Elemental Mercury	Comb. Organic Thermal	Waste Water, Direct Stabilization	Debris Non-Thermal	Sludge Thermal Treatment	Debris Stabilization	Lab Packs Stabilization	Unique Waste, Compressed Gases	Waste Water, Thermal	Lab Packs Thermal Oxidation	Waste Water Non-Thermal	Lab Packs, Chemical Oxidation	Sludge, Thermal Desorption	Debris, Thermal Desorption	Combustible Organic, Non-Thermal	Sludge, Extract/ Oxidation					
Highest Priority	1	Hg Amalgamation	x				x				x												
	2	Hg Stabilization	X	x	x		x				x		x			x	X	x					
	3	Initial Char. (NDE,NDA)	X		x		x	x							x	x		x					
	4	Hg Remove/Extract		x			x						x				X	x					
	5	Desorption Eff.													x	x							
	6	Material Handling	X				x						x		x		X						
	7	CN Destruction											x										
	8	Sorting/Seg. Imp.	X				x	x	x	x				x		x							
	9	Radiation Partitioning	X													x	x						
	10	Ash Stabilization	X		x			x				x	x				x						
Deficiency Prioritization	11	Salt Stabl. (Cl,NO ₃)	X		x	x	x		x		x	x	x		x	x	X	x					
	12	Heavy Metal Monitor	X		x			x				x											
	13	Alpha Monitor	X		x		x	x				x			x	x							
	14	Hg Monitor	X	x	x			x				x			x	x							
	15	VOC Monitor	X		x			x				x			x	x	X						
	16	Aq/Org N-Therm Destr					x							x	x		X						
	17	SC CO ₂ Extraction																x					
	18	Fission Product Rem.				x								x									
	19	Was Form Per. U/TRU	X			x	x	x	x	x		x	x	x	x	x	x	X	x				
	20	Comparative Analysis					x							x	x			X					
Lowest Priority	21	Internal Drum Press.				x								x									
	22	Improved HEPAs	X		x			x				x	x			x	x						
	23	Evapor. Design												x									
	24	Hg Filter	X		x			x				x					x						
	25	Nitrate Removal				x				x				x									
	26	Molten Prod. Decant	X		x			x				x											
	27	Refractory Perf.	X					x															
	28	Sludge Washing												x				X					
	29	Container Integrity					x																
	30	Trace MII Removal												x									

51.0 m³
0.03% of complex volume

168.2 m³
0.10% of complex volume

51.0 m³
0.03% of complex volume

168.2 m³
0.10% of complex volume

Figure 4-4. Ohio needs matrix.

		Highest Priority ←						Process Flow →						Lowest Priority				
		Debris Thermal Treatment	Elemental Mercury	Comb. Organic Thermal	Waste Water, Direct Stabilization	Debris Non-Thermal	Sludge Thermal Treatment	Debris Stabilization	Lab Packs Stabilization	Unique Waste, Compressed Gases	Waste Water, Thermal	Lab Packs Thermal Oxidation	Waste Water Non-Thermal	Lab Packs, Chemical Oxidation	Sludge, Thermal Desorption	Debris, Thermal Desorption	Combustible Organic, Non-Thermal	Sludge, Extract/Oxidation
Highest Priority	1	Hg Amalgamation		x			x				x							
	2	Hg Stabilization	x	x	x		x	x			x		x			x	x	x
	3	Initial Char. (NDE/NTA)	x		x		x	x	X						x	x		x
	4	Hg Remove/Extract		x			x						x				x	x
	5	Desorption Eff.													x	x		
	6	Material Handling	x				x						X		x		x	
	7	CN Destruction											x					
	8	Sorting/Seg. Imp.	x				x	x	X	x	x		X		x	x		
	9	Radiation Partitioning	x													x	x	
Deficiency Prioritization	10	Ash Stabilization	x		x		x				x	X				x		
	11	Salt Stabl. (Cl,NO ₃)	x		x	x	x	x	x		x	X	x		x	x	x	x
	12	Heavy Metal Monitor	x		x			x			x	X						
	13	Alpha Monitor	x		x		x	x			x	X			x	x		
	14	Hg Monitor	x	x	x			x			x	X			x	x		
	15	VOC Monitor	x		x			x			x	X			x	x	x	
	16	Aq/Org N-Therm Destr					x						x	x			x	
	17	SC CO ₂ Extraction																x
	18	Fission Product Rem.				x								x				
	19	Was Form Per. U/TRU	x			x	x	x	X	x		x	X	x	x	x	x	x
Lowest Priority	20	Comparative Analysis				x							x	x			x	
	21	Internal Drum Press.					x						x					
	22	Improved HEPAs	x		x			x			x	X			x	x		
	23	Evapor. Design											x					
	24	Hg Filter	x		x			x			x	X				x		
	25	Nitrate Removal				x			x				x					
	26	Molten Prod. Decant	x		x			x			x	X						
	27	Refractory Perf.	x					x										
	28	Sludge Washing												x			x	
	29	Container Integrity					x											
	30	Trace Mtl Removal												x				

705.6 m³
0.40% of complex volume

186.0 m³
0.11% of complex volume

Figure 4-5. Richland needs matrix.

		Process Flow																
		Highest Priority ←										→ Lowest Priority						
		Debris Thermal Treatment	Elemental Mercury	Comb. Organic Thermal	Waste Water, Direct Stabilization	Debris (Non-Thermal)	Sludge Thermal Treatment	Debris Stabilization	Lab Packs Stabilization	Unique Waste, Compressed Gases	Waste Water, Thermal	Lab Packs Thermal Oxidation	Waste Water Non-Thermal	Lab Packs, Chemical Oxidation	Sludge, Thermal Desorption	Debris, Thermal Desorption	Combustible Organic, Non-Thermal	Sludge, Extract/Oxidation
Highest Priority	1	Hg Amalgamation		x			x				x							
	2	Hg Stabilization	x	x	x	x	x				x		x			x	x	x
	3	Initial Char. (NDE/NDA)	x		x	x	x	x							x	x		x
	4	Hg Remove/Extract		x		x							x				x	x
	5	Desorption Eff.													x	x		
	6	Material Handling	x			x						x		x		x	x	
	7	CN Destruction											x					
	8	Sorting/Seg. Imp.	x			x	x	x	x	x		x		x	x	x		
	9	Radiation Partitioning	x												x	x		
Deficiency Prioritization	10	Ash Stabilization	x		x	x	x				x	x			x	x		
	11	Salt Stabl. (Cl,NO ₃)	x		x	x	x		x		x	x	x		x	x	x	x
	12	Heavy Metal Monitor	x		x		x				x	x						
	13	Alpha Monitor	x		x	x	x				x	x			x	x		
	14	Hg Monitor	x	x	x		x				x	x			x	x		
	15	VOC Monitor	x		x		x				x	x			x	x	x	
	16	Aq/Org N-Therm Destr				x							x	x			x	
	17	SC CO ₂ Extraction																x
	18	Fission Product Rem.				x							x					
	19	Was Form Per. U/TRU	x			x	x	x	x		x	x	x	x	x	x	x	x
Lowest Priority	20	Comparative Analysis				x							x	x			x	
	21	Internal Drum Press.				x							x					
	22	Improved HEPAs	x		x		x				x	x			x	x		
	23	Evapor. Design											x					
	24	Hg Filter	x		x		x				x	x				x		
	25	Nitrate Removal				x			x				x					
	26	Molten Prod. Decant	x		x		x				x	x						
	27	Refractory Perf.	x				x											
	28	Sludge Washing											x				x	
	29	Container Integrity				x												
	30	Trace Mtl Removal											x					

1,705.4 m³
0.97% of complex volume

666.0 m³
0.38% of complex volume

Figure 4-6. Rocky Flats needs matrix.

		Highest Priority ←							Process Flow							→ Lowest Priority				
		Debris Thermal Treatment	Elemental Mercury	Comb. Organic Thermal	Waste Water, Direct Stabilization	Debris Non-Thermal	Sludge Thermal Treatment	Debris Stabilization	Lab Packs Stabilization	Unique Waste, Compressed Gases	Waste Water, Thermal	Lab Packs Thermal Oxidation	Waste Water Non-Thermal	Lab Packs, Chemical Oxidation	Sludge, Thermal Desorption	Debris, Thermal Desorption	Combustible Organic, Non-Thermal	Sludge, Extract/ Oxidation		
Highest Priority ↑	1	Hg Amalgamation	X				X				X									
	2	Hg Stabilization	X	X	X		X	X			X		X			X	X	X		
	3	Initial Char. (NDE/NTA)	X		X		X	X	X						X	X		X		
	4	Hg Remove/Extract		X			X						X				X	X		
	5	Desorption Eff.													X	X				
	6	Material Handling	X				X					X		X		X	X			
	7	CN Destruction											X							
	8	Sorting/Seg. Imp.	X				X	X	X	X	X		X		X	X				
	9	Radiation Partitioning	X												X	X				
	10	Ash Stabilization	X		X			X				X	X			X				
Deficiency Prioritization	11	Salt Stabl. (Cl,NO ₃)	X		X	X	X	X	X		X	X	X		X	X	X	X		
	12	Heavy Metal Monitor	X		X		X				X	X								
	13	Alpha Monitor	X		X		X	X			X	X			X	X				
	14	Hg Monitor	X	X	X		X				X	X			X	X				
	15	VOC Monitor	X		X			X			X	X			X	X	X			
	16	Aq/Org N-Therm Destr					X						X	X			X			
	17	SC CO ₂ Extraction																X		
	18	Fission Product Rem.				X							X							
	19	Was Form Per. U/TRU	X			X	X	X	X	X		X	X	X	X	X	X	X		
	20	Comparative Analysis					X						X	X			X			
↓ Lowest Priority	21	Internal Drum Press.				X							X							
	22	Improved HEPAs	X		X		X				X	X			X	X				
	23	Evapor. Design											X							
	24	Hg Filter	X		X		X				X	X				X				
	25	Nitrate Removal				X			X				X							
	26	Molten Prod. Decant	X		X		X				X	X								
	27	Refractory Perf.	X				X													
	28	Sludge Washing											X				X			
	29	Container Integrity					X													
	30	Trace Mtl Removal											X							

4.615.7 m³
2.64% of complex volume

79.6 m³
0.05% of complex volume

4,615.7 m³
2.64% of complex volume

79.6 m³
0.05% of complex volume

Figure 4-7. Savannah River needs matrix.

needs were identified in the Needs Report, several factors led to the elimination of many of these needs from the technical baseline development process. Some of the needs were identified for more than one waste type, which resulted in duplications. These needs were combined into one overall need statement. Other needs identified were 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 in Section 5. Some of the remaining deficiencies listed in the Needs Report were clearly more applicable to other focus areas and/or crosscutting programs. Finally, some of the deficiencies included in the Needs Report were programmatic in nature and did not constitute a technical deficiency. These needs were not amenable to the prioritization process, since it was developed to perform evaluation of technical gaps and deficiencies.

A comprehensive listing of all of the deficiencies identified in the Needs Report, with their disposition in relation to the MWFA Technical Baseline Prioritization Process, has been included in Table I-1 in Appendix I. The correlating deficiency number from the Needs Report, along with a brief description of the need, has been provided. Table I-2 in Appendix I lists the technology deficiencies in prioritized order and identifies the unique needs numbers, as defined in the Needs Report, as well as the affected sites. Refer to the Needs Report for more information concerning these technology deficiencies.

5. QUICK WINS

A broad range of activities are included in a classification termed “quick wins.” These quick wins can generally be grouped into the following four areas:

1. Tasks that provide opportunities to rapidly 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, thus allowing expedited treatment of mixed waste
4. Tasks that provide for more efficient utilization of existing equipment and capabilities within the DOE complex for expedited treatment of mixed waste.

5.1 Quick Wins Disposition and Path Forward

Quick wins, as well as identified needs with characteristics similar to quick wins, were not considered in the MWFA Technical Baseline Development Process. This is because these activities are usually site specific and address small waste volume problems. Several identified needs were reclassified during the MWFA Technical Baseline Development Process (as shown in Table I-1 in Appendix I) and are now being considered as potential quick wins based on the categories described above.

A total of 27 quick win opportunities, including reclassified needs, have been identified to date, as listed in Appendix J. Additional quick wins will most likely be defined as the WTMs continue to

analyze their respective waste streams. A modified form of the evaluation process and criteria will be used as guidance for evaluating 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.

6. ISSUES AND ASSUMPTIONS

The following issues and assumptions associated with the development of the technical baseline were identified.

6.1 Issues

1. Existing mixed waste treatment facilities cannot accept transuranic (TRU) contaminated waste. The Consolidated Incineration Facility (CIF) waste acceptance criteria (WAC) allows up to 58 nCi/g alpha-contamination; however, the technical ability to detect alpha-contamination at this level hinders CIF acceptance of alpha-contaminated waste.
2. Waste stream data are suspect.
 - a. Sites did not use uniform criteria to designate waste as remote handled.
 - b. Some sites specified multiple treatment options for the same waste stream and multiple listings occurred for the same waste streams at other sites.
 - c. Treatment options for some wastes were inconsistent with the Chemical Parameter Categories and/or Radiological Parameter Categories (CPC/RPC) codes specified.
3. Because no credit is taken for waste form performance considerations in disposal performance assessments, directing additional resources to treatment systems with improved final waste forms may not be cost-effective. A definitive test or modeling effort has not been developed that predicts how well hazardous and radioactive constituents resist migration from a waste form.
4. Sufficient disposal capacity for mixed waste does not exist. The desired characteristics of the final waste form produced by the treatment systems are not known because many of the planned disposal facilities do not have final WAC.
5. The role of the MWFA in supporting the various EM privatization initiatives is evolving and must continue to be defined. The impact on MWFA technology development activities of the mixed waste treatment privatization is uncertain.
6. Public and tribal concerns were not factored into Phase I of the technical baseline development process. Phase II must incorporate such input. A separate process to validate the outcome of Phase I is now occurring through the public and tribal groups.

6.2 Assumptions

1. The waste stream data set used was the July 10, 1995, merged Mixed Waste Inventory Report/PSTP information.
2. CPC, RPC, Matrix Parameter Categories (MPC), and preferred treatment options are assumed to be correct and valid as identified in the 1995 MWIR/PSTP database.
3. The following wastes were not included in the development of the technical baseline due to insufficient information:
 - a. Waste identified in the database as "requiring further characterization"
 - b. Waste included in the database but not in a PSTP
 - c. Waste with the treatment designated as to be determined (TBD).
4. Transuranic alpha and non-TRU alpha were combined to establish a separate category of alpha low-level waste (alpha-LLW) for the process flow diagram evaluation.
5. Because of volume, all TRU waste(except for homogeneous solids/soils) was analyzed by the debris WTM.
6. Soils have been incorporated into the inorganic homogeneous solids/soils waste type analysis.
7. Wastewater and inorganic homogeneous solids/soils included less than 100% of the sites with these waste types, but the sites evaluated comprised greater than 99% of the DOE complex's waste inventory.
8. PEIS treatability groups form the basis for technical baseline process flow diagram development.
9. The primary focus of the technical baseline is to support EM-30 in meeting commitments made in the PSTPs (and ultimately in the FFCA Consent Orders).
10. All treatment trains from PSTPs, except for those for the INEL and SRS TRU waste debris, are assumed to be correct. The INEL and SRS are planning to treat their TRU waste before shipment to the Waste Isolation Pilot Plant (WIPP), while other sites are planning to ship TRU waste directly to WIPP without treatment or to treat their TRU waste only to the WIPP WAC before shipment.
11. Changes to the PSTP preferred options based on political, equity, technical, and economic issues were not considered. Issues on shipment and WAC acceptability were not considered.
12. The PSTPs were assumed to accurately reflect the final Site Treatment Plans (STPs) and consent orders.

13. The technical baseline includes the waste streams, waste volumes, and treatment options for C Category waste only (i.e., wastes for which an identified treatment facility does not exist). Enhancements for A and B Category wastes will be addressed separately.
14. The technical baseline development process focused primarily on treatment technology deficiencies (i.e., true technology development needs) as opposed to facility engineering issues/equipment adaptation.
15. WIPP will open in April 1998.
16. INEL will have disposed of 15,000 drums (3,000 m³) of untreated waste at WIPP by the end of calendar year 2002.
17. Idaho Waste Processing Facility (IWPF) treatment technologies identified for INEL alpha-LLW will be applied to INEL TRU waste not shipped to WIPP. The Advanced Mixed Waste Treatment Project (AMWTP), which is the private sector treatment facility that will replace IWPF, is assumed to use the treatment technologies that were planned for the IWPF.
18. "Nonthermal" refers to treatment that occurs at less than 350°C.

7. PATH FORWARD

During the development of the technical baseline, a number of assumptions and issues were raised, as noted previously in this report. In some cases, the basis for an assumption was suspect and requires validation. The prioritization of the process flow diagrams and deficiencies also revealed some issues or underscored the need for follow-on work in a number of technical and programmatic areas. A listing of these path forward items follows. These items are not necessarily in order of priority. Figure 7-1 depicts the steps necessary to complete several of these path forward activities.

1. With the completion of the technical baseline, a strategy will be defined to use this information to support the technical call for proposals and the Congressional budget submittal.
2. A program for the directed technical call for proposals must be defined and implemented to address those needs that are not currently being addressed. This program will include preparation of the technical call for proposal based on prioritized deficiencies outlined in the technical baseline. Criteria will be developed and implemented for review and selection of Technical Task Plans (TTPs) submitted in response to the directed call.
3. A review of technologies that are currently funded must be completed, which considers the relevance of the technology to prioritized deficiencies. Technologies that are not in concert with the deficiencies identified in the technical baseline may be redirected or eliminated in favor of other efforts that can better support the technical baseline deficiencies.
4. A strategy must be formulated to transition from current ongoing FY-1996 work to FY-1997 work. This strategy must account for the emphasis of deficiencies identified in the technical baseline.

Figure 7-1. Technical baseline development process - Phase II.

5. Responses to the needs identified during the site visit process must be prepared, which documents how the site needs have been addressed. An improved mechanism for identifying and responding to sites' needs will be developed.
6. A request for FY-1997 funding must be prepared to support the Congressional Budget Submittal. This request must detail how much money is required for activities to address key technology deficiencies.
7. Effective coordination channels must be established with the various crosscutting focus areas and organizations. This coordination will include other organizations that have similar interests in the treatment and disposal of mixed waste, or who are engaged in technologies that could be of benefit to the MWFA. The best method for communicating with these other organizations will be identified to eliminate duplication of effort.
8. A more complete definition of "quick wins," and a program for addressing them, must be established. A method to prioritize potential quick wins, with the associated defensible criteria, will be pursued. Potential quick wins must be identified that could help reduce the national mixed waste inventory in a relatively short time and in an efficient and cost-effective manner. The thrust of this effort will be to demonstrate that the focus area is achieving progress for the money being spent.
9. The WTTs must be more fully established. At the inception of the MWFA program, site involvement from EM-30, EM-40, and EM-60 organizations was recognized as a necessity for successful implementation of the MWFA strategy. In addition to the WTMs, technical participation in the WTTs is needed from those DOE sites with significant waste volume in the various waste types and stakeholder interface and regulatory support as needed.
10. A thorough validation of the MWIR database needs to be made to verify volumes, ensure assigned RPC, MPC, and CPC codes are correct, and identified preferred treatment options are compatible with the wastes. The technical baseline will be updated to incorporate waste data changes that result from this review.
11. Existing facility WAC must be analyzed to ensure that the assignments of waste to those facilities is acceptable. Additionally, a determination of whether additional C Category waste can be sent to existing facilities should be made.
12. The technical baseline will need to be updated based on the FFCA Consent Orders and the January revision of the individual Site Treatment Plans (STPs).
13. Enhancements for the facilities designated to treat Category A waste and Category B waste must be evaluated. A number of existing facilities are capable of treating mixed waste streams currently in inventory; however, significant improvements should be made to the facilities to increase certain process efficiencies and reduce operating costs. A plan needs to be developed for (a) reviewing existing processes, (b) identifying areas that could benefit from enhancements and which enhancements are supported by the technical baseline, and (c) identifying the costs for enhancements. As enhancements are identified, they need to be checked against the technical baseline for applicability. The technical baseline should be updated to incorporate them as appropriate.
14. The MWFA, through the WTMs, needs to be integrated into the management activities for

current FY-96 TTPs. This will include monitoring technical progress of the work and scope definition, reviewing major project deliverables, communicating with PIs concerning technical and programmatic issues, and monitoring monthly reporting of cost and schedule to identify and coordinate resolutions of significant issues. Day-to-day project management will remain the responsibility of the PIs.

15. The concept of thermal versus nonthermal treatment must be better defined. A defensible threshold must be established, potentially through a working group, to define whether a process is considered thermal or nonthermal.

16. Issues related to TRUPACT II that affect the technical baseline plans must be evaluated to determine if mixed waste from sites can be shipped via TRUPACT II containers. This involves ensuring that the waste characteristics are compatible with container restrictions. Deficiencies need to be identified to the sites and DOE transportation personnel.

17. Management of secondary waste streams must be addressed. A large volume of secondary waste streams may be generated during the processing of the initial mixed waste volumes. A study needs to be performed to establish the projected volume of secondary waste, "crossover" of the secondary waste streams from one process flow diagram to another, and consideration of characteristic and capacity issues.

18. Issues related to the treatment of alpha-LLW that result in the generation of TRU waste must be fully understood. Different approaches have been taken by different operations offices to the issue of treatment of alpha-LLW, which results in concentrations of radionuclides greater than 100 nCi/g.

19. The planned use of existing facilities should be reevaluated to determine whether additional waste could be treated by these facilities. Expanded use of these existing facilities could eliminate the need for certain technology development activities. Specific opportunities for expanded use of existing facilities will be brought forward for discussion with EM-30, 40, and 60.

20. The prioritization criteria used in Phase I will be analyzed against known tribal and stakeholder priorities. Crosswalk tables depicting this evaluation will be prepared. Tribal and stakeholder input will be including in the development of the prioritization criteria for Phase II of the technical baseline development process and in other Phase II activities as shown in Figure 7.1.

8. Conclusions

The MWFA has completed the first phase of activity required to establish the technical baseline, which defines the technology development activities that will be supported by the MWFA. Based on the detailed work that has been completed to date, the prioritized list of technology deficiencies that the MWFA will address has been prepared and documented in this report.

The purpose of the technical baseline is to provide strong technical justification for funded technology development, to tie technology development activities to customer needs, to systematically integrate technology development activities, and to develop technologies only when they are not commercially available. The technical baseline is a necessary step in completing the mission of the MWFA.

To ensure that technology development activities are tied to customer needs, the MWFA has implemented the WTM process, by filling key positions within the MWFA with individuals that are members of the MWFA's customer organizations (EM-30, EM-40, and EM-60). The WTM's direct the development, demonstration, and delivery of technologies that are responsive to customer needs and that achieve compliance with regulatory requirements for treating and disposing of the mixed waste within their respective waste type. To support the WTM in these activities, WTTs are being established. Additional site involvement from EM-30, EM-40, and EM-60 organizations on the WTTs is needed from those DOE sites with significant waste volume in the various waste types. Also, an improved mechanism for identifying and responding to sites' needs will be developed.

Phase II of the technical baseline development process will result in the identification of technology development activities that will be conducted through the MWFA to resolve the identified deficiencies. When completed, the technical baseline will form the basis for the FY-1997 MWFA funding strategy. Public and tribal input will be incorporated into Phase II of the technical baseline development process.

During this process, several issues and activities were identified that must be addressed to implement this funding strategy. These activities are described in this document. This technical baseline document will be a living document, updated periodically to contain the most complete and accurate technical basis for MWFA activities.

9. REFERENCES

References are being developed.