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U.S. DEPARTMENT OF ENERGY INTERIM MIXED WASTE INVENTORY REPORT: WASTE STREAMS, TREATMENT CAPACITIES AND TECHNOLOGIES VOLUME 1: OVERVIEW APRIL 1993

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U.S. Department of Energy Interim Mixed Waste Inventory Report: Waste Streams, Treatment Capacities and Technologies

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Volume 1

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U.S. Department of Energy
Interim Mixed Waste Inventory Report:
Waste Streams, Treatment Capacities and Technologies

Table of Contents

1.0 INTRODUCTION 1.1
1.1 Purpose of Report 1.1
1.2 Regulatory History 1-2
1.3 DOE Activities 1-4
1.4 Scope of Report 1-9
1.4.1 Wastes Included in the Report 1-10
1.4.2 Wastes Not Included In The Report 1-11
1.5 Organization of Report 1-11
2.0 OVERVIEW OF DOE-MANAGED MIXED WASTES AND TREATMENT FACILITIES 2-1
2.1 National Overview of DOE-Managed Mixed Wastes 2-1
2.2 Environmental Restoration Program 2-18
2.3 Environmental Restoration Activities at Naval Nuclear Propulsion Program Sites 2-24
2.4 Mixed Waste Characteristics and Treatment 2-24
2.4.1 Radioactive Characteristics and Treatability 2-25
2.4.2 Physical and Chemical Waste Matrix 2-27
2.4.3 RCRA Hazardous Components and Treatability 2-31
2.4.4 Mixed Waste Treatment Considerations 2-32
2.4.5 Treatability Groups 2-33
2.4.6 DOE Treatment Facilities 2-34
2.5 Waste Minimization 2-52
2.5.1 General DOE Policy and Program 2-52
2.5.2 Individual Site Programs 2-52
3.0 HIGH-LEVEL RADIOACTIVE WASTES AND FACILITIES 3-1
3.1 Mixed Waste Streams 3-1
3.1.1 Hanford Site 3-4
3.1.2 Idaho National Engineering Laboratory 3-4
3.1.3 Savannah River Site 3-5
3.1.4 West Valley Demonstration Project 3-5
3.2 Treatment Facilities 3-7
3.2.1 Existing Treatment Facilities 3-7
3.2.2 Existing Facilities Currently Not Being Used 3-8
3.2.3 Facilities Planned or Under Construction 3-11
3.3 Comparison of Treatment Facilities and Waste Streams 3-12
4.0 MIXED TRANSURANIC WASTES AND FACILITIES 4-1
4.1 Waste Streams 4-1

Table of Contents

4.1.1 Waste Characterization Status at DOE 4-1
4.1.2 Waste Quantities and Management 4-2
4.2 Management of MTRU Wastes in Preparation for the Waste Isolation Pilot Plant (WIPP) 4-12
4.2.1 Overview of the WIPP 4-12
4.2.2 Facilities to Meet WIPP-WAC 4-15
5.0 MIXED LOW-LEVEL WASTES AND FACILITIES 5-1
5.1 Waste Streams 5-2
5.2 Treatment Facilities 5-11
5.3 Comparison of Treatment Facilities and Waste Streams 5-47
6.0 TREATMENT REQUIREMENTS AND TECHNOLOGY DEVELOPMENT 6.1
6.1 Introduction 6-1
6.2 Factors which Shape Mixed Waste Technology Development Approach 6-2
6.3 Impact of Mixed Waste Charactertistics on Treatment Options 6-3
6.3.1 Radioactive Waste Management Strategies 6-4
6.3.2 Radioactivity Effects on Treatment Facilities 6-5
6.3.3 Physical and Chemical Matrix Categories 6-5
6.3.4 RCRA Hazardous Components 6-9
6.4 Matrix/Contaminant Combinations found in DOE Wastes 6-12
6.5 Waste Categories, Management, and Treatment 6-12
6.5.1 Waste Categories and Treatment 6-12
6.5.2 Waste Management Operations Overview 6-16
6.5.3 Waste Treatment Approaches for Multi-Component Wastes 6-20
6.6 DOE Approach to Technology Development 6-25
6.6.1 Approach 6-26
6.6.2 Discussion 6-26
6.6.3 Additional DOE Technology Development 6-27
6.6.4 Site-Specific Technology Development 6-27
6.6.5 Current Mixed Waste Technology Development Activities 6-28
7.0 GUIDE TO SITE INFORMATION 7-1
7.1 Data Collection 7-4
7.2 Data Presentation 7-5
7.2.1 Site Discussion 7-5
7.2.2 Waste Profile Sheets 7-6
7.2.3 Technology Development Summaries 7-12
8.0 CALIFORNIA 8.0-1
8.1 Energy Technology Engineering Center 8.1-1
8.1.1 Mixed Waste 8.1-1

4690

Table of Contents

8.1.2 Treatment Facilities 8.1-4
8.1.3 Technology Development 8.1-8
8.1.4 Environmental Restoration Program 8.1-8
Waste Profile Sheets WPS-1
8.2 General Atomics 8.2-1
8.3 General Electric 8.3-1
8.4 Lawrence Berkeley Laboratory 8.4-1
8.4.1 Mixed Waste 8.4-2
8.4.2 Treatment Facilities and Technology 8.4-4
8.4.3 Technology Development 8.4-7
Waste Profile Sheets WPS-1
8.5 Lawrence Livermore National Laboratory 8.5-1
8.5.1 Mixed Waste 8.5-4
8.5.2 Treatment Facilities 8.5-6
8.5.3 Technology Development 8.5-12
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1
8.6 Laboratory For Energy-Related Health Research 8.6-1
8.6.1 Mixed Waste 8.6-1
8.6.2 Treatment Facilities 8.6-3
8.6.3 Technology Development 8.6-3
8.6.4 Environmental Restoration Program 8.6-3
Waste Profile Sheets WPS-1
8.7 Mare Island Naval Shipyard 8.7-1
8.7.1 Mixed Waste 8.7-1
8.7.2 Treatment Facilities 8.7-3
8.7.3 Technology Development 8.7-3
8.7.4 Excess Heavy Metal Bearing Equipment 8.7-3
Waste Profile Sheets WPS-1
8.8 Sandia National Laboratories/California 8.8-1
8.8.1 Mixed Waste 8.8-1
8.8.2 Treatment Facilities and Technology 8.8-2
8.8.3 Technology Development 8.8-2
Waste Profile Sheets WPS-1
9.0 COLORADO 9.0-1
9.1 Grand Junction Projects Office 9.1-1
9.1.1 Mixed Waste 9.1-2
9.1.2 Treatment Facilities and Technology 9.1-4
9.1.3 Technology Development 9.1-4

05

Table of Contents

9.1.4 Environmental Restoration Program 9.1-4
Waste Profile Sheets WPS-1
9.2 Rocky Flats Plant 9.2-1
9.2.1 Mixed Waste 9.2-5
9.2.2 Treatment Facilities and Technology 9.2-7
9.2.3 Technology Development 9.2-23
9.2.4 Environmental Restoration 9.2-30
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1
10.0 CONNECTICUT 10.0-1
10.1 Knolls Atomic Power Laboratory - Windsor 10.1-1
10.1.1 Mixed Waste 10.1-1
10.1.3 Technology Development 10.1-3
Waste Profile Sheets WPS-1
11.0 FLORIDA 11.0-1
11.1 Pinellas Plant 11.1-1
11.1.1 Mixed Waste 11.1-1
11.1.2 Treatment Facilities 11.1-1
11.1.3 Technology Development 11.1-1
Waste Profile Sheets WPS-1
12.0 HAWAII 12.0-1
12.1 Pearl Harbor Naval Shipyard 12.1-1
12.1.1 Mixed Waste 12.1-1
12.1.2 Treatment Facilities 12.1-1
12.1.3 Technology Development 12.1-3
12.1.4 Excess Heavy Metal Bearing Equipment 12.1-3
Waste Profile Sheets WPS-1
13.0 IDAHO 13.0-1
13.1 Argonne National Laboratory - West 13.1-2
13.1.1 Mixed Waste 13.1-2
13.1.2 Treatment Facilities 13.1-7
13.1.3 Technology Development 13.1-7
Waste Profile Sheets WPS-1
13.2 Idaho National Engineering Laboratory 13.2-1
13.2.1 Mixed Waste 13.2-8
13.2.4 Environmental Restoration Waste 13.2-35
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1

Table of Contents

14.0 ILLINOIS **14.0-1**
14.1 Argonne National Laboratory - East 14.1-1
14.1.1 Mixed Waste 14.1-1
14.1.2 Treatment Facilities and Technology 14.1-4
14.1.3 Technology Development 14.1-4
14.1.4 Environmental Restoration Program 14.1-7
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1
14.2 Site A/Plot M Palos Forest Preserve 14.2-1
15.0 IOWA **15.0-1**
15.1 Ames Laboratory 15.1-1
15.1.1 Mixed Waste 15.1-2
15.1.2 Treatment Facilities and Technology 15.1-4
15.1.3 Technology Development 15.1-4
15.1.4 Environmental Restoration Program 15.1-4
Waste Profile Sheets WPS-1
16.0 KENTUCKY **16.0-1**
16.1 Paducah Gaseous Diffusion Plant 16.1-1
16.1.1 Mixed Wastes 16.1-1
16.1.2 Treatment Facilities 16.1-7
16.1.3 Technology Development 16.1-11
16.1.4 Environmental Restoration Program 16.1-11
Waste Profile Sheets WPS-1
17.0 MAINE **17.0-1**
17.1 Portsmouth Naval Shipyard 17.1-1
17.1.1 Mixed Waste 17.1-1
17.1.2 Treatment Facilities 17.1-1
17.1.3 Technology Development 17.1-2
17.1.4 Excess Heavy Metal Bearing Equipment 17.1-4
Waste Profile Sheets WPS-1
18.0 MISSOURI **18.0-1**
18.1 Kansas City Plant 18.1-1
18.1.1 Mixed Waste 18.1-1
18.1.2 Treatment Facilities 18.1-1
18.2 University of Missouri 18.2-1
18.3 Weldon Spring Site 18.3-1
18.3.1 Mixed Waste 18.3-1
18.3.2 Treatment Facilities 18.3-4
18.3.3. Technology Development 18.3-4

Table of Contents

18.3.4 Environmental Restoration Program 18.3-4
Waste Profile Sheets WPS-1
19.0 NEVADA 19.0-1
19.1 Nevada Test Site 19.1-1
19.1.1 Mixed Waste 19.1-1
19.1.2 Treatment Facilities and Technologies 19.1-3
19.1.3 Technology Development 19.1-3
19.1.4 Environmental Restoration Waste 19.1-4
Waste Profile Sheets WPS-1
20.0 NEW JERSEY 20.0-1
20.1 Middlesex Sampling Plant 20.1-1
20.1.1 Mixed Waste 20.1-1
20.1.2 Treatment Facilities 20.1-1
20.1.3. Technology Development 20.1-1
20.2 Princeton Plasma Physics Laboratory 20.2-1
20.2.1 Mixed Waste 20.2-1
20.2.2 Treatment Facilities 20.2-1
20.2.3 Technology Development 20.2-1
Waste Profile Sheets WPS-1
21.0 NEW MEXICO 21.0-1
21.1 Inhalation Toxicology Research Institute 21.1-1
21.1.1 Mixed Waste 21.1-1
21.1.2 Treatment Facilities 21.1-1
21.1.3 Technology Development 21.1-3
Waste Profile Sheets WPS-1
21.2 Los Alamos National Laboratory 21.2-1
21.2.1 Mixed Waste 21.2-2
21.2.2 Treatment Facilities 21.2-5
21.2.3 Technology Development 21.2-15
21.2.4 Environmental Restoration Program 21.2-17
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1
21.3 Sandia National Laboratories - New Mexico 21.3-1
21.3.1 Mixed Waste 21.3-1
21.3.2 Treatment Facilities and Technology 21.3-3
21.3.3 Technology Development 21.3-6
21.3.4 Environmental Restoration Waste 21.3-7
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1

4690

Table of Contents

21.4 Waste Isolation Pilot Plant 21.4-1
21.4.1 Mixed Waste 21.4-1
21.4.2 Treatment Facilities 21.4-2
21.4.3 Technology Development 21.4-2
Waste Profile Sheets WPS-1
22.0 NEW YORK 22.0-1
22.1 Brookhaven National Laboratory 22.1-1
22.1.1 Mixed Waste 22.1-2
22.1.2 Treatment Facilities 22.1-3
22.1.3 Technology Development 22.1-3
22.1.4 Environmental Restoration Program 22.1-3
Waste Profile Sheets WPS-1
22.2 Colonie Interim Storage Site 22.2-1
22.2.1 Mixed Waste 22.2-1
22.2.2 Treatment Facilities 22.2-3
22.2.3 Technology Development 22.2-3
22.2.4 Environmental Restoration Program 22.2-3
Waste Profile Sheets WPS-1
22.3 Knolls Atomic Power Laboratory - Knolls Site
22.3.1 Mixed Waste 22.3-1
22.3.2 Treatment Facilities 22.3-1
22.3.3 Technology Development 22.3-3
Waste Profile Sheets WPS-1
22.4 Knolls Atomic Power Laboratory - Kesselring Site 22.4-1
22.4.1 Mixed Waste 22.4-1
22.4.2 Treatment Facilities 22.4-3
22.4.3 Technology Development 22.4-3
22.4.4 Excess Heavy Metal Bearing Equipment 22.4-3
Waste Profile Sheets WPS-1
22.5 West Valley Demonstration Project 22.5-1
22.5.1 Mixed Waste 22.5-2
22.5.3 Treatment Facilities 22.5-5
23.0 OHIO 23.0-1
23.1 Battelle Columbus Laboratories 23.1.1
23.1.1 Mixed Waste 23.1-1
23.1.2 Treatment Facilities 23.1-1
23.1.3 Technology Development 23.1-1
23.1.4 Environmental Restoration Program 23.1-1
Waste Profile Sheets WPS-1

0 9

Table of Contents

23.2 Fernald Environmental Management Project 23.2-1
23.2.1 Mixed Waste 23.2-1
23.2.2 Treatment Facilities and Technologies 23.2-2
23.2.3 Technology Development 23.2-5
23.2.4 Environmental Restoration Program 23.2-10
Waste Profile Sheets WPS-1
23.3 Mound Plant 23.3-1
23.3.1 Mixed Waste 23.3-5
23.3.2 Treatment Facilities and Technology 23.3-6
23.3.3 Technology Development 23.3-6
23.3.4 Environmental Restoration Waste 23.3-6
Waste Profile Sheets WPS-1
23.4 Portsmouth Gaseous Diffusion Plant 23.4-1
23.4.1 Mixed Waste 23.4-4
23.4.2 Treatment Facilities and Technology 23.4-5
23.4.3 Technology Development 23.4-12
23.4.4 Environmental Restoration Program 23.4-12
Waste Profile Sheets WPS-1
23.5 RMI Titanium Company 23.5-1
23.5.1 Mixed Waste 23.5-1
23.5.2 Treatment Facilities 23.5-1
23.5.3 Technology Development 23.5-3
23.5.4 Environmental Restoration Program 23.5-3
Waste Profile Sheets WPS-1
24.0 PENNSYLVANIA 24.0-1
24.1 Bettis Atomic Power Laboratory 24.1-1
24.1.1 Mixed Waste 24.1-1
24.1.2 Treatment Facilities 24.1-1
24.1.3 Technology Development 24.1-3
24.1.4 Excess Heavy Metal Bearing Equipment 24.1-3
Waste Profile Sheets WPS-1
25.0 SOUTH CAROLINA 25.0-1
25.1 Charleston Naval Shipyard 25.1-1
25.1.1 Mixed Waste 25.1-1
25.1.1 Treatment Facilities 25.1-1
25.1.3 Technology Development 25.1-4
25.1.4 Excess Heavy Metal Bearing Equipment 25.1-4
Waste Profile Sheets WPS-1
25.2 Savannah River Site 25.2-1

Table of Contents

25.2.1 Mixed Waste 25.2-5
25.2.2 Treatment Facilities and Technology 25.2-7
25.2.3 Technology Development 25.2-17
25.2.4 Environmental Restoration Program 25.2-24
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1
26.0 TENNESSEE 26.0-1
26.1 K-25 Site 26.1-1
26.1.1 Mixed Waste 26.1-1
26.1.2 Treatment Facilities and Technology 26.1-4
26.1.3 Technology Development 26.1-8
26.1.4 Environmental Restoration Program 26.1-12
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1
26.2 Oak Ridge National Laboratory 26.2-1
26.2.1 Mixed Waste 26.2-3
26.2.2 Treatment Facilities and Technology 26.2-4
26.2.3 Technology Development 26.2-8
26.2.4 Environmental Restoration Program 26.2-11
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1
26.3 Y-12 Plant 26.3-1
26.3.1 Mixed Waste 26.3-1
26.3.2 Treatment Facilities and Technology 26.3-3
26.3.3 Technology Development 26.3-8
26.3.4 Environmental Restoration Program 26.3-15
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1
27.0 TEXAS 27.0-1
27.1 Pantex Plant 27.1-1
27.1.1 Mixed Waste 27.1-1
27.1.2 Treatment Facilities and Technology 27.1-4
27.1.3 Technology Development 27.1-11
27.1.4 Environmental Restoration Program 27.1-11
Waste Profile Sheets WPS-1
28.0 VIRGINIA 28.0-1
28.1 Norfolk Naval Shipyard 28.1-1
28.1.1 Mixed Waste 28.1-1
28.1.2 Treatment Facilities 28.1-1

Table of Contents

28.1.3 Technology Development 28.1-1
28.1.4 Excess Heavy Metal Bearing Equipment 28.1-3
Waste Profile Sheets WPS-1
29.0 WASHINGTON 29.0-1
29.1 Hanford Site 29.1-1
29.1.1 Mixed Waste 29.1-2
29.1.2 Treatment Facilities and Technology 29.1-10
29.1.3 Technology Development 29.1-19
29.1.4 Environmental Restoration Program 29.1-24
Waste Profile Sheets WPS-1
Technology Development Summaries TDS-1
29.2 Puget Sound Naval Shipyard 29.2-1
29.2.1 Mixed Waste 29.2-1
29.2.2 Treatment Facilities 29.2-3
29.2.3 Technology Development 29.2-3
Waste Profile Sheets WPS-1

LIST OF FIGURES

FIGURE	TITLE	PAGE
2-1	Location of Sites Generating DOE-managed Mixed Radioactive Waste	2-2
2-2	Mixed Waste Radioactivity Categories	2-26
2-3	Physical/Chemical Matrix Categories	2-27
2-4	RCRA Contaminant Categories	2-31
6.5.1-1	Technology Based Treatment Groupings	6.15
6.5.1-2	Destruction Technologies	6.17
6.5.1-3	Recovery Technologies	6.18
8-1	California Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Mixed Waste	8.0-1
9-1	Colorado Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Mixed Waste	9.0-1
10-1	Connecticut Facility that Generates, Expects to Generate, and/or Stores DOE-Managed Mixed Waste	10.0-1
11-1	Florida Facility that Generates, Expects to Generate, and/or Stores DOE-Managed Mixed Waste	11.0-1
12-1	Hawaii Facility that Generates, Expects to Generate, and/or Stores DOE-Managed Mixed Waste	11.0-
13-1	Idaho Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Mixed Waste	13.0-1
13.2-1	Summary of INEL Mixed-Waste Types by Volume	13.10
13.2-3	Summary of INEL Mixed TRU Matrices by Volume	13.13
13.2-4	Summary of the Major INEL MLLW Matrices by Volume	13.15
14-1	Illinois facilities that Generate, Expect to Generate, and/or Store DOE-Managed Mixed Waste	14.0-1
15-1	Iowa Facility that Generates, Expects to Generate, and/or Stores DOE-Managed Mixed Waste	15.0-1
16-1	Kentucky Facility that Generates, Expects to Generate, and/or Stores DOE-Managed Mixed Waste	16.0-1
17-1	Maine Facility that Generates, Expects to Generate, and/or Stores DOE-Managed Mixed Waste	17.0-1
18-1	Missouri Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Mixed Waste	18.0-1

FIGURE	TITLE	PAGE
19-1	Nevada Facility that Generates, Expects to Generate, and/or Stores DOE-Managed Mixed Waste	19.0-1
20-1	New Jersey Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Waste	20.0-1
21.1-1	New Mexico Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Waste	21.0-1
22-1	New York Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Waste	22.0-1
23-1	Ohio Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Mixed Waste	23.0-1
24-1	Pennsylvania Facility that Generates, Expects to Generate, and/or Stores DOE-Managed Mixed Waste	24.0-1
25-1	South Carolina Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Mixed Waste.	25.0-1
26-1	Tennessee Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Mixed Waste	26.0-1
27-1	Texas Facility that Generates, Expects to Generate, and/or Store DOE-Managed Mixed Waste	27.0-1
28-1	Virginia Facility that Generates, Expects to Generate, and/or Stores DOE-Managed Mixed Waste	28.0-1
29.1	Washington Facilities that Generate, Expect to Generate, and/or Store DOE-Managed Mixed Waste	29.0-1
29.1-1	Hanford Tank Waste Management Process	29.1-4
29.1-2	Mixed Waste Treatment at Hanford	29.1-5
29.1-3	Mixed Wastes at Hanford by Type	29.0

LIST OF TABLES

TABLES	TITLE	PAGE
2-1	National Overview of DOE-Managed Mixed Waste	2-3
2-2	Current Site Inventories of DOE-Managed Mixed Waste	2-5
2-3	Five-year Projections of Operations Mixed Waste	2-11
2-4	Projection of Mixed Waste to be Generated by DOE Environmental Restoration Activities (in cubic meters) [a]	2-18
2-5	National Overview of DOE Treatment Facilities	2-35
3-1	High Level Operations Wastes	3-2
3-2	Current HLW National Inventory and Five-Year Projections	3-5
3-3	Mixed Waste Treatment Facilities Currentl Treating High-level Wastes	3-8
3-4	Existing Facilities Not Currently Treating High-Level Wastes But Planning To Treat	3-9
3-5	Facilities Planned or Under Construction For Treating High-level Wastes	3-12
4-1	Mixed Transuranic Waste Inventory and Five-year Projections-Contact Handled	4-3
4-2	Mixed Transuranic Waste Inventory and Five-year Projections-Remote Handled	4-4
4-3	Mixed Transuranic Wastes Inventory and Five-year Projections	4-5
4-4	Summary of Waste Package Acceptance Criteria for the WIPP (WIPP-WAC)	4-13
4-5	Status of Facilities Planned or Under construction for Packaging TRU Wastes for Shipment to the WIPP at the TRU	4-15
5-1	Mixed Low-Level Waste Inventory and Five-Year Projections	5-2
5-2	Mixed Low-level Waste With Transuranic Alpha Content 10nCi/g to 100 nCi/g Inventory and Five-year Projections	5-4
5-3	Mixed Low-level Waste with transuranic Alpha Content <10 nCi/g Inventory and Five-year Projections	5-6
5-4	Treatment Systems at DOE That Can Treat Mixed Low-Level Wastes With Transuranic Alpha Particle content 10 nCi/g to 100 nCi/g	5-10
5-5	Mixed Waste Tretment Facilites Currently Treating Mixed Low-level Wastes With Transuranic Alpha Particle Content 10 nCi/g to 100 nCi/g	5-12

LIST OF TABLES

TABLES	TITLE	PAGE
5-6	Existing Mixed Waste Treatment Facilities Not Currently Treating But Planning To Treat Mixed Low-level Wastes With Transuranic Alpha Particle Content 10 nCi/g to 100 nCi/g	5-13
5-7	Mixed Waste Treatment Facilities That Are Planned or Under construction To Treat Mixed Low-level Wastes With Transuranic Alpha Particle Content 10 nCi/g to 100 nCi/g	5-14
5-8	Facilities currently Treting Mixed TRU Wastes	5-15
5-9	Facilities Not Currently Treating Mixed TRU Wastes	5-16
5-10	Facilities Planned or Under Construction for Treting Mixed TRU Wastes	5-17
5-11	Treatment Systems at DOE that can Treat Mixed Low-level Wastes with Transuranic Alpha < 10 nCi/g[g]	5-20
5-12	Mixed Waste Treatment Facilities Currently Treating Mixed Low-level Wastes With Transuranic Alph < 10 nCi/g	5-27
5-13	Existing Mixed Waste Treatment Facilities Not Currently Treating But Planning To Treat Mixed Low-level Wastes with Transuranic Alpha < 10 nCi/g	5-27
5-14	Mixed Waste Treatment Facilities That Are Planned or Under Construction to Treat Mixed Low-level Wastes With Transuranic Alph < 10 nCi/g	5-30
5-15	Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Pckaging Facilities Currently Treating Mixed Low-level Wastes With Transuranic Alpha Particle content 10 nCi/g to 100 nCi/g	5-39
5-16	Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities That Are Planned or Under construciton for Treating Mixed Low-level Wastes With Transuranic Alpha Particle content 10 nCi/g to 100 nCi/g	5-40
5-17	Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities That are Currently Treating Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g	5-41
5-18	Existing Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities Currently Not Processing But Plannig To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g	5-42
5-19	Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packgaging Facilities Planned or Under construction for Treating Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g	5-43

LIST OF TABLES

TABLES	TITLE	PAGE
5-20	Mixed Low-level Waste with Trnsuranic Alpha Content 10 nCi/g to 100 NCi/g Inventroy Treatment Status	5-45
5-21	Mixed Low-level Waste with Transuranic Alpha content < 10 nCi/g Inventory Treatment Status	5-48
5-22	Technology Status for Mixed Low-level Wastes With Transuranic Alph content 10 nCi/g to 100 nCi/g	5-54
5-23	Technology Status for Mixed Low-level Wastes with Transuranic Alpha Content < 10 nCi/g	5-57
6.3-1	Mixed Waste Radioactive Categories	6-6
6.3-2	EPA Codes for RCRA Wastes	6-10
6 3.3	Regulated Constituent Code Sets	6-11
6.5-1	Technology Based Treatment Standards (from 40 CFR 268.42)	6-13
6.5-2	Debris Related Alternative Treatment Standards	6-14
6.5-3	Example Treatment Options for Differing Waste Matrices	6-21
6.6-1	Technology Development Locations and Targets	6-31
8.1-1	Mixed Wastes at Energy Technology Engineering Center	8.1-2
8.1-2	Energy Technology Engineering Center Mixed Waste Treatment Facilities Currently in Use for Mixed Waste	8.1-5
8.1-3	Energy Technology Engineering Center Mixed Waste Treatment Facilities Planned or Under construction for Mixed Wastes	8.1-6
8.1-4	Energy Technology Enginerring Center Current Planned Facilities-Treatment Category Mixed Waste Treatment Facilities	8.1-7
8.4-1	Mixed Waste at Lawrence Berkley Laboratory	8.4-3
8.4-2	Lawrence Berkley Laboratory Compaction, Evaporation, Shredding, Sorting, Size Reduction & Packaging Facilities Currently in Use for Mixed Wastes	8.4-5
8.4-3	Lawrence Berkley Laboratory Compaction, Evaporation, Shredding, Sorting, Size Reduction, & Packaging Facilities Planned or Under Construction for Mixed Wastes	8.4-6
8.4-4	Lawrence Berkley Laboratory Current & Planned Facilities-Treatment Category Compaction, Evaporation, Shredding, Sorting, Size Reduction, & Packaging Facilities	8.4-8
8.5.1	Mixed Wastes at Lawrence Livermore National Laboratory	8.5-2
8.5-2	Lawrence Livermore Natinal Laboratory Mixed Waste Treatment Facilities Currently in Use for Mised Wastes	8.5-7

LIST OF TABLES

TABLES	TITLE	PAGE
8.5.4	Lawrence Livermore National Laboratory Facilities Planned or Under Construction for Mixed Wastes	8.5-9
8.5-5	Lawrence Livermore National Labortory Compaction, Evaporation, Shredding, Sorting, Size Reduction and Packaging Facilities Planned Under Construction for Mixed Wastes	8.5-10
8.5-6	Lawrence Livermore National Laboratory Current and Planned Facilities Mixed Waste Treatment Facilities	8.5-14
8.5-7	Lawrence Livermore National Laboratory Current and Planned Facilities Treatment Category Compaction, Evaporation, Sorting, Size Reduction, and Packaging Facilities	8.5-15
8.7-1	Mixed Wastes at Mare Island Naval Shipyard	8.7-2
8.8-1	Mixed Wastes at Sandia National Laboratory-California	8.8-3
9.1-1	Mixed Wastes at Grand Junction Project Office	9.1-3
9.2-1	Mixed Wastes At Rocky Flats Plant	9.2-2
9.2-2	Rocky Flats Plant Mixed Waste Treatment Facilities Curently in Use for Mixed Waste	9.2-8
9.2-3	Rocky Flats Plant Compaction, Evaporation, Shedding, Sorting, Size Reduction, & Packaging Facilities Currently In Use for Mixed Wastes	9.2-10
9.2-4	Rocky Flats Plant Mixed Waste Treatment Facilities Existing Plan to Use for Mixed Wastes	9.2-11
9.2-5	Rocky Flats Plant Compaction, Evaporation, Shedding, Sorting, Size Reduction, & Packing Facilities Existing Plan to Use for Mixed Wastes	9.2-12
9.2-6	Rocky Flats Plant Mixed Waste Treatment Facilities Planned Or Under Construction for Mixed Wastes	9.2-13
9.2-7	Rocky Flats Plant Current & Planned Facilities-Treatment Category Mixed Waste Treatment	9.2-24
9.2-8	Rocky Flats Plant-Current & Planned Facilities-Treatment Category Compaction, Evaporation, Shredding, Size Reduction & Packaging Facilities	9.2-28
9.2-9	Site-Specific Technology Development Activity	9.2.3XXX
10.1-1	Mixed Wastes at Knolls Atomic Power Laboratory - Windsor	10.1-2
11.1-1	Mixed Waste at Pinellas Plant	11.1-2

LIST OF TABLES

TABLES	TITLE	PAGE
12.1-1	Mixed Wastes at Pearl Harbor Naval Shipyard	12.1-2
13.1-1	Mixed Wastes at Argonne National Laboratory - West	13.1-3
13.2-1	Source Categories for INEL Mixed Wastes	13.2-3
13.2-2	Operations Mixed Wastes at INEL	13.2-9
13.2-3	INEL MLLW Streams for Which No Treatment Has Been Identified	13.2-17
13.2-4	INEL Mixed Waste Treatment Facilities Currently In Use For Mixed Wastes	13.2-22
13.2-5	INEL Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities Currently In Use For Mixed Wastes	13.2-23
13.2-6	INEL Mixed Waste Treatment Facilities Existing, But Not Currently Being Used for Mixed Wastes	13.2-25
13.2-7	INEL Mixed Waste Treatment Facilities Planned Or Under Construction For Mixed Wastes	13.2-28
13.2-8	INEL Waste Acceptance Parameters For Current And Planned Treatment Facilities	13.2-32
14.1-1	Mixed Wastes at Argonne National Laboratory - East	14.1-2
14.1-2	Argonne National Laboratory-East/Mixed Waste Treatment Facilities Existing, Plan To Use For Mixed Wastes	14.1-5
14.1-3	Argonne National Laboratory-East/Current and Planned Facilities-Treatment Category Mixed Waste Tretment Facilities	14.1-6
15.1-1	Mixed Wastes at Ames Laboratory	15.1-2
16.1-1	Mixed Wastes at Paducah gaseous Diffusion Plant	16.1-2
16.1-2	Paducah Gaseous Diffusion Plant Mixed Waste Treatment Facilities Currently in Use for Mixed Wastes	16.1-4
16.1-3	Paduch Gaseous Diffusion Plant Campaction, Evaporation, Shredding, Sorting, size Reduction, and Packaging Facilities Currently In Use For Mixed Wastes	16.1-5
16.1-4	Paducah Gaseous Diffusion Plant Mixed Waste Treatment Facilities Planned or Under Construction for Mixed Wastes	16.1-8
16.1-5	Paducah Gaseous Diffusion Plant Compaction, Evaporation, Shredding, sorting, Size Reduction, and Packaging Facilities Planned or Under Construction For Mixed Wastes	16.1-9

4690

LIST OF TABLES

TABLES	TITLE	PAGE
16.1-6	Paducah Gaseous Diffusion Plant Current and Planned Facilities-Treatment Category Compaction, Evaporation, Shredding, Sorting, Size Reducition , and Packaging Facilites	16.1-10
17.1-1	Mixed Wastes At Portsmout Naval Shipyare	17.1-2
18.1-1	Mixed Waste at Kansas City Plant	18.1-2
18.3-1	Mixed Wastes at Weldon Spring Site	18.3-2
19.1-1	Mixed Wastes at Nevada Test Site	19.1-2
20.1-1	Mixed Wastes at Middlesex Sampling Plant	20.1-2
20.2-2	Mixed Wastes At Princeton Plasma Physics Laboratory	20.2-2
21.1-1	Mixed Wastes At Inhalation Toxicology Research Institute	21.1-2
21.2-1	Mixed Wastes At Los Alamos National Laboratory	21.2-4
21.2-3	Los Alamos National Laboratory Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities Currently In Use For Mixed Wastes	21.2-8
21.2-4	Los Alamos National Laboratory Mixed Waste Treatment Facilities Existing, Plant To Use For Mixed Wastes	21.2-9
21.2-5	Los Alamos National Laboratory, Mixed Waste Treatment Facilities Planned or Under construction For Mixed Wastes	21.2-11
21.2-6	Los Alamos National Laboratory Current and Planned Facilities-Treatment Category Mixed Waste Treatment Facilities	21.2-12
21.2-7	Los Alamos National Laboratory Current and Planned Facilities-Treatment Category Compaction, Evaporation, Shredding, Sorting, Size Reduciton, and Packaging Facilities	21.2-14
21.3-1	Mixed Waste at Sandia National Laboratories-New Mexico	21.3-2
21.3-2	Sandia National Lab - New Mexico Mixed Waste Treatment Facilities Planned or Under Construction for Mixed Waste	21.3-4
21.3-3	Sandia National Lab-New Mexico Current and Planned Facilities-Treatment Category Mixed Waste Treatment Facilities	21.3-5
21.4-1	Mixed Wastes at the Waste Isolation Pilot Plant	21.4-3
22.1-1	MIxed Wastes At Brookhaven Laboratory	22.1-2
22.2-1	Mixed Wastes at Colonie Interim Storage Site	22.2-1
22.3-1	Mixed Waste At the Knolls Atomic Power Laboratory	22.3-2
22.4-1	Mixed Waste at Knolls Atomic jPower Lab-Kesselring	
22.5-1	Mixed Waste At West Valley Demonstration Project	22.5-3

020

LIST OF TABLES

TABLES	TITLE	PAGE
22.5-2	West Valley Demonstration Project Mixed Waste Treatment Facilities Currently In Use For Mixed Wastes	22.5-7
22.5-4	West Valley Demonstration Project Mixed Waste Treatment Facilities Planned or Under construction for Mixed Wastes	22.5-10
23.2-1	Mixed Waste At Fernald Environmental Management Project	23.2-3
23.2-2	Fernald Environmental Management Project Mixed Waste Treatment Facilities Currently In Use For Mixed Wastes	23.2-6
23.2-3	Fernald Environmental Management Project Mixed Waste Treatment Facilities Planned or Under Construction for Mixed Wastes	23.2-7
23.2-4	Fernald Environmental Management Project Current and Planned Facilities-Treatment Category Mixed Waste Treatment Facilities	23.2-8
23.3-1	Mixed Wastes at Mound Plant	23.3-2
23.3-2	Mound Facility Mixed Waste Treatment Facilities Existing, Plan To Use For MIxed Wastes	23.3-4
23.3-3	Mound Facility Current nd Planned Facilities-Treatment Category Mixed Waste Facilities	23.3
3.4-1	Mixed Wastes At Portsmouth Gaseous Diffusion Plant	23.4-2
23.4-2	Portsmouth Gaseous Diffusion Plant Mixed Waste treatment Facilities Currently In Use for Mixed Waste	23.4-6
23.4-3	Portsmouth Gaseous Diffusion Plant Mixed Waste Treatment Facilities Planned or Under Construciton for Mixed Wastes	23.4-9
23.4-4	Portsmouth Gaseous Diffusion Plant Current and Planned Facilities-Treatment Category Mixed Waste Treatment	23.4-10
23.5-1	Mixed Wastes At Reactive Metals, Inc	23.5-2
24.1-1	Mixed Wastes At Bettis Atomic Power Laboratory	24.1-2
25.1-1	Mixed Wastes At Charleston Naval Shipyard	25.1-2
25.2-1	Mixed Wastes at Savannah River Site	25.2-2
25.2-2	Savannah River Site Mixed Waste Treatment Facilities Currently In Use for Mixed Wastes	25.2-8
25.2-3	Savannah River Site Mixed Treatment Facilites currently In Use for Mixed Wastes	
25.2-4	Savannah River Site Compaction, Evaporation, Shredding, Sorting, Size Reduciton, and Packaging Facilities Planned or Under Construciton for Mixed Wastes	25.2-12

LIST OF TABLES

TABLES	TITLE	PAGE
25.2-5	Savannah River Site Current and Planned Facilites-Treatment Category Mixed Waste Treatment Facilities	25.2-18
25.2-6	Savannah River Site Current and Planned Facilities-Treatment Category-Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilites	25.2-21
26.1-1	Mixed Wastes At Oak Ridge K-25 Site	26.1-2
26.1-2	Oak Ridge K-25 Site Mixed Waste Treatment Facilities Currently In Use For Mixed Waste Treatment Facilites	26.1-5
26.1-3	Oak Ridge K-25 Site Current and Planned Facilities-Treatment Category Mixed Waste Treatment Facilities	26.1-9
26.2-1	Mixed Wastes At Oak Ridge National Laboratory	26.2-2
26.2-2	Oak Ridge National Laboratory Mixed Waste Treatment Facilites currently In Use for Mixed Waste	26.2-6
26.2-3	Oak Ridge Natinal Laboratory compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilites Currently In Use For MIxed Wastes	26.2-7
26.2-4	Oak Ridge National Laboratory Current and Planned Facilities-Treatment Category Mixed Waste Treatment Facilities	26.2-9
26.2-5	Oak Ridge National Laboratory Current and Planned Facilities-Treatment Category Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilites	26.2-10
26.3-1	Mixed Wastes At Oak Ridge Y-12 Plant	26.3-2
26.3-2	Oak Ridge Y-12 Plant Mixed Waste Treatment Facilities Currently In Use For Mixed Wastes	26.3-4
26.3-3	Oak Ridge Y-12 Plant Mixed Waste Treatment Facilities Planned or Under construciton for Mixed Wastes	26.3-9
26.3-4	Oak Ridge Y-12 Plant Current and Planned Facilities-Treatment Category Mixed Waste Treatment Facilities	26.3-10
27.1-1	Mixed Wastes at Pantex Plant	27.1-3
27.1-2	Pantex Plant Mixed Waste Treatment Facilities Currently in Use for Mixed Wastes	27.1-5
27.1-3	Pantex Plant Mixed Waste Treatment Facilities Existing, Plant To Use For Mixed Wastes	27.1-6
27.1-4	Pantex Plant Mixed Waste Treatment Facilities Planned or Under Construction For Mixed Wastes	27.1-8

LIST OF TABLES

TABLES	TITLE	PAGE
27.1-5	Pantex Plant Current and Planned Facilities-Treatment Category Mixed Waste Treatment Facilites	27.1-9
28.1-1	Mixed Wastes at Norfolk Naval Shipyard	28.1-2
29.1-1	Distribution of Wastes At Hanford	29.1-6
29.1-2	Mixed Wastes at Hanford Site	29.1-7
29.1-3	Hanford Site Mixed Waste Treatment Facilities Existing, Plan To Use for Mixed Wastes	29.1-12
29.1-4	Hanford Site Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities Existing, Plan To Use For Mixed Wastes	29.1-13
29.1-5	Hanford Site Mixed Waste Treatment Facilites Planned or Under construction for Mixed Wastes	29.1-14
29.1-6	Hanford Site Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities Planned or Under Construciton For Mixed Wastes	29.1-16
29.1-7	Effluent Treatment Facility Unit Processes	29.1-18
29.1-8	Hanford Site Current and Planned Facilities-Treatment Category Mixed Waste Treatment Facilites	29.1-20
29.1-9	Hanford Site Current and Planned Facilities-Treatment Category Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities	29.1-22
29.2-1	Mixed Wastes At Puget Sound Naval Shipyard	29.2-2

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LIST OF ACRONYMS

ACA	Amended Consent Agreement
ADGAS	Adsorb gases
ADSs	Activity Data Sheets
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
AMES	Ames Laboratory
AMLGM	Amalgamation
AMRRR	Annual Mixed Residue Reduction Report
ANL-E	Argonne National Laboratory - East
ANL-W	Argonne National Laboratory - West
BAPL	Bettis Atomic Power Laboratory
BDAT	Best Demonstrated Available Technology
BIODG	Biodegration
BNL	Brookhaven National Laboratory
BTCO	Batelle Columbus Laboratories
BU	Biodenitrification Unit
B&W	Babcock and Wilcox - Idaho
CAI	Controlled Air Incinerator
CARBN	Carbon adsorption
CBC	Case-by-Case
CDH	Colorado Department of Health
CELL 4	GE Alpha High Level Hot Cell
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CESQG	Conditionally Exempt Small Quantity Generator
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CH	Contact handled
CDH	Colorado Department of Health
CHOXD	Chemical oxidation
CHRED	Chemical reduction
CIF	Consolidated Incineration Facility
CISS	Colonie Interim Storage Site
CLHMTF	Corrosive Liquid and Heavy Metal Treatment Facility
CRW	Cladding Removal Waste
CLHMTF	Corrosive Liquid and Heavy Metal Treatment Facility
CMS	Corrective Measures Survey
CNF	Central Neutralization Facility
CNS	Charleston Naval Shipyard
CPCF	Central Pollution Control Facility
CSS	Cement Solidification System
CTF	Cyanide Treatment Facility
CTF	Chemical Transfer Facility
CTMP	Comprehensive Treatment and Management Plan

DARA	Disposal Area Remedial Actions
D&D	Decontamination and Decommissioning
DEACT	Deactivation
DETF	Dilute Effluent Treatment Facility
DNR	Department of Natural Resources
DOE	U. S. Department of Energy
DOE-CH	U. S. Department of Energy Chicago Area Office
DOE-EM	U. S. Department of Energy Office of Environmental Restoration and Waste Management
DOE-ID	U. S. Department of Energy Idaho Field Office
DOE/NV	U. S. Department of Energy Nevada Field Office
DOP	Dioctylphthalate
DP	Defense Program
DST	Double-Shell Tank
DWPF	Defense Waste Processing Facility
EBR-II	Experimental Breeder Reactor
EBWR	Experimental Boiling Water Reactor
EE/CA	Engineering Analyses/Cost Analysis (or Assessment)
EIS	Environmental Impact Statement
EPA	U. S. Environmental Protection Agency
EPA-HQ	U. S. Environmental Protection Agency Headquarters
ER	Environmental Restoration
ERWM	Environmental Restoration and Waste Management
ESP	Extended Sludge Process
ETEC	Energy Technology Engineering Center
ETF	Effluent Treatment Facility
fb	followed by
FEMP	Fernald Environmental Management Project
FERMI	Fermi National Accelerator Laboratory
FFA	Federal Facilities Agreement
FFA/CO	Federal Facilities Agreement and Consent Order
FFCA	Federal Facility Compliance Act
FR	Federal Register
FSUBS	Fuel substitution
FUSRAP	Formally Utilized Sites Remedial Action Program
FYP	Five-Year Projection
GA	General Atomics
GE	General Electric Vallecitos Nuclear Center
GJPO	Grand Junction Projects Office
GJPORAP	Grand Junction Projects Office Remedial Action Program
GWTF	Groundwater Treatment Facility
GJVP	Grand Junction Vicinity Properties
HAZWRAP	Hazardous Waste Remedial Actions Program
HEPA	High Efficiency Particulate Air
HGTF	Hanford Grout Treatment Facility

HLVIT	High-level vitrification
HLW	High-Level Waste
HSWA	Hazardous and Solid Waste Amendments
HTGR	High Temperature Gas-Cooled Reactor
HW/MW DF	Hazardous Waste/Mixed Waste Disposal Facility
HWTF	Hazardous Waste Treatment Facility
HWTPF	Hazardous Waste Treatment and Processing Facility
HWVP	Hanford Waste Vitrification Plant
IAG	Interagency Agreement
ID	Integrated Demonstrations
ICPP	Idaho Chemical Processing Plant
IETP	Ion Exchange Treatment Probe
IFR	Integrated Fast Reactor Program
IMERC	Incineration of Waste Containing Organics and Mercury
INCIN	Incineration
INEL	Idaho National Engineering Laboratory
IP	Integrated Programs
IRTS	Integrated Radwaster Treatment System
ITP	In-Tank Precipitation
ITRI	Inhalation Toxicology Research Institute
ITRS	Integrated Radwaste Treatment System
IWIF	Idaho Waste Immobilization Facility
KAPL	Knolls Atomic Power Laboratory
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LBL	Lawrence Berkeley Laboratory
LDR	Land Disposal Restrictions
LDT	Lead Decontamination Trailer
LEHR	Laboratory for Energy-Related Health Research
LET&D	Liquid Effluent Treatment and Disposal
LETF	Liquid Effluent Treatment Facility
LLEXT	Liquid-liquid extraction
ILLWEF	Liquid Low-Level Waste Evaporation Facility
LLNL	Lawrence Livermore National Laboratory
LLW	Low-Level Waste
LSTU	Liquid Storage Treatment Unit
LWTS	Liquid Waste Treatment System
MA	Material Area
MACRO	Macroencapsulation
MAWS	Minimum Additive Waste Stabilization
MCD	Magnesium Chip Dissolver
MEO	Manhattan Engineer District
MGM	Mound Glass Melter
MINS	Marc Island Naval Shipyard

MLLW	Mixed Low-Level Wastes
MLLWTF	Mixed Low Level Waste Treatment Facility
MMES	Martin Marietta Energy Systems
MNCAW	Material Not Classified As Waste
M&O	Management and Operations
MRAP	Monticello Remedial Action Project
MRRR	Mixed Residue Reduction Report
MSDS	Material Safety Data Sheets
MTRU	Mixed-TRU Waste
MVLLWEF	Melton Valley Low-Level Waste Evaporation Facility
MVLLWIF	Melton Valley Low-Level Waste Immobilization Facility
MVP	Monticello Vicinity Properties
MWSF	Mixed Waste Storage Facility
MWTF	Mixed Waste Treatment Facility
MWTP	Mixed Waste Treatment Project
NRC	Nuclear Regulatory Commission
NEUTR	Neutralization
NEPA	National Environmental Policy Act
NLDBR	No Land Disposal Based on Recycling
NNPP	Naval Nuclear Propulsion Program
NNS	Norfolk Naval Shipyard
NP	Neutralization Pit
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRC	Nuclear Regulatory Commission
NRF	Naval Reactors Facility
NRWTP	Nonradiological Wastewater Treatment Plant
NTS	Nevada Test Site
NWCF	New Waste Calcine Facility
NYSERDA	New York State Energy Research and Development Authority
ORGS	Recovery of Organics
ORNL	Oak Ridge National Laboratory
OU	Operable Unit
OTD	Office of Technical Development
PA	Performance Assessment
PBF	Power Burst Facility
PBX-M	Princeton Beta Experiment - Modification
PCBs	Polychlorinated Biphenyls
PEIS	Programmatic Environmental Impact Statement
PEW	Process Equipment Waste
PGDP	Paducah Gaseous Diffusion Plant
PNR	Pittsburgh Naval Reactors Office
PNS	Portsmouth Naval Shipyard
PORTS	Portsmouth Gaseous Diffusion Plant
PPE	Personal Protective Equipment

PPPL	Princeton Plasma Physics Laboratory
PRTF	Plating Rinsewater Treatment Facility
PRECP	Chemical precipitation
PSNS	Puget Sound Naval Shipyard
PUREX	Plutonium and Uranium Reduction Extraction Purex
PWIT/SF	Process Waste Interim Treatment and Storage Facility
PWTP	Process Waste Treatment Plant
PWTU	Portable Water Treatment Unit
RBERY	Thermal Recovery of Beryllium
RBOF	Receiving Basin for Off-site Fuels
RCGAS	Recovery/Reuse of Compressed Gases
RCORR	Recovery of Acids and Bases
RCRA	Resource Conservation and Recovery Act
RCW/RHW	Recirculating Cooling Water/Recirculating Heating Water
R&D	Research and Development
RD&D	Research, Demonstration and Development
RDDT&E	Research, Development, Demonstration, Testing and Evaluation
RERTR	Reduced Enriched Research Test Reactor
RFI/CMS	RCRA Facility Investigation/Corrective Measures Study
RFP	Rocky Flats Plant
RH	Remote handled
RI/FS	Remedial Investigation/Feasibility Study
RLEAD	Recovery of Lead
RMDF	Radioactive Material Disposal Facility
RMERC	Recovery of Mercury
RMETL	Recovery of Metals or Inorganics
RMI	Reactive Metals, Inc.
RMWMF	Radioactive and Mixed Waste Management Facility
ROD	Record of Decision
RORGS	Recovery of Organics
RSSF	Radioactive Sodium Storage Facility
RSWF	Radioactive Scrap and Waste Facility
RSWPF	Radioactive Sodium Waste Processing Facility
RTHRM	Thermal Recovery of Metals or Inorganics
RZINC	Recovery of Zinc
SEG	Scientific Energy Groups
SLAC	Stanford Linear Accelerator Center
SMC	Specific Manufacturing Capability
SMWC	Sludge Mobilization and Waste Systems
SNAP	System for Nuclear Auxiliary Power
SNL	Sandia National Laboratories
SNL/CA	Sandia National Laboratories - California
SNL/NM	Sandia National Laboratories - New Mexico
SNM	Special Nuclear Materials
SNLL	Sandia National Laboratories - Livermore
SPWTF	Steam Plant Wastewater Treatment Facility

SRTC	Savannah River Technical Center
SRS	Savannah River Site
SSFL	Santa Susana Field Laboratory
SST	Single Shell Tank
SSTD	Site Specific Technology Development
SSTRP	Steam Stripping
STABL	Stabilization
STS	Supernatant Treatment System
SWDA	Solid Waste Disposal Act
SWMUs	Solid Waste Management Units
TAN	Test Area North
TCLP	Toxicity Characteristic Leaching Procedure
TD	Technical Development or Technology Development
TFTR	Tokamak Fusion Test Reactor
TRA	Test Reactor Area
TRU	Transuranic
TRUPACT II	Transuranic Package Transporter II
TSCA	Toxic Substances Control Act
TWC	Texas Water Commission
TWF	Transuranic Waste Facility
UCD	University of California - Davis
UMTRA	Uranium Mill Tailings Remedial Action
USGPO	U.S. Government Printing Office
UST	Underground Storage Tank
UTU	Uranium Treatment Unit
UV	Ultraviolet
VOC	Volatile Organic Compound
WAC	Waste Assessment Criteria
WAG	Waste Area Groupings
WCPF	Waste Coolant Process Facility
WEC	Westinghouse Electric Corporation
WEDF	Waste Engineering Development Facility
WELD	Weldon Spring Site
WETF	West End Treatment Facility
WERF	Waste Experimental Reduction Facility
WETOX	Wet air oxidation.
WINCO	Westinghouse Idaho Nuclear Company
WIPP-WAC	Waste Isolation Pilot Plant-Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WMIS	Waste Management Information System
WNYNSC	Western New York Nuclear Service Center
WO	Waste Operations
WPS	Waste Profile Sheets
WRAP	Waste Receiving and Processing

WROC	Waste Reduction Operations Complex
WSRC	Westinghouse Savannah River Company
WTF	West Tank Farm
WTRRX	Controlled Water reaction of Highly Reactive Chemicals
WTS	Wastewater Treatment System
WVDP	West Valley Demonstration Project
WVVS	West Valley Viltrification System
WWFF	Waste Water Filtration Facility
WWTTF	Waste Water Treatment Tank Farm
ZASF	Z-Area Saltstone Facility

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Executive Summary

The United States Department of Energy (DOE) has prepared this report to provide an inventory of its mixed wastes and treatment capacities and technologies in response to section 3021(a) of the Resource Conservation and Recovery Act (RCRA), as amended by section 105(a) of the Federal Facility Compliance Act (FFCA) of 1992 (Pub. L. No. 102-386). Section 105(a) of the FFCA requires the DOE to prepare a mixed waste inventory report within 180 days of the enactment of the Act. The FFCA defines mixed waste as "... waste that contains both hazardous wastes and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954 (42 U.S.C. 2011 *et seq.*)." To fulfill this requirement, DOE has prepared this report for submission to EPA and the States in which DOE stores, generates, or treats mixed wastes. As required by the FFCA, this report contains:

- a national inventory of all mixed wastes in the DOE system that are currently stored or will be generated over the next five years, including waste stream name, description, EPA waste codes, basis for characterization (i.e., sampling and analysis or process knowledge), effect of radionuclides on treatment, quantity stored that is subject to the Land Disposal Restrictions (LDRs) storage prohibition, quantity stored that is not subject to the LDRs, expected generation over the next five years, Best Demonstrated Available Technology (BDAT) used for developing the LDR requirements, and waste minimization activities; and

- a national inventory of mixed waste treatment capacities and technologies, including information such as the descriptions, capacities, and locations of all existing and proposed treatment facilities, explanations for not including certain existing facilities in capacity evaluations, information to support decisions on unavailability of treatment technologies for certain mixed wastes, and the planned technology development activities.

The FFCA requires that this report be submitted to the Administrator of the Environmental Protection Agency (EPA) and the Governor of the States in which DOE stores or generates mixed wastes. There are 50 sites that store, generate, or are expected to generate in the next five years DOE-managed mixed wastes covered by the FFCA provisions. Figure ES-1 presents the location of these sites across 22 States. The primary DOE programs that generate or manage mixed waste are the Defense Program, the Energy Research Program, the Nuclear Energy Program, the Environmental Restoration and Waste Management Program and the Naval Nuclear Propulsion Program.

The DOE has identified over 1,478 mixed waste streams that are currently in storage or will be generated in the next five years at the 50 sites. Table ES-1 presents the number of sites within each State storing or generating DOE-managed mixed waste, the current quantity of mixed waste in each State's inventory, and the Department's best estimate of the quantity of these wastes likely to be generated during the next five years. This inventory is grouped by State for the 50 sites at which mixed waste is currently stored or might be generated over the next five years. Wastes comprising the current inventory were mainly generated from either routine site operations or from environmental restoration activities. As shown in Table ES-1, the total mixed waste volume currently in storage is approximately 589,481.5 m^3 and the volume projected for the next five years is approximately 297,932.8 m^3. This five-year projection does not include environmental restoration wastes. Because of the nature of the environmental restoration program, restoration waste projections are very preliminary. The five-year projection for environmental restoration waste has been made on the basis of generally conservative assumptions and is estimated to be approximately 620,330 m^3.

TABLE ES-1

NATIONAL OVERVIEW OF DOE MIXED WASTE

State	No. of Sites	Inventory (m^3)	Five-Year Projection[1] (m^3)
California	8	878.7	541.0
Colorado	2	57,506.6	2,914.0
Connecticut	1	0.0	10.1
Florida	1	0.0	0.0
Hawaii	1	1.5	0.9
Idaho	2	72,748.1	8,484.6
Iowa	2	97.8	31.5
Illinois	1	0.2	0.0
Kentucky	1	199.3	380.1
Maine	1	0.1	0.2
Missouri	3	91.6	0.0
Nevada	1	612.0	0.0
New Jersey	2	24,468.0	0.5
New Mexico	4	8,946.7	1,260.5
New York	5	400.0	58.9
Ohio	5	8,705.5	4,764.6
Pennsylvania	1	28.4	4.8
South Carolina	2	136,589.1	24,002.9
Tennessee	3	44,370.4	17,369.4
Texas	1	87.9	195.7
Virginia	1	0.0	1.5
Washington	2	233,749.6	237,911.6
National Total	50	589,481.5	297,932.8

[1] Five-year Projections do not include Environmental Restoration wastes.

Approximately 367,470 m^3 (62 percent) of the mixed waste currently in storage is subject to the land disposal prohibition requirements of RCRA section 3004. About 44 percent of the total inventory of waste has been characterized as hazardous waste through sampling and analysis and about 56 percent has been characterized through process knowledge.

Each of DOE's mixed wastes is classified under one of the following radiation classifications:

High-Level Waste (HLW) - HLW is defined by the DOE Order 5820.2A as ".. the highly radioactive waste material that results from the reprocessing of spent nuclear fuels, including liquid waste produced directly in reprocessing, and any solid waste derived from the liquid that contains a combination of transuranic waste and fission products in concentrations as to require permanent isolation." The primary source of HLW is the reprocessing of spent uranium and plutonium fuel and irradiated targets.

Transuranic (TRU) Waste - TRU waste, as defined by DOE Order 5820.2A, refers to all radioactive wastes that contain more than 100 nCi/g of alpha-emitting isotopes with atomic numbers greater than 92 and half-lives greater than 20 years. This definition includes isotopes of neptunium (Np), plutonium (Pu), americium (AM), curium (Cm), and californium (Cf). More than 90 percent of TRU wastes contain mainly plutonium that emits alpha particles and low-energy photons. These wastes are generated primarily by spent fuel reprocessing, plutonium metal production, plutonium weapons fabrication, and plutonium-bearing reactor fuel formulation activities.

Low-Level Waste (LLW) - LLW is defined by DOE Order 5820.2A as all radioactive waste not classified as HLW, TRU waste, spent fuel, or by-product materials such as uranium and thorium mill tailings. The primary sources of LLW are DOE's defense-related waste management and restoration activities, uranium enrichment operations, the Naval Nuclear Propulsion Program, isotope production, and research and development activities.

The DOE's HLW is assumed to be mixed waste because it contains RCRA hazardous components, or exhibits the characteristic of corrosivity, and therefore is included in this report. Some DOE sites manage their mixed TRU (MTRU) wastes separately from their TRU wastes while the other sites manage all their TRU wastes as mixed wastes. Consequently all TRU waste quantities provided by the DOE sites that have not classified or separated their mixed TRU wastes from their TRU wastes, are included as MTRU wastes in this report. Only the low-level wastes that have components regulated under RCRA or State hazardous waste laws are included as mixed wastes in this report. These wastes are referred to as mixed low-level wastes (MLLWs).

The DOE has implemented waste minimization measures to reduce the amount of waste. On August 20, 1992, the Secretary of Energy issued a new DOE Policy on Waste Minimization and Pollution Prevention. The new Policy expanded the prior DOE Waste Minimization Policy and established a hierarchy of actions to guide all future DOE operations. The key elements of the DOE's pollution prevention efforts are:

- First, avoid or reduce the generation of hazardous substances, pollutants, wastes, and contaminants at the source;
- Second, recycle or reuse what cannot be eliminated;

- Third, treat the remaining waste to reduce volume, toxicity, or mobility before storage or disposal; and

- Fourth, dispose of the residual waste in an environmentally safe manner.

Of these actions, the first two constitute DOE's waste minimization effort and are the highest priority in preventing pollution. The new Policy stresses that waste minimization and pollution prevention are the personal responsibility of both Federal and contractor employees. Waste minimization practices being used by DOE include technology changes, raw material changes, product changes, and good operating practices.

The three primary characteristics that have to be considered in selecting appropriate handling and treatment required for mixed wastes are the radioactive characteristics, the RCRA hazardous components, and the physical/chemical matrix of the waste. Based on these characteristics, the mixed waste streams are grouped into treatability groups. These treatability groups are then used to compare waste inventories to existing or planned treatment facility capacities and technology development needs. In general, treatment of HLW will consist of vitrification. TRU waste, including mixed TRU (MTRU) waste, is expected to be disposed of at the Waste Isolation Pilot Plant (WIPP), which is a deep geological repository in southeastern New Mexico. It is expected that a final no-migration petition for the WIPP will be prepared and submitted to the EPA to permit the disposal of MTRU waste at WIPP at the conclusion of the test phase. Repackaging or treatment of some MTRU waste will be needed to meet the waste acceptance criteria for disposal at the WIPP. MLLW will be treated to meet the applicable LDR standards under the RCRA.

Table ES-2 lists, by State, the number of existing DOE mixed waste treatment facilities currently in use and those planned for use in the future. As shown in this table DOE currently has 38 treatment facilities that are treating mixed waste, 15 existing facilities that are planned to be used to treat mixed waste, and 53 facilities that are planned for treating mixed waste. Some of the existing facilities that are planned to be used to treat mixed waste do not currently treat mixed waste due to technical, regulatory, or other problems. Increases to existing treatment capacity will be needed to provide for DOE-wide needs, including the likely need for treatment at some DOE sites of small quantities of off-site wastes.

Currently, available treatment technology is not adequate to address all of DOE waste treatment needs. To address this issue, DOE must develop new or improved cost-effective technologies. This is being addressed through a combination of site-specific and complex-wide activities in the following areas:

- Optimizing and adapting the existing and traditional hazardous and mixed waste treatment systems to fit specific waste stream needs, which are being pursued on a site-specific basis.

- Investigating alternative innovative technologies to improve existing treatment systems, and developing viable treatment for waste streams that do not currently have identified treatment technologies. These activities are being pursued on a complex-wide basis.

Table ES-3 presents an item by item comparison of the requirements of the FFCA, and a reference to the sections of this report that address each requirement.

TABLE ES-2

OVERVIEW OF DOE MIXED WASTE TREATMENT FACILITIES

State	Number of Existing Treatment Facilities in Use	Number of Existing Treatment Facilities Planned for Use[1]	Number of Planned Treatment Facilities[1]
California	2	0	6
Colorado	5	4	6
Connecticut	0	0	0
Florida	0	0	0
Hawaii	0	0	0
Idaho	6	4	11
Illinois	0	1	0
Iowa	0	0	0
Kentucky	1	0	1
Maine	0	0	0
Missouri	0	0	0
Nevada	0	0	0
New Jersey	0	0	0
New Mexico	1	2	4
New York	1	0	1
Ohio	6	1	6
Pennsylvania	0	0	0
South Carolina	4	0	11
Tennessee	11	0	1
Texas	1	2	1
Virginia	0	0	0
Washington	0	1	5
TOTALS	38	15	53

[1]Because DOE is still in the planning/conceptual stage, in the design stage, or in the construction stage for this facility, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

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TABLE ES-3

SUMMARY OF FFCA REQUIREMENTS FOR THE MIXED WASTE INVENTORY REPORT

Section of SWDA[1]	FFCA Requirement	Section(s) of Report Addressing Requirement
Sec. 3021(a)(1)(A)	A report containing a national inventory of all such mixed wastes, regardless of the time they were generated, on a State-by-State basis.	All
Sec. 3021(a)(1)(B)	A report containing a national inventory of mixed waste treatment capacities and technologies.	All
Sec. 3021(a)(2)(A)	A description of each type of mixed waste at each Department of Energy facility in each State, including, at a minimum, the name of the waste stream.	Section B: Waste Profile Sheets, Chapters 8-29
Sec. 3021(a)(2)(B)	The amount of each type of mixed waste currently stored at each Department of Energy facility in each State, set forth separately by mixed waste that is subject to the land disposal prohibition requirements of section 3004 and mixed waste that is not subject to such prohibition requirements.	Section A: Chapters 2-5; Section B: Waste Profile Sheets
Sec. 3021(a)(2)(C)	An estimate of the amount of each type of mixed waste the Department expects to generate in the next 5 years at each Department of Energy facility in each State.	Section A: Chapters 2-5; Section B: Waste Profile Sheets, Chapters 8-29
Sec. 3021(a)(2)(D)	A description of any waste minimization actions the Department has implemented at each Department of Energy facility in each State for each mixed waste stream.	Section B: Chapters 8-29, Waste Profile Sheets
Sec. 3021(a)(2)(E)	The EPA hazardous waste code for each type of mixed waste containing waste that has been characterized at each Department of Energy facility in each State.	Section B: Waste Profile Sheets
Sec. 3021(a)(2)(F)	An inventory of each type of waste that has not been characterized by sampling and analysis at each Department of Energy facility in each State.	Section B: Chapters 8-29; Appendix C

[1] Section 105(a) of the FFCA amends the identified sections of the Solid Waste Disposal Act (42 U.S.C. 6921 *et seq.*).

TABLE ES-3

SUMMARY OF FFCA REQUIREMENTS FOR THE MIXED WASTE INVENTORY REPORT
(Continued)

Section of SWDA[1]	FFCA Requirement	Section(s) of Report Addressing Requirement
Sec. 3021(a)(2)(G)	The basis for the Department's determination of the applicable hazardous waste code for each type of mixed waste at each Department of Energy facility and a description of whether the determination is based on the sampling and analysis conducted on the waste or on the basis of process knowledge.	Section B: Waste Profile Sheets
Sec. 3021(a)(2)(H)	A description of the source of each type of mixed waste at each Department of Energy facility in each State.	Section B: Waste Profile Sheets
Sec. 3021(a)(2)(I)	The land disposal prohibition treatment technology or technologies specified for the hazardous waste component of each type of mixed waste at each Department of Energy facility in each State.	Section B: Waste Profile Sheets
Sec. 3021(a)(2)(J)	A statement of whether and how the radionuclide contents of the waste alters or affects use of the technologies described in subparagraph (I).	Section B: Waste Profile Sheets
Sec. 3021(a)(3)(A)	An estimate of the available treatment capacity for each waste described in the report required by paragraph (1)(A) for which treatment technologies exist.	Section A: Chapters 2-5 Section B: Chapters 8-29
Sec. 3021(a)(3)(B)	A description, including the capacity, number and location, of each treatment unit considered in calculating the estimate under subparagraph (A).	Section A: Chapters 2-5 Section B: Chapters 8-29

[1] Section 105(a) of the FFCA amends the identified sections of the Solid Waste Disposal Act (42 U.S.C. 6921 *et seq.*).

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TABLE ES-3

SUMMARY OF FFCA REQUIREMENTS FOR THE MIXED WASTE INVENTORY REPORT
(Continued)

Section of SWDA[1]	FFCA Requirement	Section(s) of Report Addressing Requirement
Sec. 3021(a)(3)(C)	A description, including the capacity, number and location, of any existing treatment unit that was not considered in calculating the estimate under subparagraph (A) but that could, alone or in conjunction with other treatment units, be used to treat any of the wastes described in the report required by paragraph (1)(A) to meet the requirements of regulations promulgated pursuant to section 3004(m).	Section A: Chapters 2-5 Section B: Chapters 8-29
Sec. 3021(a)(3)(D)	For each unit listed in subparagraph (C), a statement of the reasons why the unit was not included in calculating the estimate under subparagraph (A).	Section A: Chapters 2-5 Section B: Chapters 8-29
Sec. 3021(a)(3)(E)	A description, including the capacity, number, location, and estimated date of availability, of each treatment unit currently proposed to increase the treatment capacities estimated under subparagraph (A).	Section A: Chapters 2-5 Section B: Chapters 8-29
Sec. 3021(a)(3)(F)	For each waste described in the report required by paragraph (1)(A) for which the Department has determined no treatment technology exists, information sufficient to support such determination and a description of the technological approaches the Department anticipates will need to be developed to treat the waste.	Section A: Chapter 6; Appendix B

[1] Section 105(a) of the FFCA amends the identified sections of the Solid Waste Disposal Act (42 U.S.C. 6921 *et seq.*).

DOE/NBM-1100

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U.S. Department of Energy Interim Mixed Waste Inventory Report: Waste Streams, Treatment Capacities and Technologies

Volume I - Overview
Volume II - Site Specific-California through Idaho
Volume III - Site Specific-Illinois through New York
Volume IV - Site Specific-Ohio through South Carolina
Volume V - Site Specific-Tennessee through Washington
Volume VI - Appendices

April 1993

041

1.0 INTRODUCTION

The Department of Energy (DOE) has prepared this report to provide an inventory of its mixed wastes and treatment capacities and technologies in response to Section 105(a) of the Federal Facility Compliance Act (FFCAct) of 1992 (Pub. L. No. 102-386). As required by the FFCAct-1992, this report provides site-specific information on DOE's mixed waste streams and a general review of available and planned treatment facilities for mixed wastes.

Sections 1.1 through 1.3 provide background information and discuss the purpose of this report, including the regulatory history leading to the enactment of the FFCAct - 1992, and the reporting requirements placed upon the DOE by the FFCAct-1992. In addition, these sections describe DOE's programs that generate or manage mixed wastes. Section 1.4 discusses the scope of this report, while section 1.5 describes in detail the organization of the report.

1.1 Purpose of Report

The FFCAct-1992 was enacted into law (Public Law 102-386) on October 6, 1992.[a] The FFCAct-1992 amends the Solid Waste Disposal Act (1965) which was itself previously amended by the Resource Conservation and Recovery Act (RCRA) (1976) and the Hazardous and Solid Waste Amendments (HSWA) (1984). Section 105(a) of the FFCAct-1992 requires DOE to prepare a mixed waste inventory report within 180 days of the enactment of the FFCAct-1992 (i.e., by April 5, 1993). The FFCAct-1992 defines mixed waste as "... waste that contains both hazardous wastes and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954 (42 U.S.C. 2011 *et seq.*)." To fulfill this requirement, DOE has prepared this report for submission to the Environmental Protection Agency (EPA) and the States in which DOE stores, generates, or treats mixed wastes. As required by the FFCAct-1992, this report contains:

- a national inventory of all mixed wastes, that are currently stored or will be generated over the next 5 years, including waste name, description, EPA waste codes, basis for characterization (i.e., sampling and analysis or process knowledge), effect of radionuclides on treatment, quantity stored that is subject to the Land Disposal Restrictions (LDRs) storage prohibition, quantity stored that is not subject to the LDRs, expected generation over the next 5 years, Best Demonstrated Available Technology (BDAT) used for developing the LDR requirements, and waste minimization activities; and

- a national inventory of mixed waste treatment capacities and technologies, including information such as the descriptions, capacities, and locations of all existing and proposed treatment facilities, explanations for not including certain existing facilities in capacity evaluations, information to support decisions on unavailability of treatment technologies for certain mixed wastes, and the planned technology development activities.

DOE has provided detailed site-specific information on DOE's mixed waste streams, treatment facilities, and technology development activities. The emphasis of this report is to provide waste stream-specific and treatment facility-specific information for each DOE site in each state.

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[a] The FFCA is provided in Appendix A.

To present national overviews of DOE's mixed wastes and treatment facilities, DOE has summarized the waste stream-specific and treatment facility-specific data. The summary data combine waste streams and associated treatment facilities in treatability groups. DOE established the treatability groups such that the different mixed wastes within each treatability group are amenable to similar types of treatment because they share similar physical/chemical characteristics that affect treatment selection. Hence, the use of treatability groups not only provides a consistent basis for presenting summary statistics but is also useful for assessing required and available treatment capacity for mixed wastes.

1.2 Regulatory History

The Solid Waste Disposal Act (SWDA) (42 U.S.C. 6961 *et seq.*), enacted into law in 1965, established initial requirements for the management of solid waste disposal. RCRA amended the SWDA in 1976 and established the regulatory program for the management of hazardous wastes. The RCRA program was later amended by the Hazardous and Solid Waste Amendments (HSWA) on November 8, 1984. HSWA vastly expanded the scope and requirements of RCRA. The HSWA prohibited the land disposal of untreated hazardous wastes and required EPA to promulgate treatment standards for all hazardous waste destined for land disposal, according to a statutory schedule. This portion of the HSWA is referred to as the Land Disposal Restrictions (LDR).

Additionally, the HSWA prohibited the storage of untreated hazardous wastes except where required to accumulate sufficient quantities to facilitate proper treatment, recovery, or disposal. This storage prohibition, commonly referred to as the LDR storage prohibition, is not retroactive, that is, it does not apply to wastes that were placed into storage prior to the effective date of the treatment standard established for each waste stream.

EPA established the LDR standards on the basis of best demonstrated available technologies (BDATs) rather than risk-based or health-based standards. By definition, BDATs are commercially-available technologies that have been demonstrated on a full-scale level to offer the greatest reduction of toxicity, mobility, or volume of the waste. Within this framework, EPA has established two types of LDR treatment standards: hazardous constituent concentration levels above which the waste cannot be land-disposed and a specified technology (i.e., the BDAT) which must be applied to the waste before land-disposal.

EPA set the LDR standards under three broad categories: Solvents and Dioxin wastes, California list wastes, and scheduled wastes. The standards applicable to Solvents and Dioxins were published in the Federal Register on November 7, 1986, [51 FR 40572]. EPA subsequently issued standards applicable to California list wastes on July 8, 1987, [52 FR 25760]. Scheduled wastes refer to the three-part statutory timetable followed by EPA to set the LDR standards for the remainder of the hazardous wastes. The rulemakings according to the three schedules, also referred to as the First Third, Second Third, and Third Third rules, were promulgated on August 8, 1988, [53 FR 31138], June 8, 1989, [54 FR 26594], and May 8, 1990, [55 FR 22520], respectively. In addition to these hazardous wastes, an LDR rulemaking for newly-listed wastes and hazardous debris was promulgated on August 18, 1992, [57 FR 37194].

As of the effective date of each regulation, wastes not meeting the LDR standards are prohibited from land disposal, unless the wastes are disposed of in a land disposal unit for which it has been demonstrated that there will be no migration of hazardous constituents for as long as the waste remains hazardous. EPA defines land disposal to include, but not be limited to, any placement of hazardous waste in landfills,

surface impoundments, waste piles, injection wells, land treatment facilities, salt domes or salt bed formations, underground mines or caves, or concrete vaults or bunkers intended for disposal purposes.[b]

Radioactive wastes are regulated by the Atomic Energy Act of 1954 (AEA) [42 U.S.C. 2011 *et seq.*], which was enacted to regulate the development and control of atomic energy. The AEA originally established the Atomic Energy Commission, which was replaced by the Nuclear Regulatory Commission (NRC) and DOE's predecessor, the Energy Research and Development Administration (ERDA), under the Energy Reorganization Act of 1974 [42 U.S.C. 5801 *et seq.*], to oversee nuclear energy and related activities. The AEA regulates the production, possession, and transfer of source materials, spent nuclear materials, and byproduct materials. The AEA also outlines procedures for enforcement, issuance of atomic energy licenses, indemnification and limitation of liability, research, international activities, cooperation between the Commission and States, and defense-related nuclear energy activities.

The regulatory problem posed by mixed wastes is complicated because both RCRA and AEA requirements are applicable. Moreover, section 1006(a) of RCRA states that RCRA requirements do not apply to "... any activity or substance which is subject to the ... Atomic Energy Act of 1954 [42 U.S.C. 2011 *et seq.*] except to the extent that such application (or regulation) is not inconsistent with the requirements of such [Act]." On July 3, 1986, EPA clarified the applicability of RCRA to mixed waste [51 FR 24504]. At that time, EPA stated that the radioactive components of mixed wastes are regulated by AEA while the hazardous components are regulated by RCRA. These hazardous components regulated by RCRA are either listed as hazardous in Subpart D of 40 CFR Part 261 or exhibit one of the hazardous waste characteristics identified in Subpart C of 40 CFR Part 261. Subsequently on May 1, 1987, DOE issued a rulemaking interpreting the AEA term "byproduct material" for purposes of RCRA's applicability to DOE wastes [52 FR 15937].

The definition for mixed waste (or mixed radioactive waste) was further clarified by the FFCAct-1992 as "... waste that contains both hazardous wastes and source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954 (42 U.S.C. 2011 *et seq.*)." As defined by the AEA, "source material" includes uranium and thorium, and ores containing one or more of the foregoing materials. "Special nuclear material" includes plutonium, uranium enriched in the isotope 233 or in the isotope 235, or any material artificially enriched by any of the foregoing, but does not include source material. "Byproduct material" includes any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

There is insufficient treatment capacity, and in some cases no treatment technology, to treat DOE's mixed wastes to the established LDR standards. Therefore, in many cases, DOE's storage of mixed wastes is inconsistent with the LDR storage prohibition. Although the FFCAct-1992 waives sovereign immunity to allow states to impose fines and penalties against federal facilities for violations of RCRA, the Act delays the effective date of the waiver for mixed waste storage violations for three years to allow DOE time to prepare plans for the development of treatment capacities and technologies for facilities at which DOE generates or stores mixed wastes.

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[b] On February 16, 1993, EPA promulgated amendments that wastes stored in corrective action management units (CAMUs) during RCRA corrective actions do not trigger the land disposal restrictions unless the wastes are removed from the unit for treatment or other purposes [58 FR 8658,8683].

1.3 DOE Activities

DOE was established on October 1, 1977, by DOE Organization Act of 1977 (42 U.S.C. 7131 *et seq.*). DOE was assigned the following major Federal energy functions and responsibilities:

- develop improvements in the current use of energy resources,
- conduct basic research in the sciences underlying efficient and effective energy use,
- protect society from the possible dangers of the by-products from nuclear plants, medical research, and other applications
- manage nuclear weapons production for strategic defense needs,
- manage defense and civilian nuclear power production,
- deliver electric power through five power administrations,
- manage civilian and military petroleum reserves,
- develop and maintain information on energy reserve, energy production, and possible future energy needs for use by the private and public sectors, and
- oversee environmental restoration and waste management of DOE nuclear and nonnuclear facilities.

The primary DOE programs that generate or manage mixed wastes are the Defense Program, the Energy Research Program, the Nuclear Energy Program, the Waste Management Program, the Environmental Restoration Program, the Facility Transition and Management Program, and the Naval Nuclear Propulsion Program. These programs are briefly discussed below.

Defense Program. The Defense Program (DP) manages the nuclear weapons program for DOE. Through the network of laboratories, production plants, and test sites that constitute the nuclear weapons complex, DP conducts a broad range of activities vital to the nation's security. DP's mission encompasses weapons development, production, and testing, national security, special nuclear materials production, and technology transfers.

Energy Research Program. The Energy Research Program manages fundamental science and basic energy research programs for DOE in several areas, including high-energy physics; nuclear physics; the physical, mathematical, and biological sciences; fusion energy; environmental and health effects; and the superconducting super collider. In addition, the program is responsible for university research and university-based education and training activities.

Nuclear Energy Program. The Nuclear Energy Program is responsible for the administration of advanced technology programs and projects for nuclear fission power generation and fuel technology, the evaluation of alternative reactor fuel cycle concepts, and the development of space nuclear generator systems and reactor cores.

Waste Management Program. The Waste Management program was formed when the Environmental Restoration and Waste Management organization (EM) was established in November 1989, with the broad mission to minimize, treat, store, and dispose of DOE wastes in a manner that protects human health and the environment. The Waste Management Program encompasses the characterization, treatment, storage, and disposal of mixed wastes, radioactive wastes, sanitary wastes, and spent nuclear fuel. Specifically, the Waste Management Program assists with the development of annual waste minimization goals for all DOE programs that generate waste, helps generators achieve these goals, and optimizes the management of waste streams across DOE. Under this program, DOE is focusing on treating wastes for which treatment capacity exists, on ensuring adequate permitted storage capacity for existing wastes, and on minimizing the generation of new wastes. Concurrently, DOE is constructing and testing facilities for treating and disposing of mixed wastes that currently cannot be treated due to lack of capacity.

Environmental Restoration Program. The Environmental Restoration program was also formally established when the Environmental Restoration and Waste Management organization was established in 1989, with the broad mission to safely manage the cleanup of DOE sites and related wastes and to reduce risks at these sites to acceptable levels. As used in this report, environmental restoration refers to activities and programs conducted by the Office of Environmental Restoration (EM-40). Activities conducted under the environmental restoration program address contamination at inactive sites, resulting from past practices at nuclear-related facilities that were owned or operated by DOE and its predecessor agencies. The program also includes several sites that were not owned or operated by DOE or its predecessors but that Congress has directed DOE to remediate.

Cleanup activities within the environmental restoration program have three key objectives. The first is to ensure the protection of public health, worker safety and health, and the environment at these sites. The second is to bring the sites into compliance with applicable environmental requirements, notably those of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), and the Toxic Substances Control Act (TSCA). The third is to restore property so that it can be released for other uses without restrictions.

The environmental restoration program encompasses both remedial action and decontamination and decommissioning (D&D) activities at specific sites located among the more than 100 DOE installations across 36 States and territories. Seventeen major environmental restoration projects have been identified from among these installations, and these projects have been aggregated from subprojects that are defined according to their historical uses, specific contaminant problems and the current phase of cleanup activities. For example, certain sites are in various stages of preliminary assessment to define the nature of the problem, whereas others have progressed to and beyond the stage of conducting interim removal activities.

Contaminated soil, waste pits, and ground water are the focus of many remedial actions. A variety of contaminated soil, sludge, and liquids will result from cleanup activities such as excavation, dredging, and pumping at these sites. D&D activities typically address processing plants, reactors, and storage tanks, and cleanup of those facilities is expected to result in wastes such as decontamination residuals and equipment and structural debris.

Radionuclides are a primary concern at DOE sites, and the combined environmental restoration cleanup activities will result in a considerable amount of radioactive waste. Smaller volumes of both hazardous waste and radioactive waste mixed with hazardous waste will also be produced. Nonradioactive waste constituents will result from the cleanup of material such as polychlorinated biphenyls (PCBs) associated with outdated electrical equipment, asbestos insulation from old buildings, diesel fuels from old vehicles and pumps, and paints and solvents associated with past operation and maintenance activities. Because

much of this material is only incidentally contaminated with radionuclides, the levels of radioactivity in many of the mixed wastes from remedial action and D&D activities are expected to be low.

Many of these environmental restoration projects do not have completed remedial investigations and feasibility studies, and hence, there is significant uncertainty in the estimated generation rates and anticipated types of hazardous components of mixed waste that will result from future restoration projects.

Facility Transition and Management Program. With recent global changes resulting in a large number of DOE's defense production facilities being declared surplus to the nation's defense needs, DOE has had to look closely at developing a process to transition these facilities to other uses or to prepare them for decontamination and decommissioning (D&D). To do this effectively, the Office of Facility Transition and Management was created in 1992. This Office coordinates and oversees the orderly transfer of responsibility for contaminated facilities and installations from other areas of DOE to EM and is responsible for managing and directing programs to achieve the deactivation or safe shutdown of surplus facilities that have been transferred to EM prior to being deactivated.

Deactivation is the process and activities associated with placing a facility in a safe shutdown condition while awaiting disposition. Disposition options for facilities include departmental re-use, other federal agency re-use, economic development, and final decontamination and decommissioning. Deactivation allows for environmental, safety and health, and monetary risk reduction while the strategy and technologies are developed. Deactivation activities may include stabilization runs, water rinses of systems to remove process wastes, repackaging and movement of wastes, and removal of contaminated equipment. Many of these activities generate mixed wastes. Since these facilities have only recently been transferred to EM for deactivation, planning efforts are not developed to a point where 5-year waste generation projections can be included in this report. As information becomes available it will be updated in appropriate documents.

Naval Nuclear Propulsion Program. The Naval Nuclear Propulsion Program (NNPP) is a joint DOE and Department of the Navy program responsible for all matters pertaining to naval nuclear propulsion which covers over 160 naval reactors onboard over 130 nuclear-powered warships. The Program's DOE sites are the Knolls Atomic Power Laboratory's (KAPL's) Knolls and Kesselring Sites in the State of New York, KAPL's Windsor Site in the State of Connecticut, the Bettis Atomic Power Laboratory in Pennsylvania, and the Naval Reactors Facility in Idaho, which is located on the Idaho National Engineering Laboratory (INEL) and is included in the INEL section. It should be noted that NNPP has always been organizationally separate from those parts of the DOE which deal with nuclear weapons matters. Within the Navy, the Program is also responsible for the Nuclear Power Training Unit, Charleston, South Carolina, (which, because it does not generate mixed waste, is not included in this report) and nuclear propulsion work at Portsmouth Naval Shipyard in the State of Maine, Norfolk Naval Shipyard in the Commonwealth of Virginia, Charleston Naval Shipyard in the State of South Carolina, Puget Sound Naval Shipyard in the State of Washington, Mare Island Naval Shipyard in the State of California, and Pearl Harbor Naval Shipyard in the State of Hawaii.

Program responsibility and authority for radioactivity associated with Naval nuclear propulsion, including that contained in mixed waste, at these sites is set forth in the Atomic Energy Act of 1954, as amended, and in Presidential Executive Order 12344 of 1982, enacted as permanent law by Public Law 98-525 (42 U.S.C. 7158, note). The legislative history of the FFCAct-1992 identifies that "section 102(c)(3)(B), pertaining to the delay of the effective date of the sovereign immunity waiver for the Department of Energy mixed wastes beyond 3 years, is also applicable to all mixed wastes under the joint DOE-Department of Navy efforts conducted under Executive Order 12344 (42 U.S.C. 7158 note)." Since

Section 102(c)(3)(B) contains the requirement for developing the mixed waste inventory report, mixed waste from all NNPP facilities, including shipyards, has been included herein.

NNPP management of mixed waste is predicated on several key principles:

- Ensuring radioactive waste from NNPP work continues to be managed in accordance with longstanding and successful NNPP radiological requirements which have been in place since the NNPP's inception in the 1950's and have evolved over time. These requirements are the same throughout the NNPP at DOE and Navy sites and have been demonstrated to protect the environment and public health and safety by independent EPA reviews and monitoring and detailed audits by the U.S. General Accounting Office.

- Applying the requirements of RCRA following NNPP radiological processing, so as to avoid conflict with NNPP authority and thus preclude any inconsistency among RCRA, the Atomic Energy Act and Executive Order 12344 for NNPP work. The mixed waste inventory at NNPP sites contained herein is based on application of this principle.

- Avoiding the commingling of radioactive and hazardous materials to the maximum extent practical and removing radioactivity when feasible.

- Minimizing generation of mixed waste by changes to work processes when technically acceptable.

- Minimizing the number and complexity of mixed waste streams to facilitate ease of treatment.

- Obtaining RCRA permits for storage of mixed waste at NNPP facilities which generate and store such waste.

- Relying on DOE or commercial facilities to provide treatment capacity for the small amount of NNPP mixed waste.

- Ensuring that EPA and applicable state regulatory agencies understand and accept NNPP mixed waste management responsibilities and practices (which are collectively referred to as the NNPP mixed waste policy), as discussed above. The Program has reviewed the policy with the EPA Office of Solid Waste in 1989, which culminated in an EPA letter stating "... in general, the [Naval Nuclear Propulsion Program's (NNPP)] approach to waste management is consistent with the EPA approach..." The letter went on to advise that NNPP should engage in further discussions with appropriate EPA Regions and States having mixed waste authority, since they are directly involved in the day-to-day regulation of mixed wastes and will be involved in the details of its implementation. As NNPP has sought permits for storage of mixed waste, the appropriate states and EPA regions have been apprised of the policy. Currently, NNPP is seeking EPA re-affirmation of the policy from their Office of General Counsel.

1.4 Scope of Report

Based on the requirements of the FFCAct-1992, DOE prepared this report for submission to EPA and the States in which DOE stores, generates, or treats mixed wastes. This report contains:

- a national inventory of all mixed waste generated or stored at all DOE sites, regardless of the time they were generated,
- a national inventory of mixed waste treatment capacities and technologies, and
- information about on-going and planned treatment of mixed wastes, an evaluation of mixed waste treatment technologies, and identification of wastes for which treatment technologies have not been developed or that do not exist.

Specifically, this report includes information on two types of DOE-generated wastes: mixed wastes generated from facility operations (operations wastes) and mixed wastes generated by environmental restoration programs (ER wastes). For mixed wastes that are currently in storage, this distinction is not indicated in this report. Separate estimates of the generation rates for the next 5 years (i.e., 1993 through 1997) are provided for the two distinct types of mixed wastes. The report includes national summaries and details for each mixed waste stream at each site including:

- a description including the name, source, radioactive nature, and physical/chemical form,
- the amount currently in storage,
- the amount in storage that is subject to the LDR storage prohibition,
- an estimate of the amount DOE expects to generate in the next 5 years,
- a description of any waste minimization actions that have been implemented,
- the EPA hazardous waste codes,
- identification of waste streams that have not been characterized by sampling and analysis and the basis for determining the hazardous waste codes for the waste stream,
- identification of the LDR treatment technology or technologies specified,
- a statement of whether and how the radionuclide content of the waste may alter or affect use of the specified treatment technologies, and
- an identification of whether or not the waste stream is currently being treated.

This report also provides information on DOE treatment capacities available to treat DOE's mixed wastes. The following information is provided on each treatment facility and technology:

- type of treatment, acceptable radioactive waste types and physical/chemical forms, identification of the waste streams currently being treated, capacity, and location for each existing facility;

- explanations for existing treatment facilities that currently do not treat mixed wastes;

- type of treatment, acceptable radioactive waste types and physical/chemical forms, capacity, and location, for each existing facility not included in the estimate of the available capacity, with reasons for not including the capacity;

- type of treatment, acceptable radioactive waste types and physical/chemical forms, identification of the waste streams to be treated, capacity, location, and an estimated date of availability, of all planned mixed waste treatment facilities[c]; and

- information to support the finding that currently no treatment technology exists for a given waste type and a description of technological approaches that DOE will need to take to treat such waste types.

1.4.1 Wastes Included in the Report

This report provides an inventory of DOE's mixed wastes for which the radiation categories are high-level wastes (HLW), transuranic (TRU) wastes, and low-level wastes (LLW). DOE's HLW is assumed to be mixed waste because it contains RCRA hazardous components, or exhibits the characteristic of corrosivity, and is therefore included in this report. Some DOE sites manage their mixed TRU (MTRU) wastes separately from their TRU wastes while the other sites manage all their TRU wastes as mixed wastes. Consequently all TRU waste quantities provided by the DOE sites, that have not classified or separated their mixed TRU wastes from their TRU wastes, are included as mixed TRU wastes in this report. Only the low-level wastes that have components regulated under RCRA or State hazardous waste laws are covered as mixed wastes in this report. These wastes are referred to as mixed low-level wastes (mixed LLW or MLLW).

Appendix C discusses other materials stored at DOE sites that are not mixed wastes. Section 3021(a)(2)(F) of RCRA as amended by the FFCAct-1992, requires that DOE provide an inventory of "... each type of waste that has not been characterized by sampling and analysis ..." This requirement differs from other requirements of the FFCAct-1992 because it requests information on "wastes" unlike other requirements of the FFCAct-1992 that specify information be provided on "mixed waste." DOE has included certain non-mixed waste materials in the Appendix because of this provision. Other materials have been included in Appendix C because of suggestions made by affected parties or because of the

[c] Schedules are provided in this report for bringing planned facilities on line, which include: i) Headquarters proposed fiscal year (FY) 1994 and FY 1995 new starts; ii) those currently under construction; and iii) existing facilities not yet on line (e.g., Waste Experimental Reduction Facility and Controlled Air Incinerator). The schedules for bringing these facilities on line are based on proposed budgets and are subject to change based on the availability of funding. In addition, restart of existing facilities or startup dates for facilities in the early planning/conceptual stage, in the detailed design stage, or in the construction stage are uncertain pending technical, regulatory, or other planning requirements which must be fully defined and addressed.

potential impact these materials have on the Department's overall waste management strategy. The data provided are the best currently available to the DOE; however, any additional information that becomes available on materials in this category will be updated in appropriate documents.

1.4.2 Wastes Not Included In The Report

This report on mixed wastes was prepared to meet the requirements of the FFCAct-1992. Hence the following wastes, which are not specified in the FFCAct-1992, are not included in this report:

- Mixed waste streams (e.g., from operations, ER, D&D activities, or future weapons dismantling) that are not expected to be generated after 1997;
- Waste substances that only contain radioactive components which by themselves exhibit a RCRA or State hazardous characteristic. The waste substance is not regulated by RCRA, and hence is not considered to be a mixed waste;
- Radioactive materials that occur naturally or are produced from accelerators. These materials are not source, special nuclear, or byproduct materials as defined by the AEA, and hence are not considered mixed wastes; and
- Radioactive wastes that have a toxic component regulated by TSCA but not by RCRA. These materials are not regulated by RCRA, and hence are not considered mixed wastes.

1.5 Organization of Report

Section A (Overview) consists of Chapters 1 through 6 and provides the general introduction and DOE's mixed waste stream and treatment statistics on the national level. Section B (Site-specific Inventories) provides detailed information on each waste stream and treatment facility at each DOE site.

Chapter 1: Introduction. This chapter provides a detailed description of the requirements of the FFCAct-1992 together with the regulatory history of hazardous waste relevant to the treatment of mixed waste. Additionally, the chapter provides a brief description of DOE activities that generate mixed waste and the different programs and offices within DOE. Finally, the chapter provides the scope of this report.

Chapter 2: National Overview of DOE Mixed Wastes and Treatment Facilities. This chapter of the report presents the national summary of DOE mixed wastes and treatment facilities. The chapter discusses the different categories of mixed wastes based on their radioactivity, hazardous nature, and physical/chemical form and then discusses how these characteristics may affect treatment in general. Using these categories, this chapter summarizes DOE's current inventory and 5-year projections for mixed wastes, provides a national overview of DOE mixed waste treatment facilities, and summarizes DOE's waste minimization efforts.

Chapter 3: High-level Wastes and Facilities. This chapter summarizes high-level wastes and associated treatment facilities. The chapter details the approach used for collecting information and details the limitations of the data. Information such as waste stream descriptions, quantities, and current management is provided on a national scale. High-level waste treatment facilities are discussed by treatability group and operating status (existing, existing but not used, or planned or under construction). This chapter also presents the available capacity of high-level waste treatment facilities and compares the treatment needs and capacities for high-level waste.

Chapter 4: Mixed Transuranic Wastes and Facilities. This chapter summarizes mixed TRU wastes and associated treatment facilities. The chapter details the approach used for collecting information and details the limitations of the data. Information such as waste stream descriptions, quantities, and current management is provided on a national scale. The chapter includes a discussion on mixed TRU waste treatment facilities that are planned to meet the waste acceptance criteria of the Waste Isolation Pilot Plant (WIPP) disposal site.

Chapter 5: Mixed Low-level Wastes and Facilities. This chapter summarizes mixed low-level wastes and associated treatment facilities. The chapter details the approach used for collecting information and details the limitations of the data. Information such as waste stream descriptions, quantities, and current management is provided on a national scale. Low-level waste treatment facilities are discussed by treatability group and operating status (existing, existing but not used, or planned or under construction). This chapter also presents a brief overview of the treatment needs and capacities for mixed low-level wastes.

Chapter 6: Treatment Requirements and Technology Development. This chapter describes DOE's technology development activities, including both non-site specific and site-specific technology development for the treatment of mixed wastes.

Chapter 7: Guide to Site Information. This chapter is a guide for understanding the site-specific information provided in Chapters 8 through 26 and provides background information on the site-specific information.

Chapters 8 through 29: Site-specific Mixed Waste and Treatment Inventories. Each chapter represents a state where sites having DOE-managed wastes are located. For each site in a state, detailed waste stream and treatment information on high level wastes, mixed TRU wastes, and mixed low level wastes is provided where applicable.

Lastly, this report contains five appendices:

- Appendix A - Federal Facility Compliance Act of 1992;
- Appendix B - Mixed Waste Treatment Requirements and Technology Development;
- Appendix C - Other Materials; and
- Appendix D - Glossary.

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2.0 OVERVIEW OF DOE-MANAGED MIXED WASTES AND TREATMENT FACILITIES

This chapter provides a national overview of the total quantities of mixed wastes in the current inventory as of December 1992, and provides DOE's best estimates of the quantity of these wastes likely to be generated during the period January 1993 to December 1997. Section 2.1 outlines the mixed waste inventory for each site. The current mixed waste inventory within each site is presented by radiation category, that is quantities that are High-Level Wastes (HLW), Mixed Transuranic (MTRU) Wastes, and Mixed Low-Level Wastes (MLLW). The projected five-year generation of mixed wastes from routine site operations is also presented for each site by the quantities expected to be HLW, MTRU and MLLW. Section 2.2 discusses wastes resulting from Environmental Restoration (ER) activities, and presents estimates of the wastes quantities that are in the current inventory and the quantities that each site expects to generate in the next five years. Section 2.3 separately discusses the Naval Nuclear Propulsion Program's ER activities. Section 2.4 focuses on DOE treatment facilities. It begins with a discussion of those waste characteristics affecting treatment, and examines how radioactivity, the physical/chemical waste matrix, and the RCRA hazardous components affect treatment, and how these characteristics are used to define waste treatability groups. The section concludes with a listing of the DOE treatment facilities at each site that are currently existing and those that are planned. Section 2.5 concludes with a discussion of waste minimization activities within the DOE complex.

2.1 National Overview of DOE-Managed Mixed Wastes

The data presented in this chapter and subsequent chapters is being presented as received from the sites affected by the FFCA. The data has not been manipulated or rounded off in any manner, and the totals presented are straightforward summation of the data provided by the affected sites. Consequently, no conclusions should be drawn or inferred about the precision of the data based upon the number of significant figures presented.

There are 50 sites within 22 states that store, generate, or are expected to generate DOE-managed mixed wastes in the next five years. Figure 2-1 presents the location of these sites.

Table 2-1 presents the number of sites within each state storing or generating DOE-managed mixed waste, the current quantity of mixed waste in each state's inventory (in cubic meters, m^3), and the Department's best estimate of the quantity of these wastes likely to be generated during the next five years (in m^3). This inventory is grouped by state for the 50 sites. Wastes comprising the current inventory were mainly generated from either routine site operations or from Environmental Restoration (ER) activities. Some sites were not able to provide the relative percentages of Operations and ER wastes in their current inventories. As a result, Table 2-1 does not distinguish between Operations and ER wastes in the current waste inventory. However, as explained further in Section 2.2, the contribution of wastes from environmental restoration activities to the current inventory for most facilities is considered to be relatively small (i.e., less than 30 m^3), and 90 percent (by volume) of the total ER waste quantity currently in inventory is stored at the Middlesex Sampling Plant in New Jersey.

The data presented in Table 2-1 reveal that almost 97 percent (by volume) of the current national inventory of mixed wastes is located in six states. Almost 40 percent of the current inventory is

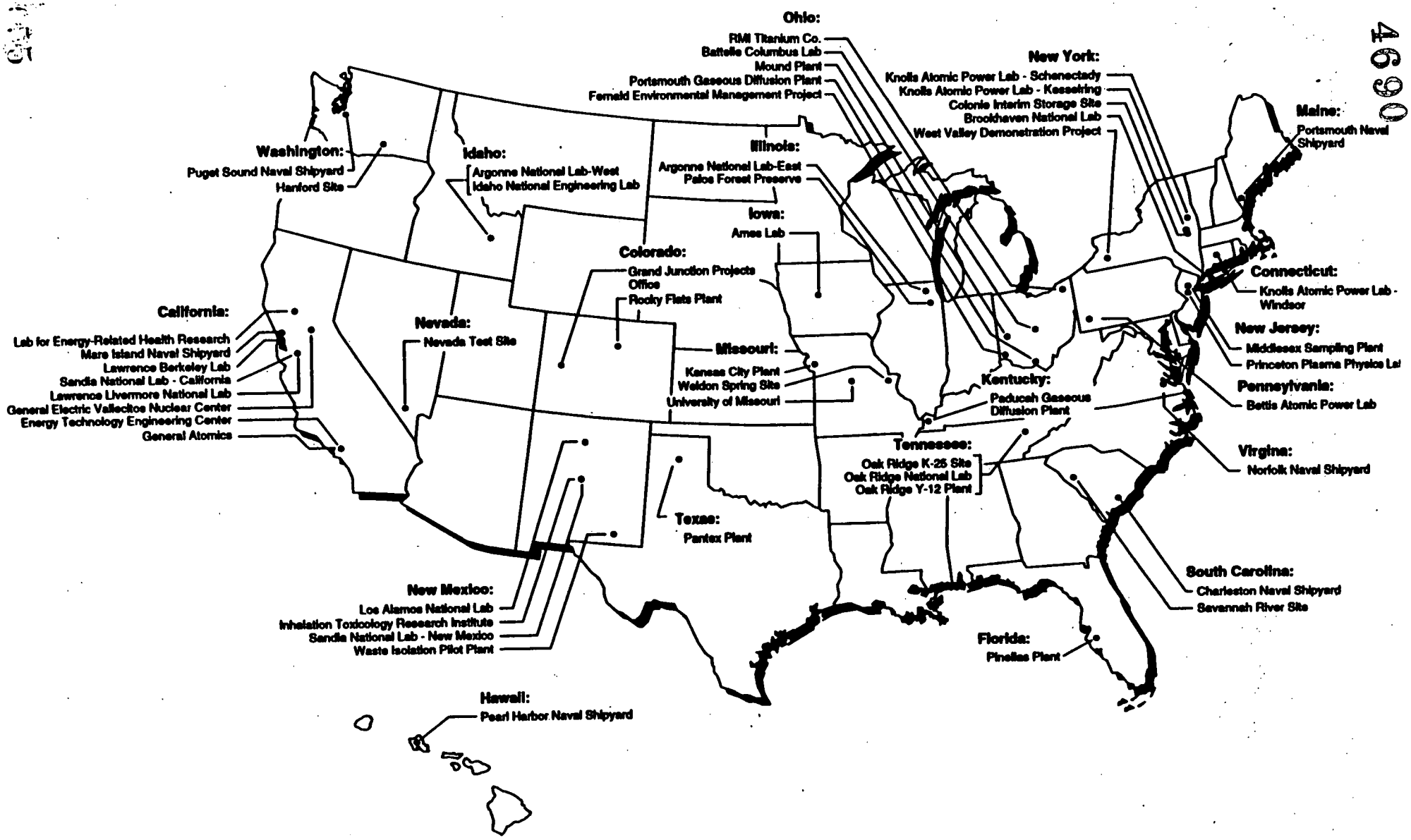

Figure 2-1

LOCATION OF SITES GENERATING DOE-MANAGED MIXED RADIOACTIVE WASTE

Table 2-1

National Overview of DOE - Managed Mixed Waste

State	No. of Sites	Inventory (m^3)	Five-year Projection (1) (m^3)
California	8	878.7	541.0
Colorado	2	57,506.6	2,914.0
Connecticut	1	0.0	10.1
Florida	1	0.0	0.0
Hawaii	1	1.5	0.9
Idaho	2	72,748.1	8,484.6
Illinois	2	97.8	31.5
Iowa	1	0.2	0.0
Kentucky	1	199.3	380.1
Maine	1	0.1	0.2
Missouri	3	91.6	0.0
Nevada	1	612.0	0.0
New Jersey	2	24,468.0	0.5
New Mexico	4	8,946.7	1,260.5
New York	5	400.0	58.9
Ohio	5	8,705.5	4,764.6
Pennsylvania	1	28.4	4.8
South Carolina	2	136,589.1	24,002.9
Tennessee	3	44,370.4	17,369.4
Texas	1	87.9	195.7
Virginia	1	0.0	1.5
Washington	2	233,749.6	237,911.6
NATIONAL TOTAL	50	589,481.5	297,932.8

Note (1): Five-year projections do not include ER wastes.

located in Washington state; 23 percent of the current national inventory is located in South Carolina; 12 percent is located in Idaho; 10 percent is located in Colorado; almost 8 percent is in Tennessee; and 4 volume percent is located in New Jersey.

DOE estimates that an additional quantity of waste equal to 51 percent of the quantity currently in inventory will be generated from routine operations during the next five years (five-year projections of wastes from ER activities are presented in section 2.2 in Table 2-4). Four states will generate 97 percent of this waste quantity. Washington state is expected to contribute 80 percent of this new generation, and the next largest contributor, South Carolina, is expected to generate 8 percent of this new quantity. Tennessee is expected to contribute 6 percent, and Idaho is expected to contribute 3 percent of the new generation.

Table 2-2 presents the current inventory of mixed wastes located within each state that are classified as HLW, MTRU, and MLLW, and is organized by state (in alphabetical order), with the sites grouped alphabetically within each state. National totals for wastes in each of these radiation classifications are also provided. Among the six states contributing the largest amounts of mixed waste to the current national inventory, almost 40 percent (by volume) of the current mixed waste inventory is located at the Hanford Site in Washington state, and 23 percent of the national mixed waste inventory is located at the Savannah River Site in South Carolina. The Idaho National Engineering Laboratory, the Rocky Flats Plant in Colorado, the Oak Ridge K-25 site in Tennessee, and the Middlesex Sampling Plant in New Jersey also contribute significant quantities of mixed waste to the national inventory. HLW comprises 48 percent of the total national inventory of mixed wastes, and is stored or generated at four sites. MTRU wastes account for 10 percent of the current national mixed waste inventory, and it is stored or generated at fifteen sites. MLLW accounts for 42 percent of the national inventory.

Several sites in Table 2-2 reported no stored quantities of mixed waste and are currently not generating mixed waste, but were included in Table 2-2 for the sake of completeness. The Knolls Atomic Power Laboratory (Windsor), the Princeton Plasma Physics Laboratory, the Norfolk Naval Shipyard and the Charleston Naval Shipyard all expect to generate mixed waste in the next five years, and these quantities are presented in Table 2-3. The General Atomics site and the Battelle Columbus Laboratory will likely generate mixed low-level waste as a result of upcoming high-level alpha hot cell activities. Continuing characterization activities at the Palos Forest Preserve are expected to generate a small amount of mixed waste. Projected waste quantities for these sites are given in Section 2.2. The General Electric Nuclear Center in California, and the University of Missouri at Columbia may generate mixed low-level wastes as a result of upcoming high-level alpha hot cell decontamination activities. Since the waste and the facilities have not been fully characterized, either by hazardous constituent or quantity, the volume of mixed waste to be generated may not be known. Further details on all of these sites may be found in the respective site chapters. The Waste Isolation Pilot Plant in New Mexico is a long-term disposal facility for DOE's transuranic (TRU) defense waste. Further details about this site may be found in Chapter 4.

Table 2-3 presents DOE's estimates of the quantity of waste that is expected to be generated at each site during routine site operations (i.e., operations waste) within each state during the next five years. The quantities of wastes that are classified as HLW, MTRU, and MLLW are given for each site within a given state. Four sites will generate 94 percent (by volume) of the mixed waste from operations during the next five years: Hanford (80 percent), Savannah River (8 percent), the Y-12 Plant at Oak Ridge (3 percent), and Idaho National Engineering Laboratory (3 percent). The data indicate that HLW is expected to account for only five percent of future operations waste generation,

Table 2-2

Current Site Inventories of DOE - Managed Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
California:				
Energy Technology Engineering Center	0.0	0.0	617.4	617.5
General Atomics	0.0	0.0	0.0	0.0
General Electric Vallecitos Nuclear Ctr	0.0	0.0	0.0	0.0
Lab. For Energy-Related Health Research	0.0	0.0	8.1	8.1
Lawrence Berkeley Laboratory	0.0	0.0	22.2	22.2
Lawrence Livermore National Laboratory	0.0	1.9	212.0	213.9
Mare Island Naval Shipyard	0.0	0.0	7.4	7.4
Sandia National Laboratory - California	0.0	0.0	9.6	9.6
Colorado:				
Grand Junction Project Office	0.0	0.0	0.6	0.6
Rocky Flats Plant	0.0	1,480.0	56,026.0	57,506.0
Connecticut:				
Knolls Atomic Power Laboratory - Windsor	0.0	0.0	0.0	0.0

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Table 2-2(Continued)

Current Site Inventories of DOE - Managed Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Florida:				
Pinellas Plant	0.0	0.0	0.0	0.0
Hawaii:				
Pearl Harbor Naval Shipyard	0.0	0.0	1.5	1.5
Idaho:				
Argonne National Laboratory - West	0.0	0.6	9.5	10.1
Idaho National Engineering Laboratory	11,320.4	38,202.2	23,215.4	72,738.0
Illinois:				
Argonne National Laboratory - East	0.0	1.9	95.9	97.8
Site A / Plot M Palos Forest Preserve	0.0	0.0	0.0	0.0
Iowa:				
Ames Laboratory	0.0	0.0	0.2	0.2
Kentucky:				
Paducah Gaseous Diffusion Plant	0.0	13.6	185.8	199.3

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Table 2-2(Continued)

Current Site Inventories of DOE - Managed Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Maine:				
Portsmouth Naval Shipyard	0.0	0.0	0.1	0.1
Missouri:				
Kansas City Plant	0.0	0.0	5.4	5.4
University Of Missouri	0.0	0.0	0.0	0.0
Weldon Spring Site	0.0	0.0	86.2	86.2
Nevada:				
Nevada Test Site	0.0	612.0	0.0	612.0
New Jersey:				
Middlesex Sampling Plant	0.0	0.0	24,468.0	24,468.0
Princeton Plasma Physics Laboratory	0.0	0.0	0.0	0.0
New Mexico:				
Inhalation Toxicology Research Institute	0.0	0.0	1.3	1.3
Los Alamos National Laboratory	0.0	8,198.5	680.5	8,879.0

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Table 2-2(Continued)

Current Site Inventories of DOE - Managed Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Sandia National Laboratory - New Mexico	0.0	1.0	65.5	66.4
Waste Isolation Pilot Plant	0.0	0.0	0.0	0.0
New York:				
Brookhaven National Laboratory	0.0	0.0	84.5	84.5
Colonie Interim Storage Site	0.0	0.0	11.4	11.4
Knolls Atomic Power Lab. - Kesselring	0.0	0.0	1.7	1.7
Knolls Atomic Power Laboratory	0.0	0.0	0.8	0.8
West Valley Demonstration Project	289.0	0.5	12.2	301.6
Ohio:				
Battelle Columbus Laboratories	0.0	0.0	0.0	0.0
Fernald Environmental Management Project	0.0	0.0	3,108.1	3,108.1
Mound Plant	0.0	3.2	50.7	53.8
Portsmouth Gaseous Diffusion Plant	0.0	0.0	5,527.7	5,527.7
R M I Titanium Company	0.0	0.0	15.9	15.9

Table 2-2(Continued)

Current Site Inventories of DOE - Managed Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Pennsylvania:				
Bettis Atomic Power Laboratory	0.0	0.0	28.4	28.4
South Carolina:				
Charleston Naval Shipyard	0.0	0.0	0.0	0.0
Savannah River Site	126,939.0	5,002.1	4,648.0	136,589.1
Tennessee:				
Oak Ridge K-25 Site	0.0	0.0	29,100.4	29,100.4
Oak Ridge National Laboratory	0.0	1,492.7	2,665.2	4,157.9
Oak Ridge Y-12 Plant	0.0	0.0	11,112.1	11,112.1
Texas:				
Pantex Plant	0.0	0.0	87.9	87.9
Virginia:				
Norfolk Naval Shipyard	0.0	0.0	0.0	0.0
Washington:				

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Table 2-2(Continued)

Current Site Inventories of DOE - Managed Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Hanford Site	145,952.0	2,935.1	84,802.5	233,689.6
Puget Sound Naval Shipyard	0.0	0.0	60.0	60.0
NATIONAL TOTAL:	284,500.4	57,945.2	247,036.1	589,481.7

063

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Table 2-3

Five-year Projections of Operations Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
California:				
Energy Technology Engineering Center	0.0	0.0	20.2	20.2
General Atomics	0.0	0.0	0.0	0.0
General Electric Vallecitos Nuclear Ctr	0.0	0.0	0.0	0.0
Lab. For Energy-Related Health Research	0.0	0.0	0.0	0.0
Lawrence Berkeley Laboratory	0.0	0.0	31.1	31.1
Lawrence Livermore National Laboratory	0.0	3.8	430.5	434.3
Mare Island Naval Shipyard	0.0	0.0	39.6	39.6
Sandia National Laboratory - California	0.0	0.0	15.8	15.8
Colorado:				
Grand Junction Project Office	0.0	0.0	0.2	0.2
Rocky Flats Plant	0.0	273.3	2,640.5	2,913.8
Connecticut:				
Knolls Atomic Power Laboratory - Windsor	0.0	0.0	10.1	10.1

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064

Table 2-3(Continued)

Five-year Projections of Operations Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Florida:				
Pinellas Plant	0.0	0.0	0.0	0.0
Hawaii:				
Pearl Harbor Naval Shipyard	0.0	0.0	0.9	0.9
Idaho:				
Argonne National Laboratory - West	0.0	2.2	3.9	6.1
Idaho National Engineering Laboratory	5,859.0	0.0	2,619.5	8,478.5
Illinois:				
Argonne National Laboratory - East	0.0	1.6	29.8	31.5
Site A / Plot M Palos Forest Preserve	0.0	0.0	0.0	0.0
Iowa:				
Ames Laboratory	0.0	0.0	0.0	0.0
Kentucky:				
Paducah Gaseous Diffusion Plant	0.0	0.0	380.1	380.1

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Table 2-3(Continued)

Five-year Projections of Operations Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Maine:				
Portsmouth Naval Shipyard	0.0	0.0	0.2	0.2
Missouri:				
Kansas City Plant	0.0	0.0	0.0	0.0
University Of Missouri	0.0	0.0	0.0	0.0
Weldon Spring Site	0.0	0.0	0.0	0.0
Nevada:				
Nevada Test Site	0.0	0.0	0.0	0.0
New Jersey:				
Middlesex Sampling Plant	0.0	0.0	0.0	0.0
Princeton Plasma Physics Laboratory	0.0	0.0	0.5	0.5
New Mexico:				
Inhalation Toxicology Research Institute	0.0	0.0	4.3	4.3
Los Alamos National Laboratory	0.0	625.7	524.7	1,150.4

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Table 2-3(Continued)

Five-year Projections of Operations Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Sandia National Laboratory - New Mexico	0.0	0.0	0.8	0.8
Waste Isolation Pilot Plant	0.0	105.0	0.0	105.0
New York:				
Brookhaven National Laboratory	0.0	0.0	27.4	27.4
Colonie Interim Storage Site	0.0	0.0	0.0	0.0
Knolls Atomic Power Lab. - Kesselring	0.0	0.0	14.0	14.0
Knolls Atomic Power Laboratory	0.0	0.0	10.2	10.2
West Valley Demonstration Project	0.0	0.0	7.3	7.3
Ohio:				
Battelle Columbus Laboratories	0.0	0.0	0.0	0.0
Fernald Environmental Management Project	0.0	0.0	151.1	151.1
Mound Plant	0.0	0.2	1.5	1.7
Portsmouth Gaseous Diffusion Plant	0.0	0.0	4,610.9	4,610.9
R M I Titanium Company	0.0	0.0	0.9	0.9

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Table 2-3(Continued)

Five-year Projections of Operations Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Pennsylvania:				
Bettis Atomic Power Laboratory	0.0	0.0	4.8	4.8
South Carolina:				
Charleston Naval Shipyard	0.0	0.0	0.7	0.7
Savannah River Site	9,324.4	140.0	14,537.7	24,002.2
Tennessee:				
Oak Ridge K-25 Site	0.0	0.0	6,401.0	6,401.0
Oak Ridge National Laboratory	0.0	136.0	599.4	735.4
Oak Ridge Y-12 Plant	0.0	0.0	10,233.0	10,233.0
Texas:				
Pantex Plant	0.0	0.0	195.7	195.7
Virginia:				
Norfolk Naval Shipyard	0.0	0.0	1.5	1.5
Washington:				

Table 2-3(Continued)

Five-year Projections of Operations Mixed Waste

State/Site	HLW (m^3)	MTRU (m^3)	MLLW (m^3)	Total (m^3)
Hanford Site	0.0	1,552.5	236,322.1	237,874.6
Puget Sound Naval Shipyard	0.0	0.0	37.0	37.0
NATIONAL TOTAL:	15,183.4	2,840.3	279,908.6	297,932.4

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and is expected to be generated at two sites. MTRU is expected to account for approximately one percent of future operations waste generation, and is expected to be generated at nine sites. The remainder (94 percent) of operations waste generation for the next five years is expected to be MLLW. It should be pointed out here that the projected quantities of MLLW at Hanford include streams that are generated within the Hanford tank farm system, and the inclusion of these waste streams results in the double-counting of waste generation. These streams collectively total approximately 144,500 m^3, and inclusion of this quantity is the primary reason for a high 5-year projected generation rate for the MLLW at Hanford. They are included in the projections because they quantify the treatment and technology requirements for these wastes.

2.2 Environmental Restoration Program

The information presented in this report for the environmental restoration program focuses on those wastes that will result from remediation and decontamination and decommissioning (D&D) activities that are expected to occur within the next 5 years. At several facilities, wastes from past cleanup efforts are currently in storage and are expected to be managed in that condition through the next 5 years pending the development of appropriate treatment and disposal plans. Such interim storage is common at sites where removal actions and other accelerated cleanup activities have been taken to minimize the possibility of near-term health and safety risks.

The inventory and 5-year projections of mixed waste associated with environmental restoration activities based on currently available data are presented in Table 2-4. This inventory is grouped by state (in alphabetical order) for the 28 facilities at which mixed restoration waste is currently in storage or might be generated over the next 5 years. The current inventory is shown as "92 and prior," with separate entries for mixed TRU and mixed LLW. Volume projections for these two waste categories are shown for the years 1993 through 1997, and combined inventory and projection totals are provided for each facility. Totals for all facilities for the current inventory and projections over the next 5 years are provided at the end of the table.

The values presented in this table must be treated as very preliminary estimates because of the nature of the environmental restoration program. Without comprehensive data on contaminant types and concentrations as well as operational information about specific response actions, the types and volumes of waste that will be generated can only be roughly estimated at this time.

Many remediation and D&D sites are currently in the assessment phase, so the precise nature and extent of contamination have not yet been fully defined. Moreover, detailed information on the specific cleanup activities that may be applied to the various contamination problems is also not yet available, so that the quantity of resultant waste that might be generated cannot yet be reliably determined. In fact, the plans for many remediation sites have not yet advanced to the stage where even the broad category of response that will be taken is known. For example, the decision on whether a given contaminated area, such as a waste pit, is to be excavated or stabilized in place is not typically made until after 1) the nature of the problem has been adequately defined, 2) various response alternatives and related impacts have been evaluated in considerable detail, and 3) other agencies (EPA and the state) and the local community have had a chance to comment on the preferred alternative. If characterization activities identified both radioactive and hazardous contaminants in the pit, it is possible that mixed waste could be generated if the pit were excavated, whereas no waste would be generated if the pit were capped in place. Thus, early volume estimates for mixed waste associated with such a pit are uncertain because of the nature of the remedial action process.

Table 2-4
Projection of Mixed Waste to be Generated by DOE Environmental Restoration Activities (in cubic meters) [a]

State/Site	1992 AND PRIOR		1993		1994		1995		1996		1997		TOTAL	
	MLLW[b]	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU
California:														
Energy Technical Engineering Center	13	-	-	-	-	-	-	-	-	-	-	-	13	-
General Atomics	-	-	8.5	-	-	-	-	-	-	-	-	-	8.5	-
Laboratory for Energy-Related Health Research[c]	8.1	-	-	-	-	-	-	-	-	-	-	-	8.1	-
Colorado:														
Grand Junction Projects Office	-	-	-	-	1,500	-	1,500	-	-	-	-	-	3,000	-
Rocky Flats Plant	43	-	77	-	11,000	-	41,000	-	41,000	-	55,000	-	150,000	-
Idaho:														
Idaho National Engineering Laboratory	11	-	180	-	46	-	5,300	-	8,500	-	48	-	14,000	-
Illinois:														
Argonne National Laboratory-East	-	-	9.9	-	10	-	9.5	-	9.5	-	9.4	-	48	-
Palos Forest Reserve - Site A/Plot M	-	-	-	-	20	-	-	-	-	-	-	-	20	-
Iowa:														
Ames Laboratory	-	-	-	-	1,000	-	-	-	-	-	-	-	1,000	-
Kentucky:														
Paducah Gaseous Diffusion Plant[e]	7	-	1,400	-	4,500	-	6,200	-	3,500	-	9,000	-	25,000	

TABLE 2-4 (continued)

PROJECTION OF MIXED WASTE TO BE GENERATED BY DOE ENVIRONMENTAL RESTORATION ACTIVITIES (in cubic meters) [a]

State/Site	1992 AND PRIOR		1993		1994		1995		1996		1997		TOTAL	
	MLLW[b]	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU
Missouri:														
Weldon Spring Site[c]	86	-	86	-	86	-	86	-	86	-	86	-	520	-
Nevada:														
Nevada Test Site	-	-	-	-	-	-	10	-	120,000	-	83,000	-	200,000	-
New Jersey:														
Middlesex Sampling Plant[c]	24,000	-	-	-	-	-	-	-	-	-	-	-	24,000	-
New Mexico:														
Los Alamos National Laboratory	-	-	-	-	-	-	-	-	-	-	8,100	-	8,100	-
Sandia National Laboratory	-	-	70	1	110	1	140	1	8,800	89	9,400	94	19,000	190
New York:														
Brookhaven National Laboratory	-	-	-	-	8.6	-	-	-	-	-	85	-	93	-
Colonie Interim Storage Site[c]	12	-	-	-	-	-	-	-	-	-	-	-	12	-
Ohio:	-													
Battelle Columbus Laboratories	-	-	15	-	15	-	15	-	15	-	15	-	75	-
Fernald Environmental Management Project[c]	2,500	-	230	-	34,000	-	34,000	-	34,000	-	63,000	-	170,000	-
Mound Plant	1.8	-	-	-	28	-	57	-	57	-	57	-	200	-
Portsmouth Gaseous Diffusion Plant[e]	18	-	550	-	360	-	1,100	-	1,100	-	620	-	3,700	-
RMI Titanium Company[c]	16	-	3.2	-	3.2	-	3.2	-	3.2	-	3.2	-	32	-

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TABLE 2-4 (continued)

PROJECTION OF MIXED WASTE TO BE GENERATED BY DOE ENVIRONMENTAL RESTORATION ACTIVITIES (in cubic meters) [a]

State/Site	1992 AND PRIOR		1993		1994		1995		1996		1997		TOTAL	
	MLLW[b]	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU	MLLW	MTRU
South Carolina:														
Savannah River Site[d]	-	-	7.8	-	7.8	-	7.8	-	7.8	-	7.8	-	39	-
Tennessee:														
Oak Ridge K-25 Site[e]	1	-	70	-	220	-	65	-	24	-	220	-	600	-
Oak Ridge National Laboratory	-	-	1	0.4	5	-	6	-	6	-	8	-	26	0.4
Oak Ridge Y-12 Plant[e]	29	-	140	-	59	-	34	-	160	-	33	-	460	-
Texas:														
Pantex Plant	-	-	720	-	120	-	-	-	-	-	-	-	840	-
Washington:														
Hanford Site	6.9	-	14	-	59	22	130	29	350	28	500	65	1,100	140
NATIONAL TOTAL:	27,000	-	3,600	1.4	54,000	23	90,000	30	220,000	120	230,000	160	620,000	330

TABLE 2-4 (continued)

PROJECTION OF MIXED WASTE TO BE GENERATED BY DOE ENVIRONMENTAL RESTORATION ACTIVITIES (in cubic meters) [a]

[a] These volume estimates represent the quantity of materials projected to be generated as a result of environmental restoration activities that may have to be managed as mixed wastes. These estimates are very preliminary and are being updated as site characterization activities proceed. Only those facilities projected to generate mixed wastes as a result of environmental restoration activities are included. All values are given to two significant figures, except in cases where information was available to only one significant figure.

[b] Low Level waste is defined in DOE Order 5820.2A as waste that contains radioactivity and is not classified as high-level waste, TRU waste, spent nuclear fuel, or 11(e) by-product material. The volume estimates for MLLW presented in this table include those classified as 11(e)2 by-product material.

[c] The mixed wastes currently in storage for these sites are described in more detail in the state chapters presented later in this report.

[d] The values for the Savannah River Site do not include Investigation Derived Waste. The DOE is currently working with EPA Region IV and the State of South Carolina to determine how this waste should be managed.

[e] The volume estimates shown in the 1992 and prior column for the Paducah Gaseous Diffusion Plant, Portsmouth Gaseous Diffusion Plant, Oak Ridge K-25 Site, and Oak Ridge Y-12 Plant represent only waste generated in 1992.

Note: **Figures appearing in the total columns of this report are derived through the rounding of totals from additions of actual numbers for each category within each site. Therefore, in limited cases, figures appearing in total columns will not reflect the totals derived through addition of the rounded figures for individual sites appearing in this report.**

Even in those cases where the decision has already been made and specific activities have advanced beyond the conceptual planning stage, the information needed to support a reasonable estimate of resultant waste volumes is still generally unavailable. For example, a site may already have conducted bench-scale and pilot-scale testing for a given water treatment system, and scale-up and construction may have been completed — but key data such as the operating efficiencies of its individual components, including pretreatment and post-treatment processes, cannot be known until the actual treatment is well under way. Similarly, the contaminant concentrations in the influents cannot be reliably known until all of the contributing sources have been defined (for example, decontamination wash water and runoff collected from storage piles), so the specific nature of the treatment residuals that may be produced over the next 5 years cannot be reliably estimated at this time. Additionally, DOE notes that to a large extent, the inventories that would result from generating mixed waste and the determination of the appropriate remediation/treatment will be determined through the existing RCRA or CERCLA process currently in existence at the site.

Because this type of detailed information is not currently available for environmental restoration and D&D activities, the waste inventories and projections in this report have been made on the basis of generally conservative assumptions. These estimates will continue to be updated as cleanup activities progress at the individual sites and the appropriate information becomes available. Since detailed waste stream information is not currently available for environmental restoration activities, the mixed waste inventory data is limited to the volume estimates given in Table 2-4. Only general descriptions of environmental restoration activities at the sites projected to generate mixed waste is given in the site-specific descriptions.

These same limitations inherent to the cleanup process also preclude providing certain detailed data that was required by the FFCA for existing types of waste. This type of information presumes detailed knowledge of waste streams — such as EPA waste codes and specified land disposal restriction treatment technologies — that is simply not available at this time for mixed wastes that will be generated from the environmental restoration program. For most sites, the contamination has not yet been fully characterized and the specific activities (including treatment) that may be conducted have not yet been finalized. Therefore, insufficient detail is available at this time to assign waste codes or other specific identifiers to environmental restoration waste projections. This is in contrast to waste streams currently being generated by operating facilities, which may have been well characterized and for which specific descriptors and treatment technologies can be provided. Nevertheless, to support comprehensive treatment planning, broad assumptions could be made at this preliminary stage for environmental restoration projects by inference and extrapolation from data for mixed TRU and LLW waste at operating DOE facilities. Thus, despite their preliminary nature, these mixed waste projections for the environmental restoration program can be useful for focusing further data collection efforts and supporting future treatment plans.

The inventories and projections for environmental restoration projects that currently expect to generate mixed waste during the next 5 years are provided in Table 2-4. All of the current inventory and essentially all of the 5-year projections consist of mixed LLW. A total of approximately 620,000 m^3 of mixed LLW is projected to be generated by environmental restoration activities over the next 5 years. In contrast, the amount of mixed TRU waste that may be generated over the next 5 years is comparatively small (less than 0.1 percent of the combined total mixed waste volume of about 620,000 m^3). About 330 m^3 of mixed TRU waste is estimated to be generated by 3 facilities during the next 5 years. Essentially all of this projected volume is expected to be generated by Sandia National Laboratory in New Mexico, and the Hanford Site in Washington; a very small quantity of mixed TRU waste is expected to be generated by the Oak Ridge National Laboratory in Tennessee.

Of the 28 environmental restoration facilities listed in the table, 15 maintain a current inventory of mixed waste, and for most facilities the estimated volume is relatively small (e.g., less than 30 m^3). The Middlesex Sampling Plant in New Jersey accounts for about 90 percent of the estimated total of 27,000 m^3 in storage for all facilities combined. The Fernald Environmental Management Project in Ohio accounts for most of the remainder. For the 5-year projections of mixed LLW, 3 sites account for more than 80 percent of the estimated volume for all sites combined. These are the Nevada Test Site, the Fernald Environmental Management Project, and the Rocky Flats Plant in Colorado. Together, these three sites account for about 85 percent of the combined inventory and 5-year projections for mixed waste resulting from environmental restoration activities

2.3 Environmental Restoration Activities at Naval Nuclear Propulsion Program Sites

Since the beginning of the Naval Nuclear Propulsion Program (NNPP), Admiral Rickover implemented stringent methods for controlling radioactivity at the source. This is necessary since the ship's crew must live in close proximity to the nuclear propulsion plant. These stringent radiological controls also serve to prevent releases to the environment. As a result, there is little, if any, radioactive waste expected to result from restoration activities at NNPP sites. However, at the Naval Reactors Facility (NRF) site, and the Knolls Atomic Power Laboratory Knolls and Kesselring sites there is a potential for restoration work to result in some low-level radioactive waste due to past activities, and in the case of NRF, past disposal practices for liquid solutions. Because an accepted disposal practice for some chemical wastes was land disposal until the late 1970's, it is possible that RCRA wastes have been co-mingled with radioactivity in the same area.

While characterization of these disposal areas under CERCLA or RCRA Sections 3004(u) and 3008(h) (corrective actions) has shown that creation of mixed waste may result from remediation, the characterization performed to date is not sufficiently definitive to provide any details on the amounts or types of mixed waste that may be created. Environmental restoration of these areas is being coordinated with the affected regulatory agencies. Additional information on this potential mixed waste stream will be provided in future site-specific treatment plans as they are developed.

2.4 Mixed Waste Characteristics and Treatment

The report uses the phrase "treatment system" to describe the equipment and processes used to treat similar waste types at treatment facilities. Treatment systems may consist of a single unit treatment operation (e.g., a stabilization unit) or a sequence of unit operations (e.g., an evaporator, followed by a precipitation unit, followed by a stabilization unit).

The selection of the treatment process for a particular mixed waste (or treatability group) depends on the mixed waste characteristics. Technical options (e.g., materials handling, hazard reduction performance) must be considered in the context of regulatory requirements such as the LDRs. Since the LDRs are often based on the performance of treatment for relatively pure wastes, mixtures of multiple waste matrices, hazardous components, and radionuclides further complicate selection of treatment. This is especially true when the wastes requiring treatment are heterogeneous materials accumulated over many years. In many cases, a series of treatment operations (i.e., a "treatment train") is required to destroy or immobilize multiple types of hazardous components (e.g., organic chemicals and toxic heavy metals) or to pretreat a waste matrix to make it more amenable to a particular treatment system. Often one of these characteristics will dominate the technology selection process, and, consequently, adequate

processing of the radioactivity (e.g., high levels of radioactivity by vitrification) may adequately address other treatment considerations in a waste (e.g., the presence of toxic heavy metals).

2.4.1 Radioactive Characteristics and Treatability

Radiation is the propagation of energy through matter or space in the form of waves, rays, or streams of energetic particles. Generally, radioactive materials emit radiation[a] in the form of alpha or beta particles or gamma rays. Depending on the source and nuclide composition, wastes can be characterized as high-level, transuranic, or low-level wastes.

High-level Wastes (HLW). High-level waste (HLW) is defined by the DOE Order 5820.2A as "... the highly radioactive waste material that results from the reprocessing of spent nuclear fuels, including the liquid waste produced directly in the reprocessing, and any solid waste derived from the liquid that contains a combination of transuranic waste and fission products in concentrations as to require permanent isolation".

The primary source of HLWs is the reprocessing of spent uranium and plutonium fuel and irradiated targets. This reprocessing generates acidic, highly radioactive, and heat-producing liquid wastes that generally contain more than 99 percent of the nonvolatile fission products produced in the fuels or targets during the reactor operation. To facilitate their handling and storage, these liquid wastes are sometimes converted to sludges, calcines, salt cakes, slurries, precipitates, zeolites, glass, or capsules of separated strontium and cesium. The HLWs contain fission products that result in the release of considerable decay energy. Hence, HLWs require special provisions such as cooling systems to dissipate this decay heat. HLWs also require heavy shielding to control the penetrating radiation. These wastes are classified as mixed wastes because of their corrosive nature, their organic content (from the reprocessing operations), and/or their fission product metal content (barium, cadmium, and silver being the main fission products).

Transuranic (TRU) Wastes. Transuranic (TRU) wastes, as defined by DOE Order 5820.2A, refers to all radioactive wastes that contain more than 100 nCi/g of alpha-emitting isotopes with atomic numbers greater than 92 and half-lives greater than 20 years. This definition includes isotopes of neptunium (Np), plutonium (Pu), americium (Am), curium (Cm), and californium (Cf). More than 90 percent of TRU wastes contain mainly plutonium that emits alpha particles and low-energy photons.

These wastes are generated primarily by spent fuel reprocessing, plutonium metal production, plutonium weapons fabrication, and plutonium-bearing reactor fuel formulation activities. Most TRU wastes are solid wastes such as protective clothing, paper trash, rags, glass, miscellaneous tools and equipment. Liquid TRU wastes are generated from chemical reprocessing operations to recover plutonium and other TRU elements, and from cladding removal operations. In general, TRU wastes can be contact-handled with little or no shielding, although the energetic gamma and neutron emissions from certain TRU nuclides and fission-product contaminants necessitate shielding or the use of remote-handling equipment.

Prior to 1970, TRU wastes were disposed of in on-site shallow, landfill-type configurations. These wastes are referred to as "buried" wastes. "Buried" wastes that are excavated as part of remedial activities are included among environmental restoration wastes in this report. In 1970, the Atomic

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[a] In nuclear physics, the term radiation has been extended to include fast-moving particles, e.g., alpha and beta particles, and gamma rays. The spontaneous decay or disintegration of the unstable nuclei in radioactive materials causes the emission of such fast-moving particles. The rate at which such emissions occur is measured in terms of the number of nuclear disintegrations occurring per unit time. The unit commonly used is the curie (Ci), which is 37 billion disintegrations per second. The designation "nCi" stands for nano-Curies which is equivalent to 37 disintegrations per second.

Energy Commission (AEC), which was the predecessor to DOE, concluded that wastes containing long-lived alpha-emitting radionuclides should have greater confinement from the environment. Hence, TRU wastes generated after 1970 were stored in retrievable storage units pending final disposal. The wastes were placed into containers such as metal drums and wooden, fiber glass, or metal boxes, and were stored in earth-mounded berms, concrete culverts, or other such facilities.

TRU wastes, as currently defined, refers to radioactive wastes that contain more than 100 nCi/g of alpha-emitting isotopes. But prior to 1982, the definition for TRU wastes was more stringent. TRU wastes were radioactive wastes that contained more than 10 nCi/g of alpha-emitting isotopes. This definition change has led to the problem of reclassifying the TRU wastes that were stored prior to 1982. Not all of these wastes have been sampled and characterized to determine whether they may still classified as TRU wastes under the current definition. It is likely that some of these wastes may be reclassified as mixed low-level wastes. These low-level wastes would then have to be handled separately from the TRU wastes. Hence, sampling and characterization studies may be required prior to developing plans for the required treatment of these mixed low-level wastes.

Low-level Wastes (LLW). According to DOE Order 5820.2A, all radioactive wastes that are not classified as high-level wastes, TRU wastes, spent fuels, or uranium or thorium mill tailings are classified as low-level wastes (LLWs).

Low-level wastes contain mostly uranium activation products and fission products and are generated by DOE's defense-related waste management and restoration activities, uranium enrichment operations, Naval Nuclear Propulsion Program, isotope production, and research and development activities. LLWs primarily consist of paper, rags, tools, equipment, parts and discarded protective clothing contaminated with radionuclides. Sludges and liquid waste treatment residues also make up the low-level waste inventory. The radioactive level of LLWs can be high enough to require shielding for safe handling.

Effect of Radioactivity on Mixed Waste Treatment

The type and level of radioactivity is a primary consideration in the selection of treatment technologies for mixed wastes. Figure 2-2 summarizes the radioactive categories DOE has used to group its mixed wastes in this report. Contact handled (CH) wastes are wastes having radiation levels at the waste container surface less than 200 mrems/hr[b]. Contact handled wastes typically emit primarily alpha particles and low energy photons. These wastes merely require packaging with sufficient containment and shielding to minimize personnel exposure problems. If the radiation levels at the waste container surface exceed 200 mrems/hr, the wastes are referred to as "remote handled" (RH). In addition to containing alpha decay type radionuclides, remote handled wastes will typically contain activation materials and fission products that decay by beta emission and produce penetrating gamma radiation (e.g., High Level Wastes). Treatment systems for these wastes would need to be remotely operated (for example by incorporating robotics) to handle the wastes, and guarantee worker safety.

Alpha emitting radionuclides can present additional treatment challenges. High alpha activity in contact with organics or water can result in radiolysis, the production of hydrogen gas, methane, and other degradation products. The buildup of hydrogen gas and other associated radiolytic interaction with the waste form can affect the design and operation of treatment facilities and the stability of final waste form. Treatments using chemical separation could result in concentrations of certain isotopes of uranium and

[b] A rem is the dosage of an ionizing radiation that will cause the same biological effect as one roentgen of X-ray of gamma-ray dosage. A millirem (mrem) is 1/1000 of this dosage.

plutonium sufficient to form a critical mass, while concentrations of high energy alpha emitters in contact with beryllium could result in the production of neutrons. Daughter products of alpha emitters may also cause problems such as the production of radon gas. While there is no absolute cut-off below which alpha emitting radionuclides require special alpha radionuclide containment, in this report we define wastes containing greater than 10 nCi/g as alpha wastes, meaning wastes that are most likely to require specialized treatment system designs to contain the alpha radionuclides. Alpha-decay type radionuclides are present in all TRU wastes as well as some mixed low-level wastes;

Wastes containing beta/gamma emitters may also present unique treatment challenges. As with alpha emitters, beta/gamma emitters may result in radiolysis when in contact with organics or water. Treatment may also result in plating, precipitation, or some other form of concentration, which could result in workers receiving a significant radiation exposure.

A significant effect of radioactivity is that recycle of the materials is difficult or impossible. Although it is specified as BDAT for some RCRA wastes - beryllium and batteries being two specific examples, it may not be practical due to the physical form of the waste (e.g., powder) to decontaminate to the extent that the material could be released into general commerce.

Figure 2-2
Mixed Waste Radioactivity Categories

High-Level Wastes (HLW)

Mixed-TRU Wastes (MTRU)

- Remote Handled (RH)
- Contact Handled (CH)

Mixed Low-Level Wastes (MLLW)

- Remote Handled (RH)
  - Require Transuranic Alpha Radionuclides Containment (Alpha)
  - Do Not Require Transuranic Alpha Radionuclides Containment
- Contact Handled (CH)
  - Require Transuranic Alpha Radionuclides Containment (Alpha)
  - Do Not Require Transuranic Alpha Radionuclides Containment

2.4.2 Physical and Chemical Waste Matrix

The mixed wastes presented in this report have been organized based on their physical/chemical matrices. Physical/chemical matrix, as used in this report, generally refers to physical form (i.e., liquid, sludge, or solid) and the primary material contaminants of the waste. The physical/chemical matrix is important to waste treatment selection because it determines how a waste can be transported through a treatment process (e.g., by pumps and piping versus conveyors) and it affects the process chemistry of destroying, removing, or immobilizing hazardous and radioactive contaminants in the waste. For instance, because water has a very high heat capacity and boiling point, it is expensive to use incineration to destroy organic toxins in wastewaters. DOE has defined several physical/chemical matrix categories to represent key waste groups from a treatment perspective. These categories are summarized in Figure 2-3 and described below.

Organic Liquids. Organic liquids are liquid materials comprised primarily of hydrocarbons such as petroleum distillates. For this report, organic liquids include liquids and slurries with a total organic carbon content of greater than 1 percent, and less than 35 to 40 percent suspended or settled solids. The organic liquid may or may not be the hazardous component of concern. Solvents are the primary type of organic liquid waste. Lab-packs containing organic liquids are grouped under lab packs.

Figure 2-3
Physical/Chemical Matrix Categories

Organic Liquids

Aqueous Liquids

Organic Sludges and Particulates

Inorganic Sludges and Particulates (including cemented solids)

Soils (including soils with <50% Debris)

Debris
- Organic Debris
- Inorganic Debris
- Heterogenous Debris

Lab Packs
- With Metals
- Without Metals

Reactive/Dangerous Wastes
- Reactive Metals
- Explosives
- Compressed Gases

Inherently Hazardous Wastes
- Liquid Mercury
- Elemental Lead
- Beryllium Dust
- Batteries

Other Wastes
- Other, Mixed, or Unknown Physical/Chemical Form

Aqueous Liquids. Aqueous liquids consist primarily of water, have a total organic carbon content less than 1 percent, and less than 35 to 40 percent settled or suspended solids. Most aqueous liquids are commonly called wastewaters, but they may not always meet EPA's definition of wastewater under RCRA (i.e., liquid wastes containing less than 1 percent total organic carbon and less than 1 percent total suspended solids). According to EPA's definition for nonwastewaters, aqueous liquids containing greater than 1 percent total organic carbon or greater than 1 percent total suspended solids are considered nonwastewaters rather than wastewaters. In the site-specific sections of this report, aqueous wastes are further subdivided based on EPA's definition of wastewater and nonwastewater for the LDR program. Aqueous liquids contained in lab packs are grouped with lab packs.

Organic Sludges and Solids. Organic sludges and solids are solid or semi-solid materials (other than debris) comprised mostly of organic materials. Semi-solid materials include highly viscous liquids as well as sludges composed of mixtures of liquids and solids. Organic sludges and solids are generally homogeneous materials (e.g., sludge from biological wastewater treatment plants, activated carbon, organic resins). Materials containing more than 50 percent debris are classified as heterogenous debris.

Inorganic Sludges and Solids. Inorganic sludges and solids are solid or semi-solid materials comprised mostly of inorganic or mineralogical materials (other than soil and debris). Inorganic sludges and solids in this category are generally homogeneous (e.g., sludge from chemical wastewater treatment plants or dusts from air pollution control devices). Cemented solids, or wastes that have already been mixed with cement, are considered a separate subcategory of homogenous inorganic solids due to their special handling and treatment requirements. Materials containing more than 50 percent debris are classified as debris.

Soils. Soils contaminated with hazardous and radioactive contaminants that are stored in waste containers (rather than *in-situ* soils) are given their own category due to the unique handling and treatment considerations for soils. In this report, mixtures of soil and debris containing less than 50 percent debris are counted among soils.

Debris. Debris is defined as solid material exceeding 60 mm (2.5 inch) particle size that is 1) a manufactured object; or 2) plant or animal matter; or 3) natural or geological material (e.g., boulders and cobbles) discarded or intended to be discarded [57 FR 37222; August 18, 1992]. Mixtures of debris and

other materials such as soil or sludge are considered debris if the mixture is comprised primarily of debris by volume. Materials, such as lead acid batteries, for which specific treatment standards are set in Subpart D of 40 CFR Part 268 and process residuals, such as smelter slag and incinerator ash, are by EPA's definition not considered debris. Debris is further categorized as organic and inorganic debris. Organic debris includes discarded paper or plastic products, wood, and fabric materials such as certain rags and clothing. Inorganic debris includes metallic or ceramic construction materials, metal turnings, and glass. Debris composed of both organic and inorganic materials is generally classified as heterogeneous debris.

Lab Packs. Lab packs are unique in that they generally include relatively small amounts of a variety of laboratory chemicals and discarded laboratory equipment.

Reactive/Dangerous Wastes. Reactive/dangerous wastes are wastes that can pose an acute physical hazard, and include reactive metals, explosives, and compressed gases. Reactive metals include sodium, alkaline metal alloys, aluminum fines, uranium fines, and zirconium fines. Wastes with reactive contaminants (e.g., cyanides) are not considered in this group unless the overall waste matrix is itself reactive.

Inherently Hazardous Wastes. Inherently hazardous wastes are wastes whose matrix, or primary components, are toxic or hazardous, and include liquid mercury, elemental lead, beryllium dust (RCRA code P015), and batteries (lead acid, cadmium, and others). Elemental lead wastes include surface-contaminated lead (e.g., bricks, counterweights, shipping casks and other shielding materials) and activated lead (e.g., lead from accelerators or other neutron sources).

Multiple Wastes. Some waste mixtures may be composed of more than one of the forms included in the groups above, and therefore may require sorting or separating prior to treatment. These wastes are grouped separately in this report and are listed as "multiple wastes."

Other Wastes. Some wastes do not readily fit into the above categories or are not yet characterized well enough to determine their physical/chemical matrix. DOE is currently working to further characterize these wastes. These wastes are grouped separately in this report and are listed as "other wastes."

Effects of Physical/Chemical Matrix on Treatment

The physical/chemical matrix categories presented in Figure 2-3 divide wastes into groups based on similar physical and chemical properties, and take into account differences in the applicability and effectiveness of treatment for particular wastes. The matrix categories are an important consideration in the determination of Best Demonstrated Available Technologies (BDAT). After a BDAT is identified, EPA develops the treatment standard for certain hazardous components in the waste. Treatment standards are expressed as maximum constituent-specific concentrations allowed in the waste (or an extract of the treated waste), as a specific technology (or group of technologies), or as a combination of both.

Although RCRA allows the discretion to establish treatment standards as either levels or methods of treatment, EPA has attempted to set concentration-based treatment standards wherever possible, because concentration-based standards provide the regulated community with flexibility in choosing treatment technologies and also allow the investigation and development of new and alternative technologies. Compliance with a concentration-based standard requires only that the treatment level be achieved; once achieved, the waste may be land disposed. The waste need not be treated by the BDAT, and any treatment, including recycling or a combination of treatments, can be used to achieve the concentration-standards.

For aqueous liquids, treatment is almost exclusively based on the hazardous components which are present. Organic liquids containing organic hazardous components could be treated by processes based on extraction or thermal destruction. Concerns about the waste matrix might influence the treatment standards for aqueous liquids to the extent that separate treatment standards would be mandated for the wastewater and non-wastewater forms.

In considering treatment for debris, the debris matrix itself influences the choice of treatment as much as the hazardous components themselves, and the treatment technologies applicable to debris illustrate the increased importance of the waste matrix in determining appropriate treatment. This last observation is reflected in the fact that, for the purposes of this report, debris has been grouped into three main categories: organic debris, inorganic debris, and heterogeneous debris.

Materials such as wood, paper, cloth and plastics, although typically classified as organic debris, are not generally amenable to destruction technologies for organic liquid wastes such as biodegradation, chemical oxidation/reduction, and photochemical (e.g., UV) treatment. These processes may destroy the debris' organic content, but will generally not destroy the debris matrix itself. Thermal destruction technologies (e.g., incineration) combined with immobilization are generally believed to be the most attractive alternative for dealing with debris streams. However, debris streams generally contain inorganic materials, which will collect in the waste residuals, and these residuals will require further treatment. For example, if the debris is incinerated, the ash will require additional immobilization, either cementation or vitrification. Cementation may not be useable, however, if the debris contained aluminum foil or aluminum sheet. The aluminum would react with the cement causing hydrogen generation and swelling during curing. Destruction technologies also tend to work best when the debris is of small, uniform size and is relatively homogeneous. For example, large objects such as filter paper rolls may have to be cut or shredded to facilitate subsequent incineration.

Concrete, glass and metal are typically considered inorganic materials. The common trait among wastes in this matrix is their lack of biodegradable and/or combustible components. When found in debris streams, however, these materials often contain organic contaminants, and the associated debris streams are typically classified as heterogeneous debris. Debris streams of this type are generally not amenable to destruction technologies such as biodegradation, chemical oxidation/reduction, and photochemical treatment, although these processes may be appropriate treatment for destroying the organic contaminants in the inorganic matrix. Debris streams of this type are generally best treated by robust technologies such as thermal destruction and immobilization; physical extraction and chemical extraction are also options for this type of debris.

Which of these technologies is actually used would also depend on other properties of the debris matrix. The effectiveness of chemical extraction technologies (e.g., water washing, liquid-liquid extraction) are very dependent on both the porosity of the debris (to ensure adequate penetration of the extracting solvent) and its particle size (to ensure aid in the transfer of the contaminant from the debris matrix into the extracting solvent). The facility to which the particle size of the debris can be reduced is dependent on both its hardness and brittleness. Treatment standards based on physical extraction technologies (e.g., CO_2 blasting, surface treatments) require both a clean debris surface and the removal of 0.6 cm of the debris surface. These standards are difficult to meet when the debris is concrete or brick covered with paper, or something similar, but would be relatively easy to meet for concrete and brick alone. Because of this lack of flexibility in extraction technologies, and the inability sometimes to have accurate characterization of the waste streams, treatment by thermal destruction and immobilization of the residuals is being given major emphasis.

For reactive/dangerous materials, the primary consideration for treatment is to make these wastes non-reactive. For example, the first order of treatment for explosive wastes is to make the wastes non-explosive, and other hazardous materials that may be present take on secondary importance.

Inherently hazardous wastes are also subject to stringent treatment standards because of the hazard these materials pose. For example, the treatment standard for lead acid batteries is a specific treatment method: recovery of the lead content in secondary lead smelters; no other option is permitted. However, as mentioned previously, because of the difficulty of recycling radioactive materials into general commerce, the lead, once recovered, would need to be disposed of in another way, perhaps by macroencapsulation or vitrification. Likewise, there is also only one primary treatment standard for mixed wastes containing elemental mercury and it is amalgamation of the elemental mercury (i.e., the treatment standard is a specific treatment method). An additional option may be recycling the mercury within the DOE system. Like the lead, the mercury too could not be recycled into general commerce, and if no use could be found for this mercury within the DOE system, it would require appropriate disposal.

2.4.3 RCRA Hazardous Components and Treatability

RCRA hazardous waste identification criteria are codified in Subpart D of 40 CFR Part 261 and under Subpart C of 40 CFR Part 261[c]. A solid waste is hazardous under Subtitle C of RCRA if it meets one of the following four criteria and is not otherwise excluded:

1) The waste exhibits: ignitability (D001), corrosivity (D002), reactivity (D003), or toxicity (D004-43);

2) The waste appears on one of three lists of hazardous wastes:
   - List of wastes from non-specific sources (the "F" codes),
   - List of wastes from specific sources (the "K" codes), or
   - List of commercial chemical products (the "P" and "U" codes);

3) The waste is a mixture of listed hazardous and non-hazardous solid waste; or

4) The waste is a residual from the treatment, storage, or disposal of a listed hazardous waste.

Effect of RCRA Hazardous Components on Mixed Waste Treatability

Chemical contaminants and characteristics are another fundamental determinant of appropriate treatment for mixed wastes. Most LDR standards are specified as concentrations of hazardous components of concern in the residue from treatment using what EPA has determined to be the Best Demonstrated Available Technology (BDAT). In cases where such concentrations are unavailable or extremely difficult to measure, EPA has specified that the BDAT be the method used to treat the waste. Any treatment (excluding dilution which is categorically prohibited) may be used to meet BDAT standards specified as concentrations. The first consideration for treating the hazardous component of a mixed waste is whether the LDR standards require the use of a specific technology.

While EPA has defined waste codes for many specific contaminants, many of these contaminants can be treated using the same technologies. In general, hazardous organic contaminants are complex molecules that can be destroyed by breaking them down to less hazardous compounds. Toxic metals, on the other

[c] Appendix D provides Subparts C and D of 40 CFR Part 261.

hand, generally cannot be broken down beyond their elemental level, but instead must be removed from a waste or immobilized to reduce the possibility that they will migrate into the environment. To indicate general treatment needs, DOE has categorized its wastes into broad contaminant groups as summarized in Figure 2-4.

Organic Contaminants. Organic contaminants generally include toxic hydrocarbon compounds. While the toxicology of these contaminants may vary considerably, they are generally treated by degrading them to nonhazardous forms by chemical, thermal, or biological processes. Halogenated organics are an important subcategory of organics due to their generally low heats of combustion, high toxicity, and potential to liberate acid gases when thermally destroyed.

Figure 2-4
RCRA Contaminant Categories

Toxic Organic Contaminants
Toxic Metal Contaminants - With Mercury - Without Mercury
Ignitable, Corrosive, or Reactive Only

Metal Contaminants. As noted above, toxic metal contaminants cannot be degraded beyond the elemental level, where they generally continue to pose health or environmental risks. EPA has defined as hazardous, wastes with sufficient leachable quantities of the following heavy metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Other metals, such as beryllium and vanadium are also of environmental concern in certain forms. Wastes containing metals are most commonly treated to immobilize the metals, however, inherently hazardous wastes composed primarily of metals (e.g., lead shielding) often offer good opportunities for recycling and reuse within the DOE. Due to the unique nature of mercury (e.g., its volatility and toxicity) DOE has subdivided metal-bearing wastes into two groups based on whether they contain mercury.

Ignitable, Corrosives, or Reactive. DOE has categorized ignitable, corrosive, and reactive wastes as a separate group because the characteristics of ignitability, corrosivity, and reactivity are not based on a particular constituent per se. Ignitables, corrosives, and reactives are generally coded as D001, D002, and D003 wastes respectively.

2.4.4 Mixed Waste Treatment Considerations

Treatment, as defined by EPA in the context of RCRA hazardous wastes, means "any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste non-hazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduced in volume." (40 CFR 260.10).

Because of this broad definition, many systems through which DOE processes mixed wastes meet this legal definition of treatment without actually reducing the hazardous nature of the wastes. These systems include processes that facilitate storage (e.g., compaction, packaging, etc.) and pretreatment processes (e.g., shredding, grinding, physical separation, etc.) that make the waste amenable to the treatment process that ultimately destroys, removes, or immobilizes the hazardous contaminants or characteristics. Though such systems may themselves be unable to render a waste suitable for disposal, they are often integral to treatment processes that do treat wastes to LDR standards. For this reason, these pretreatment systems are included in this report, but are distinguished from the treatment systems (e.g., incineration) that are designed to render a waste less hazardous and thus comply with the LDR standards.

Treatment technologies for mixed wastes, either alone or in combination, must be able to destroy, remove, or immobilize the hazardous component and ensure that any residual generated in the process is subsequently treated and is in compliance with disposal requirements under RCRA. Many of the mixed waste streams contain multiple types of contaminants, and will require either multiple types of treatments (i.e., treatment trains), or robust technologies that can accomplish multiple treatment needs, to treat all of the contaminant types present. In general, mixed waste treatment technologies resemble RCRA hazardous waste treatment technologies but have added features to control radionuclide mobility, and shield system operators and sensitive environments from the radioactivity. For this reason, the mixed waste treatment technologies have been organized according to the RCRA contaminants or characteristics they are designed to address. For each technology, the report also provides a general discussion on the major radiation or matrix considerations that may limit applicability of the technology.

It should be noted that the treatment systems rendering wastes less hazardous do not necessarily include all of the specific technologies cited as BDATs for the wastes they treat. In these cases, the system is designed to provide equivalent performance for wastes whose LDR standards are specified as concentrations, or as broad classes of technologies that include one or more of the technologies used in the system.

The most common practice for reducing the hazards from organic chemicals is to thermally, chemically, or biologically convert the contaminants of concern to a less toxic form. In some cases, such as relatively clean solvents, it may be feasible to recover organics for reuse. The major treatment technologies used for mixed wastes contaminated with organics are thermal destruction (e.g., incineration) and chemical oxidation. Biodegradation, wet air oxidation, carbon adsorption, and steam stripping are used to treat organic contaminants in aqueous wastes.

Metals treatment generally requires removal or immobilization of the metal because metals generally cannot be destroyed (in some cases, such as chromium reduction, metals can be converted to a less toxic form). Common treatment processes for metals are stabilization, vitrification, macroencapsulation, ion exchange, metals recovery, and for elemental mercury-containing wastes, amalgamation.

Most corrosives are aqueous solutions -- either acids or bases. Often the corrosivity of a waste is reduced as part of the process to destroy organics (e.g., incineration) or remove metals (e.g., precipitation) from a waste. If the waste is RCRA hazardous solely due to its corrosivity, neutralization alone is commonly used to eliminate the corrosivity of the waste.

While many of the technologies discussed above for specific types of contaminants (e.g., incineration, macroencapsulation, stabilization) may also be feasible for certain forms of debris, many forms of debris may require specialized treatment such as physical/chemical separation, to facilitate the use of more conventional technologies. Physical separation includes several processes such as washing, steam cleaning, abrasive blasting, etching, cutting and disassembly, and for waste characteristically toxic for mercury, roasting.

2.4.5 Treatability Groups

The three primary characteristics that have to be considered for the selection of appropriate handling and treatment for mixed wastes are the radioactive characteristics, the RCRA hazardous components, and the physical/chemical matrix of the waste. In this report, wastes are grouped into "treatability groups" based on distinct combinations of these characteristics. These treatability groups address the unique handling and treatment problems that each combination of the characteristics present. Mixed wastes falling into the same treatability group are amenable to similar types of treatment inasmuch as they share similar characteristics that affect treatment performance.

Broad categorizations of the mixed wastes streams based on the three waste characteristics will support rough comparisons of required and available treatment capacity for DOE's mixed wastes, and will provide insights into DOE's mixed waste treatment capacity needs. These treatability groups are an initial grouping of wastes and are not intended to provide the final, definitive treatment and technology requirements for each wastestream. Other more detailed technological assessment activities are required in many instances, and additional detailed engineering and scientific assessments (treatability analyses) are underway throughout the DOE complex to refine these categorizations.

2.4.6 DOE Treatment Facilities

Table 2-5 lists all of the sites that currently have mixed waste treatment facilities or have plans to add mixed waste treatment facilities in the future. The table is organized alphabetically by site, and then by treatment facility and treatment system within each facility. Only those systems that, as a whole, render a waste less hazardous to meet LDR requirements are included in Table 2-5. For each treatment system, Table 2-5 indicates the types of treatment the system provides. These "treatment types" may include common pretreatment practices, such as shredding, and sorting, which, by themselves may not qualify as treatment for meeting LDR treatment requirements, but are part of treatment systems that do or will meet these requirements. Table 2-5 also indicates the type of mixed waste (HLW, MTRU, or MLLW) that each facility can or will be able to treat, and the operational status of each system. More detailed information on the treatment systems that address a particular radiation category can be found in Chapters 3, 4, and 5. More details on specific treatment facilities are provided in the appropriate state chapters.

Schedules are provided in this chapter for bringing planned facilities on-line, which include: (i) validated fiscal year (FY) 1994 and FY 1995 new starts; (ii) those currently under construction or modification and (iii) existing facilities not yet on line for treatment of mixed waste or subject to restart, such as the Waste Experimental Reduction Facility and Controlled Air Incinerator. The schedules for bringing these facilities on line are based on proposed budgets and are subject to change based on the availability of funding. In addition, restart of existing facilities or start-up dates for facilities in the early planning/conceptual stage, in the detailed design, or in the construction stage are uncertain pending technical, regulatory, and other planning requirements which must be fully defined and addressed.

TABLE 2-5

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Argonne National Laboratory - East							
Alkali Metal Reaction Booths	Chemical Oxidation			√		√	
Energy Technology Engineering Center							
Radioactive Materials Disposal Facility / Amalgamation Process	Amalgamation			√			√
Radioactive Materials Disposal Facility / Neutralization Process	Neutralization			√	√		
Fernald Environmental Management Project							
Minimum Additive Waste Stabilization Facility	Soil Washing, Vitrification, Ion Exchange			√			√
Soil Washing Process Facility	Soil Washing			√			√
UNH Treatment Facility	Neutralization, Chemical			√	√		

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

087

4690

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
UNH (continued)	Precipitation, Filtration						
Hanford Site							
Effluent Treatment Facility	Filtration, UV Oxidation, Reverse Osmosis, Ion Exchange, Evaporation, Drying			√			√
Grout Treatment Facility	Stabilization			√			√
Hanford Waste Vitrification Plant	Vitrification	√	√	√			√
Maintenance & Storage Facility	Water Reaction		√	√		√	
Thermal Treatment Facility	Incineration		√	√			√
Waste Receiving And Processing Facility / Wrap IIA	Encapsulation, Stabilization, Compaction		√	√			√
Idaho National Engineering Laboratory							
Bench Scale Treatments	Ion Exchange		√	√			√

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

088

4690

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
HEPA Filter Leaching System (CPP-659)	Chemical Extraction	√	√	√	√		
ICPP Decontamination Facility / Water Washing System	Water Washing	√		√			√
ICPP Decontamination Facilty / Unit2: CO2 Decontamination System	CO2 Decontamination	√		√			√
Idaho Waste Immobilization Facility	Vitrification	√	√	√			√
Idaho Waste Processing Facility / Debris Decontamination System	Debris Decontamination		√	√			√
Idaho Waste Processing Facility / Macroencapsulation System	Macroencapsulation		√	√			√
Idaho Waste Processing Facility / Stabilization System	Stabilization		√	√			√
Idaho Waste Processing Facility /	Thermal Destruction		√	√			√

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Thermal Destruction System							
INEL / Waste Generator Treatment Plans	Ion Exchange, Neutralization, Stabilization			√	√		
INEL / Waste Generator Use Of Debris Treatments	Surface Treatment			√	√		
Liquid Effluent Treatment And Disposal	Chemical Fractionation, (Pretreatment)			√	√		
Mixed Low-Level Waste Treatment Facility	Incineration, Decontamination, Macroencapsulation, Debris Decontamination, Thermal Desorption, Stabilization, Chemical Precipitation			√			√
New Waste Calcining Facility	Calcination Pretreatment	√	√	√	√		
Portable Water Treatment System (PWTU)	Neutralization, Carbon Adsorption, Ion Exchange, Filtration			√	√		

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
TAN 726-A Treatment / TAN 726-A Treatment Unit	Ion Exchange			√		√	
Waste Characterization Facility	This facility is a, characterization and, repackaging facility with, limited Stabilization,, Amalgamation,, Neutralization, and, Adsorption capabilities.		√	√			√
Waste Engineering Development Facility / Macroencapsulation Unit	Macroencapsulation			√			√
Waste Engineering Development Facility / Stabilization Unit	Stabilization			√		√	
WERF Incinerator	Incineration			√		√	
WERF Wast Stabilization Unit / WERF Waste Stabilization Unit	Stabilization			√		√	
Oak Ridge K-25 Site							

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Central Neutralization Facility	Neutralization, Chemical Precipitation, Centrifugation, Filtration			√	√		
K-25 Site TSCA Incinerator	Incineration			√	√		
Los Alamos National Laboratory							
Controlled Air Incinerator / Liquid Feed System	Incineration		√	√		√	
Controlled Air Incinerator / Solid Feed System	Incineration		√	√		√	
Hazardous Waste Treatment Facility (HWTF) / Detox Skid	Chemical Oxidation			√			√
Hazardous Waste Treatment Facility (HWTF) / Plating Wastes Acids/Bases Skid	Neutralization, Oxidation/Reduction, Chemical Precipitation			√			√

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

4690

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Hazardous Waste Treatment Facility (HWTF) / Reactive Metals Skid	Water Reaction			√			√
Lead Decontamination Trailer	Lead Decon/Recycle			√	√		
Lawrence Livermore National Laboratory							
Area 514 WWTTF	Carbon Adsorption, Chemical Precipitation, Neutralization, Oxidation/Reduction, Flocculation, Separation			√	√		
Area 514-1 / Carbon Adsorption Unit	Carbon Adsorption			√			√
Area 514-1 / Portable Blending Unit	Neutralization			√			√
Area 514-1 / Tank Blending Unit	Neutralization			√			√
Building 513 / Solidification Facility	Solidification			√			√
Mixed Waste Management Facility	Alternative Technologies			√			√

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 2-5(Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Mound Facility							
Mound Glass Melter	Vitrification			√		√	
Oak Ridge National Laboratory							
Melton Valley Low-Level Waste Immobilization Facility	Stabilization			√	√		
Process Waste Treatment Plant	Ion Exchange			√	√		
Paducah Gaseous Diffusion Plant							
C-400-D Lime Precipitation Unit	Chemical Precipitation, Neutralization			√	√		
Wastewater Treatment System	To Be Determined			√			√
Portsmouth Gaseous Diffusion Plant							
Waste Treatment Facility	Incineration, Deactivation, Amalgamation, Stabilization,			√			√

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

4690

094

TABLE 2-5(Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Waste Treatment (continued)	Neutralization						
X-622 Groundwater Treatment Facility	Carbon Adsorption			√	√		
X-622T Groundwater Treatment Facility	Carbon Adsorption			√			√
X-623 Groundwater Treatment Facility	Carbon Adsorption			√			√
X-623 Groundwater Treatment Facility	Carbon Adsorption			√			√
X-624 Groundwater Treatment Facility	Air Stripping, Carbon Adsorption			√	√		
X-701E Groundwater Treatment Facility	Carbon Adsorption			√	√		
X-705 Decontamination Facility / Microfiltration	Neutralization, Filtration			√	√		
X-705 Decontamination Facility / Uranium Recovery System	Liquid Extraction, Neutralization, Filtration, Ion Exchange,			√	√		

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 2-5(Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
X-705 Uranium (continued)	Biodenitrofication						
Pantex Plant							
Building 11-15A	Immobilization			√		√	
Building 11-9	Immobilization			√		√	
Burning Ground / One Cage, One Tray, and One Pan	Thermal Treatment			√	√		
Hazardous Waste Treatment & Processing Facility	Immobilization, Repackaging, Neutralization, Compaction, Shredding, Sorting, Size Reduction, Solidification			√			√
Rocky Flats Plant							
Aqueous Process Waste Treatment: Building 774 / Wastewater	Deactivation, Neutralization, Filtration, Chemical Precipitation		√	√	√		

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

4690

096

TABLE 2-5(Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Building 374 / Process Waste Treatment Facility: Building 374	Decontamination, Neutralization, Immobilization, Evaporation, Deactivation, Solidification		√	√	√		
Building 374/774 Salt And Sludge Treatment	Immobilization			√			√
Chip Cementation: Building 447	Solidification, Stabilization			√		√	
Fabric Filtration: Buildings 444,447, and 460	Filtration			√	√		
Miscellaneous Waste Form Treatment	Immobilization			√			√
Miscellaneous Waste Handling & Immobilization: Bldg 774	Stabilization, Solidification		√	√	√		
Mixed Residue Treatment	Precipitation, Neutralization, Immobilization		√				√
Organic and Sludge Immobilization System: Building 774	Immobilization, Solidification		√	√	√		

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Pondcrete Solidification Process: Building 788	Solidification			√		√	
Pondcrete/Saltcrete Reprocessing Facility: 750PAD	Solidification			√		√	
Pondcrete/Saltcrete Reprocessing Facility: 904PAD	Solidification			√		√	
Solidified Bypass Sludge Treatment	Immobilization			√			√
Solvent Contaminated Waste System	Thermal, Non-thermal			√			√
Surface Organic Removal / Leaded Gloves, and Bulk Lead Treatment	Separation, Immobilization			√			√
Sandia National Lab - New Mexico							
Radioactive And Mixed Waste Management Facility	Stabilization, Crushing, Ion Exchange, Shredding, Macroencapsulation, Chemical			√			√

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Radioactive and Mixed Waste (continued)	Stripping, Reverse Osmosis, Baling, Neutralization, Chemical Precipitation, Demineralization						
Savannah River Site							
Consolidated Incineration Facility / CIF Ashcrete	Stabilization			√			√
Consolidated Incineration Facility / CIF Incinerator - Liquid Feed System	Incineration			√			√
Consolidated Incineration Facility / CIF Incinerator - Solid Feed System	Incineration			√			√
DWPF Vitrification Plant	Vitrification	√					√
F/H Area Effluent Treatment Facility	Neutralization, Chemical Precipitation, Filtration, Carbon Adsorption, Reverse Osmosis, Ion Exchange, Evaporation, Mercury			√	√		

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
F/H Area (continued)	Absorption						
Hazardous Waste/Mixed Waste Disposal Facility / Acid Leaching And Chemical Precipitation Unit	Acid Leaching, Chemical Precipitation			√			√
Hazardous Waste/Mixed Waste Disposal Facility / Macroencapsulation Unit	Macroencapsulation			√			√
Hazardous Waste/Mixed Waste Disposal Facility / Mercury Amalgamation Unit	Amalgamation			√			√
Hazardous Waste/Mixed Waste Disposal Facility / Mercury Roasting/Retorting And Recovery Unit	Hg Roasting/Retorting			√			√
Hazardous Waste/Mixed Waste Disposal Facility / Soil Washing	Soil Washing			√			√
Hazardous Waste/Mixed Waste	Stabilization			√			√

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

46 90

100

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Disposal Facility / Stabilization/Solidification Unit							
M-Area Liquid Effluent Treatment Facility	Neutralization, Chemical Precipitation, Flocculation, Filtration			√	√		
M-Area Vendor Treatment	Stabilization, Vitrification			√			√
SRL Ion Exchange Treatment Probe / High Activity	Ion Exchange			√	√		
SRL Ion Exchange Treatment Probe / Low Activity	Ion Exchange			√	√		
Z-Area Saltstone Facility	Stabilization			√	√		
West Valley Demonstration Project							
Integrated Radwaste Treatment System	Precipitation, Salts Dissolution, Ion Exchange, Evaporation, Stabilization	√			√		

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned *
		HLW	MTRU	MLLW			
Vitrification Facility	Vitrification	√					√
Oak Ridge Y-12 Plant							
Biodenitrification Unit	Evaporation, Distillation, Biodegradation			√	√		
Central Pollution Control Facility	Neutralization, Carbon Adsorption, Oil/Water Separation			√	√		
Cyanide Treatment Facility	Chemical Oxidation			√	√		
Disposal Area Remedial Actions Liquid Storage Treatment	Oil/Water Separation			√	√		
Groundwater Treatment Facility	Air Stripping, Filtration, Carbon Adsorption, Chemical Precipitation			√	√		
Oak Ridge Reservation Mixed Waste Treatment Facility	Thermal Desorption, Decontamination, Stabilization, Sorting			√			√

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

46990

102

TABLE 2-5 (Continued)

National Overview of DOE Treatment Facilities

Facility/System	Treatment Type(s)	Radiation Categories Facility Can Treat			Existing/ In Use	Existing/ Planning To Use *	Planned
		HLW	MTRU	MLLW			
Plating Rinsewater Treatment Facility	Cyanide Destruction, Oxidation/Reduction, Neutralization, Filtration			√	√		
West End Treatment Facility / Wastewater Treatment	Oil/Water Separation, Neutralization, Biodentrification, Chemical Precipitation			√	√		

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

103

4690

2.5 Waste Minimization

This last section presents an overview of DOE's waste minimization efforts. The section discusses the general DOE policy toward waste minimization, and the responsibilities of the DOE sites under this policy. The section concludes with specific examples of ongoing waste minimization activities, illustrating how the policy is being implemented at various DOE sites covered in this report.

2.5.1 General DOE Policy and Program

On August 20, 1992, the Secretary of Energy issued a new Department of Energy (DOE) Policy on Waste Minimization and Pollution Prevention. The new Policy expanded the prior DOE Waste Minimization Policy and established a hierarchy of actions to guide all future DOE operations. The key elements of the Department's pollution prevention efforts are:

- First, avoid or reduce the generation of hazardous substances, pollutants, wastes, and contaminants at the source;
- Second, recycle or reuse what cannot be eliminated;
- Third, treat the remaining waste to reduce volume, toxicity, or mobility before storage or disposal; and
- Fourth, disposal of residual waste in an environmentally safe manner.

Of these actions, the first two constitute DOE's waste minimization effort and are the highest priority in preventing pollution. A Waste Minimization Cross-cut Plan was issued March 1992. The plan establishes key objectives and strategies to make DOE a national leader in waste minimization and maximize the exchange of waste minimization technology and information with private industry, public agencies, and academic institutions.

The new Policy stresses that waste minimization and pollution prevention are the personal responsibility of DOE and contractor employees. Managers are accountable for the implementation of the policy through program plans, funding and staffing projections, as well as through training and incentive programs. The overall DOE implementation is monitored by the Waste Minimization and Pollution Prevention Executive Board comprised of the Assistant Secretary (or Principal Deputy) from each of the DOE Program Secretarial Offices. This group meets quarterly to review Department progress on waste minimization and pollution prevention, and to ensure actions are underway to implement the policy and the DOE Waste Minimization Cross-cut Plan.

2.5.2 Individual Site Programs

Individual site pollution prevention plans are required by DOE Order 5400.1. These site program plans, and annual reports on the programs, ensure that current efforts at the sites reflect and implement DOE policy on waste minimization and pollution prevention. Site program actions include: administrative or policy actions to improve operations, actual process or equipment studies and changes, employee awareness and training programs, employee incentive or award programs, material recycling or reuse projects, and other efforts to reduce waste or improve efficiency. These actions can be catalogued into two broad areas, 1) Source Reduction, and 2) Recycling, Reclamation and Reuse.

Source Reduction includes operating procedures and housekeeping practices; changes that avoid waste generation; changes in process design or equipment; process modifications, new equipment additions; inventory and procurement controls; material substitution; and waste segregation. Source reduction efforts are generally proactive and can result in pollution prevention before waste is generated.

Recycling, Reclamation and Reuse reduces or eliminates waste disposal through the reuse of materials already generated as process byproducts or by innovative uses of materials to avoid disposal as waste. The recycle/reuse efforts are waste minimization after the waste or material is already produced, procured or obtained. An example is the reuse of packaging material in shipping and receiving operations to avoid or reduce disposal of packing materials from new equipment/supply shipments. The individual waste profile data sheets provide a general description of the type of waste minimization activities at each site. Chapter 7.0 provides descriptions of the categories of waste minimization activities identified as options during data collection for the individual site data sheets.

DOE is undertaking a number of site actions to reduce mixed wastes through source reduction and recycle/reuse efforts. Many of the actions underway are directed at hazardous material reduction or elimination that can result in avoidance of mixed waste generation in the future. These actions can include segregation of strictly hazardous wastes from radioactively contaminated wastes (good operating practices) and substitution for, or restrictions on, the purchase of hazardous materials that can become mixed wastes after contamination. Other minimization methods include changes to procedures or processes that allow reuse of materials before they are considered wastes. Listed below are some specific examples.

- Within the Naval Nuclear Propulsion Program, concerted efforts are taken to avoid commingling radioactive and chemically hazardous substances. For example, these efforts include avoiding, where technically feasible, the use of acetone and other F-listed solvents, lead-based and chromium-based paint, lead shielding in disposal containers and chemical paint removers. As a result of these efforts, ongoing Program activities have typically generated only about 25 cubic meters of mixed waste per year. It should be noted that many of the waste streams identified in Chapters 8.0 through 26.0 of this report are no longer being generated.

- The West Valley Demonstration Project and the Portsmouth Gaseous Diffusion Plant are also eliminating chromium-based paints, where possible. The West Valley Demonstration Project is also re-using contaminated lead shielding in contaminated areas.

- At the Idaho National Engineering Laboratory, the Princeton Plasma Physics Laboratory, the Inhalation Toxicology Research Institute, the Los Alamos National Laboratory, the West Valley Demonstration Project and the Mound Site, a non-hazardous scintillation cocktail is now being used in laboratory radiological tests. The original cocktail mixture is proprietary but usually contains xylenes, toluene or other aromatic compounds which are hazardous materials.

- For heavy-metals contaminated waste oils, the Idaho National Engineering Laboratory, the Brookhaven National Laboratory, and the West Valley Demonstration Project are now testing the oil condition in equipment, rather than routinely changing out used oil on a preset schedule. This reduces the amount of contaminated used oil.

- The Kansas City Plant has adopted a procedure to separate low-level and hazardous components from electronic assemblies prior to storage. This will eliminate this waste stream.

- At the Los Alamos National Laboratory, waste minimization activities (such as product changes) have essentially eliminated the hazardous (RCRA-regulated) constituents in the dewatered treatment sludges so that this waste stream is no longer generated as a mixed waste.

- At Brookhaven National Laboratory, good operating practices include purchase and use of smaller quantities of materials. Non-hazardous cleaners are substituted for hazardous solvents. Also, ultrasonic and pressure cleaning systems are used to reduce solvent needs.

- Both Brookhaven and the K-25 Site in Oak Ridge are using equipment and instruments without mercury to reduce mercury wastes.

- At the Portsmouth Gaseous Diffusion Plant an aggressive campaign is underway to eliminate the use of vapor degreasers. Aqueous immersion cleaners and steam cleaners are being investigated to replace hazardous solvents. In addition, the paint shop is in the process of converting its inventory to latex-based paints. This would eliminate the use of hazardous (RCRA-regulated) solvent used as thinners, in most painting applications.

- For cadmium-coated HEPA filters in air cleaning system, the Savannah River Site is segregating the metal frames from the filter media and compacting the frames to reduce waste volume.

- The Argonne National Laboratory-West has initiated efforts to minimize production of mixed waste through improved separating practices such as waste segregation, changing inventory procedures across the site, and reducing the use of hazardous materials when possible.

- At the Idaho National Engineering Laboratory's Waste Elimination and Reduction Facility (WERF), HEPA filters are dismantled, and hazardous components are removed prior to disposal, thereby eliminating a mixed waste stream.

690

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107

3.0 HIGH-LEVEL RADIOACTIVE WASTES AND FACILITIES

This chapter summarizes the Department of Energy's (DOE) inventory of mixed high-level radioactive wastes and management of these wastes. Section 3.1 summarizes the waste streams comprising the high-level waste inventory for each site. The wastes are organized by physical/chemical matrix, and both the current inventory and the projected five-year generation for each matrix is presented. Section 3.2 presents an overview of the pretreatment and treatment facilities for high-level wastes, and presents both existing and planned DOE facilities. The treatment types and waste matrix that a particular facility can treat are discussed, as well as the facility's normal operating capacity. For facilities that are being planned, the design capacity and the date the facility is expected to be available to treat high-level wastes are also presented. Section 3.3 concludes the discussion of high-level wastes and facilities by showing that all of DOE's current inventory of high-level waste is either being treated today, or will receive treatment at a future date when planned facilities become operational. Section 3.3 also shows that any future generation of high-level waste has already been anticipated, and the facilities that will treat this future generation are either operational today or are in the planning stages. Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stages for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

3.1 Mixed Waste Streams

DOE stores its high-level waste (HLW) at three sites in the United States: in South Carolina at the Savannah River Site (SRS); in Idaho at the Idaho National Engineering Laboratory (INEL); and in Washington state at the Hanford Site. A smaller amount of non-DOE high-level waste (HLW) from commercial fuel reprocessing activities at West Valley, New York, is to be solidified by the West Valley Demonstration Project (WVDP).

HLW are generated from the reprocessing of spent fuel and related support activities, and irradiated targets, and generally contain more than 99 percent of the nonvolatile fission products present in the spent fuel and the targets. High-level wastes from a facility that recovers both uranium and plutonium contain approximately 0.5 percent of the quantity of these elements in the spent fuel or irradiated targets, while the HLW from a facility that recovers only uranium contains approximately 0.5 percent of the uranium and all of the plutonium. HLW is generated from fuel processing as an acidic, highly radioactive, and heat producing liquid, and is stored in tanks or bins. At INEL, the HLW is converted to a stable granular solid, called calcine, and is stored in stainless steel bins inside of a concrete vault. INEL stores its acidic waste in underground stainless-steel tanks pending treatment. All sites except INEL make the acidic liquid wastes alkaline with caustic soda and store the alkaline HLW in underground carbon-steel tanks.

Table 3-1 presents an overview of the current inventory of HLW and the projected generation of HLW for the next five years. For each HLW physical/chemical matrix, Table 3-1 provides the current HLW inventory and projected five-year generation in cubic meters. Table 3-1 also distinguishes the quantities of contact handled (CH) high-level wastes from those high-level wastes that will require remote handling (RH)[a].

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[a] As discussed in Chapter 2, section 2.4, contact handled (CH) wastes are wastes having radiation levels at the waste container surface less than 200 mrems/hr; remote handled (RH) wastes are those wastes having radiation levels at the waste container surface greater than 200 mrems/hr.

Table 3-1

High Level Operations Wastes

Physical/Chemical Matrix	Inventory (m^3)	Five-Year Projection (m^3)
RH, Aqueous Liquid	142,036.4	12,824.4
RH, Inorganic Sludges/Particulates	138,843.6	0.0
RH, Inorganic Debris	20.4	34.0
RH, Calcine Solids	3,600.0	2,325.0
National Total:	**284,500.4**	**15,183.4**

The remainder of this section discusses how HLW are generated at each of the sites currently having HLW inventories and projected future generations. The section concludes with Table 3-2, which presents the current inventory and five-year projections of HLW generation at each site. For each site managing HLW, Table 3-2 provides the current inventory and future generation quantity (in m^3) for each HLW physical chemical matrix generated at a particular site.

3.1.1 Hanford Site

The primary mission of the Hanford site was the production of special nuclear material for national defense, and the management of the resulting waste. At present, Hanford no longer produces nuclear materials. Hanford manages two high-level wastes:

- Single-Shell Tank (SST) Wastes. Between 1943 and 1964, 149 single-shell tanks were built to store high-level liquid radioactive waste generated from various on-site processes and operations. No new wastes have been added to the SSTs since 1980, and much of the liquid waste originally stored in the SSTs has been transferred to double-shell tanks (DST) for safer storage. Although called "inorganic sludges/particulates", the SST waste is best described as sludge with interstitial liquid; some of the SST waste is also crystalline solids, and supernatant liquid is present in some tanks.

- Double-Shell Tank (DST) PUREX Aging Waste. The PUREX Plant formerly processed irradiated reactor fuel to extract plutonium and uranium. The waste was generated as an acid, but was treated with caustic to adjust the pH[b] before being transferred to the double-shell tanks for storage.

3.1.2 Idaho National Engineering Laboratory

Until recently, the Idaho Chemical Processing Plant (ICPP) reprocessed spent nuclear fuel to recover enriched uranium for recycling. These recovery processes generated three high-level mixed wastes:

- High-Level Liquid Waste: waste generated from spent nuclear fuel reprocessing. It is sent to a tank farm for interim storage before being calcined. DOE has stopped reprocessing operations at INEL.

- High-Level Calcine Solids: granular solids produced as a result of calcining where water is removed by evaporation, and nitrates are decomposed in a heated fluidized bed. One of the two empty bin sets is now receiving calcine.

- High Efficiency Particulate Air (HEPA) Filters: These filters, used for off-gas cleaning associated with the calcining process, are contaminated with HLW particles, but are not considered HLW. These filters are discussed here since they will be leached to remove the high-level waste particles and the resulting leachate will be calcined.

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[b] pH is a measure of the acidity of a solution. The lower the pH, the more acidic the solution. The higher the pH, the more alkaline the solution.

Bin sets 1 through 5 are full, and bin sets 6 and 7 are empty. An inventory of acidic liquid HLW remains in the tank farm awaiting solidification into calcine. In addition, decontamination activities at INEL produced a sodium-bearing liquid waste. To date, this waste has not been declared either a high-level or a low-level waste; however, it is managed as a high-level acidic liquid waste (i.e., it is stored in the same tanks and blended with HLW liquid wastes prior to calcining).

3.1.3 Savannah River Site

The primary mission of SRS is the production of plutonium, tritium, and other special nuclear materials. Three high-level waste streams, accounting for 93 percent of the total volume of mixed waste stored at SRS, were generated during plutonium and uranium recovery operations and are currently stored on-site:

- 221-F and 221-H Canyon Wastes. Originating from separation processes, these wastes consist mostly of water and inert chemicals, and contain fission products generated during plutonium recovery from reactor targets.

- 244-H RBOF High Activity Liquid Waste. This waste stream results from the concentration of heavy water removed from the 244-H Receiving Basin for Off-site Fuels (RBOF). Newly generated material is no longer hazardous.

A fourth high-level waste will be generated by laboratory research, development, and analytical activities supporting the In-Tank Precipitation (ITP) program. All of these wastes will require remote handling and are alpha and beta/gamma emitters. SRS treats their acidic high-level wastes with caustic soda to adjust their pH prior to storing them in tanks.

3.1.4 West Valley Demonstration Project

The West Valley Demonstration Project is located on the site of the only commercial nuclear fuel reprocessing facility ever to operate in the United States. High-level acidic wastes generated during these operations were made alkaline with caustic soda and stored in an underground tank, except for one batch of thorium-containing waste which was kept acidic and is stored in a stainless steel tank. Two high-level wastes are currently managed at West Valley:

- High-Level Sludge. The sludge phase of the high-level waste generated during commercial reprocessing operations contains most of the radioactivity, with strontium (^{90}Sr) being the major source. The sludge phase will be vitrified and ultimately disposed of in a federal geologic repository.

- THOREX waste. A small amount of this acidic high-level waste, generated from the reprocessing of fuel containing thorium, is also stored at WVDP.

Table 3-2

Current HLW National Inventory and Five-Year Projections

Site	Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
Hanford Site	Aqueous Liquid, RH	7,352.0	0.0
	Inorganic Sludges/particulates, RH	138,600.0	0.0
	Site Subtotal:	**145,952.0**	**0.0**
Idaho National Engineering Laboratory	Aqueous Liquid, RH	7,700.0	3,500.0
	Inorganic Debris, RH	20.4	34.0
	Calcine Solids, RH	3,600.0	2,325.0
	Site Subtotal:	**11,320.4**	**5,859.0**
Savannah River Site	Aqueous Liquid, RH	126,939.0	9,324.4
	Site Subtotal:	**126,939.0**	**9,324.4**
West Valley Demonstration Project	Aqueous Liquid, RH	45.4	0.0
	Inorganic Sludges/particulates, RH	243.6	0.0
	Site Subtotal:	**289.0**	**0.0**
National Total:		**284,500.4**	**15,183.4**

112

46990

4690

3.2 Treatment Facilities

This section presents more detailed information on the treatment facilities currently capable of treating HLW, and those facilities that are planned to treat HLW. Section 3.2.1 discusses the treatment facilities that exist now and are being used to treat HLW; Section 3.2.2 discusses those facilities that exist but are not being used, and whether the sites have plans for using them to treat HLW in the future; and Section 3.2.3 discusses those facilities that are planned or under construction. The discussions on treatment facilities focus on those facilities that actually treat or will treat the waste, and not on those facilities that only pretreat or will pretreat wastes. Chapter 2 provides more details on the criteria used to determine whether a facility treats or pretreats a waste, and the reasons for making this distinction. Part B of the report provides more details on the treatment facilities themselves.

3.2.1 Existing Treatment Facilities

Table 3-3 summarizes the information discussed below on existing treatment facilities. For each site, the table lists the existing facilities at that site, the type of treatment the facility is currently capable of providing, the waste matrices the facility can process, and the facility's normal operating capacity in cubic meters per year. Brief descriptions of the facilities that currently exist and are in use at each site for treating HLW follow. Further details on these facilities can be found in the appropriate individual site chapters in Part B of this report.

3.2.1.1 Hanford Site

No facilities at the Hanford Site capable of treating high-level waste are operational at this time.

3.2.1.2 Idaho National Engineering Laboratory

HEPA Filter Leach System. The HEPA Filter Leach System at INEL will chemically extract radionuclides and hazardous constituents from used HEPA filters, some of which are contaminated with HLW particles. The extract from this process will be pretreated at a fluidized bed calciner. The filters will then be disassembled, and packaged for disposal. Regulatory issues relative to further operations of this facility are currently being negotiated with the State of Idaho.

New Waste Calcining Facility. The New Waste Calcine Facility (NWCF) performs pre-treatment of mixed wastes by calcination of liquid waste. Waste streams are converted from the liquid to a solid granular form with a maximum 8:1 volume reduction. Calcination of the liquid waste was accomplished by blending aluminum and zirconium bearing wastes, created from spent fuel reprocessing, with sodium bearing wastes generated from decontamination of plant equipment. The blending of a sodium waste with either aluminum or zirconium fluoride has been essential for the calcination process. Storage of the sodium waste for extended periods of time has been necessary to facilitate proper blending and treatment. However, sodium waste can be blended with other commercially available chemicals.

3.2.1.3 Savannah River Site

No facilities at the Savannah River Site capable of treating high-level waste are operational at this time.

113

3.2.1.4 West Valley Demonstration Project

Integrated Radwaste Treatment System. The Integrated Radwaste Treatment System (IRTS), which processes high-level waste solutions (supernatant and sludge wash solutions) from the High-Level Waste storage tanks, is comprised of the Sludge Mobilization & Wash System, the Supernatant Treatment System (STS), the Liquid Waste Treatment System (LWTS), and the Cement Solidification System (CSS). Although these processes can operate independently, they normally operate in series and are permitted together as one treatment system. The primary radionuclide removed by the STS is ^{137}Cs, although the system could be modified to remove other positively charged ions. Once the ^{137}Cs is removed, the resultant solutions are considered a low-level waste; the remaining processes in the IRTS complete the treatment of the low-level solutions. The IRTS is technically capable of treating a variety of mixed wastes. In addition, DOE's authorization pursuant to the West Valley Demonstration Project Act is specifically limited to the high-level wastes previously generated on-site.

3.2.2 Existing Facilities Currently Not Being Used

All existing facilities that can treat high-level wastes are being used at Idaho National Engineering Laboratory and the West Valley Demonstration Project.

Hanford manages its liquid high-level wastes by storing them in either double-shell tanks (DST) or single-shell tanks. The 242-A Evaporator is a closed system which reduces the volume of wastes going to DSTs by evaporating excess water from the DST waste and returning a concentrate to the DSTs. The distillates from the evaporator are passed through an ion exchange column to remove cesium. The facility is currently non-operational.

Table 3-4 lists the relevant treatment type and matrix information for this HLW treatment process, and also indicates the current operating capacity and the date this facility is expected to be available for high-level waste treatment.

TABLE 3-3

Mixed Waste Treatment Facilities Currently Treating High-level Wastes

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Idaho National Engineering Laboratory	HEPA Filter Leaching System (CPP-659)	Chemical Extraction	HEPA Filters, Inorganic Debris	16.0
	New Waste Calcining Facility (1)	Calcination Pretreatment	Aqueous Liquid	2,300.0
West Valley Demonstration Project	Integrated Radwaste Treatment System (2)	Precipitation, Salts Dissolution, Ion Exchange, Evaporation, Stabilization	Aqueous Liquids, Inorganic Sludges	1,700.0

Note (1): Reported capacity is maximum capacity.

Note (2): The Integrated Radwaste Treatment System (IRTS) consists of four subsystems: the Sludge Mobilization and Wash System (SMWS), the Supernatant Treatment System (STS), the Liquid Waste Treatment System (LWTS), and the Cement Solidification System (CSS). These four subsystems operate in series as one treatment system: the IRTS. The reported capacity is for the IRTS.

TABLE 3-4

Existing Facilities Not Currently Treating High-Level Wastes But Planning To Treat

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Capacity (m3/yr) *	Date Avail. For Use *
Hanford Site	242-A Evaporator	Evaporation, Ion Exchange	Aqueous Liquids, Organic Liquid	50,000.0	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

116

4690

3.2.3 Facilities Planned or Under Construction

Table 3-5 summarizes the information discussed below for each treatment facility that is planned or under construction at each site treating HLW. The table lists the waste matrices that the facility will treat, the types of treatment it will provide, its design capacity (in cubic meters per year), and the year it will be available to treat HLW. Brief descriptions of the facilities that are planned or under construction at each site for treating high-level waste follow. Further details on these facilities can be found in the appropriate state chapters in Part B of this report. Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stages for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

3.2.3.1 Hanford Site

Waste Vitrification Plant. The HLW fraction from DST and SST waste will be sent to the Hanford Waste Vitrification Plant, where the HLW will be mixed with borosilicate glass forming media and vitrified. The vitrified waste will be stored in stainless steel canisters on-site until shipment to a geologic repository for disposal.

3.2.3.2 Idaho National Engineering Laboratory

ICPP Decontamination Facility/Water Washing System. The ICPP Decontamination Facility is being prepared for a second demonstration project in Fiscal Year 1993 to demonstrate the effectiveness of non-porous debris treatment using a water washing technique. The project is expected to become fully operational in Fiscal Year 1994.

ICPP Decontamination Facility/Unit 2: CO_2 Decontamination System. The ICPP Decontamination Facility is currently being prepared to support material decontamination and debris treatment using existing decontamination techniques and CO_2 pellet blasting technologies. A demonstration project is being funded during Fiscal Year 1993 by DOE-ID to evaluate the effectiveness of CO_2 treatment for decontamination of lead identified for reuse within the DOE system, and for treatment of debris generated during plant maintenance and facility decommissioning.

Idaho Waste Immobilization Facility. The Idaho Waste Immobilization Facility (IWIF) is a proposed facility. Although its design is currently not funded, predesign studies are funded and currently well underway. The IWIF will treat and immobilize the high-level waste calcine now being stored. Candidate technologies and waste form options have been analyzed, and the Glass Ceramic Process was chosen as the preferred treatment; it is currently undergoing verification testing and research. This process will be designed specifically for treating calcine waste, and other wastes are not likely to be accepted at the facility.

3.2.3.3 Savannah River Site

Defense Waste Processing Facility. The Defense Waste Processing Facility (DWPF) is a vitrification plant intended to convert high-level waste sludge containing strontium (^{90}Sr) and cesium (^{137}Cs) and other radioisotopes to borosilicate glass. The molten glass waste will be poured into stainless steel canisters to solidify. Each canister will hold approximately two tons of glass, will contain 100,000 Curies of radioactivity, and will be temporarily stored in a large shielded cell on site for subsequent shipment to a geologic repository. The DWPF is scheduled to become operational in 1994, and will be used in conjunction with the Z Area Saltstone Facility to treat mixed high-level waste(s). Because the entire

facility is housed in a canyon and all operations will be remote, there will be no restrictions placed on the radioactive constituents allowed in the feed. The facility will accept feeds containing heavy metals, but it will not accept feeds containing organic waste chemicals or PCBs.

3.2.3.4 West Valley Demonstration Project

Vitrification Facility. The vitrification facility at West Valley is scheduled to begin operation in 1996, and will treat the high-level waste sludge, the acidic thorium waste, and the waste ion exchange media from the Supernatant Treatment System by combining these wastes with glass formers (principally oxides of boron, silicon, and sodium). The melter will evaporate any remaining liquid, decompose any nitrates and carbonates, and fuse the glass formers and waste into a homogeneous, chemically bonded, durable solid. The molten glass waste will be poured into stainless steel canisters to solidify. Each canister will hold approximately two tons of borosilicate glass, will contain 100,000 Curies of radioactivity, and will be temporarily stored in a large shielded cell on site for subsequent shipment to a federal geologic repository.

3.3 Comparison of Treatment Facilities and Waste Streams

All of the high-level waste streams discussed in this chapter are currently being treated now, or will be treated in the future at planned facilities. At the Hanford site, the Hanford Waste Vitrification Plant is planned to treat both the SST waste and the High-Level Waste fraction from the DST waste. At the Idaho National Engineering Lab, the New Waste Calcining Facility will be used to convert the remaining inventory and any future generation of acidic high-level liquid waste to calcine. The entire calcine inventory and any future generation is slated for vitrification at the Idaho Waste Immobilization Facility. The HEPA filters are currently being proposed to be managed as debris and are being treated via the HEPA Filter Leaching System. At the Savannah River Site, all of the high-level wastes are awaiting the completion of the Defense Waste Processing Facility's Vitrification Plant, due on-line in 1994. Finally, at the West Valley Demonstration Project, the high-level waste sludge is currently being pre-treated on-site by the Sludge Mobilization and Wash System; vitrification of this sludge, including the THOREX waste, will follow at the Vitrification Facility, due to come on-line in 1996.

TABLE 3-5

Facilities Planned or Under Construction For Treating High-level Wastes

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating High-level Waste *
Hanford Site	Hanford Waste Vitrification Plant	Vitrification	Aqueous (Slurry Liquid), Inorganic Sludge/Particulate	1,200.0	1999
Idaho National Engineering Laboratory	ICPP Decontamination Facility / Water Washing System (1)	Water Washing	Debris	To Be Determined	1993
	ICPP Decontamination Facilty / Unit2: CO2 Decontamination System (2)	CO2 Decontamination	Debris	To Be Determined	1993
	Idaho Waste Immobilization Facility (3)	Vitrification	Calcined Solids	To Be Determined	Year To Be Determined
Savannah River Site	DWPF Vitrification Plant	Vitrification	HLW Sludges, Liquid Slurries	4,368.0	1994

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (1): Proposed facility only, needed treatments are being evaluated for inclusion in facility conceptual design.

Note (2): Proposed facility only, needed treatments are being evaluated for inclusion in facility conceptual design.

Note (3): For design capacity: this is a planned facility with no capacity design developed.

TABLE 3-5 (Continued)

Facilities Planned or Under Construction For Treating High-level Wastes

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating High-level Waste *
West Valley Demonstration Project	Vitrification Facility	Vitrification	Inorganic Sludges, Liquids	83.0	1996

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

120

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121

4.0 MIXED TRANSURANIC WASTES AND FACILITIES

This chapter summarizes the Department of Energy's (DOE) current inventory and future generation of Mixed Transuranic (MTRU) wastes[a] and the management of these wastes. MTRU wastes are generated by research and development activities, plutonium recovery, weapons manufacturing, environmental restoration, and decontamination and decommissioning projects (D&D). They consist of radioactive wastes that contain in excess of 100 nCi/g of transuranic alpha-emitting isotopes with half-lives greater than 20 years. Most MTRU wastes are solid and consist of protective clothing, gloveboxes, filters, wastewater treatment sludges, paper trash, rags, glass, tools, and equipment. Greater than 90 percent of MTRU waste is slightly contaminated with plutonium, which emits alpha particles and low energy photons. Wastes characterized primarily by alpha decay may be contact-handled (CH) by facility personnel. Some MTRU wastes, though, contain activation materials and fission products that decay by beta and gamma emission thus precluding direct handling. These remote-handled wastes (RH) have radiation levels exceeding 200 mrem/hr at the surface of the storage containers.

Section 4.1 examines the waste streams comprising the MTRU waste inventory in terms of physical/chemical matrices. The section also summarizes waste generation and management practices at the six primary storage sites for MTRU wastes. Section 4.2 discusses the construction of facilities to prepare MTRU defense wastes for shipment to the Waste Isolation Pilot Plant (WIPP) disposal site.

4.1 Waste Streams

Section 4.1.1 discusses past and current efforts in characterizing MTRU wastes. Section 4.1.2 provides current inventories and five-year projections of wastes described according to their physical/chemical matrices. Section 4.1.2 also summarizes current generation and management practices at the primary storage facilities.

4.1.1 Waste Characterization Status at DOE

If DOE is successful in obtaining a no-migration petition for the disposal of MTRU wastes in the WIPP (section 4.2), adherence with treatment standards under the land disposal restrictions (LDRs) will not be required. Consequently, full characterization for treatment purposes will be unnecessary. Considerable effort is under way now, though, to develop plans, criteria, technology, and facilities to characterize the existing waste and newly generated waste to meet the waste acceptance criteria for the WIPP (WIPP-WAC) (section 4.2) . Currently, minimum characterization requirements include real-time radiography, non-destructive assay, and head-space gas sampling for volatile organic compounds. The ability to characterize MTRU waste packages is complicated by technical difficulties not encountered for non-radioactive wastes, such as radiation emission interferences with laboratory extraction and analysis procedures. An additional difficulty is the heterogenous nature of waste package contents, which limit sampling reliability and prevent the applicability of standard procedures.

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[a] Much of the retrievably stored TRU waste was generated prior to the currently used distinctions of mixed and non-mixed waste. Additionally, the current requirements on characterization for the constituents now known as RCRA hazardous wastes were not in effect when the wastes were generated and stored. Consequently, complete information on these wastes does not exist. This chapter addresses those TRU wastes that are known to be mixed and acknowledges that, as waste characterization proceeds, additional mixed wastes will be identified and so categorized. For the most part, sites use similar management practices for mixed TRU wastes and potentially mixed TRU wastes.

DOE is currently planning programs to research existing records to recreate, to the extent practicable, process knowledge of the current legacy waste. Coupled with this effort will be the design of a sampling and analytical measurement program to be used to help confirm and validate the reconstructed process knowledge of the waste. DOE anticipates that by careful searches and well-planned sampling programs, full sampling and laboratory analysis of all wastes will not be necessary.

4.1.2 Waste Quantities and Management

Generation, storage, and burial of transuranic wastes occurs or has occurred at several DOE sites. Six sites have been traditionally designated as storage sites: Hanford Site (HANF), Idaho National Engineering Laboratory (INEL), Los Alamos National Laboratory (LANL), Nevada Test Site (NTS), Oak Ridge National Laboratory (ORNL), and Savannah River Site (SRS). These sites have also generated MTRU waste. Four sites have traditionally been designated as generator sites: Argonne National Laboratory-East (ANL-East), Lawrence Livermore National Laboratory (LLNL), Mound, and Rocky Flats Plant (RFP). The majority of buried waste is at HANF and INEL, while most of the retrievably stored waste is divided among HANF, LANL, INEL, ORNL, and SRS.

A potential difficulty in characterizing waste quantities arises from a shift in the definition of MTRU wastes and the resulting reclassification of some MTRU designated wastes as mixed low-level (MLLW) designated wastes. Prior to 1982, the definition of MTRU wastes carried a threshold radioactivity of 10 nCi/g of transuranic alpha-emitting isotopes. MTRU wastes, as currently defined, however, refer to radioactive wastes that contain in excess of 100 nCi/g of transuranic alpha-emitting isotopes. This definitional shift requires the reclassification of wastes stored prior to 1982. Some of these wastes, following new radioassays, will be reclassified as mixed low-level wastes (MLLW) while others will remain as MTRU. One site, for example, has tentatively reclassified 42 percent of its MTRU waste as MLLW waste. Approximately 25,000 cubic meters of this reclassified waste will require treatment under the LDRs (Chapter 5 Mixed Low-Level Wastes and Facilities). Other DOE sites storing MTRU wastes will need to undertake similar efforts. In the interim, DOE assumes that a similar percentage of waste at other facilities will require reclassification. If 10 to 50 percent of MTRU waste is eventually reclassified as MLLW, then approximately 2,000 to 9,800 cubic meters of additional waste will require treatment to meet the LDRs. Thus, up to 35,000 cubic meters of formerly MTRU waste, originally destined for the WIPP, will need treatment to meet the LDRs.

Although the majority of MTRU wastes will be disposed of at the WIPP (refer to section 4.2) without any prior LDR treatment, this report does divide MTRU wastes according to their physical/chemical matrices largely for descriptive purposes. This division is salient for those wastes reclassified as MLLW, which will receive treatment based upon the physical/chemical matrices.

Table 4-1 provides current inventories and five-year projections for contact-handled MTRU wastes described according to their physical/chemical matrices. Table 4-2 provides current inventories and five-year projections for remote-handled MTRU wastes described according to their physical/chemical matrices. Table 4-3 provides the same quantities divided among the individual DOE sites for wastes requiring contact and remote handling. The quantities provided in these tables do not reflect environmental restoration wastes.

Table 4-1

Mixed Transuranic Waste Inventory and Five-year Projections - Contact Handled

Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
Organic Liquids, CH	1.3	<0.1
Aqueous Liquid, CH	23.5	2.6
Organic Sludges/particulates, CH	1,371.7	0.0
Inorganic Sludges/particulates, CH	8,710.1	42.2
Cemented Solids, CH	119.2	26.6
Organic Debris, CH	5,002.9	154.1
Inorganic Debris, CH	1,802.3	219.6
Heterogeneous Debris, CH	28,659.2	1,353.0
Lab Packs Without Metals, CH	2.1	324.6
Reactive Metals, CH	110.3	3.1
Elemental Lead, CH	33.1	44.9
Batteries (lead Acid, Cadmium), CH	1.1	162.3
Multiple, CH	929.8	172.5
To Be Determined, CH	7,470.0	0.0
National Totals:	**54,236.5**	**2,505.4**

Table 4-2

Mixed Transuranic Waste Inventory and Five-year Projections - Remote Handled

Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
Organic Liquids, RH	0.3	0.6
Aqueous Liquid, RH	2,767.6	242.2
Inorganic Sludges/particulates, RH	2.1	0.8
Inorganic Debris, RH	101.0	2.0
Heterogeneous Debris, RH	5.7	0.2
Reactive Metals, RH	0.1	<0.1
Elemental Lead, RH	0.3	0.0
Multiple, RH	830.7	89.2
Other, RH	1.0	0.0
National Totals:	**3,708.7**	**335.0**

Table 4-3

Mixed Transuranic Wastes Inventory and Five-year Projections

Site	Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
Argonne National Laboratory - West	Inorganic Sludges/particulates, RH	0.0	0.8
	Heterogeneous Debris, RH	0.2	0.2
	Reactive Metals, RH	0.1	<0.1
	Elemental Lead, RH	0.3	0.0
	Multiple, RH	0.0	1.2
	Site Subtotal:	**0.6**	**2.2**
Argonne National Laboratory - East	Aqueous Liquid, CH	1.5	1.5
	Inorganic Sludges/particulates, CH	0.4	0.1
	Site Subtotal:	**1.9**	**1.6**
Energy Technology Engineering Center	Elemental Lead, CH	<0.1	0.0
	Site Subtotal:	**<0.1**	**0.0**
Hanford Site	Aqueous Liquid, RH	2,767.0	241.0
	Organic Debris, CH	2.1	14.1
	Heterogeneous Debris, CH	135.2	769.0

4690

5126

Table 4-3(Continued)

Mixed Transuranic Wastes Inventory and Five-year Projections

Site	Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
	Lab Packs Without Metals, CH	2.1	324.6
	Elemental Lead, CH	27.7	41.5
	Batteries (lead Acid, Cadmium), CH	1.1	162.3
	Site Subtotal:	**2,935.1**	**1,552.5**
Idaho National Engineering Laboratory	Organic Sludges/particulates, CH	1,371.7	0.0
	Inorganic Sludges/particulates, CH	5,117.3	0.0
	Inorganic Sludges/particulates, RH	2.1	0.0
	Inorganic Debris, CH	1,144.0	0.0
	Inorganic Debris, RH	100.0	0.0
	Heterogeneous Debris, CH	22,991.6	0.0
	Heterogeneous Debris, RH	5.5	0.0
	To Be Determined, CH	7,470.0	0.0
	Site Subtotal:	**38,202.2**	**0.0**
Los Alamos National Laboratory	Inorganic Sludges/particulates, CH	3,052.2	38.3

Table 4-3(Continued)

Mixed Transuranic Wastes Inventory and Five-year Projections

Site	Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
	Cemented Solids, CH	115.9	0.4
	Heterogeneous Debris, CH	4,920.4	584.0
	Reactive Metals, CH	110.1	3.1
	Site Subtotal:	**8,198.5**	**625.7**
Lawrence Livermore National Laboratory	Organic Liquids, RH	0.3	0.6
	Aqueous Liquid, RH	0.6	1.2
	Inorganic Debris, RH	1.0	2.0
	Site Subtotal:	**1.9**	**3.8**
Mound Plant	Cemented Solids, CH	2.0	0.0
	Elemental Lead, CH	1.1	0.2
	Site Subtotal:	**3.2**	**0.2**
Nevada Test Site	Heterogeneous Debris, CH	612.0	0.0
	Site Subtotal:	**612.0**	**0.0**
Oak Ridge National Laboratory	Multiple, CH	662.0	48.0

128

46690

Table 4-3(Continued)

Mixed Transuranic Wastes Inventory and Five-year Projections

Site	Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
	Multiple, RH	830.7	88.0
	Site Subtotal:	**1,492.7**	**136.0**
Paducah Gaseous Diffusion Plant	Aqueous Liquid, CH	7.5	0.0
	Inorganic Sludges/particulates, CH	6.0	0.0
	Site Subtotal:	**13.6**	**0.0**
Rocky Flats Plant	Aqueous Liquid, CH	14.5	1.1
	Inorganic Sludges/particulates, CH	534.1	3.8
	Cemented Solids, CH	1.3	26.3
	Inorganic Debris, CH	658.3	219.6
	Reactive Metals, CH	0.2	0.0
	Elemental Lead, CH	3.8	3.1
	Multiple, CH	267.8	19.5
	Site Subtotal:	**1,480.0**	**273.3**
Sandia National Laboratory - New Mexico	Other, RH	1.0	0.0

129

4690

Table 4-3(Continued)

Mixed Transuranic Wastes Inventory and Five-year Projections

Site	Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
	Site Subtotal:	**1.0**	**0.0**
Savannah River Site	Organic Liquids, CH	1.3	<0.1
	Inorganic Sludges/particulates, CH	<0.1	0.0
	Organic Debris, CH	5,000.8	140.0
	Site Subtotal:	**5,002.1**	**140.0**
West Valley Demonstration Project	Elemental Lead, CH	0.5	0.0
	Site Subtotal:	**0.5**	**0.0**
Waste Isolation Pilot Plant	Multiple, CH	0.0	105.0
	Site Subtotal:	**0.0**	**105.0**
National Total:		**57,945.2**	**2,840.3**

4690

130

The generation of MTRU wastes at each of the six primary storage sites is discussed below.

HANFORD. Activities at Hanford, which formerly focused on plutonium production, have shifted to environmental restoration, management of the wastes generated by past reactor and processing operations, and research and development for advanced reactors, energy technologies, basic sciences, and waste disposal technologies. There are 22 MTRU waste streams at Hanford that together make up a total of approximately 2,900 cubic meters of waste. Most of the waste (94 percent) is remote-handled aqueous liquids stored in double-shell tanks. Solid contact-handled MTRU wastes are storedin the TRU Storage and Assay Facility (TRUSAF), which characterizes and assays MTRU wastes. The projected 5-year generation of MTRU waste is approximately 1,600 cubic meters.

INEL. Activities at INEL include the operation of nuclear reactors, spent fuel storage, waste management facilities, and other supporting facilities. Primary activities at INEL are environmental restoration, waste management, and technology development. As the historical recipient of defense MTRU waste from the Rocky Flats Plant for several decades, INEL has approximately 38,000 cubic meters stored at a number of locations at the laboratory. None of the waste streams are projected to be generated in the next five years. INEL manages the MTRU wastes as 20 distinct waste streams. All are solid in physical form. Three of the MTRU waste streams are remote-handled, but these account for only 0.3 percent of the overall INEL MTRU inventory. The CH inventory is managed as 18 waste streams. All CH and RH MTRU wastes received since 1970 have been contained at the Transuranic Storage Area in retrievable storage.

LANL. Activities at LANL include applied research in nuclear and conventional weapons development, nuclear fission and fusion, nuclear safeguards and security, and waste management. LANL identifies 11 transuranic waste streams stored on site, with a total volume of 8,200 cubic meters. All are contact-handled (CH) wastes. This quantity includes approximately 4,350 cubic meters of MTRU waste held below-grade in pre-RCRA retrievable storage. MTRU wastes represent the majority of the mixed waste at LANL, accounting for 92 percent of the total current volume of operational waste. An estimated 626 cubic meters of MTRU wastes will be generated in the next five years. This waste will result from research and development projects.

NTS. Activities at NTS have historically included above and below-ground nuclear testing. Current activities at NTS include the management and disposal of low-level radioactive waste, storage of MTRU waste, and the development of a mixed low-level waste disposal unit. NTS does not generate MTRU waste but does store one MTRU waste stream consisting of 612 cubic meters of heterogenous debris. This waste stream is in inventory and will not be generated in the future. The material was generated at LLNL and shipped to NTS between 1974 and 1990. The majority of the waste is contact-handled.

ORNL. Activities at ORNL include applied research and development in support of DOE programs in fusion, fission, conservation, and selected areas of the physical and life sciences. There are five MTRU waste streams at ORNL that together make up 1,500 cubic meters of waste. These streams contain a mixture of RH-liquid, RH-sludge, RH-solid, and CH-solid wastes. Current research activities primarily generate contact-handled waste streams whereas stored remote-handled wastes are predominately from past activities. Liquid MTRU waste is stored in tanks and solid wastes are in retrievable storage. The five year projection for waste generation is approximately 140 cubic meters.

SRS. The activities at SRS include the production of nuclear materials, primarily tritium and plutonium (Pu-238), for national defense. SRS lists five MTRU waste streams stored on site with a total volume of approximately 5,000 cubic meters. All of this waste is contact-handled (CH). Only two waste streams are expected to be generated in the next five years, with a projected volume of approximately 140 cubic

meters. These streams consist of a small volume of organic liquids required for analytical extractions and routinely-generated debris contaminated with organic constituents. Three other waste streams contributing to the overall stored inventory are an organic liquid stream produced during plutonium extraction, organic solvent-laden solid debris from plutonium production, and small quantities of MTRU waste from laboratory analysis. The MTRU waste streams are being stored on-site in RCRA-approved facilities until treatment capacity is available.

4.2 Management of MTRU Wastes in Preparation for the Waste Isolation Pilot Plant (WIPP)

This section discusses DOE's approach to managing RH-TRU and CH-TRU wastes. Section 4.2.1 provides an overview of the WIPP program and the requirements for packaging waste destined for the WIPP. Section 4.2.2 discusses the efforts by individual sites to construct facilities to characterize and prepare MTRU wastes for shipment.

4.2.1 Overview of the WIPP

For almost two decades, DOE's strategy for managing TRU waste has centered on the development of the WIPP in southeastern New Mexico. As specified in Section 213 of Public Law 96-164 (December 29, 1979), the repository was designated to accept DOE defense-related waste that met technical criteria to assure safety to the staff and the general public. As a national strategy, DOE did not intend to treat candidate wastes unless treatment was necessitated to meet the safety and health criteria for transport to and disposal at the WIPP. DOE anticipated that the majority of TRU wastes would not require additional treatment for shipment to the WIPP. Those requiring additional treatment are known as non-certified wastes. Following treatment, some of these wastes may be suitable for disposal in the WIPP.

The stated goal of the DOE TRU Waste Program is to terminate interim storage and to achieve permanent disposal of DOE TRU defense wastes. The WIPP project is being constructed as a defense activity of the DOE for the purpose of providing a research and development facility to demonstrate the safe disposal of radioactive transuranic wastes resulting from defense activities and programs of the United States. The WIPP is the only facility in the United States specifically designed and constructed for the disposal of TRU defense wastes. Non-defense waste has been generated in relatively small quantities by commercial power reactors and by research programs. Because of statutory limitations, a decision on where to dispose these wastes has not been made.

In 1988, DOE stated that no waste will be permanently emplaced in the WIPP until compliance is achieved with the applicable regulations of EPA. These regulations are the environmental standards for the management and disposal of TRU wastes as set forth in 40 CFR Part 191 (Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes) and the requirements of RCRA including the land disposal restrictions. To demonstrate compliance prior to permanent emplacement, DOE decided to develop WIPP in phases. Surface facilities have been constructed and considerable underground excavation is complete. Accordingly, the Secretary declared the WIPP ready to initiate testing with TRU waste in October 1991. However, a lawsuit prevented shipments of waste to the WIPP. On October 30, 1992, the President signed into law the WIPP Land Withdrawal Act, P.L. 102-579, which permanently withdrew the lands surrounding the WIPP and allows the WIPP Test Phase to proceed provided that a number of EPA and other agency approvals and certifications are obtained. The Act prescribes a new regulatory framework involving regulatory oversight by EPA and other Federal agencies.

690

Since enactment of the WIPP Land Withdrawal Act, DOE, along with other Federal agencies, has been working toward the completion of statutory requirements that will lead to a decision regarding WIPP's suitability as a permanent long-term disposal facility. Included in the Act are prerequisites for bringing a limited amount of transuranic waste to the WIPP for planned waste tests. A key prerequisite is EPA's approval of the WIPP Test Phase and the Waste Retrieval Plan. EPA expects the necessary rulemaking process to be completed by the end of 1993.

Although non-radioactive experiments at the WIPP site have been ongoing since the early 1980's, DOE cannot begin planned radioactive waste testing at the WIPP until the aforementioned authorization is received. DOE is proposing experiments with a limited amount of MTRU waste. The long-term performance will be evaluated based on these tests, which will support EPA's decision regarding compliance with RCRA's radioactive waste disposal regulations. If compliance is achieved, the WIPP project will undergo three other distinct phases: the disposal phase, the decommissioning phase, and the post-decommissioning phase. The disposal phase will commence in fiscal year 2000 and continue through 2020 with a capacity limited to approximately 176,000 cubic meters of waste.

In addition to requirements related to the WIPP itself, waste received at the WIPP must meet the WIPP Waste Acceptance Criteria (WIPP-WAC) and associated quality assurance requirements specified in WIPP/DOE-069. The acceptance criteria for the WIPP have expanded to include a range of technical requirements that are much more extensive than originally envisioned. Generator and/or storage sites must follow strict parameters to package and transport TRU wastes to the WIPP for emplacement. Table 4-4 summarizes the limiting parameters derived from all of the applicable criteria and requirements that regulate the safe handling and preparation of CH-TRU waste packages for transportation to and emplacement in the WIPP. Only preliminary packaging requirements for RH-TRU wastes have been established thus far. In this table, the criteria and requirements are organized under five major headings: Waste Containers, Waste Form, Waste Package, Data Package, and Other.

TABLE 4-4
SUMMARY OF WASTE PACKAGE ACCEPTANCE CRITERIA FOR THE WIPP (WIPP-WAC)

CRITERIA	LIMITING PARAMETERS
Waste Containers	Waste containers shall be noncombustible and meet the requirements of 40 CFR 173.412 for Type A packaging. Waste containers shall be used, handled, and stored in a manner that is expected to maintain their Type A packaging specifications from the time of certification to emplacement in the WIPP.
Waste Form	Powders, ashes, and similar particulate waste materials shall be immobilized if more than 1 weight percent of the waste matrix in each package is in the form of particles below 10 microns in diameter, or if more than 15 percent is in the form of particles below 200 microns in diameter.
Waste Package	For CH-TRU waste packages, documented evidence shall exist that the waste package has been weighed and the weight of the waste package or package assembly meets the requirements. The weight of the waste package cannot exceed the weight for which the waste package has been certified in accordance with 49 CFR 173.463. For RH-TRU waste, the canister weight may be calculated based on the weight of the empty canister plus the weight of the waste that will be placed in the canister. The weight of the canister cannot exceed the weight for which the package has been certified in accordance with 49 CFR 173.463.
Data Package	A data package with certification attesting to the fact that the waste package meets the requirements of these criteria shall be transmitted to the WIPP operator in advance of shipment. This data package/verification shall be based upon a QA program subject to audit and verification.
Other	Miscellaneous requirements for packaging and RCRA.

SOURCE: Waste Acceptance Criteria for the Waste Isolation Pilot Plant, Environmental and Waste Management, WIPP/DOE-069, Revision 4.0 UC-70, December 1991.

To meet these criteria, facilities must develop packaging procedures specifically for meeting the WIPP-WAC to prepare TRU wastes for emplacement in the WIPP. Until the Test Phase is complete and the State of New Mexico grants a RCRA Part B permit, however, the WIPP-WAC criteria may change.

4.2.2 Facilities to Meet WIPP-WAC

Transuranic wastes shipped to the WIPP must meet the WIPP-WAC. In doing so, some sites are planning or currently constructing facilities to perform treatment and/or packaging. Of the six primary storage sites, Hanford, INEL, NTS, and SRS have initiated efforts to exclusively address the WIPP-WAC. These planned facilities, although designed to package wastes to meet the current WIPP-WAC, may require modification to meet the final WIPP-WAC. LANL will use facilities handling other wastes to treat non-certified TRU volumes but a packaging facility has not been planned. The status of a future WIPP-WAC facility at ORNL is uncertain. The traditional generation facilities enumerated in section 4.1.2 are storing waste and awaiting opening of the WIPP.

Efforts to meet the WIPP-WAC are discussed below for the primary storage sites. Because DOE is still in the planning stages for these facilities, schedules and capacities are subject to change based on the availability of funds and ongoing treatability studies.

HANFORD. At Hanford, MTRU waste in storage is awaiting treatment at the Waste Receiving and Processing Plant (WRAP) Facility. The WRAP facility is planned to support examination, treatment, and packaging of CH-TRU waste in preparation for shipment to the WIPP. Phase 1 of the WRAP will provide waste package inspection, opening and sorting, waste segregation, compaction, adsorption to remove small quantities of liquids, cementation, repackaging, and certification. It should become operational in 1997. Phase 2B will process remote-handled waste and provide size reduction, decontamination, and cementation. Once the WRAP facility is operational, all solid TRU wastes will be processed and the resulting certified TRU waste packages will be sent to the interim storage area of the WRAP Facility to await transport to the WIPP. Non-certified TRU wastes from the tank system will be sent to the Hanford Waste Vitrification Plant (HWVP), which will mix the waste portions with glass-forming media and melt the waste to fit into a glass matrix. The glass, to be stored in approximately 400 stainless steel containers, may be a candidate for disposal in the WIPP. Currently, however, the ultimate fate of these containers is uncertain. Until a decision is made, the containers will be stored on-site.

INEL. At INEL, a Waste Characterization Facility will verify and repackage TRU waste to meet the WIPP-WAC for shipment to the WIPP. This facility will also have the ability to treat small quantities of TRU wastes by stabilization, amalgamation, neutralization, and adsorption in order to meet the WIPP-WAC. For TRU quantities not initially meeting the WIPP-WAC, the Idaho Waste Processing Facility (IWPF) will treat these wastes using debris decontamination, macroencapsulation, thermal destruction, and stabilization. Some residues from the IWPF may be suitable for packaging and subsequent disposal in the WIPP. Those residues that cannot meet the WIPP-WAC will be stored on-site. The proposed annual capacity of the IWPF is 500 cubic meters.

LANL. LANL is not planning to construct a facility specifically to meet the WIPP-WAC. For non-certified TRU wastes, though, LANL will provide treatment at the Controlled Air Incinerator (CAI) and the Lead Decontamination Trailer (LDT). The CAI is a dual-chambered controlled-air incinerator that can treat both solid and liquid combustible wastes. If in processing mixed low-level waste with transuranic alpha contamination, the resulting volume and mass reduction result in the waste emitting greater than 100 nCi per gram, the waste will be disposed in the WIPP after the ash is stabilized. Operation of the CAI is awaiting NEPA (National Environmental Policy Act of 1969) approval of documentation supporting a change in operation from research and development to routine waste

treatment. It is scheduled to reopen in 1995 with an annual capacity of 200 cubic meters of solid waste or 300 cubic meters of liquid waste.

NTS. None of the waste at NTS is currently WIPP certified. NTS is planning to construct a certification building to assure wastes meet the WIPP-WAC. It will be operational in 1997.

ORNL. None of the waste at ORNL is currently WIPP-certified. ORNL is proposing a facility to repackage and certify wastes to meet the WIPP-WAC. The facility is under preliminary review.

SRS. At SRS, the Transuranic Waste Facility (TWF) is intended to prepare transuranic wastes stored at the SRS for shipment to the WIPP. Low-activity transuranic wastes will be assayed, X-rayed, sorted, and repackaged. The TWF will also provide treatment for high-activity wastes. The facility is expected to begin operation in the late 1990's or early 2000's.

Table 4-5 below summarizes the TRU packaging facilities planned or under construction at each of the six storage facilities. It also provides a summary of the design capacities of these facilities and the annual quantities expected for processing. Note that Table 4-5 only provides a summary of facilities designed to package wastes to meet the WIPP-WAC. Treatment facilities for non-certified TRU wastes (e.g., the CAI at LANL) are not included.

TABLE 4-5
STATUS OF FACILITIES PLANNED OR UNDER CONSTRUCTION FOR PACKAGING TRU WASTES FOR SHIPMENT TO THE WIPP AT THE TRU WASTE STORAGE SITES[b]

Site/Facility Name	Planned Start-Up Date	Design Capacity (m^3/yr)
HANF/WRAP-PHASE 1 WRAP-PHASE 2B	1997 unknown	1,250 unknown
INEL/Waste Characterization Facility	unknown	unknown
LANL/no WIPP-WAC packaging facility planned	n/a[1]	n/a
NTS/certification building	1997	unknown
ORNL	unknown	unknown
SRS/TWF	late 1990's to early 2000's	unknown

[1] 'n/a' means not applicable

[b] Facilities with a primary function of packaging TRU wastes for shipment to the WIPP are included in Table 4-5. Facilities providing treatment (e.g., stabilization) are not included.

5.0 MIXED LOW-LEVEL WASTES AND FACILITIES

Mixed low-level wastes (MLLW) are generated or handled by most of the DOE sites and are primarily generated during defense-related activities, decontamination and decommissioning (D&D) activities, isotope productions, various research and development (R&D) activities, and environmental restoration programs. Although MLLW represent approximately 42 percent of the mixed waste volume that is generated by DOE, MLLW present the biggest treatment challenge to DOE. MLLW, which contain mostly uranium or plutonium as the radioactive component, typically include wastewaters, wastewater treatment residues, contaminated pond soils and sludges, contaminated lead, lab packs, scintillation cocktails, air filters, engine oils, grease, paint residues, cleaning materials, paper, rags, soils, tools, equipment parts, discarded protective clothing, and building materials.

While most of the MLLW can be easily handled, the radioactive levels of some MLLW streams can be high enough to require shielding for handling or treating. Also, some MLLW streams contain sufficiently high levels of transuranic alpha decay type radionuclides to require the use of special equipment to contain release of transuranic alpha-emitting particles. However, the transuranic alpha particle content of MLLW is below 100 nCi/g because wastes that have more than 100 nCi/g of transuranic alpha particles are considered TRU wastes.

A key issue for the handling and disposal of MLLW is the presence of transuranic alpha particle (i.e., particles containing elements with a molecular weight greater than that of uranium). This distinction is critical since treatment facilities require special containment precautions to protect the workers and the environment. In MLLW the transuranic alpha particle content ranges from non-detectable quantities to 100 nCi/g; MLLW that has a transuranic alpha particle content less that 10 nCi/g generally do not present any significant containment problems. MLLW with transuranic alpha particle content greater than 10 nCi/g require additional containment and are referred to as alpha MLLW or alpha mixed low-level wastes in this chapter. Due to the unique problems associated with transuranic alpha particle emission, alpha MLLW are presented separately throughout the chapter.

In addition to alpha particle emissions, beta particle and gamma ray emissions from MLLW further complicate the handling and treatment of MLLW. Generally, MLLW can be contact-handled (CH) by workers with only minimal shielding of the waste. However, MLLW having high radiation levels, i.e., having high alpha or beta particle or gamma ray emissions can cause an exposure greater than 200 mrems/hr[a] at surface contact. Consequently, these MLLW, referred to as remote-handled (RH) MLLW, must be handled within shielded facilities. This shielding is different from the containment required for alpha particles in that the risk involved is direct exposure to the beta particles or gamma rays while the risk involved with alpha particles is exposure through inhalation. Even though the quantities of such RH MLLW are relatively low (approximately 18 percent of the MLLW in inventory and approximately 12 percent of the 5-year projected generation rates of MLLW) compared to CH MLLW, RH MLLW present DOE with a greater treatment challenge due to the specialized equipment that is required for handling the RH MLLW. For this reason, RH MLLW are presented separately from the CH MLLW in this chapter.

[a] A rem is the dosage of an ionizing radiation that will cause the same biological effect as one roentgen of X-ray of gamma-ray dosage. A millirem (mrem) is 1/1000 of this dosage.

Section 5.1 summarizes MLLW quantities that are currently in inventory and the quantities DOE expects to generate over the next 5 years. Section 5.2 discusses the currently existing and planned facilities that can be used to treat MLLW.[b] Section 5.3 compares treatment needs and facilities.

5.1 Waste Streams

Table 5-1 summarizes the quantities of DOE's MLLW in inventory and the total quantities DOE expects to generate over the next five years. As of December 31, 1992, DOE had approximately 70,800 cubic meters of alpha MLLW and approximately 176,000 cubic meters of MLLW with transuranic alpha particle content less than 10 nCi/g in inventory. In addition, DOE expects to generate approximately 21,100 cubic meters of alpha MLLW and approximately 259,000 cubic meters of MLLW with transuranic alpha particle content less than 10 nCi/g for the years 1993 through 1997.

TABLE 5-1
MIXED LOW-LEVEL WASTE INVENTORY AND FIVE-YEAR PROJECTIONS

Transuranic Alpha (α) Content of MLLW	Inventory (m^3)		Total Inventory (m^3)	Five-year Projections (m^3)		Total Five-year Projections (m^3)
	Contact-handled	Remote-handled		Contact-handled	Remote-handled	
MLLW with α > 10 nCi/g and < 100 nCi/g	68,277	2,525	70,802	20,012	1,050	21,062
MLLW with α < 10 nCi/g	134,379	41,856	176,235	226,873	31,979	258,852
Totals	202,656	44,381	247,037	246,885	33,029	279,908

In the future, MLLW that will require treatment is expected to be higher than the quantities presented above. As discussed in Chapter 4, up to 35,000 cubic meters of MTRU wastes might be reclassified as alpha MLLW. This volume, originally destined for the Waste Isolation Pilot Plant (WIPP), will require treatment to meet the LDR standards. Additionally, the estimated 5-year generation rates shown above do not include mixed wastes that will be generated from future environmental restoration projects. There are significant uncertainties in the estimated generation rates and anticipated types of hazardous components of mixed waste that will result from these environmental restoration projects. Estimates on mixed wastes that will be generated from future environmental restoration projects are contained in Chapter 2 of this report.

[b] Schedules are provided in this report for bringing planned facilities on line, which include: i) validated fiscal year (FY) 1994 and FY 1995 new starts; ii) those currently under construction; and iii) existing facilities not yet on line (e.g., Waste Experimental Reduction Facility and Controlled Air Incinerator). The schedules for bringing these facilities on line are based on proposed budgets and are subject to change based on the availability of funding. In addition, restart of existing facilities or startup dates for facilities in the early planning/conceptual stage, in the detailed design stage, or in the construction stage are uncertain pending technical, regulatory, or other planning requirements which must be fully defined and addressed.

Table 5-2 presents the quantities of alpha MLLW currently in inventory and the total quantities expected to be generated over the next five years for each physical/chemical matrix. The majority of the alpha MLLW in inventory are inorganic sludges and particulates which represent approximately 57 percent of the total alpha MLLW in inventory. However, the majority of the alpha MLLW that are estimated to be generated over the next five years are organic liquids, inorganic sludges and particulates, and lab packs which account for approximately 17, 15, and 28 percent by volume.

Table 5-3 presents the quantities of MLLW with transuranic alpha particle content less than 10 nCi/g in inventory and the total quantities expected to be generated over the next five years for each physical/chemical matrix. MLLW with transuranic alpha particle content less than 10 nCi/g are dominated by aqueous liquids which represent approximately 65 percent of the mixed wastes in inventory and approximately 88 percent of the projected mixed waste.

The primary DOE sites generating MLLW are the Hanford Site (Hanford), Idaho National Engineering Laboratory (INEL), Oak Ridge K-25 Plant (K-25), Oak Ridge Y-12 Plant (Y-12), and Rocky Flats Plant (RFP). These sites account for approximately 83 percent of the MLLW currently in inventory and around 90 percent of the five-year MLLW projection. The Hanford Site, alone, accounts for approximately 34 percent of the MLLW in inventory and approximately 84 percent of the projected wastes.[c] Brief descriptions of the MLLW and the primary MLLW generation activities at these five sites are given below.

Hanford Site. The Hanford Site is located in south-central Washington. The primary mission of Hanford was the production of special nuclear materials for national defense and the management of the resulting wastes. However, Hanford no longer produces nuclear materials, and the mission is now environmental restoration and waste management (EM), technology development for the EM, and research and development on related topics. Specifically, MLLW are generated or have been generated at Hanford from the following activities: fabrication of fuel elements; operation of the production reactors; processing of irradiated fuel elements; separation and extraction of plutonium and uranium; preparation of plutonium metal parts; decommissioning and decontamination; environmental restoration; research and development support projects; and maintenance and operation support.

MLLW account for approximately one-third of the mixed wastes at Hanford. Most of these MLLW are currently subject to the LDR storage prohibition. The existing inventory and projected generation rate of liquid MLLW is expected to be reduced substantially following the concentration of the MLLW in an on-site evaporator. Liquid tank wastes constitute 98 percent of the mixed wastes at Hanford. Ninety-six percent of the MLLW emit beta particles or gamma rays and are currently in the form of sludge, liquid, or crystalline solids in the double-shell tanks. Liquid MLLW are handled within the tank farm system that is operated under the provisions for HLW as defined by DOE Order 5820.2A. However, they are included as MLLW because they will be disposed of as MLLW. Although some of the MLLW in the tanks may be contact-handled, the treatment facility to solidify the waste in grout is designed as a remote-handled facility for safety considerations. More detailed information on the MLLW at the site is provided in Chapter 29.

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[c] Some of the primary MLLW streams at Hanford are generated within a tank farm system and that the inclusion of the projected generation rates of these waste streams may have resulted in double-counting. They are included in the projections because they quantify the treatment and technology requirements for these wastes.

1690

TABLE 5-2

Mixed Low-level Waste with Transuranic Alpha Content 10 nCi/g to 100 nCi/g Inventory and Five-year Projections

Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
Contact-handled		
Organic Liquids	1,218.2	3,668.1
Aqueous Liquid	47.1	120.7
Organic Sludges/particulates	1,486.9	1,807.7
Inorganic Sludges/particulates	40,257.6	3,063.7
Cemented Solids	95.5	0.4
Soil With <50% Debris	17.7	255.7
Soils	18.1	0.0
Organic Debris	2,935.0	1,896.9
Inorganic Debris	1,293.7	477.5
Heterogeneous Debris	9,236.4	72.1
Lab Packs With Metals	54.6	2,674.7
Lab Packs Without Metals	92.6	3,266.2
Compressed Gases	0.6	5.3
Liquid Mercury	19.4	70.4
Elemental Lead	566.4	119.0
Beryllium Dust	1.5	0.7
Batteries (lead Acid, Cadmium)	1.7	99.5
Multiple	8,108.1	1,839.4
Other	2,640.5	568.5
To Be Determined	185.0	0.0

TABLE 5-2(Continued)

Mixed Low-level Waste with Transuranic Alpha Content 10 nCi/g to 100 nCi/g Inventory and Five-year Projections

Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
Total Contact-handled:	**68,276.5**	**20,006.5**
Remote-handled		
Aqueous Liquid	2,409.1	1,049.0
Organic Sludges/particulates	0.0	0.9
Elemental Lead	54.0	0.0
Multiple	62.4	0.0
Total Remote-handled:	**2,525.5**	**1,049.9**
National Totals:	**70,802.0**	**21,056.4**

TABLE 5-3

Mixed Low-level Waste with Transuranic Alpha Content < 10 nCi/g Inventory and Five-year Projections

Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
Contact-handled		
Organic Liquids	930.1	5,406.0
Aqueous Liquid	86,703.1	202,066.3
Organic Sludges/particulates	1,017.7	135.3
Inorganic Sludges/particulates	2,123.9	2,387.6
Cemented Solids	73.6	4,906.5
Soil With <50% Debris	6.0	66.1
Soils	9,888.2	181.0
Organic Debris	537.0	369.2
Inorganic Debris	25,201.7	511.3
Heterogeneous Debris	497.0	3,728.6
Lab Packs With Metals	113.1	67.5
Lab Packs Without Metals	6.7	163.6
Reactive Metals	61.1	9.1
Explosives	0.8	3.1
Compressed Gases	3.6	9.2
Liquid Mercury	12.3	20.9
Elemental Lead	345.7	66.2
Batteries (lead Acid, Cadmium)	15.1	30.7
Batteries	1.3	2.3
Multiple	6,380.1	6,590.2

TABLE 5-3(Continued)

Mixed Low-level Waste with Transuranic Alpha Content < 10 nCi/g Inventory and Five-year Projections

Physical/Chemical Matrix	Current Inventory (m^3)	Five-year Projection (m^3)
Other	460.7	152.8
Total Contact-handled:	**134,378.8**	**226,873.3**
Remote-handled		
Organic Liquids	14,475.0	3,751.0
Aqueous Liquid	27,311.0	26,056.0
Organic Sludges/particulates	<0.1	0.0
Inorganic Sludges/particulates	0.2	0.6
Inorganic Debris	0.3	4.3
Heterogeneous Debris	9.1	2,000.1
Reactive Metals	4.9	1.2
Liquid Mercury	<0.1	0.0
Elemental Lead	42.2	126.0
Multiple	3.7	35.0
Other	9.7	4.9
Total Remote-handled:	**41,856.0**	**31,979.0**
National Totals:	**176,234.8**	**258,852.3**

Idaho National Engineering Laboratory (INEL). The INEL is located in southeastern Idaho. The primary mission of INEL is to conduct research on nuclear reactors and related equipment. Specifically, MLLW are generated at INEL primarily from production activities associated with nuclear reactor technology research and development; waste management; environmental restoration; advanced energy production and utilization technology; defense-related support; safety and health; and non-nuclear research and development projects.

MLLW account for a third of the mixed wastes at INEL. Less than 1 volume percent of the MLLW currently in inventory are subject to the LDR storage prohibition. The MLLW currently in inventory are mostly heterogenous debris and lead, which each account for approximately 35 percent of the total MLLW inventory. More detailed information on the MLLW at the site is provided in Chapter 13.

Oak Ridge K-25 Site (K-25). The K-25 Site is located around 15 km southwest of Oak Ridge, Tennessee. The primary mission was originally to produce highly enriched uranium, by the gaseous diffusion method, for use in nuclear weapons and then later to produce uranium hexafluoride for use as nuclear-reactor fuel. However, currently the mission of K-25 includes waste management, environmental restoration, and research and development on advanced isotope-separation technology. The K-25 site is used for storing and treating the wastes from all of the Oak Ridge Reservation sites (ORNL, Y-12, and K-25) in addition to some offsite wastes which may contain alpha emitters or fission products.

All of the mixed wastes at K-25 are contact-handled MLLW. Most of these wastes have resulted from the past gaseous diffusion operations. Most of the MLLW were characterized based on process knowledge with some sampling and analysis being used to complement the process knowledge.

The MLLW associated with the solidified pond sludge account for about 92 percent of the total mass stored at K-25. This pond was produced during the closure of two holding ponds used in the past to store RCRA waste. More detailed information on the MLLW at the site is provided in Chapter 26.

Oak Ridge Y-12 Plant (Y-12). The Y-12 Plant is located immediately to the south of Oak Ridge, Tennessee. As a part of the Manhattan Project, the primary mission of Y-12 was to manufacture nuclear weapons components, process source and special nuclear materials, and support weapons design laboratories, energy systems installations, and other government agencies. Currently, the mission of the site is to serve as a manufacturing technology center for key processes associated with nuclear weapons components and other such applications. In addition, the Y-12 Plant's mission now includes environmental restoration and waste management.

All of the mixed wastes at Y-12 are either contact-handled beta/gamma emitting MLLW or contact-handled low-alpha emitting (< 10 nCi/g) MLLW. Most of the MLLW at Y-12 are subject to the LDRs. All of the MLLW at Y-12 were characterized based on process knowledge with some sampling and analysis being used to complement the process knowledge. More detailed information on the MLLW at the site is provided in Chapter 26.

Rocky Flats Plant (RFP). The RFP is located in Northern Jefferson County, Colorado. The primary mission of RFP was to manufacture plutonium and other metal-bearing components for nuclear weapons. Currently, RFP is in the process of decontaminating and decommissioning. Specifically, MLLW were or are generated at RFP by the following activities: fabrication of nuclear weapons components from plutonium, uranium, beryllium, and stainless steel; laboratory analytical testing; metal fabrication and assembly; chemical recovery and purification of process-produced transuranic radionuclides; duct remediation activities; facility maintenance and other supporting activities; waste management; and environmental restoration.

MLLW account for approximately 97 percent of all the mixed wastes currently in inventory at RFP. All of the MLLW can be contact-handled and are subject to the LDR storage prohibition. Approximately 83 percent of the MLLW in storage have been characterized by using process knowledge with the remainder being characterized by sampling and analysis.

Activities associated with the solar evaporation ponds and Building 374 operations generated approximately 98 percent of the MLLW in inventory at RFP. Other than the aqueous liquids that were removed from these ponds, solidified wastes (pondcrete) were produced when the sediments and sludges were removed from the ponds, mixed with cement, and poured into containers lined with plastic. More detailed information on the MLLW at the site is provided in Chapter 9.

5.2 Treatment Facilities

This section only presents summarized information on the MLLW treatment systems at DOE sites. Each of these treatment systems is discussed in greater detail in Chapters 8 through 29 for the site where the system is located. This section emphasizes treatment facilities/systems that are designed to meet LDR standards because this report was prepared in response to the requirement placed on DOE by the FFCA. As noted in Chapter 1, the FFCA was conceived as an amendment to the SWDA, which established the LDR program. However, for the reasons described below, all the treatment facilities/systems used at DOE sites, including technologies such as compaction which are not designed to meet the LDR standards, are presented in this section.

Treatment technologies for mixed wastes must be able to destroy, remove, or immobilize the hazardous component and ensure that any residual generated in the process is in compliance with disposal requirements under RCRA including applicable LDR requirements if they have been promulgated. Treatment, as defined by EPA in the context of RCRA hazardous wastes, means "any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste non-hazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduced in volume." (40 CFR 260.10).

Because of this broad definition, many systems through which DOE processes mixed wastes meet this legal definition of treatment without actually reducing the hazardous nature of the wastes as is required by the LDR standards. These systems include processes that facilitate storage (e.g, compaction, packaging, etc.) and pretreatment processes (e.g, shredding, grinding, physical separation, evaporation, etc.) that make the waste amenable to the treatment process that ultimately destroys, removes, or immobilizes the hazardous component of the waste. Though such systems may themselves be unable to render a waste suitable for disposal, they are often integral to treatment processes that do treat wastes to LDR standards. For this reason, these treatment systems are included in this report, but have less detailed information and are distinguished from the treatment systems (e.g., incineration) that are designed to comply with the LDR standards. Compaction, packaging, and size reduction systems do not represent treatment capacity for complying with the LDR requirements.

DOE has several treatment systems that can treat alpha MLLW. Table 5-4 summarizes DOE's mixed waste current treatment capabilities and plans for treating alpha MLLW. These treatment systems are grouped based on broad treatment categories. The total number of treatment systems given in Table 5-4 may exceed the actual number of treatment systems since some systems have more than one treatment type. These treatment systems are further detailed in Tables 5-5 through 5-7.

TABLE 5-4
TREATMENT SYSTEMS AT DOE THAT CAN TREAT MIXED LOW-LEVEL WASTES WITH TRANSURANIC ALPHA PARTICLE CONTENT 10 nCi/g TO 100 nCi/g[d]

Treatment	Number of Treatment Systems		
	Currently Operating	Existing But Currently Not Treating	Planned
Wastewater	1		1
Thermal Destruction	1		
Stabilization	1	2	2
Macroencapsulation			1
Lead Decontamination/Recycling	1		

[d] Because DOE is still in the planning/conceptual stages, in the design stages, or in the construction stages for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

There are only four treatment facilities/systems[e] at DOE that currently treat MLLW with transuranic alpha particle content greater than 10 nCi/g but less than 100 nCi/g. Table 5-5 presents the treatment type(s), the physical/chemical matrices that the system is capable of treating, and the normal operating capacity for this system. The normal operating capacity is the capacity of the treatment system taking into account the design capacity, permit limits, the normal operating shifts, and any other technical or legal capacity constraints. It should be noted that the physical/chemical matrix types given in treatment facility Tables 5-5 through 5-10 and 5-12 through 5-20 are not all standardized to match those used to categorize wastes in this report.

Several existing mixed waste treatment systems are capable of treating alpha MLLW but currently do not due to technical, regulatory, or other problems. Only two such treatment systems exist at DOE that are planned for future use for treating alpha MLLW.[f] Table 5-6 summarizes these existing treatment systems. The treatment type(s), the physical/chemical matrices that the system is capable of treating or typically treats, the normal operating capacity of the system, and the estimated date of availability is presented for each system. This table does not include existing mixed waste treatment facilities/systems which DOE does not plan to use for treating MLLW in the future. Information on these facilities/systems is presented in the site chapters (Chapters 8 through 29).

Table 5-7 summarizes each alpha MLLW treatment system that is planned or under construction. This table presents the treatment type(s), the physical/chemical matrices that the system is designed to treat, the design capacity, and the estimated date of availability for treating the alpha MLLW.

There are several treatment systems at DOE sites that are planned to treat mixed TRU wastes. These treatment systems consist of equipment that can contain transuranic alpha emissions, and hence can treat alpha MLLW. DOE plans to use some of these mixed TRU waste treatment systems for treating the alpha MLLW. These treatment systems are presented in this section since they may provide a significant capacity for treating alpha MLLW. Tables 5-8, 5-9, and 5-10 present information on the mixed TRU waste treatment systems.

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[e] A treatment facility may consist of more than one system, for example, an incinerator and a stabilization system. If a facility only includes one system, the system is not distinguished from the facility in this report.

[f] The reasons for which these facilities are currently not treating MLLW are outlined in the site chapters (Chapters 8 through 29).

TABLE 5-5

Mixed Waste Treatment Facilities
Currently Treating Mixed Low-level Wastes
With Transuranic Alpha Particle Content 10 nCi/g to 100 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Los Alamos National Laboratory	Lead Decontamination Trailer	Lead Decon/Recycle	Elemental Lead	40.0
Oak Ridge National Laboratory	Melton Valley Low-Level Waste Immobilization Facility	Stabilization	Liquid	91.0
Pantex Plant	Burning Ground / One Cage, One Tray, and One Pan (1)	Thermal Treatment	Explosives Contaminated Support Material, Contaminated Support Material, Organic Debris and Non-debris, Inorganic Debris and Non-debris, Heterogeneous Debris and Non-debris	1.2 (2)
Savannah River Site	SRL Ion Exchange Treatment Probe / High Activity	Ion Exchange	Aqueous Liquids	210.0

Note (1): Upgrades planned.

Note (2): Estimated quantity treated in 1992.

TABLE 5-6

Existing Mixed Waste Treatment Facilities
Not Currently Treating But Planning To Treat Mixed Low-level Wastes
With Transuranic Alpha Particle Content 10 nCi/g to 100 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Capacity (m3/yr) *	Date Avail. For Use *
Pantex Plant	Building 11-15A (1)	Immobilization	Aqueous Liquids, Heterogeneous Debris and Non-debris, Inorganic Debris and Non-debris, Organic Debris and Non-debris, Organic Liquids	185.0	Year To Be Determined
	Building 11-9 (2)	Immobilization	Aqueous Liquids, Heterogeneous Debris and Non-debris, Inorganic Debris and Non-debris, Organic Debris and Non-debris, Organic Liquids	185.0	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (1): Treatment types may also include the following RCRA and non-RCRA regulated activities: compaction, shredding, sorting, size reduction, and packaging.
Hg to be treated in trace amounts.

Note (2): Treatment types may also include the following RCRA and non-RCRA regulated activities: compaction, shredding, sorting, size reduction, and packaging.
Hg to be treated in trace amounts.

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TABLE 5-7

Mixed Waste Treatment Facilities
That Are Planned or Under Construction To Treat Mixed Low-level Wastes
With Transuranic Alpha Particle Content 10 nCi/g to 100 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Pantex Plant	Hazardous Waste Treatment & Processing Facility (1)	Immobilization, Repackaging, Neutralization, Compaction, Shredding, Sorting, Size Reduction, Solidification	Aqueous Liquid, Heterogeneous Debris and Non-debris, Inorganic Debris and Non-debris, Organic Debris and Non-debris, Organic Liquid	500.0	1999
Sandia National Lab - New Mexico	Radioactive And Mixed Waste Management Facility	Stabilization, Crushing, Ion Exchange, Shredding, Macroencapsulation, Chemical Stripping, Reverse Osmosis, Baling, Neutralization, Chemical Precipitation, Demineralization	To Be Determined	55.0	1996
Savannah River Site	Consolidated Incineration Facility / CIF Ashcrete	Stabilization	Inorganic Sludges/Particulates (Ash)	344,029.0 KG/YR	1996

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (1): Design capacity estimate for all waste types planned will treat non-RCRA regulated hazardouswaste, mixed waste, and radioactive, non-RCRA waste.

TABLE 5-8

Facilities Currently Treating Mixed TRU Wastes

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Rocky Flats Plant	Aqueous Process Waste Treatment: Building 774 / Wastewater	Deactivation, Neutralization, Filtration, Chemical Precipitation	Aqueous Liquids, Inorganic Liquids, Inorganic Sludges	1,819.0
	Building 374 / Process Waste Treatment Facility: Building 374 (1)	Decontamination, Neutralization, Immobilization, Evaporation, Deactivation, Solidification	Aqueous Liquids, Inorganic Liquids, Inorganic Sludges, Liquids	149,000.0
	Miscellaneous Waste Handling & Immobilization: Bldg 774 (2)	Stabilization, Solidification	Inorganic Liquids	42.0
	Organic and Sludge Immobilization System: Building 774 (3)	Immobilization, Solidification	Organic Liquids, Organic Sludges, Waste Oils	270.0

Note (1): Reported capacity is permitted capacity.
Note (2): Reported capacity is maximum permitted capacity.
Note (3): Reported capacity is maximum permitted capacity.

152

4690

TABLE 5-9

Facilities Not Currently Treating Mixed TRU Wastes

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating TRU Waste *
Hanford Site	Maintenance & Storage Facility	Water Reaction	Solids, Debris	To Be Determined	Year To Be Determined
Los Alamos National Laboratory	Controlled Air Incinerator / Liquid Feed System	Incineration	Liquids	To Be Determined	1995
	Controlled Air Incinerator / Solid Feed System	Incineration	Solids	To Be Determined	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 5-10

Facilities Planned or Under Construction for Treating Mixed TRU Wastes

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Capacity (m3/yr) *	Date Available For Use *
Hanford Site	Thermal Treatment Facility (1)	Incineration	To Be Determined	To Be Determined	Year To Be Determined
	Waste Receiving And Processing Facility / Wrap IIA	Encapsulation, Stabilization, Compaction	Debris	To Be Determined	1999
Idaho National Engineering Laboratory	Bench Scale Treatments (2)	Ion Exchange	Liquids and Solids - Heavy Metals	To Be Determined	1994
	Idaho Waste Processing Facility / Debris Decontamination System (3)	Debris Decontamination	Debris, Heterogeneous Debris, Combustible Solids, Solids	To Be Determined	Year To Be Determined
	Idaho Waste Processing Facility / Macroencapsulation(4)	Macroencapsulation	Debris, Lead Solids	To Be Determined	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (1): For corrosives: ICR.

Note (2): Bench scale treatments will be implemented as appropriate and available.

Note (3): For design capacity: this facility is in the pre-conceptual design phase with as yet unspecified capacities.

Note (4): For design capacity: this facility is in the pre-conceptual design phase with as yet unspecified capacities.

154

4690

TABLE 5-10(Continued)

Facilities Planned or Under Construction for Treating Mixed TRU Wastes

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Capacity (m3/yr) *	Date Available For Use *
	System				
	Idaho Waste Processing Facility / Stabilization System (5)	Stabilization	Liquids, Solids, Soil	To Be Determined	Year To Be Determined
	Idaho Waste Processing Facility / Thermal Destruction System (6)	Thermal Destruction	Combustible Solids, Liquids	To Be Determined	Year To Be Determined
	Waste Characterization Facility (7)	This facility is a characterization and repackaging facility with limited Stabilization, Amalgamation, Neutralization, and Adsorption capabilities.	Liquids, Solids	To Be Determined	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (5): For design capacity: this facility is in the pre-conceptual design phase with as yet unspecified capacities.

Note (6): For design capacity: this facility is in the pre-conceptual design phase with as yet unspecified capacities.

Note (7): The primary purpose of this facility is characterization of wastes in compliance with RCRA treatment and disposal requirements. Alsoincluded are repackaging and certification of watse for WIPP with only minor treatemtns available.

TABLE 5-10(Continued)

Facilities Planned or Under Construction for Treating Mixed TRU Wastes

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Capacity (m3/yr) *	Date Available For Use *
Rocky Flats Plant	Mixed Residue Treatment	Precipitation, Neutralization, Immobilization	Inorganic Liquid, Inorganic Sludge, Liquids, Solids	To Be Determined	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

4690

156

Most of DOE's mixed waste treatment systems for MLLW with transuranic alpha particle content less than 10 nCi/g are wastewater treatment, thermal destruction, or stabilization systems. Table 5-11 summarizes DOE's mixed waste current treatment capabilities and plans for treating MLLW with transuranic alpha particle content less than 10 nCi/g. These treatment systems are grouped based on broad treatment categories. The total number of treatment systems given in Table 5-11 may exceed the actual number of treatment systems since some systems have more than one treatment type. These treatment systems are further detailed in Tables 5-12 through 5-14.

TABLE 5-11

TREATMENT SYSTEMS AT DOE THAT CAN TREAT MIXED LOW-LEVEL WASTES WITH TRANSURANIC ALPHA < 10 nCi/g[g]

Treatment	Number of Treatment Systems		
	Currently Operating	Existing But Currently Not Treating	Planned
Wastewater	23	1	10
Thermal Destruction	1	1	5
Stabilization	2	6	11
Vitrification		1	1
Macroencapsulation			2
Mercury Amalgamation			3
Alkali Metals Treatment		1	2
Lead Decontamination/Recycling			2
Debris Decontamination	1		3
Other	1		5

Table 5-12 summarizes DOE's mixed waste treatment facilities/systems[h] that currently treat MLLW with transuranic alpha particle content less than 10 nCi/g. For each system, the treatment type(s), the physical/chemical matrices that the system is capable of treating, and the normal operating capacity of the system are provided. Table 5-13 summarizes each existing treatment system that DOE plans to use in the future for treating MLLW with transuranic alpha particle content less than 10

[g] Because DOE is still in the planning/conceptual stages, in the design stages, or in the construction stages for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

[h] A treatment facility may consist of more than one system, for example, an incinerator and a stabilization system. If a facility only includes one system, the system is not distinguished from the facility in this report.

nCi/g.[i] The treatment type(s), the physical/chemical matrices that the system is capable of treating, the normal operating capacity of the system, and the estimated date of availability are presented for each system. Table 5-14 summarizes for each treatment system that is planned or is under construction for treating MLLW with transuranic alpha particle content less than 10 nCi/g, presenting the treatment type(s), the physical/chemical matrices that the system is designed to treat, the design capacity, and the estimated date of availability for treating the MLLW.

[i] The reasons for which these facilities are currently not treating MLLW are outlined in the site chapters (Chapters 8 through 29).

TABLE 5-12

Mixed Waste Treatment Facilities Currently Treating Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Energy Technology Engineering Center	Radioactive Materials Disposal Facility / Neutralization Process	Neutralization	Aqueous Liquid	1.0
Fernald Environmental Management Project	UNH Treatment Facility	Neutralization, Chemical Precipitation, Filtration	Liquid	795.0
Idaho National Engineering Laboratory	INEL / Waste Generator Treatment Plans (1)	Ion Exchange, Neutralization, Stabilization	Aqueous Liquids, Solids, Debris	Note (1)
	INEL / Waste Generator Use Of Debris Treatments (2)	Surface Treatment	Heterogeneous Debris, Porous/Non-Porous Solids	Note (2)
	Liquid Effluent Treatment And Disposal	Chemical Fractionation, (Pretreatment)	Aqueous Liquid	10,991.0

Note (1): Capacity TBD based on number of generator plans required.

Note (2): Waste generators have required debris CBC documentation. Treatabilitystudies to be done by 09-30-93. Operations scheduled to start by 1994. Current debris CBC ends May 93 with a possible extension being requested. Primary planned treatments include CO2 pellet blasting and water washing technologies (for INEL wastes).

TABLE 5-12(Continued)

Mixed Waste Treatment Facilities Currently Treating Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Idaho National Engineering Laboratory (continued)	Portable Water Treatment System (PWTU) (3)	Neutralization, Carbon Adsorption, Ion Exchange, Filtration	Aqueous Liquids (D004-D043, D002), Liquids	187.0
Oak Ridge K-25 Site	Central Neutralization Facility (4)	Neutralization, Chemical Precipitation, Centrifugation, Filtration	Aqueous Liquids, Wastewater	345,381.3
	K-25 Site TSCA Incinerator	Incineration	Aqueous Liquids, Organic Liquids	1,420.0
Lawrence Livermore National Laboratory	Area 514 WWTTF	Carbon Adsorption, Chemical Precipitation, Neutralization, Oxidation/Reduction, Flocculation, Separation	Aqueous Liquids, Liquids	170.0
Oak Ridge National Laboratory	Process Waste Treatment Plant	Ion Exchange	Liquid	259,000.0
Paducah Gaseous Diffusion Plant	C-400-D Lime Precipitation Unit	Chemical Precipitation, Neutralization	Aqueous Liquids	136.1
Portsmouth Gaseous Diffusion Plant	X-622 Groundwater Treatment Facility	Carbon Adsorption	Groundwater, Aqueous Liquids	79,576.0

Note (3): Reported capacity is maximum capacity.
Note (4): Based on reported capacity of 250,000 gal/day and assuming 365 days operating per year.

TABLE 5-12(Continued)

Mixed Waste Treatment Facilities Currently Treating Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Portsmouth Gaseous Diffusion Plant (continued)	X-624 Groundwater Treatment Facility	Air Stripping, Carbon Adsorption	Groundwater, Aqueous Liquids	99,470.0
	X-701E Groundwater Treatment Facility	Carbon Adsorption	Groundwater, Aqueous Liquids	99,470.0
	X-705 Decontamination Facility / Microfiltration	Neutralization, Filtration	Aqueous Liquids & Slurries	3,000.0
	X-705 Decontamination Facility / Uranium Recovery System	Liquid Extraction, Neutralization, Filtration, Ion Exchange, Biodenitrofication	Aqueous Liquids & Slurries	150.0
Rocky Flats Plant	Fabric Filtration: Buildings 444,447, and 460 (5)	Filtration	Aqueous Liquids	3,411.0
Savannah River Site	F/H Area Effluent Treatment Facility	Neutralization, Chemical Precipitation, Filtration, Carbon Adsorption, Reverse Osmosis, Ion Exchange, Evaporation, Mercury	Aqueous Liquids	16,264.0

Note (5): Reported capacity is maximum permitted capacity.

TABLE 5-12(Continued)

Mixed Waste Treatment Facilities Currently Treating Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Savannah River Site (continued)		Absorption		
	M-Area Liquid Effluent Treatment Facility	Neutralization, Chemical Precipitation, Flocculation, Filtration	Aqueous Liquids	480.0
	SRL Ion Exchange Treatment Probe / Low Activity	Ion Exchange	Aqueous Liquids	1,500.0
	Z-Area Saltstone Facility (6)	Stabilization	Aqueous Liquids	39,840.0
Oak Ridge Y-12 Plant	Biodenitrification Unit (7)	Evaporation, Distillation, Biodegradation	Liquids, Nitric Acid	1,136.0
	Central Pollution Control Facility (8)	Neutralization, Carbon Adsorption, Oil/Water Separation	Liquids	7,571.0

Note (6): Essentially the feed to this is the supernate fraction of SRS HLW. Primary feed streams are the concentrates from ETF facility & HLW supernate exiting the ITP process.

Note (7): Annual capacity based on reported capacity of 1,000 gal/day and assuming 300 days operating per year.

Note (8): Normal capacity ranges from 1,350,000 to 2,000,000 gal/yr or 5110 to 7575 m3/yr.

TABLE 5-12(Continued)

Mixed Waste Treatment Facilities Currently Treating Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Oak Ridge Y-12 Plant (continued)	Cyanide Treatment Facility	Chemical Oxidation	Liquids	25.0
	Disposal Area Remedial Actions Liquid Storage Treatment (9)	Oil/Water Separation	Liquids	3,270.6
	Groundwater Treatment Facility (10)	Air Stripping, Filtration, Carbon Adsorption, Chemical Precipitation	Liquids	3,270.6
	Plating Rinsewater Treatment Facility	Cyanide Destruction, Oxidation/Reduction, Neutralization, Filtration	Liquids	30,300.0
	West End Treatment Facility / Wastewater Treatment	Oil/Water Separation, Neutralization, Biodentrification, Chemical Precipitation	Wastewater	8,300.0

Note (9): Annual capacity based on reported capacity of 2 gal/minute assuming 24-hour operation 300 days per year.
Note (10): Annual capacity based on reported capacity of 2 gal/min assuming 24-hour operation 300 days per year.

TABLE 5-13

Existing Mixed Waste Treatment Facilities
Not Currently Treating But Planning To Treat Mixed Low-level Wastes
with Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Capacity (m3/yr) *	Date Avail. For Use *
Argonne National Laboratory - East	Alkali Metal Reaction Booths (1)	Chemical Oxidation	Alkali Metals	To Be Determined	Year To Be Determined
Idaho National Engineering Laboratory	TAN 726-A Treatment / TAN 726-A Treatment Unit (2)	Ion Exchange	Liquids, Wastewater	128.0	1993
	Waste Engineering Development Facility / Stabilization Unit (3)	Stabilization	Liquids, Solids	2,765.0	Year To Be Determined
	WERF Incinerator (4)	Incineration	Liquids, Solids, Liquid	49,625.0	Year To Be

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (1): Design capacity = 120 lbs per hour.

Note (2): TAN 726A treatment is expected to be closed under interim status in FY93 after it completes treatment of 106 cubic meters of waste stored in Tan 726 and the rinsate generated from closing the Tan 726 tank storage unit.

Note (3): Maximum capacity based on permitted capacity of 2,000 gallons per day and 365 days per year. Normal operating capacity will be determined by the amount of waste requiring treatment when operation begins.

Note (4): WERF incineration maximum capacity based on a permitted capacity of 400 lbs per hour, 24 hours per day, 365 days per year and a density of 7 lbs per cubic foot. Anticipated start up in FY 1993. Normal operations based on 120 days per year.
TRU < 0.1 nCi/g. PCB < 50 ppm. Total WERF facility limited to less than 15 grams TRU in facility at any one time.

164

4690

TABLE 5-13(Continued)

Existing Mixed Waste Treatment Facilities
Not Currently Treating But Planning To Treat Mixed Low-level Wastes
with Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Capacity (m3/yr) *	Date Avail. For Use *
	WERF Incin(contd.)		Organics, Combustible Solids		Determined
	WERF Wast Stabilization Unit / WERF Waste Stabilization Unit (5)	Stabilization	Other Liquids, Solids, WERF Ash	2,765.0	1993
Mound Facility	Mound Glass Melter	Vitrification	Liquids, Sludges, Solids	200.0	1995
Rocky Flats Plant	Chip Cementation: Building 447 (6)	Solidification, Stabilization	Composite Chips, Inorganic Debris, Metal Turnings	5.3	Year To Be Determined
	Pondcrete Solidification Process: Building 788 (7)	Solidification	Inorganic Sludge/Particulates, Solar Pond Sludge	20,800.0 TONS/YR	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (5): WERF stabilization maximum capacity based on a permitted capacity of 2000 gallons per day and 365 days operations per year. Anticipated start-up in FY 93.
TRU < 10nCi/gm. Total WERF Facility limited to less than 15 grams TRU in facility at any one time.
Normal capacity is maximum capacity.

Note (6): Reported capacity is maximum permitted capacity.

Note (7): Reported capacity is maximum permitted capacity.

TABLE 5-13(Continued)

Existing Mixed Waste Treatment Facilities
Not Currently Treating But Planning To Treat Mixed Low-level Wastes
with Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Capacity (m3/yr) *	Date Avail. For Use *
Rocky Flats Plant (continued)	Pondcrete/Saltcrete Reprocessing Facility: 750PAD (8)	Solidification	Inorganic Sludges/Particulates, Pondcrete, Saltcrete	6,608.0 TONS/YR	Year To Be Determined
	Pondcrete/Saltcrete Reprocessing Facility: 904PAD (9)	Solidification	Inorganic Sludges/Particulates, Pondcrete, Saltcrete	3,312.0 TONS/YR	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (8): Reported capacity is maximum permitted capacity.

Note (9): Reported capacity is maximum permitted capacity.

166

4690

TABLE 5-14

Mixed Waste Treatment Facilities That Are Planned or Under Construction To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Energy Technology Engineering Center	Radioactive Materials Disposal Facility / Amalgamation Process	Amalgamation	Liquid Mercury	1.0	1994
Fernald Environmental Management Project	Minimum Additive Waste Stabilization Facility (1)	Vitrification	Soil, Sludges	To Be Determined	Year To Be Determined
	Soil Washing Process Facility (2)	Soil Washing	Soil	To Be Determined	Year To Be Determined
Hanford Site	Effluent Treatment Facility (3)	Filtration, UV Oxidation, Reverse Osmosis, Ion Exchange, Evaporation, Drying	Aqueous Liquids, Liquid Wastewater	80.0	1994

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (1): The overall design capacities for the MAWS system are: bench test=55 m3/yr, pilot test=4,414 m3/yr, and full scale=40,200 m3/yr. Date available for the MAWS system is 6/93 for the bench test. Dates available for the pilot test and full scale operation are to be determined. Bench test 6/93.

Note (2): Design capacity: Batch-1 continuous-441. Date available: Batch-4/93 continuous-1994. Planned: Batch 4/93, continuous 1994.

Note (3): Design capacity ranges from 40-150 gpm.

TABLE 5-14(Continued)

Mixed Waste Treatment Facilities That Are Planned or Under Construction To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Hanford Site (continued)	Grout Treatment Facility	Stabilization	Liquids	15,000.0	1993
Idaho National Engineering Laboratory	Mixed Low-Level Waste Treatment Facility (4)	Incineration, Decontamination, Macroencapsulation, Debris Decontamination, Thermal Desorption, Stabilization, Chemical Precipitation	Combustible Soilds, Debris, Liquids	To Be Determined	Year To Be Determined
	Waste Engineering Development Facility / Macroencapsulation Unit (5)	Macroencapsulation	Cadmium Solids, Debris, Lead Solids, Solids	864.0	FY95
Los Alamos National Laboratory	Hazardous Waste Treatment Facility (HWTF)	Chemical Oxidation	Organic Liquids, Solvents With Elevated H3 And	To Be Determined	1998

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (4): This facility is in the pre-conceptual design phase with as yet unspecified capacities.

Note (5): WEDF macroencapsulation design capacity based on request for expansion under interim status of 5000 lbs. per day, 365 days per year operation, and a density of 8 lbs per gallon.

Note (6): Design capacity has not yet been determined.

168

4690

TABLE 5-14(Continued)

Mixed Waste Treatment Facilities That Are Planned or Under Construction To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste
Los Alamos National Laboratory (continued)	/ Detox Skid (6)		Cl4, Vermiculite Contaminated With Organics		
	Hazardous Waste Treatment Facility (HWTF) / Plating Wastes Acids/Bases Skid (7)	Neutralization, Oxidation/Reduction, Chemical Precipitation	Aqueous Liquids	To Be Determined	1998
	Hazardous Waste Treatment Facility (HWTF) / Reactive Metals Skid (8)	Water Reaction	Reactive Metals	To Be Determined	1996
Lawrence Livermore National Laboratory	Area 514-1 / Carbon Adsorption Unit	Carbon Adsorption	Aqueous Liquid	64,000.0	1993
	Area 514-1 / Portable Blending Unit	Neutralization	Aqueous Liquids	64,000.0	1993

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (7): Design capacity has not yet been determined.

Note (8): Design capacity has not yet been determined.

TABLE 5-14(Continued)

Mixed Waste Treatment Facilities That Are Planned or Under Construction To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Lawrence Livermore National Lab. (continued)	Area 514-1 / Tank Blending Unit	Neutralization	Aqueous Liquids	6,700.0	1993
	Building 513 / Solidification Facility (9)	Solidification	Liquid, Sludge, Solid	2,100.0	1993
	Mixed Waste Management Facility	Alternative Technologies	Organic Liquids, Solids	To Be Determined	Year To Be Determined
Paducah Gaseous Diffusion Plant	Wastewater Treatment System (10)	To Be Determined	Liquids	To Be Determined	Year To Be Determined
Portsmouth Gaseous Diffusion Plant	Waste Treatment Facility	Incineration, Deactivation, Amalgamation, Stabilization, Neutralization	Various	To Be Determined	Year To Be Determined
	X-622T Groundwater	Carbon Adsorption	Aqueous Liquids,	69,628.0	1993

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (9): Design capcity based on reported capacity of 7 m3/day and assuming 300 days operating per year.

Note (10): Contaminants treated TBD.

170

4690

TABLE 5-14(Continued)

Mixed Waste Treatment Facilities That Are Planned or Under Construction To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Portsmouth (continued)	Treatment Facility		Groundwater		
	X-623 Groundwater Treatment Facility	Carbon Adsorption	Groundwater, Aqueous Liquids	99,470.0	1994
Rocky Flats Plant	Building 374/774 Salt And Sludge Treatment	Immobilization	Inorganic Sludge/Particulates, Solids	To Be Determined	2005
	Miscellaneous Waste Form Treatment	Immobilization	Aqueous Liquids, Inorganic Debris, Inorganic Liquids, Inorganic Sludges/Particulates, Solids, Liquids	To Be Determined	2005
	Solidified Bypass Sludge Treatment	Immobilization	Inorganic Sludge/Particulate, Sludges	To Be Determined	2005
	Solvent Contaminated	Thermal, Non-thermal	Inorganic Debris,	To Be Determined	2005 - 2012

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (11): Date available for treating mixed waste: 2005 for thermal, 2012 for non-thermal.

TABLE 5-14(Continued)

Mixed Waste Treatment Facilities That Are Planned or Under Construction To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Rocky Flats Plant (continued)	Waste System (11)		Inorganic Liquids, Inorganic Sludges, Organic Liquids, Solids		
	Surface Organic Removal / Leaded Gloves, and Bulk Lead Treatment	Separation, Immobilization	Inorganic Debris, Inorganic Sludges/Particulates, Solids	To Be Determined	2007
Savannah River Site	Consolidated Incineration Facility / CIF Incinerator - Liquid Feed System	Incineration	Organic Liquids, Aqueous Liquids	340.0	1996
	Consolidated Incineration Facility / CIF Incinerator - Solid Feed System (12)	Incineration	Organic Solids	14,300,000.0 KG/YR	1996
	Hazardous Waste/Mixed Waste Disposal Facility / Acid Leaching And	Acid Leaching, Chemical Precipitation	Inorganic Debris, Cadmium Solids	17.0	2004

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (12): Incinerator capacity must be reported in mass flow rather than volume flow to account for varying densities and heat content of the waste feed.

172

4699

TABLE 5-14(Continued)

Mixed Waste Treatment Facilities That Are Planned or Under Construction To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Savannah River (continued)	Chemical Precipitation Unit				
	Hazardous Waste/Mixed Waste Disposal Facility / Macroencapsulation Unit	Macroencapsulation	Elemental Lead	73.0	2004
	Hazardous Waste/Mixed Waste Disposal Facility / Mercury Amalgamation Unit	Amalgamation	Elemental Mercury	0.6	2004
	Hazardous Waste/Mixed Waste Disposal Facility / Mercury Roasting/Retorting And Recovery Unit	Hg Roasting/Retorting	Mercury Contaminated Solids	17.1	2004
	Hazardous Waste/Mixed Waste Disposal Facility / Soil Washing	Soil Washing	Soil	340.0	2004
	Hazardous Waste/Mixed	Stabilization	Aqueous Liquids,	484.0	2004

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 5-14(Continued)

Mixed Waste Treatment Facilities That Are Planned or Under Construction To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Savannah River Site (continued)	Waste Disposal Facility / Stabilization/Solidification Unit		Inorganic Sludges/Particulates, Solids		
	M-Area Vendor Treatment	Stabilization, Vitrification	Inorganic Sludges/Particulates, Aqueous Liquids	2,134.0	1995
Oak Ridge Y-12 Plant	Oak Ridge Reservation Mixed Waste Treatment Facility	Thermal Desorption, Decontamination, Stabilization, Sorting	Liquids, Sludges, Solids	To Be Determined	2004
	Steam Plant Wastewater Treatment Facility (13)	Neutralization, Sludge Dewatering	Wastewater	178,000.0	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (13): The influent to this facility is nonradioactive.

174

4690

4690 As discussed in Section 2.4, some DOE systems that qualify as "treatment" under RCRA are not designed to meet LDR requirements. These treatment systems include compaction, evaporation, shredding, sorting, size reduction, and packaging systems, that play an integral role in the mixed waste handling and treatment at DOE. Tables 5-15 and 5-16 present information on alpha MLLW compaction, evaporation, shredding, sorting, size reduction, and packaging systems that are not themselves designed to treat wastes to meet LDR requirements. The format used for presenting this information is the same as that used in Tables 5-5 and 5-7 for the alpha MLLW treatment systems that are designed to comply with the LDR requirements. Tables 5-17 through 5-19 present similar information on treatment systems for MLLW with transuranic alpha particle content less than 10 nCi/g.

TABLE 5-15

Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities Currently Treating Mixed Low-level Wastes With Transuranic Alpha Particle Content 10 nCi/g to 100 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Lawrence Berkeley Laboratory	Building 75 / Unit 131 AFH	Neutralization, Consolidation	Aqueous Liquids, Elemental Lead, Lab Packs With Metals, Liquid Mercury, Organic Debris, Organic Liquids	1.0

176

4690

TABLE 5-16

Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities That Are Planned or Under Construction For Treating Mixed Low-level Wastes With Transuranic Alpha Particle Content 10 nCi/g to 100 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Lawrence Berkeley Laboratory	Building 85 / Unit MW-7	Consolidation, Solidification	Aqueous Liquids, Organic Liquids	550.0	1995

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

TABLE 5-17

Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities That Are Currently Treating Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Normal Operating Capacity (m3/yr)
Idaho National Engineering Laboratory	Drum Evaporator	Evaporator	Liquids	138.2
	TAN 681 / Drum Evaporator (1)	Evaporator	Liquids	138.2
Los Alamos National Laboratory	Scintillation Vial Crusher	Packaging	Solids	400.0
Lawrence Berkeley Laboratory	Building 75 / Unit 131 E	Consolidation, Solidification	Aqueous Liquids, Elemental Lead, Organic Liquids	50.0
Lawrence Livermore National Laboratory	Area 514 WWFF	Filtration	Aqueous Liquids	4,420.0
	Building 513 / Shredding/Compaction Unit	Shredding, Compaction	Solids	43.0
	Building 612 Drum/Container Unit	Size Reduction	Solids	46.0
Paducah Gaseous Diffusion Plant	C-400-C Evaporator	Evaporation	Aqueous Liquids	19.6

Note (1): Reported capacity is maximum capacity.

1178

4690

TABLE 5-18

Existing Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities Currently Not Processing But Planning To Treat Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

4690

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Capacity (m3/yr) *	Date Avail. For Use *
Rocky Flats Plant	Building 776 Low-Level Mixed Waste Baler (1)	Compaction	Combustible Solids, Inorganic Debris, Organic Debris	1,056.0 TONS/YR	Year To Be Determined
	Low-Level Mixed Waste Baler: Building 889	Compaction	Inorganic Debris, Organic Debris, Solids	1,056.0 TONS/YR	Year To Be Determined

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Note (1): Reported capacity is maximum permitted capacity.

TABLE 5-19

Compaction, Evaporation, Shredding, Sorting, Size Reduction, and Packaging Facilities Planned or Under Construction For Treating Mixed Low-level Wastes With Transuranic Alpha < 10 nCi/g

Site	Facility/System	Treatment Types	Physical/Chemical Matrix	Design Capacity (m3/yr) *	Date Available For Treating Mixed Low-level Waste *
Lawrence Berkeley Laboratory	Building 85 / Unit MW-6	Consolidation, Neutralization	Aqueous Liquids, Elemental Lead, Lab Packs With Metals, Liquid Mercury, Organic Debris, Organic Liquids	68.0	1995
Lawrence Livermore National Laboratory	Area 514-1 / Centrifugation Unit	Centrifugation	Aqueous Liquid	4,000.0	1993
	Area 514-1 / Cold Vapor Evaporation Unit	Evaporation	Aqueous Liquid	1,700.0	1993
	Building 612 / Size Reduction Unit	Size Reduction	Solid	50.0	Year To Be Determined
Savannah River Site	Hazardous Waste/Mixed Waste Disposal Facility / Size Reduction	Size Reduction, Sorting, Shredding, Compacting	Solids	1,313.0	2004

* Because DOE is still in the planning/conceptual stage, in the design stages, or in the construction stage for these facilities, schedules and capacities are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

180

4690

5.3 Comparison of Treatment Facilities and Waste Streams

This section compares DOE's MLLW treatment needs and its treatment capacity for treating the MLLW to the LDR standards. Generally, each type of MLLW has one predominant type of treatment technology which is typically used. This does not necessarily preclude the use of other treatment technologies that may adequately treat the same MLLW to the LDR standards. For the capacity evaluations presented in this report only the most commonly used treatment technology is considered for the comparison. The consideration of all available treatment options would require an in depth capacity evaluation which is beyond the scope of this report.

As described in Chapter 2, proper treatment of mixed waste, including milling, must consider the radiation characteristics, physical/chemical matrix, and RCRA hazardous component. Several of the currently existing and planned DOE facilities are specifically designed for the treatment of particular types of mixed wastes, e.g., deactivation systems for certain alkali metals, decontamination systems for special types of filters, or treatment systems that can only accept wastewaters. These treatment systems are not readily adaptable to accept other types of wastes. In general, many of DOE's treatment systems cannot accept mixtures of multiple waste matrices or hazardous components, which are often found in DOE's MLLW. This limits DOE's overall treatment capacity for the MLLW.

Alpha Mixed Low-level Wastes

Treatment facilities are limited to particular physical/chemical matrices. Hence, the physical/chemical matrix of the MLLW plays a very important role in the selection of the treatment facility. Table 5-20 summarizes the treatment status for DOE's alpha MLLW in inventory. For each physical/chemical matrix type, this table presents the number and quantity of wastes that are currently being treated, planned for treatment in existing facilities which are not currently treating the waste, or intended to be treated at a planned facility. Note that all waste streams that are treated or are expected to be treated in treatment facilities that are not designed to meet the LDR requirements (e.g., compaction, size reduction, etc.) were included with the waste streams that have not been assigned to any existing or planned facility.

Very few treatment facilities can accept alpha wastes. Most existing and planned facilities that can handle the alpha particle emissions are expected to be used for treating HLW and TRU wastes. Consequently, DOE has an acute shortage of treatment capacity for treating alpha MLLW. This shortage may be compounded by the on-going reclassification of TRU wastes which could result in additional quantities of alpha MLLW. Using conservative estimates, DOE anticipates that the reclassified TRU wastes may increase, up to 40 percent, the total quantity of alpha MLLW that require treatment for meeting the LDR requirements.

Mixed Low-level Wastes With Transuranic Alpha Particle Content Less Than 10 nCi/g

Table 5-21 summarizes the treatment status of DOE's MLLW with transuranic alpha particle content less than 10 nCi/g in inventory (i.e., for wastes that do not require special alpha containment). For each physical/chemical matrix type, this table presents the number and quantity of wastes that are currently being treated, planned for treatment in existing facilities which are not currently treating the waste, or intended to be treated at a planned facility. Brief discussions for the general physical/chemical matrices are provided below.

TABLE 5-20

Mixed Low-level Waste with Transuranic Alpha Content 10 nCi/g to 100 nCi/g Inventory Treatment Status

Physical/Chemical Matrix	Currently Being Treated		Plan To Treat At Existing Facility		Plan To Treat At Planned Facility		Treatment Facility Not Yet Identified	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Contact-handled								
Organic Liquids	16	793.8	1	5.9	9	319.9	6	98.6
Aqueous Liquid	1	1.3			5	12.1	11	33.7
Organic Sludges/particulates					5	1,454.5	3	32.4
Inorganic Sludges/particulates					15	37,415.3	15	2,842.3
Cemented Solids					3	95.5		
Soil With <50% Debris							6	17.7
Soils							1	18.1
Organic Debris					3	15.6	5	2,919.4
Inorganic Debris					18	1,283.4	6	10.3
Heterogeneous Debris					5	9,127.0	16	109.4
Lab Packs With Metals							14	54.6

182

4690

TABLE 5-20(Continued)

Mixed Low-level Waste with Transuranic Alpha Content 10 nCi/g to 100 nCi/g Inventory Treatment Status

Physical/Chemical Matrix	Currently Being Treated		Plan To Treat At Existing Facility		Plan To Treat At Planned Facility		Treatment Facility Not Yet Identified	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Lab Packs Without Metals							12	92.6
Compressed Gases							3	0.6
Liquid Mercury							3	19.4
Elemental Lead					2	429.0	4	137.4
Beryllium Dust					1	1.5		
Batteries (lead Acid, Cadmium)							3	1.7
Multiple					7	640.8	5	7,467.4
Other					7	535.5	3	2,105.0
To Be Determined					1	185.0		
Total Contact-handled:	**17**	**795.2**	**1**	**5.9**	**81**	**51,515.0**	**116**	**15,960.4**

4690

TABLE 5-20(Continued)

Mixed Low-level Waste with Transuranic Alpha Content 10 nCi/g to 100 nCi/g Inventory Treatment Status

Physical/Chemical Matrix	Currently Being Treated		Plan To Treat At Existing Facility		Plan To Treat At Planned Facility		Treatment Facility Not Yet Identified	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Remote-handled								
Aqueous Liquid	2	1,321.1					1	1,088.0
Organic Sludges/particulates								
Elemental Lead					1	54.0		
Multiple							1	62.4
Total Remote-handled:	2	1,321.1			1	54.0	2	1,150.4
National Totals:	19	2,116.3	1	5.9	82	51,569.0	118	17,110.8

184

4690

TABLE 5-21

Mixed Low-level Waste with Transuranic Alpha Content < 10 nCi/g Inventory Treatment Status

Physical/Chemical Matrix	Currently Being Treated		Plan To Treat At Existing Facility		Plan To Treat At Planned Facility		Treatment Facility Not Yet Identified	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Contact-handled								
Organic Liquids	18	372.0	42	116.7	12	40.5	133	401.0
Aqueous Liquid	8	92.8	23	122.8	7	45,447.3	63	41,040.2
Organic Sludges/particulates			4	6.5	1	<0.1	74	1,011.2
Inorganic Sludges/particulates			7	17.4	8	1,038.0	81	1,068.5
Cemented Solids			1	3.3	1	0.2	5	70.2
Soil With <50% Debris			1	<0.1			3	6.0
Soils			1	4.0	2	4,722.6	25	5,161.5
Organic Debris	1	2.9	3	5.5	6	12.8	36	515.9
Inorganic Debris			8	52.7	6	93.9	61	25,055.1
Heterogeneous Debris			12	35.0	3	1.1	70	460.9
Lab Packs With Metals			2	0.3	1	<0.1	16	112.7

185

4690

TABLE 5-21(Continued)

Mixed Low-level Waste with Transuranic Alpha Content < 10 nCi/g Inventory Treatment Status

Physical/Chemical Matrix	Currently Being Treated		Plan To Treat At Existing Facility		Plan To Treat At Planned Facility		Treatment Facility Not Yet Identified	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Lab Packs Without Metals							13	6.7
Reactive Metals							9	61.1
Explosives			1	0.8				
Compressed Gases			1	0.4			5	3.1
Liquid Mercury			2	<0.1			10	12.2
Elemental Lead	1	0.1	1	0.2	5	40.9	14	304.5
Batteries (lead Acid, Cadmium)			1	1.8			9	13.3
Batteries							1	1.3
Multiple	4	49.1	10	79.9	2	4,884.8	26	1,366.3
Other			2	0.4			142	460.3
Total Contact-handled:	**32**	**516.9**	**122**	**447.8**	**54**	**56,282.2**	**796**	**77,131.9**

4690

186

TABLE 5-21(Continued)

Mixed Low-level Waste with Transuranic Alpha Content < 10 nCi/g Inventory Treatment Status

Physical/Chemical Matrix	Currently Being Treated		Plan To Treat At Existing Facility		Plan To Treat At Planned Facility		Treatment Facility Not Yet Identified	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Remote-handled								
Organic Liquids							2	14,475.0
Aqueous Liquid							3	27,311.0
Organic Sludges/particulates							1	<0.1
Inorganic Sludges/particulates							1	0.2
Inorganic Debris							1	0.3
Heterogeneous Debris			1	8.9			1	0.2
Reactive Metals							3	4.9
Liquid Mercury							1	<0.1
Elemental Lead			1	40.8			2	1.4
Multiple			1	3.7				

187

4690

TABLE 5-21 (Continued)

Mixed Low-level Waste with Transuranic Alpha Content < 10 nCi/g Inventory Treatment Status

Physical/Chemical Matrix	Currently Being Treated		Plan To Treat At Existing Facility		Plan To Treat At Planned Facility		Treatment Facility Not Yet Identified	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Other							1	9.7
Total Remote-handled:			3	53.4			16	41,802.7
National Totals:	32	516.9	125	501.1	54	56,282.2	812	118,934.6

188

Aqueous Liquids. This broad category includes all pumpable aqueous liquids which may have total suspended or settled solid (TSS) levels as high as 40 percent. EPA defines wastewater as containing less than one percent TSS. Hence, the aqueous liquid category used in this report should not be confused with EPA's regulatory definition for wastewaters. Most of DOE's treatment capacity is represented by currently existing and planned mixed waste treatment facilities that are limited to wastewaters. These treatment facilities have excess capacity for treating DOE's MLLW that are wastewaters. Typically these treatment facilities cannot handle aqueous liquids having a high TSS and are not readily adaptable for other waste forms. Consequently, even though quantitatively the total mixed wastewater treatment capacity is more than the total quantity of mixed wastes, DOE has limited treatment capacity (currently available or expected within the next five years) for the treatment of its non-wastewater MLLW.

Organic Liquids, Sludges, and Solids. Organic liquids, sludges, and solids are primarily treated by incineration, though other treatment technologies such as carbon adsorption may also be used in some cases. DOE's only operating incinerators are the TSCA Incinerator at K-25 and the Burning Cages at Pantex. INEL also has an incinerator (the WERF incinerator) but it is currently not operative. DOE's current plans include an incinerator as part of the planned MLLWTF at INEL, the Solvent Contaminated Waste System at RFP, the CIF incinerator (with the solid and liquid feed systems) at SRS, and the Waste Treatment facility at PORTSGDP. The combined capacity of the TSCA and WERF incinerators and the liquid feed system of the CIF incinerator is around 51,385 m^3/yr and the capacity of the solid feed system of the CIF incinerator is 14,300,000 kg/yr while the capacities of the Burning Cages, the MLLWTF incinerator, the Solvent Contaminated Waste System, and the Waste Treatment Facility have not yet been determined. However, considering the total inventoried and projected quantities of the organic liquids, solids, and sludges. There is insufficient capacity for treating these mixed wastes to the LDR standards.

Inorganic Sludges and Solids. Inorganic sludges and solids are generally stabilized prior to disposal. For stabilizing these mixed wastes, DOE has only three treatment facilities that are currently operative: the Melton Valley LLWIF at ORNL, the Z-Area Saltstone Facility at SRS, and the Waste Generator Treatment Plans plant at INEL. However, DOE has several existing facilities that are currently not operative and several planned facilities. The treatment capacities of some of these facilities are not yet determined. Without an in-depth capacity analysis it is difficult to estimate the actual treatment capacity available for treating these mixed wastes. However, DOE currently does not have adequate operating capacity for treating these wastes and estimates that the treatment capacity for the next five years may not suffice for treating all the inventoried and projected inorganic sludges and solids.

Soil and Debris. Soil and debris present a distinct problem to DOE. Organic debris, like other organic solids, generally require incineration, while inorganic and heterogenous debris are either decontaminated, or macroencapsulated. Soil is either washed with water or a solvent, or stabilized. The currently existing, as well as, the planned treatment facilities have little treatment capacity for stabilizing, incinerating, decontaminating, or macroencapsulating soil or debris. There is an acute shortage of existing and planned treatment capacity for treating soil and debris. This shortage is expected to be compounded by activities conducted under programs such as the Environmental Restoration program because these activities are expected to generate large quantities of soil and debris in the future.

Other Wastes. This category includes several distinct categories such as laboratory packs, reactive metals, elemental mercury, elemental lead, explosives, and compressed gases. Typically, all these wastes require specialized treatment. Laboratory packs are generated in small quantities, however,

they present very specific treatment problems since they contain mixtures of multiple waste matrices or hazardous components. DOE has a reactive metal treatment facility at ANL-E that is currently not operating; and plans to build reactive metal treatment facilities at LANL and PORTSGDP. In order to meet the LDR requirements, all MLLW containing elemental mercury must be amalgamated prior to disposal. DOE has plans to build amalgamate facilities at ETEC, SRS, and PORTSGDP. MLLW containing elemental lead must be macroencapsulated. DOE has plans for a macroencapsulating system at SNL-NM and two macroencapsulating systems at INEL. MLLW debris containing lead must be decontaminated/ recycled at lead decontamination/recycling facilities. DOE is currently treating MLLW debris containing lead at LANL and plans to build lead decontamination/recycling systems at RFP and SRS. However, DOE currently has insufficient treatment capacity for all of these waste types.

There are several mixed waste streams that present unique treatment problems. Hence, it is useful to know whether any mixed waste treatment technology currently exists (which may need modification) or does not exist for treating the mixed waste streams to the LDR standards. For each of the physical/chemical matrices, Tables 5-22 and 5-23 present the technology status for the alpha MLLW and the MLLW with transuranic alpha particle content less than 10 nCi/g streams, respectively, in inventory. The technology status of some of the mixed waste streams in inventory can change since they have not yet been completely characterized to accurately assess whether any treatment technology exists, needs modification, or does not exist for treating the waste stream to the LDR standards. Waste streams for which such technology assessments have started but are incomplete are included in the column for "Assessing Technology." These tables show that most of the MLLW streams in inventory at DOE either have existing technologies or have technologies that exist but need to be modified for treating the mixed wastes. The tables also indicate that there are relatively low quantities of MLLW for which DOE has not yet started any technology assessments. In addition, the tables show that there is only one waste stream in inventory for which no technology exists. Information on this waste stream for which no technology exists is provided in Chapter 6. Information on technology development activities at DOE is provided in Chapter 6 and Appendix B of this report.

Conclusions

With the exception of wastewater treatment plants, DOE currently has few operating mixed waste treatment systems. Hence, other than for wastewaters, there is insufficient capacity to handle the other waste forms. Additionally, DOE has limited treatment capacity for the alpha MLLW and the MLLW that must be remote-handled.

DOE sites have used commercial mixed waste treatment facilities for treating their MLLW in the past, but considering the limited commercial treatment capacity and the current demand on commercial treatment facilities, DOE expects that the commercial facilities may provide little mixed waste treatment capacity for its MLLW in the foreseeable future.

DOE is currently in the process of sampling and characterizing its waste streams. Consequently, several waste streams could be reclassified (e.g., "buried" TRU wastes could be reclassified as MLLW) which can result in significant changes in the inventories currently reported. Additionally, sampling and characterization studies are required prior to developing treatment plans for the MLLW that lack sufficient treatment capacity. Furthermore, many of the environmental restoration projects are not yet completed causing a significant uncertainty in the estimated generation rates and anticipated types of hazardous components of mixed waste that will result from future restoration projects.

TABLE 5-22

Technology Status for Mixed Low-level Wastes with Transuranic Alpha Content 10 nCi/g to 100 nCi/g

Physical/Chemical Matrix	Technology Exists		Technology Exists But Needs Modification		Technology Does Not Exist		Assessing Technologies [a]		Technology Assessment Has Not Started	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Contact-handled										
Organic Liquids	18	799.9	10	319.9			1	6.0	3	92.5
Aqueous Liquid	1	1.3	13	42.6			1	3.1	2	<0.1
Organic Sludges/particulates	2	1,017.0	5	74.8					1	395.0
Inorganic Sludges/particulates	6	28,174.3	24	12,083.2						
Cemented Solids			3	95.5						
Soil With <50% Debris			6	17.7						
Soils			1	18.1						
Organic Debris			6	143.1					2	2,791.9
Inorganic Debris	3	618.0	21	675.7						
Heterogeneous Debris	3	9,054.0	16	109.4					2	73.0
Lab Packs With Metals	1	<0.1	12	51.0					1	3.6

[a] Assessing technologies to determine if technology exists, technology needs modification or technology does not exist.

TABLE 5-22(Continued)

Technology Status for Mixed Low-level Wastes with Transuranic Alpha Content 10 nCi/g to 100 nCi/g

Physical/Chemical Matrix	Technology Exists		Technology Exists But Needs Modification		Technology Does Not Exist		Assessing Technologies [a]		Technology Assessment Has Not Started	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Lab Packs Without Metals	2	0.1	9	60.1			1	32.4		
Compressed Gases									3	0.6
Liquid Mercury			3	19.4						
Elemental Lead	1	397.1	4	163.9			1	5.4		
Beryllium Dust			1	1.5						
Batteries (lead Acid, Cadmium)			3	1.7						
Multiple	3	7,388.5	9	719.7						
Other	3	2,255.0	6	374.8					1	10.8
To Be Determined	1	185.0								
Total Contact-handled:	**44**	**49,890.2**	**152**	**14,972.0**			**4**	**46.9**	**15**	**3,367.4**

[a] Assessing technologies to determine if technology exists, technology needs modification or technology does not exist.

4690

192

TABLE 5-22(Continued)

Technology Status for Mixed Low-level Wastes with Transuranic Alpha Content 10 nCi/g to 100 nCi/g

Physical/Chemical Matrix	Technology Exists		Technology Exists But Needs Modification		Technology Does Not Exist		Assessing Technologies [a]		Technology Assessment Has Not Started	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Remote-handled										
Aqueous Liquid	3	2,409.1								
Organic Sludges/particulates										
Elemental Lead	1	54.0								
Multiple	1	62.4								
Total Remote-handled:	**5**	**2,525.5**								
National Totals:	**49**	**52,415.7**	**152**	**14,972.0**			**4**	**46.9**	**15**	**3,367.4**

[a] Assessing technologies to determine if technology exists, technology needs modification or technology does not exist.

193

4690

TABLE 5-23

Technology Status for Mixed Low-level Wastes with Transuranic Alpha Content < 10 nCi/g

Physical/Chemical Matrix	Technology Exists		Technology Exists But Needs Modification		Technology Does Not Exist		Assessing Technologies [a]		Technology Assessment Has Not Started	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Contact-handled										
Organic Liquids	76	594.0	114	227.8	1	12.7	11	90.0	3	5.6
Aqueous Liquid	42	40,360.7	51	46,339.4			7	1.2	1	1.8
Organic Sludges/particulates	11	28.7	65	976.0			2	2.9	1	10.1
Inorganic Sludges/particulates	19	1,046.1	65	971.7			1	0.2	11	105.9
Cemented Solids	6	43.6	1	30.0						
Soil With <50% Debris	2	0.9	2	5.2						
Soils	3	5.1	21	9,883.1			4	<0.1		
Organic Debris	22	310.2	19	203.9			3	3.0	2	19.9
Inorganic Debris	20	280.0	46	421.6			3	4.0	6	24,496.1
Heterogeneous Debris	24	51.7	52	382.6			3	35.7	6	27.0
Lab Packs With Metals	4	8.4	7	30.6			1	43.2	7	30.9

[a] Assessing technologies to determine if technology exists, technology needs modification or technology does not exist.

4690

194

TABLE 5-23(Continued)

Technology Status for Mixed Low-level Wastes with Transuranic Alpha Content < 10 nCi/g

Physical/Chemical Matrix	Technology Exists		Technology Exists But Needs Modification		Technology Does Not Exist		Assessing Technologies [a]		Technology Assessment Has Not Started	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Lab Packs Without Metals	5	3.3	7	3.3					1	0.1
Reactive Metals	1	11.3	6	49.0			1	0.3	1	0.5
Explosives			1	0.8						
Compressed Gases			5	2.7					1	0.8
Liquid Mercury	6	11.7	4	0.3					2	0.2
Elemental Lead	7	321.4	7	11.7			1	1.5	6	11.1
Batteries (lead Acid, Cadmium)			9	14.2					1	0.8
Batteries									1	1.3
Multiple	7	29.9	34	6,338.6					1	11.6
Other	5	2.5	129	90.9					10	367.3
Total Contact-handled:	**260**	**43,109.4**	**645**	**65,983.4**	**1**	**12.7**	**37**	**182.0**	**61**	**25,091.3**

[a] Assessing technologies to determine if technology exists, technology needs modification or technology does not exist.

195

4690

TABLE 5-23(Continued)

Technology Status for Mixed Low-level Wastes with Transuranic Alpha Content < 10 nCi/g

Physical/Chemical Matrix	Technology Exists		Technology Exists But Needs Modification		Technology Does Not Exist		Assessing Technologies [a]		Technology Assessment Has Not Started	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Remote-handled										
Organic Liquids	1	3,479.0	1	10,996.0						
Aqueous Liquid			3	27,311.0						
Organic Sludges/particulates	1	<0.1								
Inorganic Sludges/particulates			1	0.2						
Inorganic Debris	1	0.3								
Heterogeneous Debris			2	9.1						
Reactive Metals			2	4.2			1	0.7		
Liquid Mercury			1	<0.1						
Elemental Lead			3	42.2						
Multiple	1	3.7								

[a] Assessing technologies to determine if technology exists, technology needs modification or technology does not exist.

4690

TABLE 5-23(Continued)

Technology Status for Mixed Low-level Wastes with Transuranic Alpha Content < 10 nCi/g

Physical/Chemical Matrix	Technology Exists		Technology Exists But Needs Modification		Technology Does Not Exist		Assessing Technologies [a]		Technology Assessment Has Not Started	
	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)	Number Of Waste Streams	Quantity (m 3)
Other							1	9.7		
Total Remote-handled:	4	3,482.9	13	38,362.8			2	10.4		
National Totals:	264	46,592.3	658	104,346.2	1	12.7	39	192.3	61	25,091.3

[a] Assessing technologies to determine if technology exists, technology needs modification or technology does not exist.

197

690

6.0 TREATMENT REQUIREMENTS AND TECHNOLOGY DEVELOPMENT

6.1 Introduction

DOE must achieve and maintain full compliance with applicable Federal, state, and local requirements for the management of solid and hazardous waste. Currently, available technology is not adequate to address all of DOE waste treatment needs. To accomplish its mission DOE must develop and implement new or improved cost-effective technologies rapidly. Consideration is given to the development of treatment technologies which are applicable to several waste streams where systems analyses shows this to be advantageous. These DOE needs are being addressed through a combination of site-specific and cross-complex technology development activities.

This chapter presents an overview of the EM approach to technology development activities. Existing and planned treatment facilities are summarized in chapters 2.0, 3.0, 4.0, and 5.0, and discussed in detail in the individual site chapters. This overview is presented without discussion of individual technology development activities. A more detailed description of specific technology development activities related to mixed waste management is found in Appendix B. In the first sections of this chapter there is material that has been presented in Chapter 2. This material is presented here, again, in more detail to provide a more complete picture of the factors that influence technology selection and technology development for mixed waste management for those readers who may have bypassed the initial chapters in arriving at Chapter 6.

These DOE technology development activities address the following areas:

Demonstration and test activities for baseline processes. Even processes considered mature for traditional hazardous waste treatment or radioactive materials applications often require optimization of process operating parameters to meet the functional and operational requirements for treatment of specific mixed waste streams. Demonstration and test activities are necessary to provide data which are needed for the optimization process.

Alternative technologies. In some cases available technology is considered to be too slow, too difficult to operate, or produces too much secondary waste. Therefore, alternative approaches are being evaluated. Alternative technologies are being pursued where the potential benefit is projected to be significant (reduced personnel exposure or other safety risks, faster processing rates, and lower cost) or the pursuit of several options is necessary to ensure at least one available technology.

Related Technology Activities. DOE also includes in its technology development activities programs which are primarily directed at other activities but contain elements that can be transferred to waste treatment operations. For example, these include characterization, material handling, automation, and waste minimization efforts.

New technology. In a limited number of cases, a new technical approach is being examined. These more innovative technologies are being pursued where the potential high payoff justifies the cost and technical risk. The DOE approach is to develop the necessary capability through involvement of the DOE Labs, Universities, and the commercial sector in problem definitions, evaluation of options and development of the required treatment capability.

The summaries of technology development activities included in site chapters and Appendix B represent a snapshot in time of the current portfolio of technology development. Activities may be added or deleted based on funding priorities, completion of tasks, identification of new needs, performance of tested technologies, etc. Some of the activities included may only be under consideration for funding. The number and the wide variety of development activities described in this report indicates the extent of the resources that are being applied to these problems.

The remainder of the chapter will discuss how the requirements of RCRA and the AEA influence the way in which treatment can be approached. The influences of properties of the waste such as its radionuclide constituents and their concentration on the choices of appropriate treatment technologies will be discussed. The different set of constraints brought about by the presence of RCRA regulated constituents is also considered. DOE's mixed waste technology development program is discussed with respect to the development of new mixed waste management technologies or the alteration and implementation of currently available processes. Descriptions of the development activities that are currently being funded can be found in some of the site-specific chapters and in Appendix B.

6.2 Factors Which Shape Mixed Waste Technology Development Approach

The management of mixed waste is a multifaceted activity that is best understood based on a framework that provides a link between the radioactive constituents, types of waste matrix, RCRA requirements, and possible management techniques. This chapter will present and discuss the radiation classifications, RCRA treatment standards, and treatability groupings upon which the operational and technical aspects of mixed waste management with the concomitant technology development needs can be discussed.

The selection of appropriate treatment for mixed wastes is based on careful consideration of three primary characteristics:

1) radioactivity,
2) physical/chemical matrix, and
3) hazardous constituent.

Examining the impacts of these characteristics provides a road map through the treatment requirements and will help develop an understanding of DOE's mixed waste treatment capability needs. In each of these areas, technical options (e.g. materials handling, hazard reduction, etc.) must be considered in the context of regulatory requirements such as the LDRs. Since the treatment standards are based on the performance of treatment technologies for contaminants in a simple matrix, the treatment of mixtures of matrices combined with multiple contaminants and radionuclides complicates the selection of treatment strategies. In many cases the treatment strategy will involve plans for several treatment operations in order to satisfy the LDR requirements for the materials contained in the waste. These multiple treatment strategies are discussed in more detail later in this chapter.

The following section reviews the regulatory framework against which all technologies must be evaluated and discusses the impact of the above waste characteristics on the process of establishing treatment capability for DOE wastes. An understanding of these factors is necessary for the selection, development, evaluation, or adaptation and implementation process.

6.3 Impact of Mixed Waste Characteristics on Treatment Options

Technology status for the treatment of mixed waste in DOE has been examined for each individual waste stream. Most treatment technology attention is focused on the RCRA requirements for compliant treatment of the RCRA regulated constituent. There are, however, numerous additional steps involved in the waste-management chain which will also be RCRA and state regulated. A serious issue which has a profound effect on the selection of treatment technologies is the lack of approved disposal facilities. Performance assessments define the waste acceptance criteria for disposal facilities. Without waste acceptance criteria to provide performance specifications for waste disposal forms, it is difficult to make sound treatment technology selections.

The selection of appropriate handling and treatment processes for mixed wastes is based on careful consideration of three primary factors listed above: the radioactive characteristics, the physical/chemical (e.g. matrix properties), and the RCRA hazardous constituents of the wastes. In each of these areas, technical options (e.g., materials handling, hazard reduction) must be considered in the context of regulatory requirements such as the LDR standards. The original LDR standards are often based on the performance of treatment for relatively simple wastes. Mixtures of multiple waste matrices, hazardous components, and risks due to the presence of radioactivity significantly complicate selection of treatment approaches. This is especially true when the wastes to be treated are heterogeneous materials accumulated over many years. In many cases, a series of pretreatment and treatment operations, i.e., a treatment train, is required to destroy or immobilize multiple types of hazardous components (e.g., organic chemicals and toxic heavy metals). Pretreatment operations include processes to mix, separate, or reduce the size of the waste material. Often, one of the three characteristics, listed above, will dominate the technology selection process. That is, adequate treatment of one characteristic (e.g., high levels of radioactivity by vitrification), will adequately address a RCRA co-contaminant in a mixed waste (e.g., the presence of toxic heavy metals).

When considering the design of a facility to treat mixed wastes, it should be noted that many of the required components can be provided from commercially available equipment. Engineering analysis and judgements can predict the successful adaption of commercially available process equipment. Selection of treatment technology often begins with evaluation of commercial technology.

There are many mixed waste streams which are similar enough in their overall characteristics to commercial waste streams that an engineering judgment would predict that a currently available technology for treating the commercial stream would perform adequately when processing one of DOE's waste streams. However, performance data in addition to engineering judgments are required. Additionally, modifications are necessary for most commercial processes in order to address the radionuclide content of a DOE waste stream. Time and resources are necessary to gather the data and adapt the technology. Once the adaptations are made performance data are again required to insure that the adapted system will perform as projected.

Only two waste streams have been determined to have no treatment technology available at this time. This determination is crucial in light of the requirement of the FFCA to identify any waste for which DOE has determined that there is no treatment technology (RCRA section 3201(a)(3)(f), as amended). These streams will be dealt with in more detail in the last portion of this chapter.

There are, in addition, a significant number of wastes for which adequate characterization data are not available to start technology evaluation as well as those for which technology options are still being evaluated. It is impossible to predict, in the absence of characterization information how many wastes will be determined to have no treatment technology available.

6.3.1 Radioactive Waste Management Strategies

The DOE waste management strategy is different for each radioactive category of mixed waste. Following are summaries of radioactive waste categories and treatment strategies.

High-level Wastes (HLW). High-level Waste (HLW) is defined by the DOE Order 5820.2A as "... the highly radioactive waste material that results from the reprocessing of spent nuclear fuels, including the liquid waste produced directly in the reprocessing, and any solid waste derived from the liquid that contains a combination of transuranic waste and fission products in concentrations as to require permanent isolation".

High Level Wastes Treatment Strategy DOE plans to treat all high level wastes to glass or glass ceramic final forms. The treatment standard for the regulated metals in the high level wastes is vitrification (40 CFR 268.42, Table 1) therefore, the DOE planned treatment for this waste will provide full compliance with RCRA requirements.

Transuranic (TRU) Wastes. Transuranic (TRU) wastes, as defined by DOE Order 5820.2A, refers to all radioactive wastes that contain more than 100 nCi/g of alpha-emitting isotopes with atomic numbers greater than 92 and half-lives greater than 20 years. This definition includes isotopes of neptunium (Np), plutonium (Pu), americium (Am), curium (Cm), and californium (Cf). More than 90 percent of TRU wastes contain mainly plutonium that emits alpha particles and low-energy gamma rays.

Mixed Transuranic Wastes Treatment Strategy. DOE plans to dispose of transuranic wastes in the Waste Isolation Pilot Plant (WIPP). This waste covers a broad range of physical matrix categories. The current strategy is to treat MTRU wastes to comply with the WIPP Waste Acceptance Criteria (WIPP-WAC). DOE plans to meet the requirements of RCRA for mixed TRU through a test phase program to support the analysis and application for a no migration "petition" for the WIPP facility. Final waste acceptance criteria for the WIPP will be established based on the results of the testing program. The TRU waste physical matrix and RCRA waste contaminants are very similar to the mixed low-level wastes. It is anticipated that any technology required for treatment of TRU wastes to the ultimate WIPP waste acceptance criteria can be adapted from the technologies that must be brought on-line for mixed low-level wastes.

Low-Level Wastes (LLW). Low-level wastes are radioactive wastes that are not classified as high-level wastes, TRU wastes, spent fuel, or by-product materials.

Mixed Low-Level Waste Treatment Strategy: DOE plans to treat all mixed low level waste in accordance with the RCRA treatment standards. There are a number of facilities which are currently planned or under construction. Planned facilities have identified baseline technologies. However, final selection of technologies will depend upon waste characterization, treatability studies and evaluation of alternate technologies as appropriate. Technology development will focus on modification of existing technologies to adapt them for treatment of the physical/chemical matrices of DOE waste streams as well as implementing the modifications

necessary to treat radioactive materials. DOE will also evaluate innovative technologies that could provide a more cost effective treatment system and better final waste form.

6.3.2 Radioactivity Effects on Treatment Facilities.

In order to develop a waste management or treatment capability for a waste stream, the first characteristics that must be considered are the radionuclide type and radiation type and intensity. Low level wastes are sorted to determine the presence of alpha contamination before further sorting by waste matrix type and RCRA constituents. Treatment facilities for wastes which have alpha contamination have differing design requirements in order to manage differences in hazardous characteristics safely when compared to beta/gamma bearing wastes. These requirements were formulated to account for the differences in biological damage potential for the different radionuclides and radiation types. MTRU and MLLW may contain radionuclides that create high enough radiation fields to require further shielding. The intensity of the radiation field in the vicinity of the waste determines whether the waste can be handled manually (contact handled - CH) or must be handled remotely (remote handled - RH).

Table 6.3-1 summarizes the radioactive categories DOE has used to group its mixed wastes in this report. Wastes with beta or gamma radioactivity in excess of 200 mr/hr at the waste container surface must be remotely handled. Therefore, treatment systems for these wastes must be designed for remote, automatic, or indirect operation. Mixed wastes may contain radionuclides such as tritium (a gaseous radionuclide) that require unique treatment considerations. Mixed low-level wastes that contain alpha decay type radionuclides represent special containment challenges to control the release of alpha-emitting materials.

Alpha emitting radionuclides can present other treatment challenges. High alpha activity in contact with organics or water can result in radiolysis, the production of hydrogen gas, methane, and other degradation products. Radiation interaction with the waste form can affect the design and operation of treatment facilities and the stability of final waste form. Treatments using chemical separation or matrix destruction could result in concentrating of certain isotopes of uranium and plutonium to form a critical mass. Moderate concentration of polonium or plutonium in contact with beryllium could result in the production of neutrons. Daughter products of alpha emitters may also cause problems such as the production of radon gas, emissions from short-lived daughter products, and potential chemical incompatibility.

Wastes containing beta/gamma emitters also present treatment challenges. As with alpha emitters, beta/gamma emitters may also result in radiolysis when in contact with organics or water. Treatment may also result in plating, precipitation, or some other form of concentration of radionuclides, which could result in creating a significant local radiation source.

6.3.3 Physical and Chemical Matrix Categories

Once a facility's requirements regarding the radioactive components of the waste stream or group of streams has been determined, the treatment requirements necessary to deal with the RCRA regulated components as constrained by the matrix of the waste need to be determined. The first

Table 6.3-1

Mixed Waste Radioactive Categories

High-Level Waste (HLW)

Mixed TRU Waste (MTRU)
- Contact Handled (CH)
- Remote Handled (RH)

Mixed Low-Level Waste (MLLW)
- Contact Handled (CH)
  - TRU alpha radionuclides present
  - No TRU alpha radionuclides present
- Remote Handled (RH)
  - TRU alpha radionuclides present
  - No TRU alpha radionuclides present

step in this process is the determination of whether the treatment requirement for the contaminant(s) is concentration based or if a technology based standard has been established. The technology based standards are presented in 40 CFR 268.42. The concentration based standards appear in 40 CFR 268.43. Care must be taken in analyzing the treatment technology options based on these requirements. The BDATs have been demonstrated for pure materials with no allowances for matrix effects. Since the matrix is the larger fraction of the waste, its chemical and physical properties will tend to dominate any process.

The mixed wastes data presented in this report have been organized based on physical/chemical matrices. Clustering the wastes by matrix facilitates the consideration of technologies which are capable of treating a range of contaminants in a common matrix. Physical/chemical matrix, as used in this report, generally refers to physical form (i.e., liquid, sludge, or solid). DOE has defined several physical/chemical matrix categories to represent key waste groups from a treatment perspective. These categories are described below.

Organic Liquids : Organic liquids are liquid materials comprised mainly of petroleum distillates and halogenated solvents. For this report organic liquids are any pumpable fluids, liquids and slurries, with a total organic carbon content of at least one percent. The organic liquid may or may not be the hazardous component of concern. Solvents are the primary type of organic liquid waste. Lab-packs containing organic liquids are grouped under lab packs.

Aqueous liquids: Aqueous liquids consist of aqueous solutions and slurries. The total organic carbon content is less than 1%. Some aqueous liquids are waste waters but not all will meet the EPA definition of wastewater under RCRA because they contain greater than 1% total suspended solids. Non-wastewaters may contain suspended solids up to the pumpable limit. In the site specific sections of this report, aqueous wastes are further subdivided based on EPA's definition of wastewater and non-wastewater for the LDR program.

Organic sludges and solids: Organic sludges and solids are solid or semi-solid materials, not meeting the definition of debris, comprised primarily of organic materials. Semi-solid materials include highly viscous, non-pumpable materials. Organic sludges and solids are generally homogeneous materials. Materials containing more than 50% debris are classified as debris.

Inorganic sludges and solids: Inorganic sludges and solids are solid or semi-solid materials, not meeting the definition of debris, comprised primarily of inorganic or mineralogic materials other than soil. Semi-solid materials include highly viscous, non-pumpable materials. Inorganic sludges and solids are generally homogeneous materials. Cemented solids, or waste that have already been mixed with cement, are considered a separate sub-category of homogeneous solids. Materials containing more than 50% debris are classified as debris.

Cemented solids: This category includes liquids, sludges or miscellaneous solids that have been solidified/stabilized with portland cement or other solidifying agent but do not meet LDR treatment standards.

Organic debris: Organic debris includes wastes with matrices meeting the definition of debris. This is primarily discarded rags, plastic, rubber, paper, wood and gloves, protective clothing, and animal carcasses.

Inorganic debris: Inorganic debris includes primarily discarded materials, equipment and structures. This consists of metal piping and equipment, glassware, windows, bottles, ceramics concrete, rocks and asphalt.

Heterogeneous debris: Heterogeneous wastes include wastes meeting the definition of debris but which are mixtures of organic and inorganic debris or debris with soils or process solids up to 50% of the total wastes.

Soils: Soils with <50% debris
Soils are geologic materials less than 2.5 inches in diameter.

Labpacks: Labpacks include wastes with one or more small containers of free liquids or solids surrounded by solid adsorbent material in a larger container. These categories include discard chemicals, scintillation vials. "Labpacks with metals" contain one or more RCRA Toxic Characteristic (TC) metal. Labpacks not contaminated with TC metals are categorized as "Labpacks without metals".

Reactive metals: Reactive metals include bulk reactive metals that when mixed with water generate toxic or flammable gases. Bulk reactive metals include sodium, alkali metals, aluminum fines, uranium fines, and other pyrophoric materials.

Explosives: Explosives include waste materials that may explode during normal or extreme handling. This includes discard high explosives materials and nitrated celluloses.

Compressed gases: Compressed gases include discarded pressurized gas cylinders and aerosol cans.

Liquid mercury: Liquid mercury includes any waste containing bulk quantities of liquid mercury.

Elemental lead/Lead shapes: Elemental lead includes both surface contaminated and activated elemental lead. Activated lead includes material activated by neutron or accelerated particle absorption. Surface contaminated lead includes bricks, shipping casks and other shielding materials.

Beryllium dust: This category includes only beryllium dust in bulk amounts.

Batteries: Batteries are primarily lead acid and cadmium batteries.

Other wastes: This includes any wastes which cannot be placed into any of the above categories. This also includes mixtures of wastes not otherwise defined.
The physical/chemical matrix is important to waste treatment selection because it determines how a waste can be transported through a treatment process (e.g., by pumps and piping versus conveyors). It affects pretreatment as well as the process and system configuration and capability to destroy, remove, or immobilize hazardous and radioactive contaminants in the waste. For instance, because water has a very high heat capacity and boiling point, it is difficult to use incineration to destroy hazardous organics in wastewaters. EPA hazardous waste regulations are based on recognition of the constraints that the waste matrix places on treatment options. This will be examined in more depth after the contaminant code categories are discussed.

6.3.4 RCRA Hazardous Components

EPA waste treatment standards are specified as technology standards (TS) or concentration based (CB). Where EPA has designated a treatment technology that has been determined to be the best demonstrated available technology (BDAT), an alternate technology may be used if it has been demonstrated to EPA to achieve equivalent treatment of the regulated constituent. In other cases, EPA has specified a concentration based standard for the waste. Any treatment (excluding dilution which is categorically prohibited) may be used to meet concentration based standards.

While EPA has defined waste codes for many specific contaminants, many of these contaminants can be treated using the same technologies. In general, hazardous organic contaminants are complex molecules that can be destroyed by breaking them down to less hazardous compounds. Toxic metals, on the other hand, generally cannot be broken down beyond their elemental level, but instead must be removed from a waste or immobilized to reduce the possibility that they will migrate in the environment.

Table 6.3-2 is presented to provide a framework around which the following discussions, dealing with RCRA regulated contaminants, will be structured. In order to simplify initial discussions the RCRA regulated contaminants (commonly found in DOE wastes) have been grouped into clusters, that require similar treatments. The waste codes that are missing in Table 6.3-2 were omitted by reason of lack of significance in DOE waste streams. DOE has clustered its wastes into broad, regulated constituent groups as summarized in Table 6.3-3. These clusters were chosen to simplify considerations of the various contaminant/matrix combinations. The contaminant clusters were formed such that the required treatment is similar for each member of the cluster. Over the assortment of mixed wastes that DOE manages, almost any combination of waste matrix and contaminant can be found. These clusters and how they affect treatment are described below.

Organic Contaminants. Organic contaminants include toxic compounds. While the toxicology of these contaminants may vary considerably, they are generally treated by degrading them to nonhazardous forms by chemical, thermal, or biological processes. Halogenated organics are an important subcategory of organics due to their generally low heats of combustion, high toxicity, and potential to liberate acid gases when thermally destroyed.

Metal Contaminants. As noted above, toxic metal contaminants cannot be degraded beyond the elemental level, where they generally continue to pose health or environmental risks. EPA has defined as hazardous, wastes with sufficient leachable quantities of the following heavy metals; arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Other metals, such as beryllium and vanadium are also of environmental concern in certain forms. Wastes containing metals are most commonly treated to immobilize the metals, however, inherently hazardous wastes composed primarily of metals (e.g., lead shielding) often offer good opportunities for recycling. Due to the unique nature of mercury (e.g., its volatility and toxicity) DOE has subdivided metal-bearing wastes into two groups based on whether they contain mercury. Since mercury is a volatile species, it cannot be immobilized by the same technologies as the other metals and must be removed to be treated separately.

TABLE 6.3-2

EPA Codes for RCRA Wastes

D001	EPA Code for ignitable wastes
D002	EPA Code for corrosive wastes
D003	EPA Code for reactive wastes
D004-8, 10, 11	EPA Codes for the toxic metals excluding mercury
D009	EPA Code for mercury
D012-43	EPA Codes for pesticides and toxic organic compounds
F001-6	EPA Codes for wastes from non-specific sources
K	EPA Code for wastes from specific sources
P	EPA Code for discarded chemicals that are acutely hazardous
U	EPA Code for discarded chemical that are toxic, reactive, ignitable or corrosive

TABLE 6.3-3

Regulated Constituent Code Sets

Toxic organic contaminants
Toxic metal contaminants contains mercury does not contain mercury
Characteristic contaminant ignitable corrosive reactive

Ignitable, Corrosive, and Reactive. DOE has categorized characteristic wastes together as a single group for this report. This set of wastes will require specific treatment for the characteristic designated. Reactive metals such as sodium and powdered uranium will react with water to produce dangerous quantities of hydrogen. Slower reactions must be used to oxidize these metals. Corrosives such as acids and bases are subjected to neutralization. Ignitable liquids can sometimes be used for fuel substitutes under certain conditions.

6.4 Matrix/Contaminant Combinations Found in DOE Wastes

The physical/chemical matrices and the regulated constituent codes discussed previously can be combined to indicate the various possible wastes that must be addressed. At this combined level, within the DOE waste inventory, almost any combination of waste matrix and contaminant code will occur. Some combinations are physically excluded by the nature of DOE operations. While most combinations do occur in some waste streams, most wastes contain a limited number of regulated constituents.

There are also some general observations that can be made. Aqueous solutions often have trace organics but more commonly they are corrosive with metal contaminants. Inorganic sludges are a significant portion of the total inventory. These sludges frequently result from precipitation and filtration steps taken to remove contaminants from aqueous streams. The most common contaminant of inorganic sludges will be precipitated metals. Trace organics may be present or suspected to be present. Organic contaminants tend to be present in organic liquids, organic debris, (solvent rags), and organic sludges. Regulated organic contaminants may also be found in aqueous (wastewaters), emulsions, asphalt, and soils from spill cleanups. They may also occur in most of the debris types found in the DOE system.

6.5 Waste Categories, Management and Treatment

6.5.1. Waste Categories and Treatment

There is a wide variety of technologies that are applied to the treatment of waste. However, as mentioned above, RCRA has specified standards for the treatment of most regulated hazardous wastes. A simple statement of the required goals would be that reactive materials must be rendered unreactive, all hazardous organics and inorganics (non-metallics) must be destroyed, toxic metals must be immobilized, and corrosives must be neutralized. The LDR technology based treatment standards are described in 40 CFR 268.42 and debris related treatment standards are enumerated in the Federal Register, 57(FR, p.37278) (August 13, 1992). In addition to the technology based standards there also concentration based standards listed in these same sources. These standards state the concentration limits allowable for compliant land based disposal of materials containing regulated constituents.

Table 6.5-1 lists the technology based treatment standards and their technology codes. Table 6.5-2 lists the debris related alternate treatment standards and their technology codes. The technology standards are listed alphabetically. However, they are ordered by groups related to the output of the process in Figure 6.5-1. Eight of the technologies are directed toward chemical destruction or modification of the target contaminant. Eleven of these technologies are directed toward recovery of a material. A twelfth, NLDBR, is a generic standard which can include the eleven recovery

TABLE 6.5-1

Technology Based Treatment Standards (from 40 CFR 268.42)

ADGAS	Venting of a compressed gas onto an absorbing or reacting medium
AMGLM	Amalgamation of elemental Hg contaminated with radionuclides using Cu, Zn, Ni, Au, or S
BIODG	Biodegradation of organic or nonmetallic inorganics
CARBN	Carbon adsorption of nonmetallic inorganics, organometallics, and/or organics
CHOXD	Chemical oxidation or electrolytic oxidation using one of a list of specified oxidizers
CHRED	Chemical reduction using one of a list of specified reducing agents
DEACT	Deactivation to remove hazardous characteristics, e.g. corrosivity, ignitability, reactivity
FSUBS	Fuel substitution in units operated in accordance with applicable technical standards
HLVIT	Vitrification of high-level mixed radioactive wastes
IMERC	Incineration of wastes containing organics and mercury
INCIN	Incineration in units operated in accordance with 40 CFR 254 and 40 CFR 265
LLEXT	Liquid- extraction of organics
MACRO	Macroencapsulation with surface coating and contacting materials
NEUTR	Neutralization with acids, bases or water
NLDBR	No land disposal based on recycling
PRECP	Chemical precipitation of metals or other inorganics with a selection of anions, etc.
RBERY	Thermal recovery of beryllium
RCGAS	Recovery/reuse of compressed gas
RCORR	Recovery of acids or bases with one of a list of specified technologies
RLEAD	Thermal recovery of lead in secondary smelters
RMERC	Roasting or retorting for the volatilization, capture and recovery of Hg
RMETL	Recovery of metals using one of a list of specified technologies
RORGS	Recovery of organics using one of a list of specified technologies
RTHRM	Thermal recovery of metals or inorganics as described in 40 CFR 260.10
RZINC	Resmelting for the recovery of zinc
STABL	Stabilization with Portland cement, lime/pozzolans with possible additives
SSTRP	Steam stripping of organics from liquid wastes
WETOX	Wet air oxidation
WTRRX	Controlled reaction with water for highly reactive organics and inorganics

TABLE 6.5-2

Debris Related Alternative Treatment Standards

Extraction Technologies

(PE) Physical Extraction

Abrasive blasting
Scarification grinding
Spalling
Vibratory finishing
High pressure steam and water sprays

(CE) Chemical Extraction

Water washing and spraying
Liquid phase solvent extraction
Vapor phase solvent extraction

(TE) Thermal Extraction

High temperature metals recovery
Thermal desorption

Destruction Technologies

(BD) Biological Destruction (biodegradation)

(CD) Chemical Destruction

Chemical oxidation
Chemical reduction
Thermal destruction

Immobilization Technologies

(MAE) Macroencapsulation

(MIE) Microencapsulation

(SE) Sealing

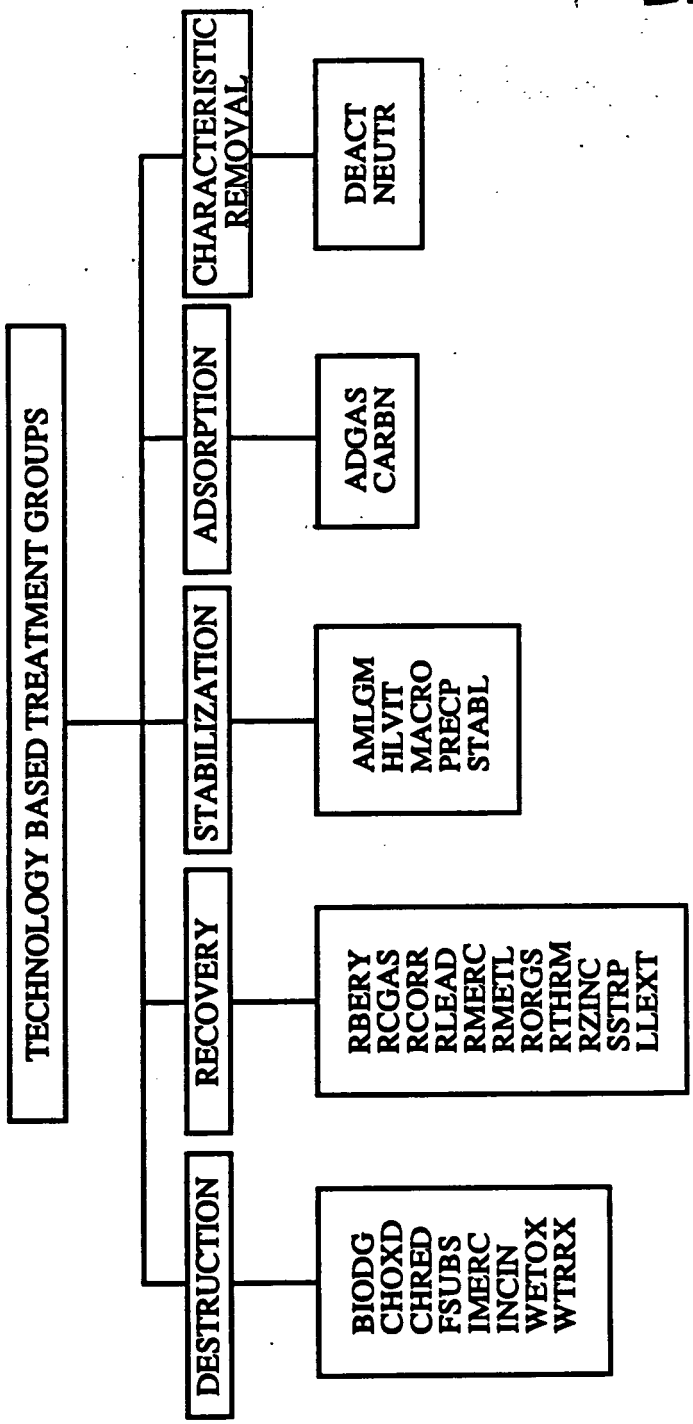

FIGURE 6.5-1

Technology Based Treatment Groupings

technologies. Another group of five address stabilization or immobilization techniques. Two technologies concern adsorption technologies for treating gases and liquids. The final two remaining treatments, are concerned with removing acidity and basicity as well as other hazardous characteristics, e. g. reactivity and ignitability. In later discussions of the various technology development activities that are being pursued within DOE, these groupings will be used to provide the organizing framework for the new or altered technologies.

Figure 6.5-1 illustrates these groupings. A further splitting of these groups into treatments directed toward destruction of organic or inorganic contaminants is seen in Figure 6.5-2 which shows how the technology codes would be distributed. Assignment of BDATs to the recovery of regulated constituents from organic and inorganic matrices is illustrated in Figure 6.5-3.

The recovery standards are heavily emphasized for the metals as is chemical conversion for anions. It should be noted that stabilization is recommended for very few of the EPA codes (only a few of D, F, P, K, and U codes, 40 CFR 268.42). Any stabilized wastes must pass specific leach tests to demonstrate compliance with the Constituent Concentration in Waste Extract (CCWE) requirements. It is significant to note that in the Debris Rule (Federal Register,57[160], p.37280[August 1992]) immobilization has been designated BDAT for all waste types and all contaminants.

In later discussions of technology development for mixed waste treatment these groupings and the treatments themselves will be used to help categorize the technologies which are being studied. By providing this tie to the Technology Based Treatment Standards for the technology development efforts, it will be possible to relate the technology development activities to specific contaminants.

6.5.2 Waste Management Operations Overview

Treatment is only one element of the overall waste management operations. Other elements of the management process include characterization, retrieval, preprocessing, transportation, disposal, etc. There are a variety of technology and engineering issues associated with these ancillary waste management functions. Waste that has been previously dispositioned or stored has several steps such as characterization and retrieval which must occur prior to the treatment step. Newly generated waste does not have a retrieval step. However, characterization and waste handling activities are still required parts of the waste management process. Characterization is the important initiating step from two points of view. At a fundamental level a treatment process cannot be designed until the waste radionuclide content, matrix, and its RCRA constituents of the waste are understood well enough that a safe, effective treatment system can be designed. Secondly, waste cannot be shipped to an existing treatment facility until it is determined that the waste acceptance criteria are satisfied.

Characterization is the first step in the waste management process. A waste stream can be characterized in two different ways: by process knowledge or by sampling and analysis. When a waste stream is characterized by process knowledge, the constituents of the waste stream are those which comprised the process feed and which were not consumed in the process. Known byproducts from the process are also included. The more difficult and expensive method for waste characterization is sampling and analysis. This process involves gathering representative samples and subjecting them to a variety of materials characterization techniques (both chemical and radionuclide analysis for mixed waste). There are a number of important issues which arise when discussing characterization such as representative sampling and cost (in sampling and analysis methodologies). Also at issue is the accuracy of process knowledge.

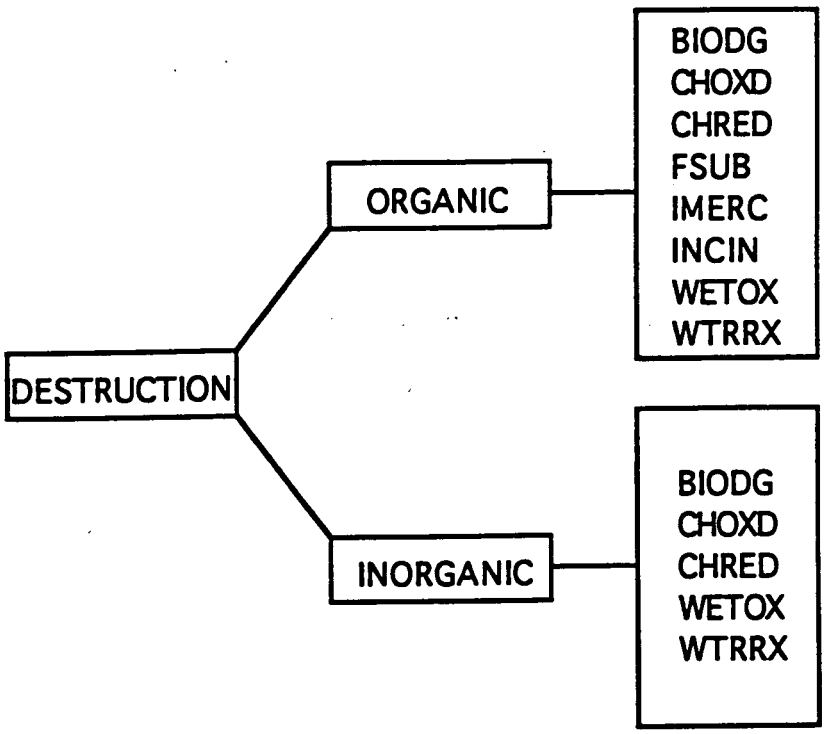

FIGURE 6.5-2

Destruction technologies

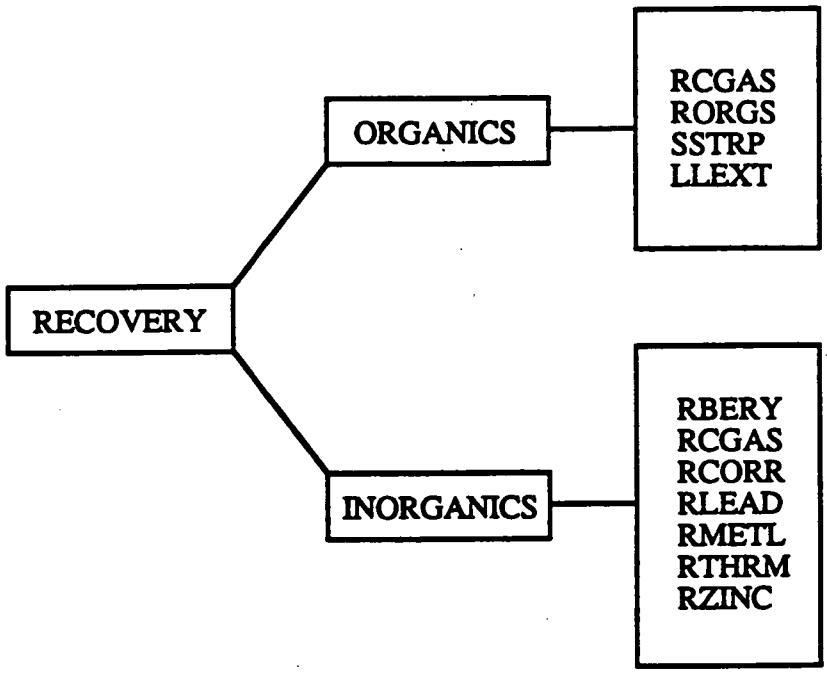

FIGURE 6.5-3

Recovery Technologies

Characterization and its related activities, monitoring and sensing, are crucial parts of the waste management process. As mentioned above, the design of a waste treatment facility cannot be started without waste characterization data. Characterization issues are even more significant when considering waste generated and stored prior to issuance of RCRA regulations. These wastes may be poorly characterized or have incomplete records. Characterization of legacy stored waste is currently a topic of active technology development and discussion. An issue is the level to which such waste must be characterized. What level of characterization will be required for treatment? Does such waste have to be given a full RCRA screening or can it be characterized at a minimal level sufficient to provide enough data to provide a safe and effective process? A characterization to provide safe and effective treatment would cost much less than a full RCRA screening. A full RCRA characterization of a drum of DOE waste could cost more than $100,000. The characterization costs for DOE wastes under these circumstances would reach trillions of dollars.

The related areas of monitoring and sensing are aspects of characterization that allow control of processes. As elements of the waste operations sequence, they have important influences on which waste treatment processes are chosen and how they are operated. The lack of appropriate process monitors and sensors for a treatment technology will seriously impede its inclusion in a treatment train.

Transportation of the waste from its source or storage point to the waste treatment facility is the first operation in which the differences between CH and RH waste become apparent. CH waste containers may be moved and handled by commonly employed contact methods and equipment, e.g. human hands, manually moved dollies, etc. However, RH waste (material which exceeds 200 mr/hr at contact) has considerably different requirements. There is a broad range of activity levels in the RH waste category, ranging from moderate beta/gamma activity, mixed low level waste to very intense beta/gamma emissions from high level waste generated by nuclear fuel reprocessing operations. The existence of these differences in radiation characteristics with the concomitant differing requirements for personnel protection does not change the objective of the waste handling operations which is to move the waste from the source to the treatment facility but does increase the complexity of the waste handling activity for RH material. These differences also illustrate why the first parameter used in sorting waste into management sets is the radiation category.

Advances in computing power in small processors and in computer/machine interfaces are having an impact on the development of remote and robotic waste handling equipment and strategies. Robotic and automated systems for waste characterization and handling are beginning to replace manual/remote systems for handling waste in high radiation environments and are being developed for retrieval of waste from underground storage tanks. Remote/robotic stacker retriever systems have been investigated for the handling of boxed or drummed waste into, and treated waste out of, the plant. Waste handling operations can also include preparation operations such as sorting, sizing, and shredding. Some waste treatment methods may require opening boxes and/or drums with subsequent separation of the wastes from these containers. These will be non-trivial activities for RH waste.

It is important to remember these functions of waste management are necessary, in addition to treatment. The existence of a good treatment system is not an advantage if there is no technology to answer a problem presented by one of the other waste management activities. Discussions of specific treatment and waste management technologies at this point could place undue emphasis on particular technologies. More definitive indications of technology choices and possibilities will be

found in the subsequent discussions of waste types, site-specific chapters, the technology development descriptions later in this chapter and in Appendix B.

6.5.3 Waste Treatment Approaches for Multi-Component Wastes

The goal of waste treatment is to process the material so that it is destroyed or the resulting material is in a compliant disposable form. Since mixed waste contains both a RCRA regulated constituent and a radionuclide, there is no process that will entirely destroy the waste. The toxic metals are elemental substances that cannot be destroyed. Treatment is often based on multiple process steps, treatment trains, and often has interconnected operations with parallel processing lines.

DOE wastes streams can be highly complex. Some streams contain contaminants from more than one hundred of the listed waste codes. There is a wide range of matrices in which these contaminants are found. Table 6.5-3 was designed to aid in the simplification of the discussion of waste types, the treatment types, and the treatment considerations that are driven by the waste matrix. The table indicates RCRA contaminant and matrix concerns that must be dealt with after the approach to dealing with the radioactive classification has been determined. The table contains a partial indication of the RCRA treatment standards that might apply to the matrix types associated with different contaminants.

The rows in the table are identified with the dominant matrix for a given waste, i.e. organic liquids would include organic based solvents, oils, etc. contaminated with a radionuclide and/or RCRA regulated constituents. The aqueous liquids category covers aqueous solutions of RCRA regulated organics and inorganics in the company of radionuclides. These waste matrix categories were chosen in order to group waste streams with similar matrix characteristics. The matrix governs how the waste is initially handled, the feed preparation or pretreatment required, and the types of treatment that can be applied to the RCRA constituents. The second column from the left in Table 6.5-3 contains a listing of the types of wastes in the general matrix category of each row. This list of waste matrices was used to define the categories of waste to be reported by the DOE sites in the site-specific waste stream inventories. The waste stream inventories appear in the site-specific chapters later in this report.

The middle column in this table indicates the appropriate disposition of the matrix which ,in most cases, should be the bulk of the waste. The activities, described by the two column headings at the right of the table, indicate what treatment standards apply to the RCRA regulated component. It is in this portion of the table that the similarities of the treatment goals are apparent. However, while there is superficial similarity indicated in the RCRA treatment goals (proceeding down a column) for each of the rows, it is not necessarily true that a given organic destruction technique will be applicable to all waste matrices in a specific case. The indications of applicable treatment standards in the last two columns are intended to be representative, not complete. Later discussion will provide more detail and resolution for the relationships that these broad categories have with respect to detailed treatment requirements. For example, the following list of treatment standards could be applicable to aqueous liquids under a variety of different circumstances depending on the constituents and their concentrations.

- biodegradation
- carbon adsorption
- chemical oxidation

TABLE 6.5-3

Example Treatment Options for Differing Waste Matrices

General Waste Matrix Category	Waste streams	Matrix disposition	RCRA organic treatment	RCRA inorganic treatment
Organic liquids	Organic liquids	Organic destruction	INCIN, LLEXT	STABL,IMERC (inorg. residue)
Aqueous liquids	Aqueous liquids	Evaporation, ion exchange	WETOX,CHOXD CARBN	PRECP,CHRED RMERC,STABL
Organic solids	Homogeneous organic solids Organic sludges/ Particulates	Organic destruction wash, leach and recycle	INCIN,CHOXD (applied to extract, wash or leachate)	STABL,RMERC (inorg. residue) CHRED,CARBN (aqueous washes, etc.)
Inorganic solids	Homogeneous inorganic solids Inorganic sludges/ Particulates, Cemented Solids	Extract, wash, leach and direct dispose	INCIN,CHOXD (applied to extract, wash or leachate)	STABL,RMERC (inorg. residue) CHRED,CARBN (aqueous washes, etc.)
Soils	Soils Soils with<50% debris soils	Extract,wash, leach and direct dispose	INCIN,CHOXD (applied to extract, wash or leachate)	STABL,RMERC (inorg. residue) CHRED,CARBN (aqueous washes, etc.)
Debris	Organic Debris Organic debris	Extract, wash, leach, or immobilize and direct dispose as appropriate under the debris rule	INCIN,CHOXD (applied to extract, wash or leachate)	STABL,RMERC (inorg. residue) CHRED,CARBN (aqueous washes, etc.)
	Inorganic Debris Inorganic debris Heterogeneous debris	Extract, wash, leach, or immobilize and direct dispose as appropriate under the debris rule	INCIN,CHOXD (applied to extract, wash or leachate)	STABL,RMERC (inorg. residue) CHRED,CARBN (aqueous washes, etc.)

TABLE 6.5-3

Example Treatment Options for Differing Waste Matrices
(Continued)

General Waste Matrix Category	Waste stream sets/with numbered subcategories	Matrix disposition	RCRA organic treatment	RCRA inorganic treatment
Other Wastes	**Lab Packs** Lab Packs with Metal, Lab Packs without Metal	Extract, wash, leach, or immobilize and direct dispose	INCIN,CHOXD (applied to extract, wash or leachate)	STABL,RMERC, CHRED,RMETL
	Reactive/dangerous Reactive Metals, Explosives, Compressed Gases	Extract, wash, leach, or immobilize and direct dispose	DEACT,WTRRX, RCGAS,ADGAS	STABL,DEACT,
	Inherently hazardous Liquid Mercury, Elemental Lead, Beryllium Dust, Batteries	Extract, wash, leach, or immobilize and direct dispose		AMLGM, MACRO,HLVIT, RTHRM,Recycle
	Misc. Other Other	Varies, see discussion		

- chemical reduction
- deactivation
- liquid-liquid extraction
- neutralization
- precipitation
- recovery

The remaining waste matrix rows in the treatment summary tabulation have similar groupings of treatment standards that are applicable under varying conditions.

Recent amendments (August 1992) to the LDR regulations have been promulgated with respect to appropriate treatments for debris. Physical, chemical, and thermal extraction have been described as appropriate treatments. Destruction by biological, chemical, or thermal means is also applicable. Macroencapsulation, microencapsulation, and sealing complete the suite of acceptable treatment technologies for debris. The wastes resulting from the application of physical, chemical or thermal extraction techniques to debris are to be treated by the appropriate standards.

6.5.3.1 Treatment Systems

A waste treatment system can be designed to treat a variety of waste streams and as such will contain many unit operations. A treatment train is a useful concept in discussing an operational waste treatment facility. A treatment train is a sequence of operations (unit operations) that each act on a waste to alter it in such a way as to prepare it for the next operation in the train with the ultimate goal of preparing a waste suitable for disposal under the requirements of RCRA and the Atomic Energy Act (AEA). Discussion of a potential treatment scheme for an organic sludge contaminated with radionuclides, RCRA regulated organics, and a toxic metal (Row three in Table 6.5-3) serves as an example. Since the matrix is organic and there is a RCRA organic component, a thermal destruction of the matrix material as first step in a treatment train would destroy the matrix and the RCRA organic simultaneously. In an idealized system the secondary waste stream produced by this process would be an inorganic ash containing the toxic metal and the radionuclide. The next operation in the train would involve immobilization of the ash in a stable form (that will meet RCRA TCLP requirements) such as grout, vitrified material, etc. This treatment train a straightforward two step process that takes the waste to a final disposable form.

Frequently, however, treatment trains are not so straightforward. An inorganic sludge could be used as a more complicated example. Assume this inorganic matrix has incorporated RCRA organics and RCRA inorganics as well as radionuclides. The contaminants dictate that more than a single treatment must be used since the treatment based standards for organics and inorganics are different. A dewatering process could be envisioned as the first step in a treatment train. The recovered water from this process might need to go through a thermal or other oxidative process to destroy the soluble RCRA organic fraction. This treated aqueous stream could still contain soluble RCRA inorganics and radionuclides and would require treatment in the next step in the treatment train. The dried solid from the first step would embark on a parallel treatment path and might be subjected to a vitrification process which would immobilize the RCRA inorganic and the insoluble radionuclides. Alternatively, a separation step might be employed to separate the hazardous components from the inorganic matrix in order to reduce the treatment volume in the final steps. One might also consider direct thermal processing of such a sludge with the objective of driving off water, destroying the organic, and fixing the inorganic and radionuclides in a single processor. Such a process could be adapted from currently available technology. The process would need to be operated as to assure destruction of organics that are carried off with the moisture during initial

heating and to assure the reproducible production of a treated residual that will meet the requirements of the applicable leach test.

This discussion of treatment trains is useful in understanding that even for a homogeneous waste such as an organic liquid the number of steps in the treatment train is often dependent on the numbers and types of contaminants. In the course of treating more complex mixtures such as sludges or soils, as treatment moves across the treatability table removing regulated wastes from the matrix, secondary waste streams are generated. These secondary waste streams are often less complex and belong in matrix categories in earlier parts of the treatability table, e.g. aqueous or organic liquids. Any hazardous waste produced will still be subject to the appropriate RCRA treatment.

These treatment train interrelationships are the core around which a comprehensive treatment facility can be developed. While the key steps, organic destruction and metals fixation, receive the initial attention, all operations throughout the treatment train must be examined for technology improvement needs. For analysis of the total number of processing steps in a facility planned for treatment of more than one or two waste streams, it is necessary to develop a flowsheet for the plant processes. Engineering analyses then are used to optimize the facility. For example, the facilities used for treating the organic or aqueous secondary waste streams from a sludge processing operation, as described above, could be designed with enough capacity to coprocess a primary organic or aqueous waste stream from other sources and, thus, provide a multifunctional facility.

Some of the MLLW treatment technology is being adapted from processes developed for processing radioactive materials containing no regulated constituent. An example is the incinerator development efforts throughout DOE. These programs were originated for incineration of low-level or transuranic wastes. When RCRA requirements were imposed, the incinerators were tested and or operations modified to meet the incineration-destruction requirements for PCBs and RCRA organic constituents. Adapting technologies to treatment of all classes of mixed wastes does not always work so readily. In cases where incineration of a waste leads to 95-99% waste matrix destruction, the resulting concentration of radionuclides into the residuals may increase the radiation source term and may lead to criticality concerns. On the other hand, designs of critically safe configured equipment are usually limited to eight inches or less in internal diameter. An incinerator for combustibles can not be made to operate to achieve the RCRA organic destruction requirements at that small scale. In such a case, an otherwise permittable technology can not be employed. Therefore an alternative approach which can be built at the small scale must be developed for implementing at the criticality limited sizes.

6.5.3.2 Wastes for Which no Treatment Technology Exists.

The following discussion covers the different degrees of availability of the waste specific technology treatment steps. For some wastes, technologies exist or are considered readily available based on previous commercial sector or DOE experience. No significant process modifications are required for the stream treatment of wastes with this determination.

In many cases it has been determined that the technology exists but must be modified for application to DOE mixed wastes. Most technology development efforts fall in this group. Modifications may include adaptations of design and operation to assure containment of radionuclides. Other modifications may be aimed at treatment of the mixed waste matrix. DOE mixed wastes range from aqueous solution to sludge to debris. Frequently, several types of debris or debris and soils and sludges may be mixed in one container. Destruction of regulated organic

contaminants in the presence of sludges or debris is much more complicated if all operations must be engineered to contain alpha emitters. As discussed in the incinerator example above, some technologies do not work at all desired sizes. Other technical approaches may not be applicable if they are difficult to seal adequately for alpha containment or are difficult to operate or maintain in enclosed environments.

For some wastes the technology selection and evaluation process has not begun. The wastes are not yet well enough characterized from sampling or process knowledge, to provide sufficient knowledge for technology evaluation. Sampling and analysis is both time consuming, hazardous, and costly. Policy issues such as the degree of characterization necessary in order treat the waste need to be addressed. Technology development is proceeding which will reduce both the cost and hazard involved in characterizing the wastes. It is expected, that once these wastes are characterized, most will have technologies available (with some modification) to provide treatment capacity.

For other wastes technology selection analysis and review is still going on. For this latter set of wastes it seems likely that technology with or without modification is available. Current engineering judgement is that technologies exist that require only adaptation to treat most DOE waste streams which have been characterized.

In the case of waste streams which have no treatment technology there are at least two approaches to resolving this problem. The first approach would be to embark on a technology development program that has the goal of producing a new technology capable of treating the waste. However, the task of inventing a process and developing that process to the point of plant scale operation can often take five to ten years. In cases where it can be shown that the treatment or concentration standards cannot be achieved due to characteristics of the waste that are dramatically different from those for which the standards were developed, the second approach would be to submit a petition for a treatment variation to the Administrator of the EPA (40 CFR 268.44).

There are currently only two waste streams which are identified in this inventory report (see Savannah River, Chapter 25.2) as fitting the classification of "No treatment technology exists." One of these streams, the in-tank precipitation filters, that will constitute an anticipated waste stream has been submitted to EPA for a treatment variance. These filters are large assemblies of stainless steel tubing which will filter the supernatant liquid after the in-tank precipitation. Over a period of time these filters will become clogged with material that is very radioactive. It will not be possible to remove enough of the activity by washing to make these filters safe to handle. The process of size reduction for treatment and the subsequent treatment would have to be carried out in a high radiation field environment. The means to accomplish these tasks safely is not apparent. The second stream is an oil recovered from equipment associated with tritium handling operations. This oil is contaminated with both tritium and mercury. While the BDAT for the oil is incineration or fuel substitution, these are not viable options because of the high levels of tritium complicated by the presence of mercury. Other technology options are being evaluated.

6.6 DOE Approach to Technology Development

DOE's Office of Technology Development (OTD) has fashioned a comprehensive needs-driven program based on input from Environmental Restoration (ER) and Waste Operations (WO). This program is designed to provide technologies, methods, processes, and analytical tools to achieve compliant and effective waste management and environmental remediation, with reduced personnel exposures, in a shorter time and at a lower cost than is possible with current techniques. In part,

OTD's mission includes management and direction of programs and activities to establish and maintain an aggressive national program for applied research, demonstration, and development (RD&D) to resolve major technical issues and rapidly advance beyond current technologies for environmental restoration and waste management operations. Through this program, OTD will focus, manage, and accelerate the technology generation cycle.

Consistent with the overall mission for the OTD, its strategic goals include: (1) focus applied Research, Development, Demonstration, Testing and Evaluation (RDDT&E) on needed solutions for the Technology Development (TD) customer within, including the Office of Waste Operations (OWO), the Office of Environmental Restoration (OER), Defense Programs (DP), Nuclear Energy (NE), and Energy Research (ER); (2) minimize duplication of technology development within the DOE complex; (3) leverage technology development through joint programs and consortia; (4) maximize technology transfer in and out of DOE; and (5) achieve early and broad regulatory acceptance for new or improved technologies.

6.6.1 Approach

OTD established major RDDT&E areas and programs to focus its efforts upon programmatic needs defined by the performance of DOE and EM missions. Three major RDDT&E program areas were defined: (A) Groundwater and Soils Cleanup, (B) Waste Retrieval and Waste Processing, and (C) Waste Minimization and Waste Avoidance. The Innovative Technologies Program stimulates the creativity of the technical community, including DOE National Laboratories, universities, and private industry. Supporting technologies that serve multiple applications, such as analytical laboratory management, robotics, international technology exchange, and risk management, are also provided. Technology development areas and program summaries are provided in Appendix B.

6.6.2 Discussion

Success for OTD is defined as the implementation of newly developed technologies in EM programs. Obstacles blocking success have been recognized, and the means for overcoming them are in place. The potential return on investment from the focused program planned for 1993 and beyond is great.

It is necessary to evaluate and prioritize users' needs and potential technology options that address those needs, evaluate and select proposals, and apportion resources among them. The process begins with a cooperative effort by the user community to identify its technology needs. Needs are identified, analyzed, and prioritized by ER and WO. These needs are based on operational roadmaps derived from appropriate laws, regulations, and agreements; from strategic planning and policy guidance; and from needs assessments by individual DOE sites. Following prioritization, each need is divided into relevant "technology groups," such as characterization technologies, site barrier technologies, waste treatment, etc. These technology groups form the basis for integrated programs. The solution to most waste management problems requires a technology system which assembles technologies from several groups. A close working relationship between the user community and OTD is necessary to ensure that all problems have been identified and that appropriate demonstrations are planned to address major problem categories.

OTD prioritizes the initiation of integrated demonstrations and the selection of technologies funded within integrated programs based on identified OER and OWM problems, needs, acceptance criteria, and other parameters, such as the frequency of occurrence across the DOE complex and

institutional and regulatory considerations. Estimated time for the implementation of the technology, likelihood of solving the problem, and availability of funds also affect priorities. Funding of work is based on the result of the prioritization process and subsequent application of evaluation criteria developed by OTD. These evaluation criteria include health and safety, cost and schedule, performance, regulatory and legal compliance, and institutional considerations. Industrial procurements follow a merit review process involving competitive procurements to select and award grants and contracts. In addition to technology needs, prioritization of applied research consider the severity of the problem addressed, timeliness, innovation, breadth of application, likelihood of success, and regulatory and social acceptability.

Within the major areas and programs, OTD uses integrated demonstrations (IDs) and integrated programs (IPs) to bring about the required organization and coordination. IDs are designed as full-scale pilot waste management operations in which alternative technical solutions to specific problems can be tested in parallel and in a context that includes consideration of all factors that bear on a full-scale operation - planning, regulatory permitting, and public acceptance. IPs assemble promising applied research activities to address one or more specific sets of waste management needs and provide a continuing mechanism to focus R&D activities to develop new technologies, evaluate their relative merit and suitability for various applicable IDs, and advance results rapidly to the Demonstration, Testing and Evaluation (DT&E) phase.

6.6.3 Additional DOE technology development

In addition to the EM Office of Technology Development (OTD) activities discussed above, other technology development activities supported in DOE (by DP, NE, ER, etc.) have been identified as potentially or directly applicable to needs across the DOE complex. Evaluations are ongoing to coordinate applicable technology development activities supported elsewhere in DOE with EM's needs. Indexed narrative descriptions of these activities are presented in Appendix B and these activities are listed in the Appendix B, Cross-complex Technology Development Treatability Summary Tables.

6.6.4 Site-Specific Technology Development

In addition to the broad based and longer range technology development activities , there are often urgent site specific technology development needs. A number of DOE's major sites have current agreements with their host states, EPA and other concerned parties. These agreements to which the parties have agreed and are signatories have distinct, enforceable milestones. These milestones may include such things as permit filing dates, Title I and Title II design delivery dates, and dates for start of construction for treatment facilities.

In support of the design activities which address the deliverables for these milestones sites are faced with the immediate task of making technology selections for their process flow sheets which describe the unit operations and their organization within the facilities. The technology selections need to be based on performance data which does not exist at this time. The generation of performance data for a specific DOE waste stream may be urgent enough to require the investing of short term resources in technology development activities to provide the data.

Performance data are not the only technology development activities necessary to meet these short term goals. As mentioned earlier there are many commercially available waste management technologies which have not been applied to DOE waste streams but should be adequate to the task with some modification. These "engineering adaptations" fall within the realm of technology

development. As above, the time constraints can be such that for this development need the use of local resources is required.

Technology development activities, such as those described above, often support the construction and commissioning of a line item waste treatment or management facility and as such are included as an integrated part of that program. Other such activities may be directed at individual waste streams or collections of streams which have increased in priority in the overall waste management strategy for a site. These changes in priority often have very short time scales in which to address the problem and are best addressed by local strategic decisions.

The site-specific technology development activities are discussed in detail in the individual site chapters. Site-specific technology development (TD) activity indexed narrative descriptions are presented in Appendix B and these activities are listed in the Appendix B, Site-Specific Technology Development Treatability Summary Tables. While these activities target site-specific needs, they have been identified as potentially applicable to other sites needs. Evaluations are continuing to match technologies to other sites needs.

6.6.5 Current Mixed Waste Technology Development Activities

As mentioned earlier, the details concerning individual technology development activities is presented at the end of the thirteen site chapters for which there are site specific development activities. Not all sites have technology development capabilities and not all sites are targeted by specific technology development work. A more global presentation of the technology development work which can be related to aspects of mixed waste management is found in Appendix B.

It is not the intent of this report to supply information on all environmental restoration and waste management technology development work (in excess of 630 programs) currently funded within the Department. The collection of technologies discussed here is the result of a sorting process in which those development programs which could have an effect on the management of mixed waste were selected. There are 267 technology development activities within DOE which have been determined to have an impact on mixed waste management.

The selection process was accomplished by two paths, and the results of the two paths were combined. The first part of the selection process was to request information from the sites concerning site-specific technology development activities which they were pursuing. In this case the sites selected the development activities which they deemed related to the management of mixed waste. The second part of the process was to examine the OTD funded programs to determine which of these could be considered to support mixed waste management.

An important distinction to be made here is the difference between "mixed waste treatment" and "mixed waste management". "Mixed waste treatment" is only one element of the "mixed waste management" process. The management process is comprised of such activities as waste minimization, characterization, retrieval, disposal, and pretreatment in addition to treatment. Any technology development activity that enhances the capability to carry out these supporting functions has been considered as part of the mixed waste technology development efforts for the purposes of this report. This is an important fact to keep in mind when looking at the technology development portions of the site-specific chapters and Appendix B.

For those sites which have relevant site-specific activities (These may be carried out at the site or on the site's behalf at some other location.), the technology development portion of the chapter will

contain a brief narrative which will lead to a table of technology development activity titles which have been linked to an appropriate BDAT. The RCRA BDATs, which were discussed earlier, are convenient baseline technologies to provide the context for classifying individual treatment technology development activities as they are presented in the site-specific chapters. The BDATs are listed in alphabetical order in each chapter. Within a BDAT group the development activities are listed by their ID number in ascending order. The ID number corresponds to the ID number of this technology development activity in the database which was used to compile the technology information. The technology summaries are arranged in ascending order, based on this number, following the table of titles.

The site-specific chapters contain technology development tables which have technologies listed which are not linked to BDATs. These technologies are related to waste management elements other than treatment. Characterization is the area with the greatest number of supported development programs outside of treatment with a total of forty-five supported activities (16% of the number of mixed waste related programs). Characterization is an area that is heavily supported since there are overlapping RCRA and CERCLA needs that can be addressed in parallel. Activities which have parallel CERCLA goals are addressing needs for field portable analytical chemistry instrumentation to speed the production of chemical characterization information. Also important is the development of non-destructive methods for the determination of the composition of waste contained in drums or other containers without opening the containers. Additional programs are directed at modifying EPA analytical procedures or devising procedures of equivalent performance to be utilized in environments which have been isolated for radionuclide containment.

The evaluation of final waste forms is another broadly supported activity with twenty-three active programs. RCRA specifies immobilization as the BDAT for many of the hazardous metals with stringent requirements on the leach rates of hazardous constituents from the final waste form. In addition, vitrification (HLVIT is a RCRA BDAT designation) is the specified technology for high level waste. In some of the technology lists are found HLVIT as a BDAT associated with final waste forms for wastes other than high level waste. This only implies that the waste form may match that of this BDAT, i.e. a vitrified product, and does not imply additional high level waste streams. There are a number of activities evaluating a variety of waste forms to determine if they are hazardous by TCLP leaching and if they satisfy physical durability requirements. Varying compositions of glass-ceramics and glasses are being evaluated for high level waste vitrification. Materials such as polyethylene, sulfur polymers, and iron enriched basalt formulations are being examined for their applicability as low level waste disposal forms.

An additional area of broad activity is in the application of robotics (at least thirteen programs) to radioactive waste management. The intent of these programs is to reduce worker exposure to radiation. However, an additional benefit to be realized from these developments will be an increased reproducibility in repetitive operations.

The majority of the remaining programs are directed at developing alternative treatment technologies to RCRA specified BDATs. As new treatment problems emerge the composition of the technology development program will be altered. As mentioned previously, there are a number of DOE mixed wastes which have not yet been sufficiently characterized to determine the appropriate treatment technology. If one or more of these wastes should fall into the "no treatment...." category, resources would be allocated to address the development opportunity.

Table 6.6-1 shows the distribution of technology development activities across the sites possessing the majority of the mixed waste. There are additional development activities distributed across six

smaller sites. One column of the table indicate the number of technology development programs in place at the site (Location). The next column shows the number of technology development activities that target mixed waste management issues at that site. It should be noted that the columns do not add up to 267. In the case of the Activities Targeted for Locations Column the reason for this discrepancy is the fact that many of the development activities being funded by OTD are cross-cutting technologies which are expected to have broad applicability rather than site-specific goals. The activity numbers listed for the locations do not combine to reach 267 either. This reflects the fact that a small number of development programs are being supported at smaller sites that are not included in this listing.

The chapters for those sites which have site-specific technology development will contain descriptions which tie some of the technology development activities to specific facilities which are in the construction or planning phases. Examples of such programs include the calcine immobilization studies at INEL which will support the eventual operation of the Idaho Waste Immobilization Facility. Other activities of this type are the evaluation of reverse osmosis, UV photooxidaton, and ion exchange processes to include the planned Liquid Effluent Treatment Facility at Hanford. The Consolidated Incineration Facility (to be constructed at the Savannah River Site) and the Controlled Air Incinerator (at Los Alamos) both have associated technology development activities related to the immobilization of the incinerator ash which will be a secondary waste stream having RCRA regulated constituents in both cases. The technology development summary sheets provide additional information concerning the need for a particular activity.

The previous discussions in this chapter as well as the additional material to be found in Appendix B and the site chapters provides an overview of the technology development programs and identifies the links between the development activities and some of the waste management problems associated with mixed waste. The information presented here is not yet complete and by its nature undergoes constant changes. This information will be subjected to corrections as well as periodic updates. The synthesis of the waste stream data and the current baseline of technology development activities will be used in the future as a planning tool to guide technology selection and development activities.

Table 6.6-1

Technology Development Locations and Targets

Site	Number of Technology Development Activities	Number of Technology Development Activities Targeted for Site
Hanford	29	6
INEL	28	8
Oak Ridge	18	6
LANL	46	21
LLNL	18	10
Rocky Flats	83	72
SNL	15	9
SRS	18	21

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7.0 Guide to Site Information

The 1992 Federal Facility Compliance Act (FFCAct-1992) requires the Secretary of Energy to submit mixed waste inventory reports to the Administrator of EPA and to the Governor of each State in which the DOE stores or generates mixed waste. Two inventories are required: a national inventory of all mixed waste currently stored by DOE and an estimate of quantities to be generated during the next 5 years, and a national inventory of DOE treatment capacities and technologies. The FFCAct (Sec. 105) specifically requires that the following information be included in the report.

The inventory of wastes shall include:

(a) A description of each type of mixed waste at each Department of Energy facility in each State, including, at a minimum, the name of the waste stream.

(b) The amount of each type of mixed waste currently stored at each Department of Energy facility in each State, set forth separately by mixed waste that is subject to the land disposal prohibition requirements of Section 3004 and mixed waste that is not subject to such prohibition requirements.

(c) An estimate of the amount of each type of mixed waste the Department expects to generate in the next 5 years at each Department of Energy facility in each State.

(d) A description of any waste minimization actions the Department has implemented at each Department of Energy facility in each State for each mixed waste stream.

(e) The EPA hazardous waste code for each type of mixed waste containing waste that has been characterized at each Department of Energy facility in each State.

(f) An inventory of each type of waste that has not been characterized by sampling and analysis at each Department of Energy facility in each State.

(g) The basis for the Department's determination of the applicable hazardous waste code for each type of mixed waste at each Department of Energy facility and a description of whether the determination is based on sampling and analysis conducted on the waste or on the basis of process knowledge.

(h) A description of the source of each type of mixed waste at each Department of Energy facility in each State.

(i) The land disposal prohibition treatment technology or technologies specified for the hazardous waste component for each type of mixed waste at each Department of Energy facility in each State.

(j) A statement of whether and how the radionuclide content of the waste alters or affects use of technologies described in subparagraph (i).

The inventory of treatment capacities and technologies shall include:

(a) An estimate of the available treatment capacity for each waste described in the inventory report.

(b) A description, including the capacity, number and location, of each treatment unit considered in calculating the estimated available treatment capacity under subparagraph (a).

(c) A description, including the capacity, number and location , of any existing treatment unit that was not considered in calculating the estimated available treatment capacity under subparagraph (a) but that could, alone or in conjunction with other treatment units, be used to treat any of the wasted described in the inventory report to meet the requirements of regulations promulgated pursuant to the land disposal requirements of section 3004 (m).

(d) For each unit listed in subparagraph (c), a statement of the reasons why the unit was not included in calculating the estimated available treatment capacity under subparagraph (a).

(e) A description, including the capacity, number, location, and estimated date of availability, of each treatment unit currently proposed to increase the treatment capacities estimated under subparagraph (a).

(f) For each waste described in the inventory report for which the Department has determined no treatment technology exists, information sufficient to support such determination and a description of the technological approaches the Department anticipates will need to be developed to treat the waste.

The Interim Mixed Waste Inventory Report presents the required information for a total of 50 DOE sites in 22 states. A Chapter is devoted to each state (Chapters 8 through 29) and the information is organized alphabetically by state and by site within each state. The following sections discuss how the required data were collected and how they are presented in each site section.

7.1 Data Collection

Mixed waste inventory and treatment facility data for this report were collected through data calls to the sites. Six sites - Hanford, Paducah, Savannah River and the three Oak Ridge sites (ORNL, K-25 and Y-12) - have provided quantitative mixed waste inventory data as of December 31, 1991; the other 44 sites' data are current as of December 31, 1992. The information provided represents each site's current record of stored waste and the best estimate of future waste generation.

Data was collected on waste streams, treatment facilities, technology development projects, and site environmental restoration programs.

7.2 Data Presentation

All site sections have two main subsections: a site discussion in text format and Waste Profile Sheets (WPS) that summarize the waste inventory information required by the FFCA. Sites that have technology development programs have a third subsection, Technology Development Summaries.

7.2.1 Site Discussion

Text for each site is organized according to the following format:

- Site Summary
- General Information
- Mixed Waste
  - High Level Waste
  - Mixed Transuranic Waste
  - Mixed Low-Level Waste
- Treatment Facilities and Technology
  - Existing Treatment Facilities
  - Planned Facilities
- Technology Development
- Environmental Restoration Program

Each site discussion begins with a general description of the site and its operations, with emphasis on activities that generate mixed waste. This is followed by a detailed description of the types of mixed waste (high level, transuranic and low-level) generated. Mixed waste inventory data are summarized by waste type and matrix (e.g., organic liquids, aqueous liquid) in tabular format. Treatment facilities and technology development are then discussed. If a facility is treating or plans to treat its mixed waste, the treatment information specified by FFCAct-1992 is discussed in the text and summarized in treatment facility tables. The treatment discussion is based on the following definitions:

> Treatment. Any method, technique, or process designed to change the physical or chemical character of waste to render it less hazardous, safer to transport, store or dispose of, or reduced in volume. (DOE Order 5820.2A)
>
> Capacity. Capacity of a facility is the annual process throughput, in m^3/yr under normal operating conditions. "Normal operating conditions" are defined as the shift schedule under which the facility normally operates; e.g., one 8-hour shift/day, 5 days a week.

Treatment information is presented in one or more tables, as needed, depending on the site. In some cases, tables were broken down to show different levels of treatment. Some treatments bring about volume reduction through compaction, or evaporation, but do not treat the hazardous component in the mixed waste. Other treatments may deactivate, immobile, or destroy the hazardous component. The tables in the treatment section reflect these different types of treatment, as appropriate.

The treatment section concludes with a summary table of the capabilities of current and planned treatment facilities at each site. This table lists the physical form of both the feed and the treatment product(s), the current operating status and whether a facility is intended for HLW, mixed-TRU, mixed-low-level, or a combination of these wastes. The table also summarizes relevant waste acceptance parameters for each facility, including whether or not the facility can accept remote or contact-handled

waste, waste with alpha radiation greater than 10 nCi/g, and/or waste containing mercury, other toxic metals, or toxic organics. Parameters marked as acceptable are still subject to concentration limitations.

A summary of site technology development programs follows the treatment facilities section. The text concludes with a discussion of the site environmental restoration program, if applicable.

7.2.2 Waste Profile Sheets

The waste inventory information required by FFCAct-1992 is contained in individual Waste Profile Sheets for each waste stream at each site. A sample sheet is shown in Figure 7-1. Each numbered WPS item (Figure 7-1) is discussed in the following sections.

In most cases DOE believes that based upon process knowledge, treatment technology exists for the mixed waste identified in this report. To avoid any confusion, DOE would like to clarify in several situations its approach to treatment capabilities. In one situation EPA has not determined BDAT for newly listed wastes. DOE does not feel that the lack of a BDAT should preclude identification of a potential treatment. DOE believes that process knowledge and the generic similarities of these waste streams to other mixed wastes allows DOE to propose treatments for these newly listed wastes. DOE would reevaluate the applicability of these treatments, once EPA publishes treatment standards.

In another situation DOE either has not completed waste characterization by lab analysis or has not started/completed treatability studies to validate the applicable technology. This particular case may be indicated on the WPS as not having started the technology assessment. However, DOE does have the process knowledge required to identify a potential treatment.

7.2.2.1 WPS Item #1: Header Block (RCRA Sec 3021(a) 2A as amended by FFCAct-1992)

The header block contains the names of the site, the state where the site is located, and the waste stream; the waste identification number (ID#), the waste matrix, and the waste type. The identification number may be a number assigned by the Waste Management Inventory System (WMIS) database, it may be a number assigned to the stream by the site to correspond with their State reporting, or it may be a number assigned by the Waste Management Input Program (MWIP) used to gather data for this report. The waste stream name is a short and unique name used as a stream identifier that may also correspond to the waste name used in the WMIS database. The waste type may be high level waste (HLW), mixed transuranic (MTRU), or mixed low-level waste (MLLW). The waste matrix categories are listed below:

Waste Matrix Categories

Organic Liquids	Aqueous Liquids
Organic Sludges/Particulates	Inorganic Sludges/Particulates
Organic Debris	Inorganic Debris
Heterogeneous Debris	Soil With <50% Debris
Soil	Lab Packs - With Metals
Lab Packs - Without Metals	Reactive Metals
Explosives	Compressed Gases
Liquid Mercury	Beryllium Dust
Elemental Lead (Activated and Non-Activated)	Multiple
Batteries (Lead Acid. Cadmium)	Other

4690

State: South Carolina ID #: 915

Site: SAVANNAH RIVER SITE

Waste Stream Name: M-AREA SLUDGE TREATABILITY SAMPLES-F006

Matrix: Cemented Solids Waste Type: MLLW

Waste Stream Description and Source:

This waste stream is stabilized sludge samples (F006 sludge) from 313-M stabilized with cement, or cement/flyash/blast furnace slag or vitrification samples. The samples are generated during waste treatability studies to determine the formulation for the stabilized wasteform. The samples remaining after testing are stored until a treatment/disposal facility is constructed.

Current Inventory as of December 31, 1991						Projected Generation 1992 through 1996	
Not Subject To LDR Prohibition		Subject To LDR Prohibition		TOTAL			
m^3	kg	m^3	kg	m^3	kg	m^3	kg
0.200	27.4	0.000	0.000	0.200	27.4	1.000	137.0

Treatability Group:

MLLW CH, Cemented Solids, Toxic Metals w/o Mercury

Treatment Status:

Plan to treat on-site at the planned M-Area Vendor Treatment facility. Treatment of the M-Area sludge will be either a cementatious or vitrification process. Technology exists but no facility is available at this time.

Technology Status:

Technology exists. No modifications are necessary.

Radiation Characteristics:

1) Contact-handled

Waste-Specific Radiation Effects on Treatment:

1) None.

Waste Minimization Activities:

1) Improved operating practices: changes in material handling and inventory procedures; waste segregation; and changes in production scheduling.

EPA CODES

Waste Characterization Basis: Sampling/Analysis

Waste Codes	LDR Basis	Best Demonstrated Available Technologies
F006	Conc.	Alkaline Chlorination followed by Chemical Precipitation; and Stabilization; or Incineration; or High Temperature Metals Recovery

Figure 7-1. Sample Waste Profile Sheet

235

Waste streams are frequently based on a common hazardous waste code rather than on a common waste form. For example, a waste stream entitled "Mercury-Bearing Wastes" could be liquid mercury, lab packs with mercury containing solutions, soil with mercury contamination, etc. Multiple waste matrices would be reported for this type of waste stream.

7.2.2.2 WPS Item #2: Waste Stream Description and Source (RCRA Sec3021(a)(2)(B) and (C), as amended by FFCAct-1992)

This item is a brief description of how the waste stream was generated and its contents. If possible, the waste stream is identified in terms of both location and process; e.g., "Building 800, laboratory analysis". For "generic" waste streams, such as aerosol cans, sources such as "facility-wide" or "site-wide" are used.

In preparing this report, DOE may not have employed a standard or uniform definition of a "waste stream". Each site used its own waste stream definition and criteria for determining the source of each mixed waste stream contained herein. While DOE realizes that this practice may have led to the use of inconsistent definitions of what constituted a waste stream, the Department adopted this approach because many of the wastes subject to the FFCAct-1992 are i) heterogeneous wastes, ii) wastes in storage, and iii) laboratory wastes. DOE believes that the individual sites possess the best knowledge of the wastes that they generate and manage, and would be in the best position to identify distinct waste streams and their sources as required by FFCAct-1992 . DOE is currently working with its sites to formulate a uniform definition of what constitutes a waste stream, and will update this report to employ this new definition where appropriate.

7.2.2.3 WPS Item #3: Waste Inventory Block (RCRA Sec3021(a)(2)(B) and (C), as amended by FFCAct-1992)

The waste inventory block lists the current inventory that is subject and not subject to the land disposal prohibition requirements and the projected 5-year generation for each waste stream. Amounts are listed in cubic meters and/or kilograms. If a site reported stored inventory as of December 31, 1991, the 5-year generation covers the years 1992 through 1996; if stored inventory is as of December 31, 1992, the 5-year period is 1993 through 1997.

7.2.2.4 WPS Item #4: Treatability Group

Treatability groups categorize waste streams according to both their radiation, waste matrix, and hazardous characteristics for treatment purposes. In addition to the waste matrices listed above, the treatability group includes the waste type (HLW, MTRU or MLLW), whether the stream is contact-handled (CH) or remote-handled (RH), or if the stream requires containment of transuranic alpha-emitting radionuclides (AL). The treatability groups also indicate if the waste contains toxic organic or toxic metal contaminants, or if the waste is hazardous only because of hazardous characteristics (e.g., ignitable, corrosive, or reactive.

7.2.2.5 WPS Item #5: Treatment Status

The treatment status of each waste stream may be one of the following statements:

Currently being treated (on-site, off-site, at a site-specified facility).
Plan to treat off-site at an existing facility.

Plan to treat on-site at (a site-specified facility, a TBD facility).
Plant to treat off-site at a planned facility.
Plan to treat on-site at the planned (site-specified facility, a TBD facility).
Plan to treat at a planned facility.
Have not identified a planned facility for this waste stream at this time.

Whenever the words "site-specified facility" appear in the above list, the name of the facility will appear in the WPS. Additional stream-specific comments from the site will also be included.

7.2.2.6 WPS Item #6: Technology Status

This item indicates whether or not technology is available to treat the waste stream. One of the following comments will be listed:

Technology exists. No modifications are necessary.
Technology exists. Needs modification or verification for application to DOE waste streams.
No technology exists (based on assessment).
Assessing technologies to determine if the technology exists, and, if so, whether it needs modification.
Technology assessment has not started.

Any additional comments from the site will also be included.

In most cases, DOE believes that, based upon process knowledge, treatment technology exists for the mixed waste listed in the WPSs. However, to avoid any confusion, DOE would like to clarify its approach to treatment capabilities when EPA has not determined BDAT(s) for newly listed wastes and when waste characterization or analyses/treatability studies to validate a particular technology have not been completed. DOE does not feel that lack of a BDAT should preclude identification of a potential treatment. DOE believes that process knowledge and the generic similarities of these waste streams to other mixed wastes allows DOE to propose treatments for these newly listed wastes. DOE would reevaluate the applicability of these treatments once EPA publishes treatment standards.

In the case where waste characterization by laboratory analysis or treatment technology assessment has not been started or completed, this information may be indicated on the WPS as not having started the technology assessment. However, DOE does have the process knowledge required to identify a potential treatment.

7.2.2.7 WPS Item #7: Radiation Characteristics

This item lists whether the stream is remote-handled or contact-handled, and, if known, the type of radiation (alpha, beta, gamma) present, and whether or not transuranic contaminants and/or volatile radionuclides are present. In some cases, sites have listed the specific radionuclides and the waste stream radiation level in nCi or pCi/g.

7.2.2.8 WPS Item #8: Waste-Specific Radiation Effects on Treatment (RCRA Sec3021(a)(2)(J) as amended by FFCAct-1992)

Once the radiation characteristics of a waste stream were identified, the sites were asked to identify any

expected radiation effects on treatment of the mixed waste stream. The following menu choices may be supplemented with stream-specific comments:

None - Radiation has no effect on treatment.

High alpha activity in contact with organics can result in radiolysis, with production of hydrogen gas, methane and other degradation products. The buildup of hydrogen gas and radiation interaction with the waste form can affect storage, design and operation of treatment facilities, and stability of the final waste form.

Treatments using chemical separation could result in concentration of certain isotopes of uranium and plutonium to form a critical mass; concentration of polonium or plutonium in contact with beryllium could result in production of neutrons.

Certain isotopes of U, Pu, Am, Cm, Cf, Np and Th are non-accountable if present below specific levels, and require different levels of safeguards, depending on the amount present. Treatments resulting in concentration of the material can result in the "roll up" of large volumes of non-accountable wastes into a smaller volume of accountable waste.

Daughter products of alpha emitters may cause problems, i.e., production of radon gas, emissions from short-lived daughter products, and potential chemical incompatibility of daughter products.

Radioactive decay may produce significant amounts of heat that need to be considered during treatment and disposal.

Many activation products are short-lived and treatment should be delayed to allow radiation levels to subside.

Treatment could result in plating, precipitation, or some other form of concentration, which could cause workers to receive a significant radiation exposure. The potential for concentration of beta and gamma emitters will affect the design and operation of a treatment facility.

High beta or gamma levels in contact with organics can result in radiolysis, with production of hydrogen gas, methane and other degradation products. The buildup of hydrogen gas and radiation interaction with the final waste form are important considerations, in storage, design, and operation of treatment facilities, and in stability of the final waste form.

Radiation levels requiring remote handling will affect the design and operation of a treatment facility, i.e., need for robotics, additional shielding, etc.

Treatment must contain all radioactive off-gases to protect treatment facility personnel and the public. Safeguard issues may be a concern. Treatment involves tritium release, which must be reported.

Treatment must contain all radioactive off-gases to protect the public and treatment facility personnel from releases.

7.2.2.9 WPS Item #9: Waste Minimization Activities (RCRA Sec3021(a)(2)(D) as amended by FFCAct-1992)

Sites were asked to choose appropriate waste minimization activities for each waste stream from the

following menu:

Improved operating practices: material handling and inventory procedures; waste segregation; or changes in production scheduling.

Technology changes: process changes; equipment, piping, or layout changes; automation; changes in operational settings; energy, water conservation.

Raw material changes: raw material purification; substitution.

Product change: product substitution and conservation; change in product composition.

Waste avoidance due to recycling/reuse; solvent, oil, and metals recycling; chemical exchange and reuse; packaging material reuse.

Change in operations status: process interruptions; work stoppages; mission changes; new processes.

Not Applicable. (Waste no longer generated.)

Additional comments were provided for many streams.

A number of future mixed waste streams are included in this inventory report. Since no appropriate waste minimization activity can be selected from the above list, the waste profile sheet for these future waste streams indicates that the waste minimization activitiy was "not reported". However, DOE is planning to evaluate minimization options for implementation prior to waste generation.

7.2.2.10 WPS Item #10: EPA Codes (FFCAct-1992 Waste Inventory Requirements (e), (f), (g) and (i))

This item indicates whether a stream has been characterized by sampling and analysis or process knowledge and lists all applicable EPA codes for hazardous constituents, the corresponding waste code Best Demonstrated Available Technology (BDAT) and whether the BDAT is concentration-based (Conc.) or a technology-based standard (Tech.). Definitions of the EPA hazardous waste codes may be found in 40 CFR Part 261.

Fundamental to waste treatment is the concept that the type of treatment technology used and the level of treatment achieved depend on the physical and chemical characteristics of the wastes. Therefore, EPA has developed broad "waste treatability groups" in order to account for differences in treatment used and the effectiveness of treatment. EPA determined the waste treatability groups for the LDR treatment standards to be based on either wastewater or non-wastewater treatability groups. Site data identified whether a stream was a wastewater or non-wastewater based on the definitions given in 40 CFR, Section 268.2. Once each stream is identified as a wastewater or non-wastewater, the LDR information, including the LDR basis and the BDAT, are automatically filled in by the database program as either "concentration-based" or "technology-based standard" for each EPA hazardous waste code identified by the site. Several waste codes had additional definitions applied to them in order to develop an appropriate BDAT. These specific definitions that apply to the LDR requirements are listed below:

D001A IGNITABLE LIQUIDS, HIGH TOC NONWASTEWATERS
D001B IGNITABLE LIQUIDS, LOW TOC NONWASTEWATERS
D001C IGNITABLE LIQUIDS, WASTEWATER SUBCATEGORY

D001D	IGNITABLE COMPRESSED GASES
D001E	IGNITABLE REACTIVES
D001F	OXIDIZERS
D002A	ACID LIQUIDS
D002B	ALKALINE LIQUIDS
D002C	OTHER CORROSIVES
D003A	REACTIVE CYANIDES
D003B	REACTIVE SULFIDES
D003C	EXPLOSIVES
D003D	WATER REACTIVES
D003E	OTHER REACTIVES
D006A	CADMIUM CONTAINING BATTERIES
D006B	CADMIUM
D008A	LEAD ACID BATTERIES
D008B	LEAD
D008C	RADIOACTIVE LEAD SOLIDS
D009A	HIGH MERCURY* (CONTAINS ORGANICS)
D009B	HIGH MERCURY* (CONTAINS INORGANICS)
D009C	LOW MERCURY
D009D	ELEMENTAL MERCURY CONTAMINATED WITH RADIOACTIVE MATERIALS
D009E	HYDRAULIC OIL CONTAMINATED WITH MERCURY; REACTIVE MATERIALS CATEGORY
F005A	SPENT SOLVENTS
F005B	CONTAINS 2-NITROPROPANE
F005C	CONTAINS 2-ETHOXYETHANOL

These alphanumeric additions to the EPA waste codes appear in the waste code tables where appropriate.

7.2.3 Technology Development Summaries

Technology Development Summaries are provided at the end of sections for sites that have technology development programs. A sample summary is shown in Figure 7-2. The target site is the site for which the technology is being developed and the location site is the site where the technology is being developed.

The identification number (ID) is the number of the program in DOE's technology development database. The BDAT is the standard EPA abbreviation for the appropriate technology area, as defined in 40 CFR Part 261. These abbreviations are defined in the Acronym List at the beginning of this document. The Functional Areas are key words and phrases under which the program would appear in a search of the DOE technology development database. Remaining items in Figure 7-2 are self-explanatory.

4690

Target Site: Hanford

Location site: Pacific Northwest Laboratory

Programs/Facilities Supported:
UST ID

ID: 264

Program Title: UST: Tank Waste Processing Analysis

Summary Description:

This task will evaluate pretreatment requirements of Hanford tank waste on a tank-by-tank basis. Completion of this task will (1) identify the processing required for each tank to meet pretreatment criteria; (2) evaluate the effects of change in pretreatment criteria on processing requirements; and (3) optimize the deployment of distributed processes for pretreatment. Data from other DOE-funded associated tasks will be factored into this task, as indicated by the UST-IDC and/or UST-ID DOE-HQ PM.

Summary Purpose/Need:

Evaluation of pretreatment requirements of Hanford tank wastes is needed.

Summary Result/Endpoint/Deliverable:

Deliverables include Issue Project Management Plan, Preliminary Engineering Design and Cost Estimate report for Clean Option, technology profile for ProTech Info System, and FY 1993 Status Report.

BDAT: NA
Functional Areas: system analysis
decision support

Figure 7-2. Sample Technology Development Summary

Work Performed Under Contract Numbers:
DE-AC04-76DP00789
DE-AC06-76RL01830
DE-AC07-76ID01570
Letter Contract AF-6871

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161